



RESEARCH JOURNAL OF AGRICULTURAL SCIENCES AN INTERNATIONAL JOURNAL

Proceedings of the International Conference on

“Precision Nutrition and Health: Foresight Future of Disease Prediction and Prevention”

*Jointly Organizing by
The Research Centre of Home Science (Human Nutrition and Nutraceuticals), Fatima College,
Madurai, Tamil Nadu, India and Department and P. G. Department of Zoology
On
20th December 2022*

Special Editors of the Issue

*Dr. Vasantha Esther Rani
Dr. K. Karthiga
Ms. D. Mouna
Ms. J. Josephine Jesintha*

Published by:

Center for Advanced Research in Agricultural Sciences
Bhat Complex, N/H 44, Awantipora - 192 122, Jammu and Kashmir, India
01933- 294741

Research Journal of Agricultural Sciences

Vol. 14(Special): 743 - 868 (June 2023)

CONTENTS

Title	Authors	Page No.
Effect of Dual Modified Pearl Millet Starch on Physiochemical, Textural and Sensory Properties of Yogurt	M. Aruna and R. Parimalavalli	743-749
Association Between Sleep Quality and Body Mass Index in Police Officers	Damini M and Shajini Judith Diana J.	750-753
Seaweed is a Smart Ingredient to Control Glycemic Responses	Aswini M, Thahira Banu A, Subhalakshmi S. U, Kiruthigha V and Reka P	754-760
A Study on Consumption Pattern and Knowledge of Millet's Processing among the People	A. Thahira Banu, Amutha Keerthana G, S. U. Subha Lakshmi and Janeline Lunghar	761-765
Nutrient Intake, Physical Activity and Menstrual Pattern of Female Students from Selected Schools and College	Deepikha K, Afeefah Firdaus, Rufinaroshini and Gowri Ramesh	766-771
Estimation of Heavy Metals in <i>Bryophyllum pinnatum</i>	Irfan Fathima S and Beautlin Mistica Paul M. D	772-776
Assessment of Heavy Metal Accumulation in Pomegranate and Orange Fruits Available in Local Market	Hannah Jessie Francis T and Vasantha Esther Rani	777-782
Standardization of Herbal Tea to Promote Sleep	Rathi Devi O. S, Vaishnavi R and Mouna D	783-785
A Study on the Physio-Chemical Analysis of <i>Borassus flabellifer</i> and <i>Artocarpus heterophyllus</i> and its Incorporation in the Formulation of Functional Food Products for Adolescents	Poornima Jeyasekaran, U. Divyashree, S. Shahid Akeel, S. Manoranjani, M. Jeyadharshini, R. Gandhimathy, C. Mabel Joshaline and D. Mouna	786-790
Standardization of <i>Vitex negundo</i> Leaves Powder Incorporated Food Products	Sankari K and K Karthiga	791-796
Effects of Defatted Soy Flour Incorporation on Nutritional and Storage Properties in Common Snacks of Regional Preference	Anitha C. and Vasantha Esther Rani	797-807
Impact of Nutrition Education in the Management of Hypercholesterolemia on Selected Mild Hypercholesterolemic Adults in Kottayam	Lincy P and Anooja Thomas K	808-810
A Study on Probing the Therapeutic effects of Bamboo Rice Supplementation on Reducing Hyperlipidemia on Female Adults	Kamali C and Kavitha Devi U	811-815
Incorporation of Whey Water in Sugar, Palm Jaggery and Jaggery Syrup and its Acceptability	J. Mahalakshmi and J. Merlin Rani	816-819
Formulation of <i>Centella asiatica</i> Incorporated Functional Ice Cream	Revathi P and Vasantha Esther Rani	820-823
Nutritional Knowledge and Practice to Enhance Health and Sporting Performance Among Sports Professionals – A Consensus Study	S. Selvanayaki and R. Saravana Prabha	824-827
A Study on the Challenges of Middle Adulthood Years Especially Menopause	Sivakami P. and S. Kavitha Maithily	828-831
Incorporation of Powdered Jackfruit (<i>Artocarpus heterophyllus</i> Lam) Seed in Snacks for Juvenile Diabetes	Yamuna Valli S and Vasantha Esther Rani	832-835
Diet Diversity, Macronutrient Consumption and Self-Perceived Diet Adherence in Type-2 Diabetics	Sharmila JB, Thahira Banu A and Janeline Lunghar	836-844
Assessment of Nutritional and Fitness Status of Adolescent Sports Girls	Rajiga R, Manjuladevi M and Sharmila JB	845-850
Molecular Docking Study of Lignans Obtained from Flax Seeds for their Role in the Management of Polycystic Ovarian Syndrome (PCOS)	Jeyamani Divya Christodoss, Raamapriya V and Vasantha Esther Rani	851-855
Comparative Analysis of Blossoms of Rasthali, Malai Valai and Nattu Valai for Product Development	K. Akshaya, K. Sindhuja and K. Nithya	856-860
Quality Evaluation of Bakery Products Enriched with Sweet Potato Flour and Sapota Concentrate	M. Ishwaryalakshmi and C. Hele	861-864
Alginate Extraction from Brown Seaweed (<i>Sargassum wightii</i>)	Josephine Jesintha J and Karthiga K	865-868

Effect of Dual Modified Pearl Millet Starch on Physiochemical, Textural and Sensory Properties of Yogurt

M. Aruna¹ and R. Parimalavalli*²

^{1,2}Department of Food Science and Nutrition, Periyar University, Salem-11, Tamil Nadu, India

Correspondence to: R. Parimalavalli, Department of Food Science and Nutrition, Periyar University, Salem-11, Tamil Nadu, India, Tel: +91 9468980481; E-mail: parimala1996@gmail.com

Abstract

Pearl millet is in the limelight of research in recent years for its functional qualities, availability and economics. Starch is abundantly used in the food industry and used as a stabilizer in yogurt to enhance the textural and sensory qualities of yogurt. The present study focused on the utilisation of pearl millet starch as a stabiliser in yogurt. Yogurt was prepared from skimmed milk with the addition of 2% to 3% starter culture and known as T₁ (Control), addition of 0.5% xanthan gum as stabilizer in the yogurt is T₂ and 0.5% dual modified pearl millet starch (PMS) in the yogurt is T₃. Yogurts were kept at 4 °C for 21 days and the quality and sensory parameters were studied at regular intervals (7 days) and compared. The syneresis, pH, acidity, water holding capacity (WHC %) and sensory qualities differed among the three treatments. Modified PMS treated yogurt was found to be better and received higher scores than the other treatments. Modified PMS had a substantial effect on the textural characteristics like firmness and gumminess of yogurt. The results imply that modified pearl millet starch can be utilised as a stabiliser on an industrial scale in production of commercial yogurt.

Key words: Yogurt, Xanthan gum, Textural properties, Hydrocolloid, Water holding capacity

Yogurts are widely consumed across the globe and are produced by controlled fermentation of different types of milks with bacteria such as *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, and *Lactobacillus acidophilus*, resulting in a product with creamy characteristics, typical aromas, and a slightly acidic taste (Andrade, et al., 2010; Costa et al., 2020). Yogurts are considered to have cardioprotective properties, to reduce the risk of type 2 diabetes, and to have positive effects on body composition and weight (Barros et al., 2020). The global yogurt market was valued at \$ 97,999.5 million in 2020 and is projected to reach \$ 171,826.1 million by 2031, growing at a compound annual growth rate (CAGR) of 5.5% from 2020 to 2031. Among the different types of yogurt, set yogurt segment dominated the global yogurt market, with \$ 32,496.3 million in 2020 and is estimated to reach \$50,491.8 million by 2031, growing at a CAGR of 4.4% (Anil.K, Roshan D 2022). The global market is mainly driven by the health benefits associated with consuming yogurt and increase in awareness among people for losing weight. The health benefits associated with eating yogurts include healthy digestion, low risk of suffering from type 2 diabetes, protection against colorectal cancer, prevent and treat osteoporosis, enhance weight and fat loss, improve immune system and reduce blood pressure and bad cholesterol. Apart from getting the regular dose of animal protein (about 9 grams per 6-ounce serving), and several other nutrients like calcium, vitamin B-2, vitamin B-12, potassium, and magnesium, yogurt is also considered a good

probiotic. Among the various approaches that can be used to reduce the fat content and stabilize the texture of yogurt without compromising its quality is the application of hydrocolloids, which has attracted the attention of producers globally, resulting in several types of hydrocolloids already, being used as additives (Cardenas et al. 2018; Yousefi and Jafari 2019). Hydrocolloids are a diverse group of biopolymers that are used as gelling, thickening, emulsifying, water-binding, or coating agents in industrial food products (Li & Nie 2016; Nikoofar et al., 2013) and can also help to improve the textural properties, sensory properties, and microbial stability of food products (Hadjimbei et al. 2020).

In the case of yogurt, additions of hydrocolloids were found to be effective in absorbing water, increasing viscosity, strengthening and improving the texture of yogurt (Abdelmoneim et al. 2016). Thickening agents can be added to achieve the desired thickness and to improve and enhance the texture properties of yogurt, such as the appearance, mouthfeel, viscosity, and consistency. Hydrocolloids also maintain the morphological features of yogurt during transportation and storage (Mathias et al. 2012; Mortazavian and Sohrabvandi 2006). They also improve the consistency of yogurt. These compounds include long and branched molecules, which are able to establish links with each other or with other molecules present in the environment in the form of an emulsion. Hydrocolloids reduced the syneresis in yogurt and increased the water holding capacity in two ways; physical and chemical.

Free water is physically trapped and confined within the increased network density, and chemically, the hydrophilic nature of hydrocolloids facilitates a link with the water molecules, thus increasing gel water-binding capacity (Bahrami *et al.* 2013). Hydrocolloids also maintain the morphological features of yogurt during transportation and storage (Mathias *et al.* 2012).

Earlier studies have utilized different native and modified starches as hydrocolloid in yogurt and vast information is available on the effect of the hydrocolloids on yogurt. Meanwhile, very feeble literature is available on the usage of pearl millet starch as hydrocolloid in yogurt. Pearl millet starch which is cost effective and abundantly available could be commercially exploited as a hydrocolloid. Hence, this study was taken up with the objective of evaluating the physicochemical, textural and sensory properties of yogurt on addition of dual modified pearl millet starch as a hydrocolloid.

MATERIALS AND METHODS

The research was conducted at the Department of Food Science and Nutrition at Periyar University in Salem. Procurement of raw material Xanthan gum (Sigma®, 11138-66-2) was purchased from Hi-Media Chemicals, Mumbai. Skim milk powder (SMP - protein 32.3, moisture 3.9, fat 0.9, lactose 53.7, and ash 9.2 g/100 g) Sagar, was purchased from Amulfed Dairy, India. The yogurt starter (*Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus*) was obtained from Hi-Media Chemicals, Mumbai.

Experimental plan and Set Yogurt preparation

The experimental plan included three treatments viz., T₁ = Control (without any stabilizers); T₂ = Yogurt with 0.5% xanthan gum and T₃ = yogurt with 0.5% modified PMS. Milk was prepared with 100 g of skimmed milk powder/1000 mL of distilled water and heated at 82–85 °C for 30 min; Yogurt was prepared from skim milk by adding 2.5% of a starter culture (freeze-dried 125 commercial cultures) containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Pre-culture was prepared by dissolving 10 mg of freeze-dried culture in 50 mL of milk, followed by activation at 40 °C for 30 minutes. Afterwards, the prepared culture was used in yogurt preparation @ 2.5%.

Yogurt was produced according to the methods of Lee and Lucey (2010) with slight modifications. This involved homogenising the milk (skimmed milk) and heating it to 85–90 °C for 10 minutes in a pasteurizer. In the case of T₂, Xanthan gum was added in 0.5% concentrations as a hydrocolloid, followed by yogurt preparation. And for T₃, modified PMS (0.5% w/v) was added. The heated milk and starch mixtures were then allowed to cool to 45 °C before being inoculated with a starter culture (2.5% w/v). The mixture was stirred for 30 sec., for complete dissolution and equal distribution of culture granules and incubated at 42–45 °C for 5–6 h to allow fermentation and setting of the yogurt. Yogurt samples were then aged at 10 °C overnight to allow for cooling.

Syneresis

Syneresis in the yogurt samples was measured using the centrifuge method described by Goncalvez *et al.* (2005) and Keogh and O'Kennedy (1998), but with a higher centrifugal force and a longer time. 30 g of yogurt sample was centrifuged at 300 ppm for 20 min at 4°C. After centrifugation, the clear supernatant was poured off, weighed and used to determine the percentage (w/w) of syneresis. The measurements were taken on days 1, 7, 14 and 21.

$$\text{Syneresis (\%)} = \frac{\text{Supernatant weight (g)}}{\text{weight of sample(g)}} \times 100$$

Acidity

The titratable acidity of fermented yogurt was determined according to Noh *et al.*, (2013). Yogurt (10 g) was titrated against 0.1 N NaOH using phenolphthalein as an indicator. The titratable acidity was recorded as a percentage of lactic acid. Lactic acid (mmol/g product) is calculated as follows:

$$\text{Lactic acid} = \frac{\text{ml of alkali} \times \text{Normality of alkali}}{\text{weight of sample}} \times 100$$

Water holding capacity (WHC)

The methods described by Omojola *et al.* (2010) were used. Yogurts (20 g), after cooling to +4 °C in 24 hours of storage, were centrifuged for 10 minutes at 3000 rpm, at +20 °C. The released serum was removed and weighed. The water-holding capacity of fermented milk is calculated by the following formula:

$$\text{WHC \%} = \frac{\text{Weight of the sample before centrifuge} - \text{Weight of the sample after centrifuge}}{\text{Weight of the sample before centrifuge}} \times 100$$

pH

The pH was measured with an electronic digital-type pH meter (WTW series pH-720). Firstly, the electrodes of the pH meter were adjusted and calibrated at room temperature using buffer solutions of pH 4. The pH metre electrodes were then immersed in a beaker containing 5 g of yogurt and readings were taken directly (Olugbuyiro, 2011).

Microbiological analysis

Starter bacteria enumeration was carried out by using selected media. *Streptococcus thermophilus* was counted on M-17 and *Lactobacillus delbrueckii subsp. bulgaricus* on MRS agar (pH 5.4), according to ISO 7889/IDF 117 as described by (Szołtysik *et al.* 2020).

Texture Properties of Yogurt

Yogurt instrumental texture was analysed as per Joon *et al.*, (2017). Texture analyser (TA.XT Plus, Stable Microsystem, Surry, UK) was used to analyse the firmness, cohesiveness, consistency, and index of viscosity. The texture analyzer with a 50 kg load cell was run in back extrusion and it was set as follows: Pre-test speed, test speed, post-test speed was 1.0 mm/s; trigger force was 10.0 g; and the distance was 30 mm. The tests were carried out in the original 150-ml containers at room temperature.

Sensory evaluation of yogurt

The sensory evaluation was carried out by using quantitative descriptive analysis. The evaluation of the yogurt samples included the following sensory attributes: appearance, color, texture, aroma, taste, and overall acceptability. The scale used was nine points hedonic scale, where 1 represents extremely dislike, 5 for neither dislike or like, and 9 for extremely like and who were regular consumers of yogurt, was used for the evaluation. The assessors were provided with still water to rinse their mouths and refresh their palates. The assessments were done in four sessions: 1 day, 7 days, 14 days, and 21 days of storage in a facility that conforms to the requirements of ISO 8589.

Statistical analysis

All determinations were done in triplicate and the data are reported as the mean values \pm standard deviation (SD). ANOVA (analysis of variance) was performed by one way analysis followed by Duncan's multiple range tests ($P < 0.05$) to compare treatments' means using SPSS (version 19.0).

RESULTS AND DISCUSSION

Syneresis

Syneresis is a typical flaw in yogurt storage that is principally caused by the rearrangement of casein particle aggregates in the gel network. Yogurt syneresis has been

decreased using modified starches that store a lot of water in flimsy gel structures (Luo and Gao 2011). Adding different concentrations of isolated starch/stabilizers had highly significant results in decreasing syneresis in manufacturing yogurt during storage at 4°C for 21 days as shown in Table 1. The study indicated that 0.5% (T₃) exhibited the maximum reduction in syneresis. During the storage period, 0.5% modified PMS was more successful in decreasing syneresis, recording lower syneresis values compared to starch from control or xanthum gum added yogurt. The modified starch as a hydrocolloid had contributed to the reorganization of the gel structure to reduce wheying-off of the yogurt in storage (Lucey J.A, 2004 and Walstra *et al.* 2006).

Table-1. Effect of dual modified starches in syneresis of yogurt

Treatments	Day 1	Day 7	Day 14	Day 21
		Syneresis (%)		
T ₁	24.63 \pm 0.17 ^a	23.21 \pm 0.48 ^a	21.45 \pm 0.91 ^a	21.00 \pm 0.13 ^a
T ₂	22.55 \pm 0.38 ^a	22.61 \pm 0.59 ^a	22.00 \pm 0.22 ^a	21.80 \pm 0.65 ^a
T ₃	20.39 \pm 0.06 ^a	19.33 \pm 0.34 ^b	18.21 \pm 0.74 ^c	16.45 \pm 0.37 ^d

T₁ = Control (without gum addition); T₂ = 0.5% xanthan gum; T₃ = 0.5% modified PMS

a-d Mean values having different superscript in rows are significantly different at $p \leq 0.05$

A significant amount of reconfiguration within the milk gel network most likely occurred throughout the storage period as well. The findings reveal that there has been a gradual reduction in the syneresis during the storage period of 21 days which is consistent with the findings of Isleten *et al.* (2006), Guven *et al.* (2005), who noted that the lowest syneresis levels were achieved during storage as opposed to the initial day of production. In order to thicken yogurt-based systems and obtain good hedonics with regard to textural qualities, starch is added in yogurts, despite the possibility that consumer preferences may vary across different geographic areas (Bruzzone *et al.* 2013).

Acidity and pH

Fermentation causes decrease in pH during yogurt production, which has an impact on the product's flavour and texture due to the breakdown of lactose by lactic acid bacteria [Raju and Pal (2014). A decrease in this value favored the contraction of protein clots formed by lactic bacteria, affecting the yogurt's sensory quality Marulanda *et al.* (2016). Table 3 shows the changes in yogurts' pH and titratable acidity over the period of storage. A statistical examination of pH and acidity revealed that storage period and treatments had a considerable impact on both parameters.

Table - 2. Effect of dual modified starches in pH and titratable acidity of yogurt

Treatments	Day 1	Day 7	Day 14	Day 21
		pH		
T ₁	4.72 \pm 0.03 ^a	4.66 \pm 0.11 ^{a,b}	4.55 \pm 0.08 ^{a,b}	4.47 \pm 0.16 ^b
T ₂	4.65 \pm 0.92 ^a	4.65 \pm 0.92 ^a	4.62 \pm 0.11 ^a	4.66 \pm 0.01 ^a
T ₃	4.51 \pm 0.01 ^a	4.46 \pm 0.17 ^a	4.37 \pm 0.15 ^{a,b}	4.19 \pm 0.05 ^b
		Titratable acidity (g/L)		
T ₁	0.75 \pm 0.00 ^a	1.18 \pm 0.01 ^b	2.11 \pm 0.05 ^c	2.00 \pm 0.00 ^d
T ₂	0.83 \pm 0.02 ^a	1.19 \pm 0.04 ^b	2.39 \pm 0.01 ^c	2.64 \pm 0.04 ^d
T ₃	1.77 \pm 0.02 ^a	1.80 \pm 0.01 ^a	2.55 \pm 0.06 ^b	2.75 \pm 0.11 ^c

T₁ = Control (without gum addition); T₂ = 0.5% xanthan gum; T₃ = 0.5% modified PMS

a-d Mean values having different superscript in rows are significantly different at $p \leq 0.05$

On day one, the highest mean pH value of 4.72 was reported by T₁, followed by T₂ (4.65) and T₃ (4.51), whereas on day twenty one, the highest mean pH value was reported for T₂ (4.66), followed by T₁ (4.66) and T₃ (4.19). The study reveals that during the 21-day storage period, at the end-point of yogurt fermentation, a declining pattern in the pH values (4.51-4.19) was seen in T₁ and T₃, as reported by Puvanenthiran *et al.* (2002). The pH values was almost constant for T₂ (4.65 - 4.66), in conformity with the studies of El-Sayed *et al.* (2002), who reported that the use of xanthan gum (0.005%) as a stabilizer in the manufacturing of fermented dairy products reduced the syneresis rate without altering pH values or the contents of total solids. The statistical analysis demonstrated that all yogurt samples containing hydrocolloids had an increase in acidity during 21 days of storage from 1.77 to 2.75 (g/L) (T₃). The study revealed that storage was found to decrease the pH of yogurt, while increasing the titratable acidity (Table 2). The pH

value of yogurt declined mostly as a result of the lactic acid production during storage, according to findings comparable to those published by (Seelee *et al.* 2009, Hassan *et al.* 2011).

Water holding capacity

Yogurt's WHC is a firm's ability to keep serum in the gel-like structure of the yogurt. This ability helps to ensure minimum whey separation, which is essential to the yogurt's overall quality (Lee and Lucey 2010). From table 3, it could be inferred that the water holding capacity of yogurt reduced steadily during the storage period in all the treatments. The results indicate that T₃ sample had the highest WHC% on day one. Nevertheless, the highest reduction in WHC%, during the storage period of 21 days was found in T₃ sample, from 69.40 to 57.53, this reveals that modified PMS as a hydrocolloid has better water binding capabilities than the other treatments.

WHC is also the ability of food to retain water against gravity and has shown to play a major role in the formation of food texture Sahni *et al.* (2014). Similar findings were reported by

(Waliszewski *et al.* 2003), claiming that modified banana starches had greater water binding properties than native starches due to the incorporation of hydrophilic groups.

Table – 3. Effect of dual modified starches in water holding capacity of yogurt

Treatments	Day 1	Day 7	Day 14	Day 21
	WHC (%)			
T ₁	62.36±0.64 ^a	62.10±2.08 ^a	61.87±2.69 ^a	60.45±0.38 ^a
T ₂	65.70±0.62 ^a	65.60±0.34 ^a	61.94±1.94 ^b	60.33±1.53 ^b
T ₃	69.40±2.07 ^a	68.36±2.57 ^a	64.25±0.64 ^b	57.53±1.59 ^c

T₁ = Control (without gum addition); T₂ = 0.5% xanthan gum; T₃ = 0.5% modified PMS

a-d Mean values having different superscript in rows are significantly different at p ≤ 0.05

Microbial count

In Table 4, the variations in the starting microflora count are shown. *S. thermophilus* and *Lb. bulgaricus*, the two species under study, were found in the maximum concentration in all samples on day one following production. During the 21 days of storage, the count showed very slight differences in T₃ than T₂ and T₁. *S. thermophilus* was counted at a level of 8.53–9.05 log₁₀ CFU/ mL on the first day of production, while *Lb. bulgaricus* was counted at a lower level of 7.76–9.35 log₁₀ CFU/ mL, probably due to the documented oxygen sensitivity.

The findings of this study are consistent with those of Ni *et al.* (2018), who found that *S. thermophilus* had higher viable counts than *Lb. bulgaricus* in yogurts fortified with fruit extracts. This decline may have been brought on by the pH values falling as a result of the development of acidity is attributable to the activity of microorganisms, which use residual carbohydrates and produce lactic acid, small amounts of CO₂, and formic acid reported by Lee and Lucey (2010). On the other hand, Nguyen and Hwang (2017) who added 2% and 3% of chokeberry juice to yogurt noticed a considerably larger quantity of examined bacteria.

Table - 4. Count of *Lb. bulgaricus* and *S. thermophilus* in yogurt during storage (log₁₀ CFU/ mL)

Treatments	Day 1	Day 7	Day 14	Day 21
	<i>Lactobacillus bulgaricus</i>			
T ₁	7.76±0.03	7.66±0.03	7.66±0.03	7.34±0.05
T ₂	7.86±0.03	7.75±0.02	7.64±0.05	7.54±0.04
T ₃	9.35±0.52	8.26±0.03	8.17±0.03	7.94±0.03
	<i>Streptococcus thermophiles</i>			
T ₁	8.53±0.03	8.46±0.04	8.37±0.03	8.25±0.03
T ₂	8.55±0.02	8.55±0.04	8.32±0.03	8.26±0.03
T ₃	9.06±0.02	8.96±0.03	8.87±0.03	8.96±0.02

T₁ = Control (without gum addition); T₂ = 0.5% xanthan gum; T₃ = 0.5% modified PMS

Texture analysis

Yogurt's texture is strongly correlated with the interior structure of the gel, which is often the result of physical interactions between casein micelles and determines the overall quality of the final product. Measuring characteristics like hardness, cohesion, and adhesiveness is a common method for evaluating texture Peng and Guo (2015). Overall, yogurt that was prepared with or without starch exhibited harder texture. Control and stabilizers increased the hardness of the yogurt. Similarly corn and sweet potato starches increases the hardness during storage periods as reported by Saleh *et al.* (2020a). Similarly, Saleh *et al.* (2020b). This could be attributed to weaker corn starch amylose network, which allows for the water to be free after it has been trapped in the gel network. The

highest yogurt hardness was recorded for T₃. This could be accredited to the high amylose content capable of forming stronger network. The cohesiveness is the degree of yogurt deformation during testing while adhesiveness is the attractive force between the food and the teeth that can predict the stickiness of the food. T₃ yogurt exhibited the highest in terms of cohesiveness and adhesiveness as seen in table 5. Generally, the higher value of adhesiveness suggests softer yogurt texture. The stickiest yogurt is the one with T₂ and T₁. Gumminess, which is characterized by semisolid meals with a low level of hardness and a high level of cohesiveness, is defined as the product of hardness and cohesiveness. T₃ had the highest gumminess value than all other samples. The texture analysis reveals that the yogurt stabilized with modified PMS was found to be better on most counts and better suited as a hydrocolloid.

Table - 5. Effect of dual modified pearl millet starch on textural properties of yogurt

Treatments	Cohesiveness	Adhesiveness	Gumminess	Hardness	Springiness
T ₁	130.63±0.05	0.54±0.03	32.40±0.55	54.58±0.04	0.85±0.03
T ₂	113.42±0.16	0.37±0.02	38.42±0.32	59.49±0.14	0.58±0.02
T ₃	157.69±0.05	0.66±0.05	52.06±0.25	92.44±0.10	0.96±0.03

T₁ = Control (without gum addition); T₂ = 0.5% xanthan gum; T₃ = 0.5% modified-PMS

Sensory evaluation

Sensory analysis is a powerful tool that allows the correlation between microstructural data and consumer preference for the developed food product (Sass *et al.* 2021). The sensory and nutritional properties of yogurt are highly

influenced by the initial composition, processing conditions, starter culture, and additives (Bonczar *et al.* 2002). The concentration of hydrocolloids plays an important role in governing yogurt's stability and texture and finds a correlation with improved quality and sensory perception (Saleh *et al.*, 2020b). Figure-1 shows the average results of the evaluated

parameters. Sensory evaluation results revealed the influence of stabilizers on the attribute ratings, especially mouth-feel and texture for 21 days of storage period [Fig.-1]. Scores for these two attributes ranged from 8.42 to 8.75 (mouth feel) and 8.33 to 8.66 (texture) respectively during the first week. Yogurt made from skim milk with 0.5% modified PMS was rated the highest in terms of texture, mouth-feel and acceptability. This is in agreement with Gonzalez *et al.* (2005), who reported a relationship between the amount of starch used as a thickener and the organoleptic properties of yogurt. The enhanced viscosity of the aqueous phase resulting from adding up to 0.5%

starch led to yogurt with a thick smooth consistency. This explains why this yogurt sample was generally the most acceptable. The results also revealed a conspicuous decrease in attribute scores from day one through day 21. This is reflective of the decrease in some of the quality indices evaluated in the study. For instance, the scores for sourness of skim milk yogurt with 0.5% PMS decreased from 8.0 in day 7 to nearly 7.0 at the end of day twenty-one. This observation may be attributed to post acidification of yogurt samples during storage. Similar reductions in sensory quality of yogurt during storage have been independently reported by Zhao *et al.* (2006).

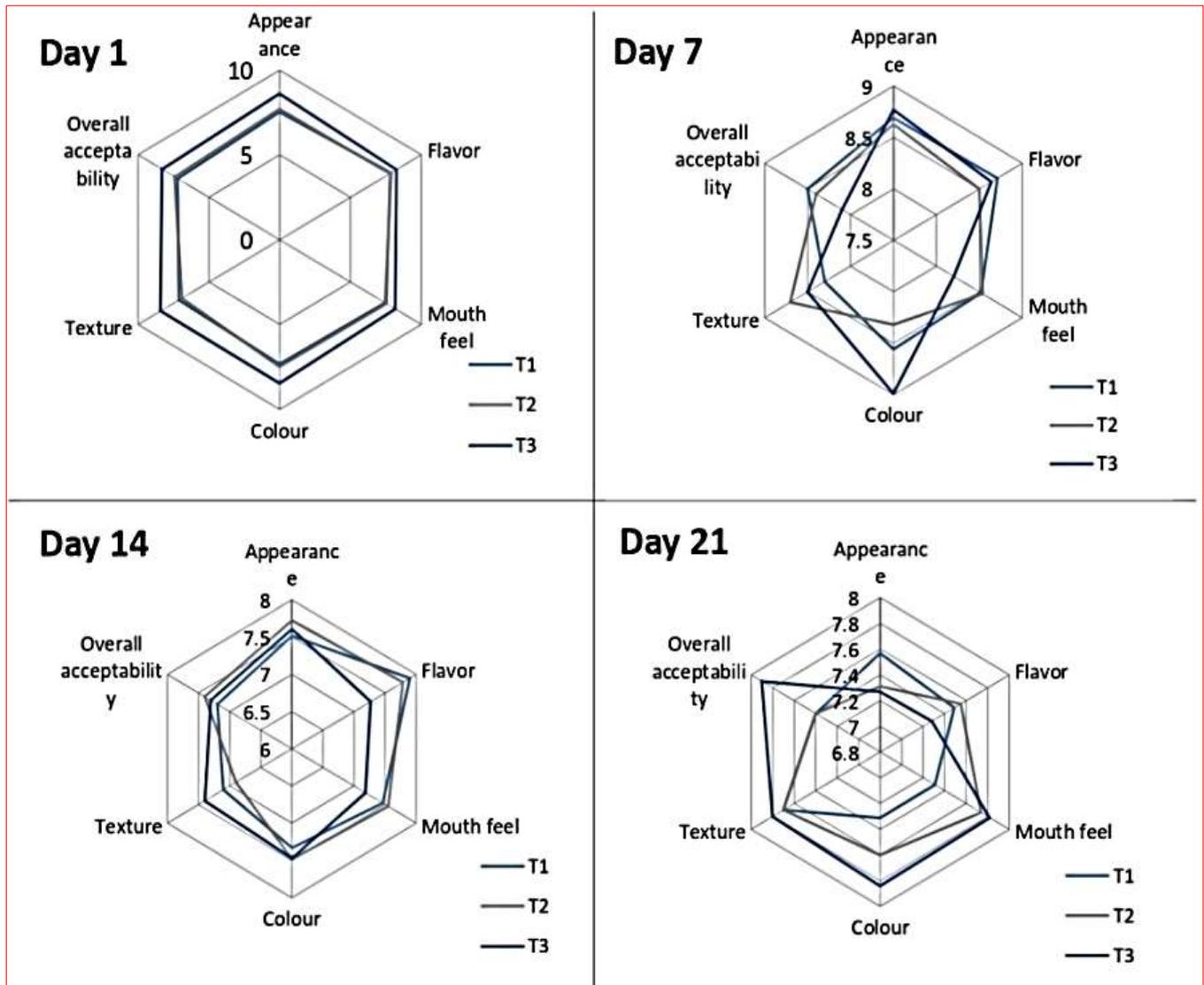


Figure -1 Effect of starches on sensory evaluation of yogurt

In terms of the texture and mouthfeel, the samples containing modified PMS as stabilizers were equally preferred by the panelists and better accepted than the sample containing xanthan gum and the control. In terms of flavor, the yogurts containing modified PMS as stabilizers had a rich aroma, while the sample containing xanthan gum alone and the control were the least preferred. Meanwhile, all the three treatments were on the same scale as ranked by the panelists. It is interesting to note that the sample containing 0.5% modified PMS stabilizer were found to be highest overall acceptability, while the control sample was disliked and ranked lowest for the organoleptic scores after 21 days of storage period. The results reveal that modified PMS stabilized yogurt turned to be better than the other treatments in the sensory evaluation.

CONCLUSION

The current work reveals that using stabilizers such as xanthan gum and modified pearl millet starch is a successful method for enhancing yogurt quality by reducing syneresis and increasing viscosity, water holding capacity, and textural profile. In terms of the physicochemical, textural, and sensory qualities of yogurt, the study found that modified pearl millet starch performed better than xanthan gum and the control yogurt sample. Additionally, it was shown that, in comparison to other treatments, the highest reduction in syneresis and retention of the yogurt's capacity to hold water was obtained with the addition of 0.5% modified pearl millet starch (T₃). These results indicate that stabilizing yogurt with modified

PMS could result in yogurt with superior sensory qualities. Thus, it can be concluded that the use of modified pearl millet starch can be encouraged at the industrial level to enhance the

texture, stiffness, and viscosity of yogurt and to lessen the issue of syneresis during the marketing and storage of yogurt.

LITERATURE CITED

1. Andrade, R., Arteaga, M., Simanca, M., Effect of the bran wheat on the rheological behavior of yogurt buffaomik, *Inf. Tecnol.* 21 (5),117–124 (2010). Doi:10.1612/inf.technol.42771 it.09
2. Costa, G. M., Paula, M. M., Costa, G. N., Esmerino, E. A., Silva, R., Freitas, M. Q, Preferred attribute elicitation methodology compared to conventional descriptive analysis: A study using probiotic yogurt sweetened with xylitol and added with prebiotic components. *Journal of Sensory Studies*, 35(6), e12602. (2020).<http://dx.doi.org/10.1111/joss.12602>
3. Barros, R. F., Torres, F. R., Silva, P. H. F., Stringheta, P. C., Pereira, J. P. F., Paula, J. C. J., Cutrim, C. S., & Cortez, M. A. S. (2020). Lutein as a functional ingredient in sheep milk yogurt: development, characterization and extraction recovery. *Food Science and Technology*, 40(Suppl. 2), 683-690. <http://dx.doi.org/10.1590/fst.36019>.
4. Anil.K, Roshan D.Gobal opportunity and industry forecast 2021-2031; March 2022 (<https://www.alliedmarketresearch.com/yogurt-market>).
5. Cardenas, A., Alvites, H., Valladares, G., Obregon, J., Vasquez, V. Optimizacionmediantedisenode mezclas de sin ~ eresis y textura sensorial de yogurt natural batidoutilizandotrestipos de hidrocoloides. *Agroindust. Sci.* 3 (1), 35–40 (2013).
6. Yousefi, M., &Jafari, S. M. Recent advances in application of different hydrocolloids in dairy products to improve their technofunctional properties. *Trends in Food Science & Technology*, 88, 468-483. (2019)<http://dx.doi.org/10.1016/j.tifs.2019.04.015>
7. Li, J.-M., &Nie, S.-P. The functional and nutritional aspects of hydrocolloids in foods. *Food Hydrocolloids*, 53, 46-61. (2016). <http://dx.doi.org/10.1016/j.foodhyd.2015.01.035>
8. Nikoofar, E.; Hojjatoleslami, M.; Shariaty, M.A. Surveying the effect of quince seed mucilage as a fat replacer on texture and physicochemical properties of semi fat set yoghurt. *Int. J. Farm. Alli. Sci.*, 2, 861–865 (2013)
9. Hadjimbei, E., Botsaris, G., Goulas, V., Alexandri, E., Gekas, V., &Gerothanassis, I. P. Functional stability of goats' milk yoghurt supplemented with Pistaciaatlantica resin extracts and Saccharomyces boulardii. *International Journal of Dairy Technology*, 73(1), 134-143 (2020). <http://dx.doi.org/10.1111/1471-0307.12629>
10. Abdelmoneim, A.H.; Sherif, A.M.; Sameh, K.A. Rheological properties of yoghurt manufactured by using different types of hydrocolloids. *Aust. J. Nutr. Food Sci.* 4, 1082 (2016)
11. Mathias T, Carvalho JR, Carvalho C, Sérvulo EFC. Rheological characterization of coffee-flavored yoghurt with different types of thickener Caracterizaçãoreológica de iogurtesabor café com diferentes tipos de espessante. *Alimentos e NutriçãoAraraquara*. 22: 521-529 (2012).
12. Mortazavian A, Sohrabvandi S. Probiotics and food Probiotic products. Eta Publication, Iran. Farsi; 2006
13. Bahrami, M., Ahmadi, D., Alizadeh, M., & Hosseini, F. Physicochemical and sensorial properties of probiotic yogurt as affected by additions of different types of hydrocolloid. *Korean Journal for Food Science of Animal Resources*, 33, 363-368 (2013).
14. Lee, W., & Lucey, J.. Formation and physical properties of yogurt. *Asian-Australasian Journal of Animal Sciences*, 23(9), 1127-1136 (2010). <http://dx.doi.org/10.5713/ajas.2010.r.05>
15. Goncalvez, D.; Pérez, C.; Reolon, G.; Segura, N.; Lema, P.; Gábaro, A.; Ares G, Varela P. Effect of Thickeners on the Texture of Stirred Yogurt. *Alimentos Nutricionales.*;16(3):207-211 (2005)
16. Keogh, M., &O'kenedy, B. Rheology of stirred yogurt as affected by added milk fat, protein and hydrocolloids. *Journal of Food Science*, 63, 108-112 (1998).
17. Noh HJ, Seo HM, Lee JH, Chang YH. Physicochemical and Sensory Properties of Yogurt Supplemented with Cornifructus during Storage. *Preventive nutrition and food science*. 18(1):45-49. (2013)
18. Omojola, M.O., Akinkunmi, Y.O., Olufunsho, K.O., Egharevba, H.O., Martins, E.O., "Isolation and physico-chemical characterization of cola starch", "African Journal of food, agriculture, nutrition and development", 10, 7, 2884-2900, (2010)
19. Olugbuyiro, J.A.; Oseh, J.A. Physico-chemical and sensory evaluation of market yoghurt in Nigeria. *Pak. J. Nutr.*, 10, 914–918 (2011).
20. Szołtysik, M.; Kucharska, A.Z.; Sokół-Ł etowska, A.; D abrowska, A.; Bobak, Ł.; Chrzanowska, J. The effect of Rosa spinosissima fruits extract on lactic acid bacteria growth and other yoghurt parameters. *Foods*, 9, 1167 (2020). [CrossRef]
21. Joon R, Mishra SK, Brar GS, Singh PK, Panwar H. Instrumental texture and syneresis analysis of yoghurt prepared from goat and cow milk. *The Pharma Innovation Journal*. 6(7):971-974(2017)
22. Luo, Z., &Gao, Q. Effect of enzyme-modified carboxymethyl starch as a fat replacer on the functional properties of sausages. *Starch - Stärke*, 63(10), 661–667(2011).
23. Lucey J.A, Cultured dairy products: an overview of their gelation and texture properties, *Int. J. Dairy Technol.* 57 77–84 (2004).
24. Walstra P., J.T.M. Wouters, T.J. Guerts, *Dairy Science and Technology*, 2 nd Ed., CRC Press, Boca Raton, FL, (2006)
25. Isleten, M.; Karagul-Yuceer, Y. Effects of dried dairy ingredients on physical and sensory properties of nonfat yogurt. *J. Dairy Sci.*, 89, 2865–2872 (2006). [CrossRef]
26. Guven, M.; Yasar, K.; Karaca, O.B.; Hayaloglu, A.A. The effect of inulin as a fat replacer on the quality of set-type low-fat yogurt manufacture. *Int. J. Dairy Technol.*, 58, 180–184 (2005). [CrossRef]
27. Bruzzone, F., Ares, G., &Giménez, A. Temporal aspects of yoghurt texture perception. *International Dairy Journal*, 29(2), 124-134. (2013). doi:<https://doi.org/10.1016/j.idairyj.2012.10.012>
28. Raju, P.N.; Pal, D. Effect of Dietary Fibers on Physico-Chemical, Sensory and Textural Properties of MistiDahi. *J. Food Sci. Technol.*, 51, 3124–3133(2014). doi:10.1007/s13197-012-0849-y.

29. Marulanda, M.; Granados, C.; García-Zapateiro, L.A. Análisis Sensorial y Estimación Físicoquímica de Vida Útil de Una Bebida Tipo Yogur a Base de Lactosuero Dulce Fermentada Con *Streptococcus Salivarius* Ssp. *Thermophilus* y *Lactobacillus Casei* Ssp. *Casei*. *Prod. Limpia* 11, 94–102 (2016).
30. A. Puvanenthiran, R.P.W. Williams, M.A. Augustin, Structure and visco-elastic properties of set yogurt with altered casein to whey protein ration, *Int. Dairy J.* 12 383–391 (2002).
31. El-Sayed, E., El-Gawad, I. A., Murad, H., & Salah, S. Utilization of laboratory-produced xanthan gum in the manufacture of yogurt and soy yogurt. *European Food Research and Technology*, 215, 298-304 (2002).
32. Seelee, W.; Tungjaroenchai, W.; Natvaratat, M. Development of low-fat set type probiotic yoghurt from goat milk. *Asian J. Food Agro-Ind.* 2, 771–779 (2009).
33. Hassan, F.A.; Helmy, W.A.; Enab, A.K. Utilization of some local polysaccharide in manufacture of yoghurt. *Egypt. J. Dairy Sci.*, 2, 281–289, (2011).
34. Sahni, C., Gupta, R. K., & Nand, P. Insignificant viability of the granules of probiotic 46 and prebiotic with skimmed milk powder. *Biomedicine & Preventive Nutrition*, 4, 603-605, (2014).
35. Waliszewski, K.N., Aparicio, M.A., Bello, L.A., Monroy, J.A. Changes of banana starch by chemical and physical modification. *Carbohydr. Polym.* 52 (3), 237– 242 (2003).
36. Ni, H.; Hayes, H.E.; Stead, D.; Raikos, V. Incorporating salal berry (*Gaultheria shallon*) and blackcurrant (*Ribes nigrum*) pomace in yogurt for the development of a beverage with antidiabetic properties. *Heliyon*, 4, 00875 (2018). [CrossRef]
37. Nguyen, P.T.M.; Kravchuk, O.; Bhandari, B.; Prakash, S. Effect of Different Hydrocolloids on Texture, Rheology, Tribology and Sensory Perception of Texture and Mouthfeel of Low-Fat Pot-Set Yoghurt. *Food Hydrocoll.*, 72, 90–104, (2017). doi:10.1016/j.foodhyd.2017.05.035.
38. Peng, X., & Guo, S. Texture characteristics of soymilk gels formed by lactic fermentation: A comparison of soymilk prepared by blanching soybeans under different temperatures. *Food Hydrocolloids*, 43, 58-65. (2015). <http://dx.doi.org/10.1016/j.foodhyd.2014.04.034>.
39. Saleh, A., Mohamed, A., Alamri, M., Hussain, S., Qasem, A., Ibraheem, M., & Shahzad, S. A. Nonfat set yogurt: effect of okra gum and various starches on the rheological, sensory, and storage qualities and wheying-off. *Journal of Chemistry*, (2020a).
40. Saleh, A., Mohamed, A. A., Alamri, M. S., Hussain, S., Qasem, A. A., & Ibraheem, M. A. Effect of different starches on the rheological, sensory and storage attributes of non-fat set yogurt. *Foods*, 9(1), 61 (2020b)
41. Sass, C. A., Pimentel, T. C., Guimarães, J. T., Silva, R., Pagani, M. M., Silva, M. C., Queiroz, M. F., Cruz, A. G., & Esmerino, E. A. How buyer-focused projective techniques can help to gain insights into consumer perceptions about different types of eggs. *Food Research International*, 144, 110320 (2021). <http://dx.doi.org/10.1016/j.foodres.2021.110320>. PMID:34053525
42. Bonczar, G., Wszolek, M., & Siuta, A. The effects of certain factors on the properties of yoghurt made from ewe's milk. *Food Chemistry*, 79(1), 85-91 (2002). [http://dx.doi.org/10.1016/S0308-8146\(02\)00182-6](http://dx.doi.org/10.1016/S0308-8146(02)00182-6).
43. Q.Z. Zhao, J.S. Wang, M.M. Zhao, Y.M. Jiang, C. Chun, Effect of casein hydrolysates on yoghurt fermentation and texture properties during storage, *Food Technol. Biotechnol.* 44 429–434 (2006).

Association Between Sleep Quality and Body Mass Index in Police Officers

Damini M^{*1} and Shajini Judith Diana J.²

¹ Department of Home Science-Clinical Nutrition and Dietetics, Mohamed Sathak College of Arts and Science, Chennai, Tamil Nadu, India

² Department of Home Science, Women's Christian College, Chennai, Tamil Nadu, India

Correspondence to: Damini M, Department of Home Science-Clinical Nutrition and Dietetics, Mohamed Sathak College of Arts and Science, Chennai, Tamil Nadu, India, Tel: +91 9498312926; E-mail: daminimadhan@gmail.com

Abstract

Law enforcement is a 24-hour job and working in night shift is inevitable. Sleep, like nutrition and physical activity, is a critical determinant of health and well-being. Police officers are exposed to a multitude of risk factors like extended work schedules, shift work, occupational stress, dangerous and traumatic events which can affect their sleep quality. Poor sleep quality has been shown to be associated with poor food choice, unhealthy dietary intakes, high body fat and obesity. The aim of this study was to analyze sleep quality among police officers using the Pittsburgh Sleep Quality Index and examine its correlation with Body Mass Index. The results of this study showed that police personnel had to work in extended shifts, experienced poor sleep quality and exhibited unhealthy dietary patterns and improper snacking behaviour. Results from this study indicate a high prevalence of poor sleep quality (77%) among the police and a significant difference between shift work and sleep quality ($p < 0.05$). There is a significant difference ($p < 0.05$) between the body weight and BMI of the police personnel based on their dietary patterns. Regular health education programs and counselling sessions should be implemented to enhance the health and performance of the first/emergency responder.

Key words: Police, Shift work, Dietary patterns, Sleep quality, Body Mass Index, Lifestyle modification

Police personnel play a crucial role in the community by ensuring safety and stability. They represent a peculiar occupational force and are vulnerable to violence at work, which directly and indirectly alter their health [19]. Policing is a 24-hour profession. Overtime and shift work are prerequisites to ensure security. Early start of shift, working an extra or staying late to make sure adequate manpower, public events, court time which require additional police existence and the necessity of a second job potentially intensify the health effects found in shift work [24]. Important factors to be considered for any police agency are the physical health, psychological well-being, security and effectiveness at work. Police officers who are fatigued or tired are also a great danger to themselves as well as the people they serve [23].

Police officers work in shifts and often for long duration, and experience a poor-quality night sleep [21-22]. About 10% of rotating shift workers in the age group 18 and 65, have been found to have "shift-work sleep disorder" [5]. Sleep recommendations for young adults (18-25 years) and adults (age 26-64 years) is 7 to 9 hours. Sleep, not more than 10 hours or less than 6 hours (for adults) is not healthy [13]. Sleep problems are interrelated with faulty health outcomes and poor sleep quality and has been shown to be associated with unhealthy dietary intakes, poor food choices [12], increased

body fat and obesity [17]. There is a strong connection between sleep and obesity. Poor sleep quality is very common in obese individual and it is also independently linked to deficits in cognition specially in the areas of attention and memory [7], [10], [11], [15], [18]. Poor cognition is associated with both obesity and sleep quality and such an effect could be an effect of altered function in the prefrontal cortex related to disrupted sleep [4].

Occupational stress for a persistent time is considered to be a risk factor for Metabolic Syndrome [19]. Sleep problems were remarkably associated to incident cases of metabolic syndrome [8] Law enforcement officers form an important occupational force who constantly work under taxing situations [3], experience more fatigue, sleep deprived due to constant changes in their normal work and sleep schedule and pose numerous health issues like depression, diabetes, obesity, heart disease and stroke.

Police work is highly stressful and due to their rotating shifts police personnel are sleep deprived. The special occupational group also experience more fatigue than people in other occupations. It is miserable that a group chosen for extraordinary physical fitness at the entry level fail to preserve it and surrender themselves to lifestyle diseases that are very much preventable. Incidence of overweight and obesity is also becoming more common in the special group.

Sleep is an important determinant of health. Poor sleep is common in police officers. Police officers reporting high workloads often holds the lowest in the police hierarchy. The events that occur with poor and short sleep can result in disease risk. Officers with bad sleep take more sick leave or have problems in occupational activities. This study of association between enlightens the importance of sleep-in law enforcement officers and it also exposes the various factors contributing to sleep deprivation in them. Poor sleep quality affects alertness, performance, physical health and mental wellness. Shift work makes it demanding for the police personnel to maintain the normal sleep cycle. Due to which, police officers have poor sleep quality and improper dietary habits. This study rates the sleep quality in police officers and brings to light the importance of sleep promotion for the health and wellbeing of the law enforcement officers.

MATERIALS AND METHODS

This cross-sectional study was carried out on 100 male police personnel from the Armed Reserve force, Tamil Nadu Police, India. Male Police Personnel from the Armed Reserve force in the age group of 25 -50 years and officers who were willing to participate in the study were included in the study and a written consent was obtained. This study was approved by the institutional ethics committee of Women’s Christian College after critically reviewing the study method. The necessary information for the study was collected through a well-designed questionnaire. The information regarding demographic, family history of diseases, occupational and lifestyle related details were collected and the physical activity level of the participants was assessed. In addition, information regarding dietary intake like 24-hour recall and food frequency were collected.

Anthropometric assessment

Anthropometric measurements like height, body weight, and Body Mass Index of the police officers were assessed. Height was measured using a non-stretchable tape. The subjects were asked to remove their shoes and instructed to stand straight and look forward. Body Weight was measured using a well calibrated weighing machine. The subjects were asked to remove their shoes and instructed to stand straight and look forward. Body Mass Index (BMI), previously called as the

Quetelet index is a measure of nutritional status in adults was later calculated.

Dietary assessment

In addition, information regarding dietary intake like 24-hour recall and food frequency were collected.

Sleep quality

Sleep quality of the police officers was assessed through the Pittsburgh Sleep Quality Index (PSQI). PSQI is a constructive tool used to compute the quality and patterns of sleep in the adult.

RESULTS AND DISCUSSION

The present study was done with the objective of assessing the sleep quality in police officers and determining its association with Body Mass Index. It is evident from the study that 84 percent of the participants were less than 40 years. So, a majority of people enter into police force at a young age. It can be noticed that a high percentage of law enforcement officers, about 50 percent earn a monthly income of Rs. 20,000 - 30,000. It can be noticed that majority of participants (69%) were enrolled in rotating shift and 31 percent participants provided their service through a fixed shift.

Results shows that majority of participants (49%) were overweight. The disturbances in sleep, forecast overweight among young adults [21]. The result of this study shows that there is a significant difference ($p<0.05$) between the anthropometric measurements of the participants based on the habit of skipping meals (Table 1). This study clearly shows that meal skipping was high among police officers. Skipping meals in law enforcement officers might link to increased bodyweight, insulin resistance, hypertension, and increased fasting lipid concentrations. From this study it can be inferred that majority of participant (54%) had the habit of skipping meals, and 45 percent of the participants did not skip meals. A large number of participants (29%) seems to skip breakfast, and 14 percent of the participants had the habit of skipping dinner and about 12 percent of the participants had the habit of skipping lunch. The results also shows that police officers the habit of consuming meals at irregular intervals (83%). This might be due to their continuous duty schedule, travelling or poor appetite.

Table 1. Comparison of anthropometric measurement of police personnel based on skipping of meals

Variables	Meal skipping	N	Mean \pm SD	S.E Mean	't'	Level of significance
Body weight	No	45	76.53 \pm 10.62	1.58	-2.054	.043*
	Yes	55	72.56 \pm 8.70	1.17		
BMI	No	45	25.55 \pm 3.09	0.46	-2.221	.029*
	Yes	55	24.28 \pm 2.63	0.35		

* $p<0.05$

Results also shows that majority of participant (66%) had the habit of eating out daily due to their extended work schedule and shifts. It was also noted that majority of participants (80%) had the habit of consuming soft drinks. Caffeinated beverages may also influence the poor sleep quality in police officers.

It is noticeable that a majority of officer (77%) had a poor sleep quality based on the scores obtained on the Pittsburgh Sleep Quality Index (PSQI). The prevalence of poor sleep quality in law enforcement officers might be due to extended work schedule and shift work. Poor sleep quality in police personnel results in adverse health.

It is evident from the table 2 that there is a significant difference between the sleep quality scores and type of shift work at $p<0.05$. From the mean values it can be seen that participants in fixed shift had a higher sleep quality score which indicates poor sleep quality when compared to those who were involved in rotating shift. Evening and night work schedules are interrelated with greater prevalence of poor-quality sleep among police officers. There is also evidence that connects shift work to countless ill effects on health [6]. Shift work has been associated with certain illnesses and chronic diseases Long-term shift work is linked to an increased risk of certain cancers,

as well as heart disease, metabolic problems, gastrointestinal problems, ulcers and obesity. Shift work has also been found to change the appetite and metabolism. Numerous studies have

reported that shift workers have higher levels of triglycerides than day workers. Shift work disorder can also increase the risk of mental health problems like depression [14].

Table 2. Comparison of anthropometric measurement of police personnel based on skipping of meals

Variables	Shift	N	Mean \pm SD	S.E Mean	't'	Level of significance
Sleep quality scores	Fixed shift	31	22.97 \pm 11.97	2.15	2.321	.022*
	Rotating shift	69	17.13 \pm 11.47	1.38		

*p<0.05

CONCLUSION

It is well known that sleep disorders are very common among first responders like police officers. A major source of occupational stress for any law enforcement officer is shift work, which can involve nightshifts, overtime work, as well as fixed, rotating and irregular shift schedules [16]. Long shifts are associated with increased sleepiness [1] and may decrease the opportunity for sleep, impairing the officer's ability to recover from work demands [2]. Constantly changing shift work from day to evening or day to night alters a person's sleep-wake cycle

and impairs their sleep quality [9]. From the data obtained from the study, it can be concluded that the police personnel from the Armed Reserve force working in irregular shifts were more likely to have faulty dietary habits and a higher prevalence of poor sleep quality. The police personnel with high scores in PSQI have higher BMI and found to be obese. Consistency in work schedules and reducing frequency and duration of night and long shifts should be explored as a way to lower the high prevalence of poor sleep quality. Regular health education programs and counselling sessions should be implemented, to enhance their health and performance.

LITERATURE CITED

- Amendola, K., Weisburd, D. and Hamilton, E. (2011). The impact of shift length in policing on performance, health, quality of life, sleep, fatigue, and Extra- Duty employment: National Institute of justice, office of justice programs. US department of justice
- Barger, L. K., Lockley, S. W., Rajaratnam, S. M. W. (2009). Neurobehavioral, health, and safety consequences associated with shift work in safety- sensitive professions. *Curr Neurol Neurosci Rep*, 9, pp 155–64
- Boyanagari, M., Boyanagari, V., Shankar, M. and Ayyanar, R. (2018) Impact of occupational and psychological stress on police health in South India. *Arch Ment Heal*, 19(2), p 136.
- Curcio, G., Ferrara, M. and De Gennaro, L. (2006). Sleep loss, learning capacity and academic performance. *Sleep Med Rev*, 10(5), pp 323-337. doi:10.1016/j.smr.2005.11.001
- Drake, C. L., Roehrs, T., Richardson, G., Walsh, J. K. and Roth, T. (2004). Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers. *Sleep*, 27(8), pp 1453–1462. <https://doi.org/10.1093/sleep/27.8.145>
- Fekedulegn D, Burchfiel CM, Charles LE, Hartley TA, Andrew ME, Violanti JM. HHS Public Access Author manuscript. 2016;(March). doi:10.1097/JOM.0000000000000620
- Fergenbaum, J. H., Bruce, S., Lou, W., Hanley, A. J., Greenwood, C. and Young, T. K. (2009). Obesity and lowered cognitive performance in a Canadian First Nations population. *Obesity*, 17, pp 1957–1963.
- Garbarino, S., Guglielmi, O., Puntoni, M., Bragazzi, N. L. and Magnavita, N. (2019). Sleep quality among police officers: Implications and insights from a systematic review and meta-analysis of the literature. *Int J Environ Res Public Health* 16(5), pp 1-15.
- Ghods, K., Abdoallahpour, A., Ahmadi, M., Mirmohammadkhani, M., Gohari, A.(2017). The Relationship Between Sleep Disorders and Quality of Life in Rotating Shift Workers at a Textile Factory, Middle East J Rehabil Health Stud, 4(3), pp e12289. doi: 10.5812/mejrh.12289.
- Gunstad, J., Paul, R. H., Cohen, R. A., Tate, D. F, Spitznagel, M. B. and Gordon, E. (2007). Elevated body mass index is associated with executive dysfunction in otherwise healthy adults. *Comprehensive Psychiatry*, 48, pp 57–61.
- Gunstad, J., Paul, R. H., Cohen, R. A., Tate, D. F. and Gordon E. (2006) Obesity is associated with memory deficits in young and middle-aged adults. *Eating and Weight Disorders—Studies on Anorexia, Bulimia and Obesity*, 11, pp 15–e19.
- Min, C., Kim, H. J., Park, I. S., Kim, J. H., Sim, S. and Choi, H. C. (2018). The association between sleep duration, sleep quality, and food consumption in adolescents: A cross-sectional study using the Korea Youth Risk Behavior Web-based Survey. *BMJ Open*, 8(7), pp 1-9. doi:10.1136/bmjopen-2018-022848
- National sleep foundation. (2015). Sleep recommendation for adults. <https://www.sleepfoundation.org/press-release/national-sleep-foundation-recommends-new-sleep-times>
- National sleep foundation. (2016). Living and coping with shift work disorder. <https://www.sleepfoundation.org/shift-work-disorder/what-shift-work-disorder/living-coping-shift-work-disorder>
- Nilsson, L. G. and Nilsson, E. (2009). Overweight and cognition. *Scandinavian Journal of Psychology*, 50, pp 660–667.
- Pedersen, J., Lund, R., Andersen, I., Clark, A., Prescott, E. and Rod, N. (2019). Psychosocial risk factors for the metabolic syndrome: A prospective cohort study. *International Journal of Cardiology*, p 215.
- Peterson SA, et al. *BMJ Open* 2019;9:e030302. doi:10.1136/bmjopen-2019-030302
- Rahe, C., Czira, M. E, Teismann, H. and Berger K. (2015). Associations between poor sleep quality and different measures of obesity. *Sleep Med*, 16(10), pp 1225-1228. doi:10.1016/j.sleep.2015.05.023
- Sabia, S., Kivimaki, M., Shipley, M. J., Marmot, M. G. and Singh-Manoux, A. (2009). Body mass index over the adult life course and cognition in late midlife: The Whitehall II Cohort Study. *American Journal of Clinical Nutrition*, 89, pp 601–607.

20. Thayyil, J., Jayakrishnan, T. T., Raja, M. (2012) Metabolic Syndrome and Other Cardiovascular Risk Factors Among Police Officers. *North American Journal of Medical Sciences*, 4(12), pp 1-6. doi:10.4103/1947-2714.104313
21. Vargas, P. A., Flores, M. and Robles, E. (2014). Sleep quality and Body Mass Index in college students: the role of sleep disturbances. *J Am Coll Health*, 62(8), pp 534-541. doi:10.1080/07448481.2014.933344.
22. Vila B (2006). Impact of long work hours on police officers and the communities they serve. *American Journal of Industrial Medicine*, 49, pp 972–980. [PubMed: 17006951]
23. Vila, B. and Kenney, D. J. (2002). Tired cops: The prevalence and potential consequences of police fatigue. *NIJ Journal*, p 248 Retrieved from <http://www.ncjrs.gov/pdffiles1/jr000248d.pdf>
24. Violanti, J. M. (2012). Shifts, extended work hours, and fatigue: An assessment of health and personal risks for police officers. *NatInst Correct*, pp 1-63.
25. Violanti, J. M. (2014). Dying for the job: Police Work Exposure and Health, Charles C Thomas publisher, LTD. USA pp 26.

Seaweed is a Smart Ingredient to Control Glycemic Responses

Aswini M¹, Thahira Banu A^{*2}, Subhalakshmi S. U³, Kiruthigha V⁴ and Reka P⁵

¹⁻⁵School of Sciences, Department of Home Science, The Gandhigram Rural Institute- Deemed to be University, Gandhigram - 624 302, Dindigul, Tamil Nadu, India

Correspondence to: Thahira Banu A, Department of Home Science, The Gandhigram Rural Institute- Deemed to be University, Gandhigram - 624 302, Dindigul, Tamil Nadu, India, Tel: +91 9940917039; E-mail: thaaze@gmail.com

Abstract

A systematic investigation was carried out to evaluate the nutrient, phytonutrient, antioxidant, anti-diabetic activity and physicochemical properties of *Gracilaria edulis* and *Ulva lactuca* collected from the Mandapam coast of Rameswaram, Tamil Nadu, India. The results showed that the *Ulva lactuca* had the maximum content of carbohydrate (45.2±1.0 g/ 100g DW), protein (15.2±1.0g/ 100g DW), crude fibre (14.9±1.5g/ 100g DW), moisture (7.3±0.1% DW), ash (14.6±0.8% DW), vitamin C (11.8±0.9mg/ DW), beta carotene (4.3±0.2 mg/ DW), and iron (0.6±0.0 mg/g DW). The total dietary fibre content (41.9±0.6 g/ DW) was found to be high in *Gracilaria edulis*. The seaweeds had below-detectable levels of heavy metals. The tannin, flavonoids, saponins, alkaloids, terpenoids, steroids, and total polyphenols were present in substantial amounts in the selected seaweeds. The FRAP and H₂O₂ radical scavenging activity was maximum in *Gracilaria edulis* in the both aqueous and hot water extract. The physicochemical properties were high in *Gracilaria edulis*. The anti-diabetic activity was high in hot water extract of *Gracilaria edulis* showing 77.9±1.6% and 37.9±0.6% against α -glucosidase and α -amylase inhibition respectively. The study suggested that both seaweeds could be potentially used as a raw ingredient to improve the nutrient content, therapeutic value and functional property in functional food formulation.

Key words: Anti-diabetic, α -glucosidase, Functional food, Phytonutrient, Therapeutic

In recent times, a person living in developing countries primarily depends on alternative diet therapies which include natural resources for their primary health care. Several studies reported that anti-diabetic agents from natural sources have more attention, due to the clinical trials of several synthetic anti-diabetic drugs terminated because of safety concerns. Nowadays, marine resources are attracting attention in the search for bioactive components to formulate new drugs and healthy foods (Reka, Thahira Banu and Seethalakshmi, 2017). Seaweeds (macroalgae) are known as essential marine biological resources, which are abundantly available in the coastal area.

Seaweeds are rich sources of macro (carbohydrate-polysaccharide, protein, dietary fibre, amino acids and essential fatty acids), micro (vitamins and minerals) nutrients and some bioactive components, which have several therapeutic properties (i.e.,) antioxidant, antimicrobial and anti-diabetic activity (Kim et al., 2009; Chaturedi et al., 2011). Therefore, seaweeds are an essential source of vital elements which plays an important role in the metabolic process of human health, such as the regulation of carbohydrate, protein and lipid metabolism.

Therefore, a diet rich in marine products lowers the incidence of diabetes, cancer and obesity. The polyphenolic-rich extracts from edible seaweed may have anti-diabetic effects

due to their ability to inhibit certain digestive enzymes and were responsible for the stimulation of glucose uptake (Lucy Mohapata et al., 2013; Hang Wang, Zhi-Ming Fu and Chunn-Chao Han, 2014). Seaweeds may take a longer time to digest and stays for a longer period in the gastro intestine and the fibre and phenolic contents may interfere with the absorption which in turn delays the rise in blood glucose levels.

In recent times, seaweeds can be used in the formulation of novel drugs, due to their functional, therapeutic and pharmaceutical applications. Hence, keeping the above fact in mind the present investigation was aimed to determine the nutrient content, dietary fibre content, phytonutrient, functional and therapeutic properties of the selected two edible seaweeds (i.e.,) *Gracilaria edulis* (red seaweed) and *Ulva lactuca* (green seaweed).

MATERIAL AND METHODS

Two edible seaweeds namely *Gracilaria edulis* and *Ulva lactuca* were collected from the south coast area of Rameswaram, Tamil Nadu, India. The collected seaweeds were washed thoroughly with seawater and finally cleaned with running tap water to remove impurities and other foreign materials. The cleaned seaweeds were dried in shade for 5-8 days at room temperature (25±2°C) and ground into a fine

powder using a pulverizer. The seaweed powders were stored in an air-tight container until further analysis.

2.1. Evaluation of nutrient content of the selected seaweed

a) Proximate nutrient composition: moisture (AOAC, 1990), ash (AOAC, 1990), carbohydrate (Dubois et al., 1956), protein (Lowry's et al., 1951), fat (AOAC, 1990), Crude fibre (Maynard, 1970) and total dietary fibre (soluble and insoluble fraction) (AOAC, 1990), beta carotene (Ranganna, 1977) and Vitamin C (Harris and Ray, 1935) using standard procedure.

b) *Mineral composition*: Evaluation of the elemental composition of seaweeds using Energy Dispersive Spectroscopic Analysis: EDAX (Energy Dispersive Spectroscopic Analysis, Bruker Nano, German) were used to identify the presence of cell wall elements of the selected seaweeds. The component weight and atomic weight (per cent) were determined.

Evaluation of mineral composition (quantitative): calcium, sodium, potassium, phosphorus, iron, magnesium and zinc were determined using AAS (Atomic Absorption Spectrophotometer) (Raghuramulu, Madhavan and Kalyana Sundaram, 2003).

c) *Heavy metals in the selected seaweeds*: Heavy metals, namely lead, cadmium, arsenic and mercury (Raghuramulu, Madhavan and Kalyana Sundaram, 2003) were estimated using the Atomic Absorption Spectrophotometer.

2.2. Evaluation of phytonutrient content

Preparation of the sample

The two (aqueous and hot water) extracts (1:10 w/v) at 37°C and 1:10 w/v at 40°C with an extraction time of eight hours were prepared using a water bath cum incubator shaker, KWBS.2. Both extracts were filtered using a Whatmann No. 1 filter paper and stored in an air-tight container at 4-8°C until further use.

d) *Phytonutrients (qualitative)*: flavonoids, alkaloids, steroids, saponins, tannins, Anthroquinone, phlorotannins, terpenoids, glycosides, cardiac glycosides, phenols, quinones and coumarins were screened using the prepared extracts (Harbone, 1973; Deyab Mohammed, Elkatomy Taha and Ward Fatma, 2016).

e) *Phytonutrients (quantitative)*: tannin (Scanderl, 1970), flavonoids (Bohm and Koupaic-Abyazani, 1994), saponins (Obdoni and Ochuko, 2001), alkaloids (Harbone, 1973), terpenoids (Ferguson, 1956), steroids (Mann, Barnabas and Daninel, 2010) and total polyphenols content (Singleton and Rossi, 1965; Dibacto Ruth Edwige Kemadjou et al., 2021) were quantified using standard procedures.

2.3. Determination of functional characteristics

f) *Physiochemical properties*: Bulk Density (BD) (Narayana and Narasinga Rao, 1982), Tapped Density, Bulkiness, Carr's index, Hausner's Index, Water Absorption/Holding Capacity (WAC) (Beuchat, 1977), Oil Absorption Capacity (OAC) (Beuchat, 1977), Swelling Capacity (SWC) (Leach et al., 1959) and pH were determined for the selected edible seaweeds.

2.4. Evaluation of in vitro antioxidant activity and anti-diabetic

antioxidant activity: The antioxidant activity of the selected seaweeds was evaluated using the aqueous and hot water extracts by DPPH (2, 2-diphenyl-1-picrylhydrazyl) (Wang et al., 1998), hydrogen peroxide (H₂O₂) radical scavenging assay (Ruch, Cheng and Klaunig, 1989) and Ferric Reducing Antioxidant Power (FRAP) (Benzie and Strain, 1999) methods. Anti-diabetic activity: The α -amylase (Miller, 1959) and α -glucosidase (Krishnaveni, Theymoli and Sadasivam, 1984) inhibition activity of the selected seaweed extracts were determined.

2.5. Statistical analysis

The nutrient content, phytonutrient composition, physicochemical properties, antioxidant and anti-diabetic activity results were performed in triplicates (n=3), and mean \pm standard deviation (SD) were calculated.

RESULTS AND DISCUSSION

Nutrient content: The moisture, ash, carbohydrate, protein, fat, crude fibre, total dietary fibre, beta carotene and vitamin C content of the selected seaweeds are presented in (Table 1).

Table 1. Nutrient content of the selected seaweeds

Nutrients	<i>Gracilaria edulis</i>	<i>Ulva lactuca</i>
Moisture (%)	7.8 \pm 0.1	7.3 \pm 0.1
Ash (%)	14.4 \pm 0.7	15.6 \pm 0.8
Carbohydrate (g)	44.8 \pm 1.4	45.2 \pm 1.0
Protein (g)	14.6 \pm 0.8	15.2 \pm 1.0
Fat (g)	1.0 \pm 0.2	1.3 \pm 0.3
Crude fibre (g)	17.2 \pm 1.6	14.9 \pm 1.5
Soluble dietary fibre (g)	19.5 \pm 1.4	10.4 \pm 1.2
Insoluble dietary fibre (g)	22.5 \pm 1.7	16.6 \pm 1.4
Total dietary fibre (g)	41.9 \pm 0.6	27.0 \pm 1.3
Beta carotene (mcg)	2.6 \pm 0.3	4.3 \pm 0.2
Vitamin C (mg)	10.0 \pm 0.5	11.8 \pm 0.9

The ash content (15.6 \pm 0.8 %/ 100g DW), carbohydrate (45.2 \pm 1.0 g/ 100g DW), protein (15.2 \pm 1.0g / 100g DW), fat (1.3 \pm 0.3 g/ 100g DW), beta carotene (4.3 \pm 0.2 mcg/ DW), and vitamin C (11.8 \pm 0.9 mg/ DW) was high in *Ulva lactuca* whereas the maximum moisture content (7.8 \pm 0.1 %), crude fibre (17.2 \pm 1.6g /100g DW) and total dietary fibre (41.9 \pm 0.6 g/ 100g DW) content were noticed in *Gracilaria edulis*. The results of the nutrient content were in line with the studies reported by (Wong and Cheung, 2000; Syad et al., 2013; Sakhivel and Devi, 2015).

The carbohydrate content of the seaweed is mainly influenced by the type of biomass, which reveals the link between growth and carbohydrate content. Moreover, seaweeds are considered potential marine plant sources of protein. Seaweed proteins have antibacterial, antioxidant, anti-thrombotic, anti-inflammatory and immune-stimulating properties. Further, it can be utilized to treat/prevent hypertension, diabetes and hepatitis (Francavilla et al., 2013). *Gracilaria edulis* may have a promising source of dietary fibre and is utilized in nutraceutical industries due to its physiological properties for the prevention and treatment of obesity, cancer and diabetes (Francavilla et al., 2013; Kendall et al., 2010). The seaweed polysaccharides are primarily composed of polymers of at least 10 monosaccharides linked by glycosidic bonds. In recent times, seaweed polysaccharide contains outstanding bioactive compounds and it is considered low toxicity (Ju, Deng and Xi, 2019). However, a

polysaccharide from *Gracilaria* species varies due to seasonal variations, physicochemical factors, environmental conditions, extraction methods and atmospheric temperature. The marine macroalgae are the richest sources of minerals (trace elements), due to their cell wall polysaccharide and proteins containing sulphate, phosphate and anionic carboxyl groups which act as a metal-holding binding site.

Seaweeds contain a high amount of ash content than terrestrial plants and animal sources. The highest total dietary fibre was found in *Gracilaria edulis* than in green seaweed. The consumption of dietary fibre has several beneficial properties such as the prevention of cardiovascular disease, constipation,

and diabetes (Elleuch et al., 2011; Braithwaite et al., 2014). Therefore, seaweed dietary fibre can be used as a potential alternative source of cereal-based dietary fibre.

Elemental components in cell wall: The EDAX (elemental dispersive X-ray spectrum) result shown in Figure: 1 indicates the presence of different chemical components in the cell wall of *Gracilaria edulis* and *Ulva lactuca*. The order of twelve cell wall chemical elements presents in *Gracilaria edulis* namely Cl>C>Na>O>K>S>Ca>Si>Mg>Se>Al>Fe and *Ulva lactuca* C>O>Cl>Na>Mg>S>K>Se>Si>Al>Ca>Fe were observed.

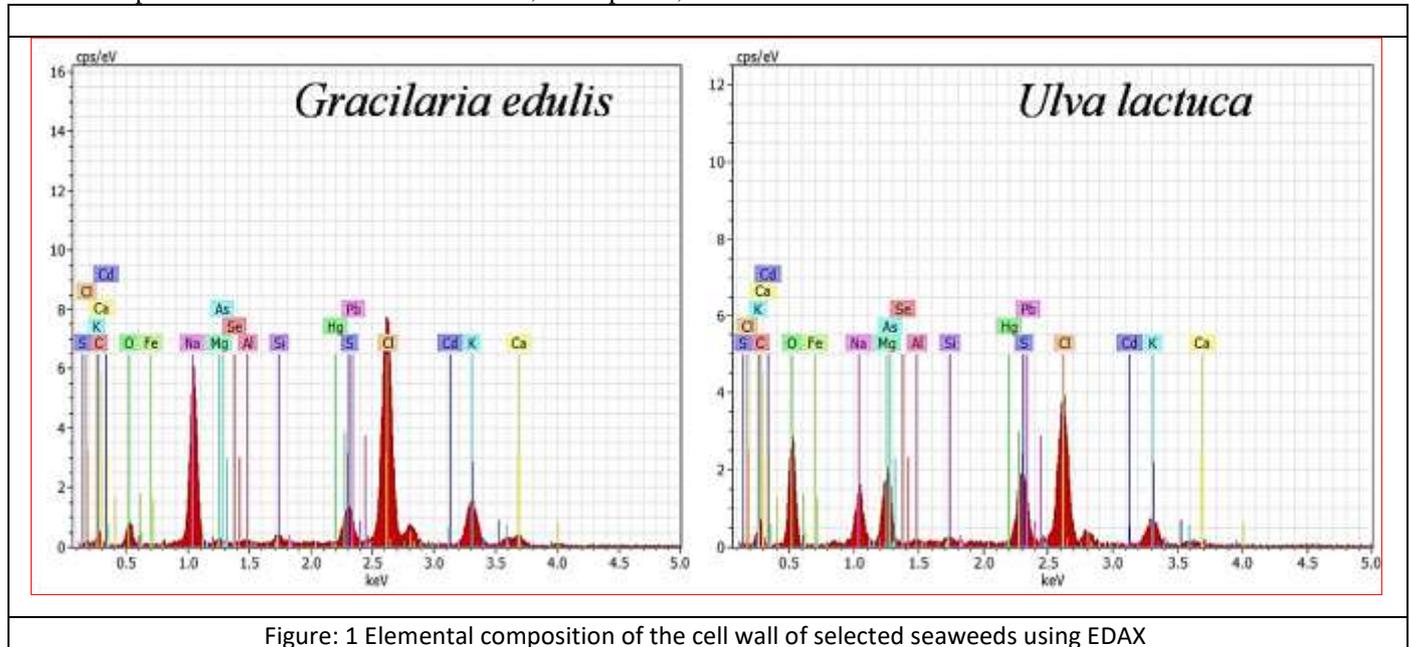


Figure: 1 Elemental composition of the cell wall of selected seaweeds using EDAX

Mineral composition: Seaweeds are important sources of macro (calcium, sodium, potassium, phosphorus, magnesium) and micro (iron, zinc) minerals and the minerals in the selected seaweeds is presented in Table: 3. Macro minerals are inorganic elements and required large quantities for several physiological body function (i.e.,) regulation of body fluid, electrolyte balance, muscle contraction, blood clotting, iron utilization and regulation of hypertension in the body. The maximum amount

of calcium (32.2±3.3 g/g DW), sodium (8.8±3.5 g/g DW), potassium (31.2±2.6 g/g DW), phosphorus (1.2±0.1 g/g DW), magnesium (11.1±1.3 g/g DW) and zinc (0.04±0.0 g/g DW) was observed in *Gracilaria edulis* whereas highest iron (0.6±0.0 g/g DW) content was found in *Ulva lactuca*. The mineral content namely sodium, potassium, and calcium content reported by Debbama Jesmi et al., (2016) in their study are in line with the results of the present study.

Table 3 Mineral composition of the selected seaweeds

Minerals	<i>Gracilaria edulis</i> (g/g DW)	<i>Ulva lactuca</i> (g/g DW)
Calcium	32.2±3.3	3.6±0.6
Sodium	8.8±3.5	7.6±1.3
Potassium	31.2±2.6	10.5±1.6
Phosphorus	1.2±0.1	0.6±0.1
Iron	0.5±0.0	0.6±0.0
Magnesium	11.1±1.3	8.8±1.4
Zinc	0.04±0.0	0.03±0.0

Table 4 Heavy metals of the selected seaweeds

Heavy metals	<i>Gracilaria edulis</i>	<i>Ulva lactuca</i>
Arsenic (ppm)	1.83±0.04	1.70±0.07
Mercury (ppm)	<0.01	<0.01
Cadmium (ppm)	0.02±0.0	<0.01
Lead (ppm)	0.05±0.0	0.13±0.0

Seaweeds contain a substantial amount of iron and calcium. The seaweeds in measured quantity can be supplemented for people with macro and micronutrient deficiency. Therefore, it is understood that seaweeds are rich sources of macro and micronutrients. Further, the essential minerals present in seaweeds are much higher than the

terrestrial plants, especially spinach (Savindra et al., 2015). The nutritional composition of the selected seaweeds mainly depends on some factors (i.e.,) geographical location, species, temperature, the intensity of sunlight and salinity of seawater (Debbarma Jesmi et al. 2016).

Heavy metals: Arsenic, mercury, cadmium and lead are presented in Table: 4. The number of heavy metals was below the detection limit in both seaweeds. Seaweed can accumulate metals, which mainly depend on various factors (i.e.,) plant age, season, temperature, pH, salinity, location, exposure, light, nitrogen content and metabolic processes, the affinity of the plant for each element (Rosemary Thomas *et al.* 2019).

Phytonutrient (qualitative): Table 5 shows the presence of phytonutrients in the extracts of the selected seaweeds. Both seaweed extracts have flavonoids, alkaloids, steroids, saponins, tannins, terpenoids, glycosides, cardiac glycosides phenols, quinones, and coumarins in aqueous and hot water extracts.

Table 5 Phytonutrients (qualitative) of the selected seaweeds

Phytonutrients	<i>Gracilaria edulis</i>		<i>Ulva lactuca</i>	
	AE	HWE	AE	HWE
Flavonoids	+	+	+	+
Alkaloids	+	+	+	+
Steroids	+	+	+	+
Saponins	+	+	+	+
Tannins	+	+	+	+
Anthraquinone	-	-	-	-
Phlobatannins	-	-	-	-
Terpenoids	+	+	+	+
Glycosides	+	+	+	+
Cardiac glycosides	+	+	+	+
Phenols	+	+	+	+
Quinones	+	+	+	+
Coumarins	+	+	+	+

Note: (+) presence, (-) absence; AE: Aqueous Extract; HWE: Hot Water Extract

Phytonutrient composition: The phytonutrient content of the seaweeds is presented in Table 6. *Ulva lactuca* has 20.0±0.0 g of tannin, 3.7±0.5 g of flavonoids and 74.7±0.6 mg/g GAE of total polyphenols, in *Gracilaria edulis* 25.0±1.4 g of saponin, 1.8±0.8 g of alkaloids, 0.9±0.0 g of terpenoids and 27.0±0.6 g

of steroids. Reddy, Anarthe and Raghavendra (2010) reported that polyphenols have been reported to cause effects similar to insulin in the utilization of glucose. Seaweeds with high total polyphenols can be utilized as an ingredient in the development of therapeutic foods for people with diabetes mellitus.

Table 6 Phytonutrient composition of the selected seaweeds

Phytonutrients	<i>Gracilaria edulis</i> (g)	<i>Ulva lactuca</i> (g)
Tannin	17.3±0.6	20.0±0.0
Flavonoids	3.4±0.6	3.7±0.5
Saponin	25.0±1.4	22.8±1.3
Alkaloids	1.8±0.8	1.6±0.3
Terpenoids	0.9±0.0	0.8±0.0
Steroids	27.0±0.6	21.4±0.7
Total Polyphenols (mg/g GAE)	56.7±0.6	74.7±0.6

Physicochemical properties: It is evident from the present study and results depicted in Table 7 that the physicochemical properties such as bulk density (0.6±0.0 g/cm³), tapped density (0.8±0.0 g/cm³), bulkiness (1.8±0.0

ml/g), carr's index (25.9±0.0%), Hausner's index (1.4±0.0 %), water absorption capacity (3.5±0.2g/g), swelling capacity (19.2±0.2), oil absorption capacity (2.8±0.2) and pH (8.3±0.0) were recorded for both the seaweeds.

Table 7 physicochemical properties of the selected seaweeds

Physicochemical properties	<i>Gracilaria edulis</i>	<i>Ulva lactuca</i>
Bulk density (g/cm ³)	0.6±0.0	0.6±0.0
Tapped density (g/cm ³)	0.8±0.0	0.7±0.0
Bulkiness (ml/g)	1.8±0.0	1.8±0.0
Carr's index (%)	25.9±0.0	22.9±0.0
Hausner's ratio (%)	1.4±0.0	1.3±0.0
Water Absorption Capacity (g/g)	3.5±0.2	3.5±0.1
Swelling Capacity	19.2±0.2	15.8±0.2
Oil Absorption Capacity	2.8±0.2	2.6±0.5
pH	8.3±0.0	6.8±0.0

The compressibility index (Carr's index) and Hausner's ratio are utilized to measure the flow properties of the flour. The water absorption capacity of the seaweeds is closely related to the polysaccharide composition whereas high oil absorption capacity allows the stabilization of food emulsion of the high-fat food products. Seaweeds contain a high amount of dietary

fibre and it has maximum water absorption/holding capacity, this is closely related to the presence of sustainable quantities of polysaccharides. This may be due to the reason that seaweed possesses a high inhibition activity of carbohydrate hydrolyzing enzyme (Cox and Abu-Ghannam, 2013).

The swelling capacity, water holding/absorption capacity, and oil holding/absorption capacity of seaweeds are mostly related to their type and content of polysaccharides as well as protein, which links to the cell wall polysaccharide. The swelling capacity and water holding/absorption capacity (SWC and WHC) of seaweeds might be attributed due to protein content and an increase in the number and nature of the water binding site of the protein molecules. Moreover, the oil absorption capacity of food particles correlated with their surface properties and overall charge density lipophilic compounds whereas low oil absorption capacity is commonly related due to its hydrophilic nature (Rosemary Thomas et al., 2019). However, this can be used as an ingredient in value-added products and may help to enhance the texture of food products and improve the acceptability of food (Elleuch et al., 2011). Seaweeds may be utilized in the formulation of therapeutic food products, due to their increased physicochemical properties, which help to improve the texture and overall acceptability of the food products.

In vitro Antioxidant activity: The antioxidant activities of the selected seaweeds were evaluated using DPPH, hydrogen peroxide (H₂O₂) and Ferric Reducing Antioxidant Power (FRAP) assay. The aqueous and hot water extracts were used for the determination of free radical scavenging activity and Butylated Hydroxy Toluene (BHT) was used as the standard and the results are presented in Table: 8. The maximum DPPH (64.1±1.0 %; 64.4±1.8%), FRAP (2.4±0.4 mg/g of AAE, 1.8±0.2mg/g of AAE) and H₂O₂ (56.8±0.8%; 55.2±0.6%)

activity was noticed in aqueous extract of both selected seaweeds whereas lowest DPPH (32.5±0.7%; 35.8±0.8%), FRAP (1.3±0.0 mg/g of AAE; 0.73±0.3 mg/g of AAE), and H₂O₂ (55.1±2.3%; 49.9±0.8%) activity was found in hot water extracts of *Gracilaria edulis* and *Ulva lactuca*. The antioxidant properties are due to the presence of phenolics and their ability to act as reducing agents, hydrogen donors and free radical quenchers and can also act as metal chelators which prevent the catalytic function of metal in the process of initiating radicals. Phenolic components and other bioactive compounds like vitamin E, provitamin A, carotenoid and sulphated polysaccharides are considered to have important antioxidant free radical scavenging activity (De Alencar Daniel et al., 2013).

The antioxidant activity of seaweed possesses a positive health effect on human health because they protect the human body against deterioration by free radicals and Reactive Oxygen Species (ROS) including single oxygen, hydrogen peroxide, superoxide anion and hydroxyl radical. Besides, free radicals and ROS attack macromolecules (i.e.,) DNA, proteins, and lipids leading to many health disorders which include neurodegenerative, cardiovascular, diabetes, inflammatory aging and cancer (Ngo et al., 2011). FRAP (Ferric-Reducing Power) is a major indicator of the potential antioxidant compound. The ability to reduce ferric ions indicates that the antioxidant components are electron donors and it helps to reduce the oxidized intermediate of lipid peroxidation processes, which act as a primary and secondary antioxidant.

Table: 8 Antioxidant activity of the selected seaweeds

Antioxidant activity	<i>Gracilaria edulis</i>		<i>Ulva lactuca</i>		Standard (BHT)
	AE	HWE	AE	HWE	
DPPH (%)	64.1±1.0	32.5±0.7	64.4±1.8	35.8±0.8	69.6±0.7
FRAP (mg/g of AAE)	2.4±0.4	1.3±0.0	1.8±0.2	0.73±0.3	3.3±0.8
H ₂ O ₂ (%)	56.8±0.8	55.1±2.3	55.2±0.6	49.9±0.8	68.3±0.7

Note: AE: Aqueous Extract; HWE: Hot Water Extract; AAE: Ascorbic Acid Equivalent; BHT: Butylated Hydroxy Toluene

In vitro Anti-diabetic inhibition assay: Alpha-amylase and Alpha-glucosidase inhibition assay of the selected seaweed is presented in Table: 9. The maximum α -amylase (75.9±1.6%) inhibition assay was found in aqueous extract of *Ulva lactuca*, whereas the maximum α -glucosidase (77.9±1.6%) was found in hot water extract of *Gracilaria edulis*. Further, α -amylase and α -glucosidase enzymes play an important role in diabetes. The α -amylase catalyze the hydrolysis of starch to a

mixture of simpler saccharide that consists of maltose, maltotriose and oligo glucans and α -glucosidase enzyme helps to degrade glucose, which is absorbed into the bloodstream (Gomathi, Kalaiselvi and Uma, 2012). Further, inhibition of alpha-glucosidase enzymes leads to a reduction in disaccharide hydrolysis that has several beneficial effects on glycemic control in diabetic patients (Reka, Thahira Banu and Seethlakshmi, 2017).

Table: 9 Anti-diabetic inhibition assay of the selected seaweeds

Anti-diabetic inhibition assay	<i>Gracilaria edulis</i>		<i>Ulva lactuca</i>		Standard (Acarbose)
	AE	HWE	AE	HWE	
α -amylase	51.2±1.7	37.9±0.6	75.9±1.6	33.7±2.1	58.2±1.2
α -glucosidase	66.0±1.8	77.9±1.6	63.6±1.4	74.2±1.1	78.4±0.5

Note: AE: Aqueous Extract; HWE: Hot Water Extract

The marine macroalgae contain a wide range of bioactive secondary metabolites, which as therapeutic potential and help in the development of functional ingredients in nutraceutical, cosmeceuticals, pharmaceutical and agricultural applications (Thomas and Kim, 2013; Blunt et al., 2013; Blunt et al., 2012). Seaweeds are extraordinary sustainable resources in the marine ecosystem that can be utilized as a source of food, medicine and industrial products (John Peter Paul and Mahadevi, 2014). Hang Wang et al., (2014) reported that a diet rich in marine products lowers the incidence of diabetes, cancer and obesity. Seaweeds contain a high level of soluble dietary fibres (carrageenan, agar and alginate). This possesses a wide range of beneficial physiological function which includes

increased satiety, increased gut transit time, reduced cholesterol and glucose absorption in the gastrointestinal tract and it also reduces the risk of coronary heart disease.

CONCLUSION

The present study it is concluded that the *Gracilaria edulis* and *Ulva lactuca* are rich in macro and micronutrients. Seaweeds are abundantly present in a marine environment and they can be utilized as human food. In comparison, of the terrestrial plants and animal foods, seaweeds contain a higher amount of minerals. Seaweeds used as a part of our daily diet will improve the nutritional status of the population and helps

to eradicate micronutrient deficiency. Besides, alpha-amylase and alpha-glucosidase enzyme which is utilized to maintain the postprandial blood glucose level. Seaweeds possess promising inhibitory activity of the enzymes due to their soluble dietary fibre, phenolic compounds and some of the pharmaceutical

components. Therefore, seaweed can be utilized as a functional raw ingredient in the formulation of therapeutic diets and also help to maintain postprandial blood glucose which helps to delay the complication of diabetes. So, seaweed can be considered a smart ingredient for regulating blood glucose.

LITERATURE CITED

1. AOAC. 1990. Official methods of analysis, 15th edition. Association of Official Analytical Chemists, Washington, DC, USA.
2. Benzie IF and Strain JJ. 1999. Ferric reducing/antioxidant power assay; a direct measure of total antioxidant activity of biological fluids and modified version for simultaneous measurement of total antioxidant power and ascorbic acid concentration. In *Methods in Enzymology*. 299: 15-27. Academic Press.
3. Beuchat LR. 1977. Functional and Electrophoretic Characteristics of Succinylated Peanut Flour Protein. *Journal of Agricultural and Food Chemistry*. 25: 258-261. doi:10.1021/jf60210a044.
4. Blunt JW, Copp BR, Keyzers RA, Munro MH and Prinsep MR. 2012. Marine natural products. *Nat Prod Rep*. 29: 144-222.
5. Blunt JW, Copp BR, Keyzers RA, Munro MH and Prinsep MR. 2013. Marine natural products. *Nat Prod Rep*. 30: 237-323.
6. Bohm BA and Kocipai- Abyazan, R. (1994). Flavonoid and condensed tannins from the leaves of *Vaccinium raticulation* and *Vaccinium calcyimium*. *Pacific Sci*. 48: 458-463.
7. Braithwaite MC, Tyagi C, Tomar LK, Kumar P, Choonara YE and Pillay V. 2014. Nutraceutical based therapeutics and formulation strategies augmenting their efficiency to complement modern medicine: An overview. *J. Func. Foods*. 6: 82-99.
8. Chaturedi M, Sing M, Kumar R and Chugh MR. 2011. A diet with nutritional, medicinal and industrial value. *Res J Med Plants*. 5: 153-57.
9. Cox S and Abu-Ghannam N. 2013. Enhancement of the phytochemical and fiber content of beef- patties with *Himanthalia elongata* seaweeds. *International Journal of Food science and Technology*. 48(11): 2239-49.
10. De Alencar Daniel et al. 2013. Antioxidant potential and cytotoxic activity of two red seaweed species, *Amansia multifida* and *Meristiella echinocarpa*, from the coast of Northeastern Brazil. *Anais da Academia Brasileira de Ciências*. 86(1). doi:10.1590/0001-37652014116312.
11. Debbarma Jesmi, Rao Mzdhusudana, Narasimhamurthy L, Mathew Suseela, Venkateshwarlu G and Ravisankar CN. 2016. Nutritional profiling of the edible seaweeds *Gracilaria edulis*, *Ulva lactuca* and *Sargassum* sp. *Indian J. Fish*. 63(3): 81-7. doi:10.21077/ijf.2016.63.3.600073-11.
12. Deyab Mohammed, Elkaton Taha, and Ward Fatma. 2016. Qualitative and Quantitative analysis of phytochemical studies on brown seaweed, *Dictyota dichotoma*. *International Journal of Engineering Development and Research*. 4(2): 674-78.
13. Dibacto Ruth Edwige Kemadjou et al. 2021. Total Polyphenol and Flavonoid Content and Antioxidant Capacity of Some Varieties of *Persea americana* Peels Consumed in Cameroon. *Hindawi: The Scientific World Journal*. 2021, 8882594: 1-11. doi:10.1155/2021/88825942021.
14. Dubois M, Gilles KA, Hamilton JK, Rebers PA and Smith F. 1956. Estimation of Carbohydrates. *Anal. Chem*. pp 26, 350.
15. Elleuch M, Bedigian D, Roiseux O, Besbes S, Blecker C and Attia H. 2011. Dietary fibre and fibre rich byproducts of food processing: Characterization, technological functionality and commercial applications: A review. *Food Chem*. 124: 411-21.
16. Ferguson N. 1956. A textbook of pharmacognosy, Max Millam Company.
17. Francavilla M, Franchi M, Monteone M and Caroppo C. 2013. The red seaweed *Gracilaria gracilis* as a multi products source. *Mar. Drugs*. 11: 3754-76.
18. Gomathi D, Kalaiselvi M and Uma C. 2012. In vitro alpha amylase and alpha glucosidase inhibitory effects of ethanolic extra of *Evolvulus alsinoides* (L.). *Int Res J Pharm*. 3: 226-9.
19. Hang Wang, Zhi-Ming Fu and Chunn-Chao Han. 2014. The potential applications of marine bioactive against diabetes and obesity. *Am J Marine Sci*. 2: 1-8.
20. Hang Wang, Zhi-Ming Fu, and Chunn-Chao Han (2014). The potential applications of marine bioactive against diabetes and obesity. *Am J Marine Sci*. 2,: 1-8.
21. Harborne JB 1973. *Phytochemical methods*. Chapman and Hall Ltd., London. pp 49-88.
22. Harris LJ and Ray SN. 1935. Estimation of Ascorbic Acid. *Lancet*. pp 1, 462.
23. John Peter Paul J and Mahadevi B. 2014. Distribution and seasonal variation of some *caulerpa* species (Green seaweed) in Thoothukudi Region, the Southeast coast of Tamil nadu, India. *Int J Pure Appl Bio sci*. 2: 135-8.
24. Ju T, Deng Y and Xi J. 2019. Optimization of circulating extraction of polysaccharides from *Gracilaria lemaneiformis* using pulsed electrical discharge. *ACS Sustain. Chem. Eng*. 7: 3593-601.
25. Kim AR, Shin TS, Lee MS, Park JY, Park KE and Yoon NY et al. 2009. Isolation and identification of phlorotannins from *Ecklonia stolonifera* with antioxidant and anti-inflammatory properties. *J Agric Food Chem*. 57: 3483-89.
26. Krisnaveni S, Theymoli B and Sadasivam S. 1984. Sugar distribution in sweet stalk sorghum. *Food Chem*. 15: 229.
27. Leach HW, Mc Cowen LD and Schoch TJ. 1959. Structure of the starch granules. In: *Swelling and solubility patterns of various starches*. *Cereal Chem*. 36: 334-544.
28. Lowry's OH, Rosebrough NJ, Farr AL and Randall R.J. 1951. Estimation of protein. *J. Bio. Chem*. pp 193, 265.
29. Lucy Mohapata, Premalathapathi, Ramachandra Panigrahy, and Asaubrat Kumar Bhattamisra. 2013. Therapeutic health booster: seaweeds against several maladies. In *J Geo-Marine Sci*. 42: 538-46.
30. Mann A, Barnabas BB and Daniel II. 2010. The effect of methanolic extracts of *Anogeissus leicarpus* and *Terminalia avicenniodes* on the growth some food born microorganisms. *Autr. Journal of Basic Applied Science*. 4(2): 6041-45.
31. Maynard AJ. 1970. Estimation of crude fibre. *Methods in Food Analysis*. Academic Press, New York. pp 176.
32. Miller GL. 1959. Use of dinitro salicylic acid reagent for determination of reducing sugar. *Analy Chem*. 31: 426-8.

33. Narayana R and Narasinga Rao MS. 1982. Functional properties of raw and heat processed winged bean (*Psophocarpus tetragonolobus*) flour. *J. Food Sci.* 57: 1534-8.
34. Ngo DH, Wijesekara I, Vo TS, Ta QV and Kim SK. 2011. Marine food-derived functional ingredients as potential antioxidants in the food industry: An overview. *Food Research International.* 44: 523-529.
35. Obdoni BO and Ochuko PO. 2001. Phytochemical studies and comparative efficacy of the crude extracts of some Homostatic plants in Edo and Delta States of Nigeria. *Glob J Pure Appl Sci.* 8b: 203-208.
36. Raghuramulu N, Madhavan NK and Kalyana Sundaram SA. (2003). *Manual of laboratory techniques.* NIN Hyderabad. vol 177, pp 140-146.
37. Ranganna S 1977. Plant pigments. In: *Manual of analysis of fruit and vegetable products.* New Delhi: Tata McGraw-Hill. pp 73-77.
38. Reddy NV, Anarthe SJ and Raghavendra NM. 2010. In Vitro Antioxidant and Antidiabetic activity of *Asystasia gangetica* (Chinese Violet) Linn. (Acanthaceae). *J Res. Biomed. Sci.* 1(2): 72-75.
39. Reka P, Thahira Banu A and Seethalakshmi M. 2017. Alpha-amylase and alpha-glucosidase inhibition activity of selected edible seaweeds from south coast area of India. *Int J Pharm Pharm Sci.* 9(6): 64-68. doi:10.22159/ijpps.2017v9i6.17684.
40. Rosemary Thomas et al. 2019. Biochemical, micronutrient and physicochemical properties of the dried red seaweeds *Gracilaria edulis* and *Gracilaria corticata*. *Molecules.* 24 (2225): 1-14. doi:10.3390/molecules24122225.
41. Ruch RJ, Cheng SJ and Klaunig JE. 1989. Prevention of cytotoxicity and inhibition of intercellular communication by antioxidant catechins isolated from Chinese green tea. *Carcinogenesis.* 10(6): 1003-08.
42. Sakthivel R and Devi KP. 2015. Evaluation of physicochemical properties, the proximate and nutritional composition of *Gracilaria edulis* collected from Palk Bay. *Food Chem.* 174: 68-74.
43. Savindra K, Dinabandhu S and Ira L. 2015. Assessment of nutritional value in a brown seaweed *Sargassum wightii* and their seasonal variations. *Algal. Res.* 9: 117-25.
44. Schanderl SH. Estimation of tannins. In: *Method in Food Analysis,* Academic Press, New York, 709. (1970).
45. Singleton V and Rossi J. 1965. Colorimetry of total phenolics with phosphomolydic-phosphotungstic acid reagents. *American Journal of Enology Viticulture.* 16: 144-158.
46. Syad AN, Shunmugiah KP and Kasi PD. 2013. Seaweeds as nutritional supplements: Analysis of nutritional profile, physicochemical properties and proximate composition of *G. acerosa* and *S. wightii*. *Biomed. Prev. Nutr.* 3: 139-44.
47. Thomas NV and Kim SK. 2013. Beneficial effects of marine algal compounds in cosmeceuticals. *Mar Drugs.* 11: 146-64.
48. Wang M, Li J, Rangarajan M, Sao Y, Lavoie Huang T and Ho CT. 1998. Antioxidative phenolic compounds from sage (*Salvia officinalis*). *Journal of Agriculture and Food Chemistry.* 46: 4487-867. doi:10.1021/jf980641b.
49. Wong KH and Cheung PCK. 2000. Nutritional evaluation of some subtropical red and green seaweed: Part I - Proximate composition, amino acid profiles and some physicochemical properties. *Food Chem.* 71: 475-82.

A Study on Consumption Pattern and Knowledge of Millet's Processing among the People

A. Thahira Banu¹, Amutha Keerthana G^{*2}, S. U. Subha Lakshmi³ and Janeline Lunghar⁴

¹⁻⁴Department of Home Science, School of Sciences, The Gandhigram Rural Institute (Deemed to be University) Gandhigram - 624 302, Dindigul, Tamil Nadu, India

Correspondence to: Amutha Keerthana G, Department of Home Science, School of Sciences, The Gandhigram Rural Institute (Deemed to be University) Gandhigram - 624 302, Dindigul, Tamil Nadu, India, Tel: +91 63805552296; E-mail: amuthakeerthana2012@gmail.com

Abstract

Milletts are subjected to different processing (polishing, pearling, or decortications) and sold in the market without labeling as polished, semi-polished and unpolished. This processing is done to improve the appearance, cooking quality, and digestibility. Eventually, this damages the grain and leads to nutrient loss and consumers consume millet that is devoid of the intended benefits. All this process is not explained to a customer and they are kept in dark. This study is undertaken with the above facts in mind in order to understand the type, form, and frequency of millet used in people's daily diets, as well as their basic understanding of unpolished, semi polished, and polished millets sold in the markets. The survey was carried out from December 5th, 2021 to January 5th, 2022, using a Google form in an online platform accessible from any device with an Internet connection. A total of 200 people between the ages of 17 and 50 were recorded. The results showed that the most commonly consumed millets were Finger millet (85%) and Kodo millet (62.5%). Before cooking the most common pre-processing methods for millets before cooking was soaking (45%) and roasting (35%). The most popular dishes were millet roti, traditional drinks, dosa/idly, and snacks. The survey's most significant finding was that the majority of the public (67.5%) was unaware that millets were polished and available in this form on the market. Thus, the study concluded that consumer education is essential for millet selection and ways to consume them for health and well-being.

Key words: Millets, Consumption pattern, Traditional food, Consumer preference, Nutrition education

Milletts are among the oldest foods known to humans, and they may have been the first cereal grain in use for domestic purposes (Joseph, 2013). Milletts are referred to as a functional or agronomic group. These crops continue to be the primary source of energy, protein, vitamins, and minerals for millions of the region's poorest residents. As a result, they are primarily consumed by disadvantaged communities; they are also known as "raw grains" or "poor man's crops" (Dayakar Rao *et al.* 2017). Most millet crops are native to India and are commonly known as Nutri-cereals because they provide the majority of the nutrients important for body functioning (Verma and Khurana, 2019). The emergence of non-communicable diseases as a public health problem and the awareness that increased millet consumption may have benefits in reducing the incidence of cardiovascular disease and diabetes have opened a window of opportunity to increase millet production and consumption (Rao, 2012; Anil *et al.* 2021).

Milletts have become increasingly popular as a nutritional and economic supplement to cereal-based food products. India declared 2018 to be the "Year of Milletts," and the Food and Agricultural Organization (FAO) also announced 2023 to be the "International Year of Milletts." All of these

factors contribute to the great significance of milletts (Verma and Khurana, 2019). Millet-based value-added products now have the potential to add value to businesses and have large growth potential because consumers believe that milletts and millet-based foods make a significant contribution to their health (Pushpavalli, 2015). Millet grains have a coarse appearance and may not be appealing to many people, especially when compared to the appearance of other food grains. Polishing the millet to improve its appearance is one method of increasing its acceptability. The Central Food Technological Research Institute (CFTRI) in Mysore has developed a method for removing the outer skin of millet grains. Milletts processed in this manner are known as "pearled milletts." (Rao, 2012). In recent times almost all households have started to purchase millet for its health benefits. A large population is consuming processed milletts that no longer provide the intended benefits. Hence, awareness of the polishing, morphological features and nutritional aspects of millet is required to empower consumers for making appropriate nutritional choices. Keeping in view all the above points, the present study has been taken up with the following objective to study the consumer preference for the milletts,

consumption pattern and buying frequency and their understanding of the processing of millets by the locals.

MATERIALS AND METHODS

The survey was conducted from Dec 5th 2021 to the 05th of Jan 2022, using a google form in an online platform, accessible through any device with an Internet connection. A structured questionnaire was developed according to the logical order which includes personal information, millet preference, frequency of consumption, cooking methods used, the quantity of millet intake, buying outlets and some questions about the basic understanding of the unpolished, semi-polished and polished millets. The survey questionnaire was disseminated to known contacts on Whats App and mailing lists. This method was completely effective because it facilitated the wide dissemination of the survey questionnaire. Moreover; the use of the internet is high among people around the globe due to the pandemic situation. The introductory page of the survey included information about the study. Participants proceeded to complete and submit their responses. Only responses with a 100% completion rate were saved. Participants were not rewarded for taking part in the study and all data was collected anonymously. The study was conducted following the ethical code for internet and social media research (Brightman and Grotti, 2020). A pre-test with 30 subjects was conducted before the survey to address issues with the content and completeness of the questions. Based on the pre-tested satisfaction level, annotations, and comments, the questionnaire was enhanced

and resolved. This helped ensure that both interviewers and respondents answered the questions and reduced sampling error (Kane-Potaka *et al.* 2021). A total of 200 people between the ages of 17 and 50 recorded their responses.

Data analysis

For convenience in data recording and analysis, the variables chosen for the study were categorized and the data were analyzed and interpreted. Statistical measures like percentage, average, standard deviations and rank correlation were used by using SPSS software version 23.

On completion of data collection, the investigator turns to the task of analyzing them, in the process of analysis, relationships or differences supporting or conflicting with the original or new hypothesis should be subjected to statistical tests of significance to determine with what validity data can be said to indicate any conclusion (Kothari, 2004).

RESULTS AND DISCUSSION

Age and Gender

Overall, 200 responses were recorded and the knowledge of millets among the public, consumption patterns, methods of cooking millets and purchasing practices were analyzed. As shown in (Table 1), 81.5 per cent of the respondents were females and 18.5 per cent were male respondents. The majority of 70.5 per cent of the responses were received from women in the age group of 20-30 years, followed by 13.50 per cent of responses from women in the age group of 40-50 years.

Table 1 Age and gender of the participants

Age of the respondent	Gender of the respondent		Total N=200 Percent
	Male n=37 Percent	Female n=163 Percent	
17-19	5.00	5.00	10.00
20-30	11.50	59.00	70.50
30-40	1.00	5.00	6.00
40-50	1.00	12.50	13.50

Knowledge of millets among the public

The majority of the participants are aware of millet, and their first thought on millet is that it is abundant in nutrients (68.5% of responses).

Finger millet (85%), Pearl millet (63.5%), Kodo millet (62.5%), Sorghum millet (54%), Foxtail millet (36%), Little millet (30%), Barnyard millet (24%), Amaranth millet (10%),

Broomcorn millet (8%), and Buckwheat millet (2.5%) were the most commonly consumed millet, among the selected respondents (Figure 1). When queried about which millet they thought was nutrient-rich, nearly half of the respondents indicated that finger millet (49.5%) had the highest nutritious content, followed by pearl millet (25.5%) and so on (Table 2).

Table 2 Basic Knowledge of millets among the public

Parameters	Variables	Percentage
Basic Knowledge of millet	Yes	95.00
	No	5.00
My first thought on millet	Nutritious	68.50
	Expensive	2.50
	Gluten-free	1.50
	Rural/Traditional food	20.00
	Weight management	7.00
Nutrient-dense millet	Other	0.50
	Finger Millet	49.50
	Foxtail Millet	5.00
	Sorghum Millet	2.50
	Pearl Millet	25.50
	Buckwheat Millet	0.50
	Amaranth Millet	0.50
	Little Millet	6.00
	Barnyard Millet	4.50
	Broomcorn Millet	1.00
Kodo Millet	5.00	

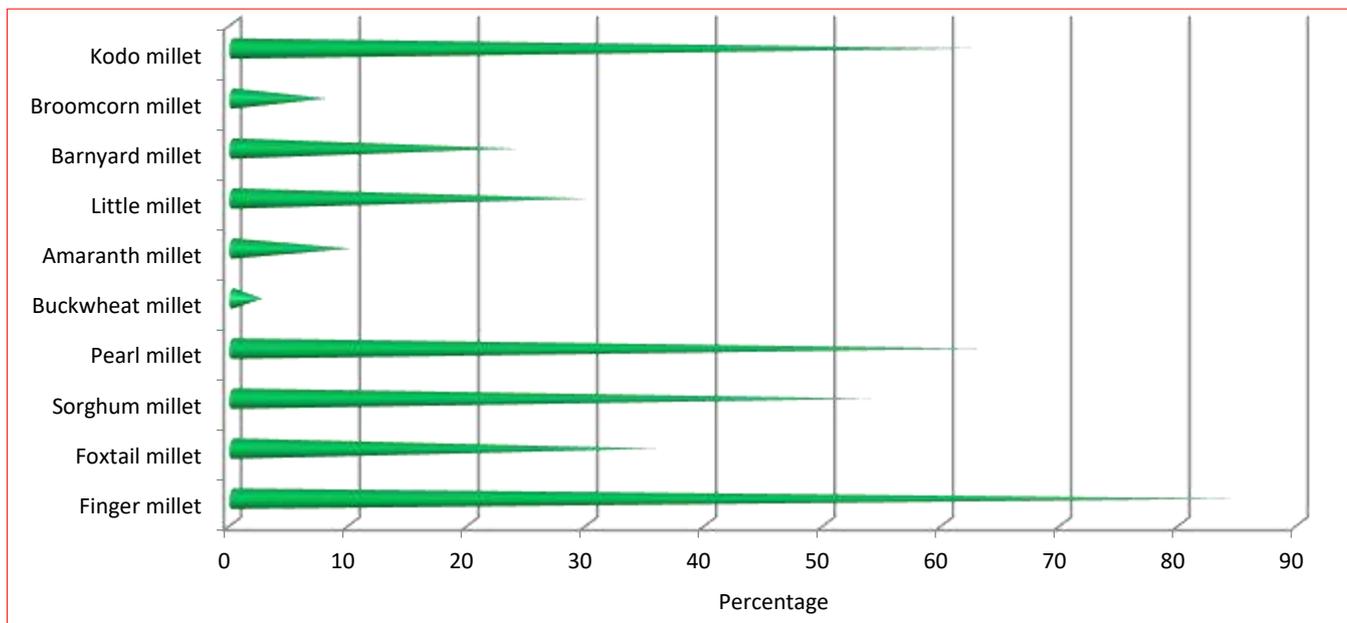


Figure 1: Most commonly consumed millets

Consumption pattern of millet

The frequency of consumption as well as the family's average consumption of millets per month was represented in (Table 3, Figure 2). The readily available processed form of millets purchased from the market is Idly/dosa mix (67.5%), followed by vermicelli (11.5%), flakes (7%), semolina (6%) (Table 3). Forty-one per cent reported that millet roti is the most

popularly consumed dish, followed by snacks (31%), RTE goods (7.5%), traditional sweets (7%), kichadi (6.5%), and traditional beverages (6.5%) (Figure 3). When inquiring about the reason for consuming millet, the majority 80.5 per cent of the respondents reported that they consumed millet to keep themselves healthy (Figure 4). This data shows that people were aware of the nutrient content of millet.

Table 3 Consumption pattern of millets

Parameters	Variables	Percentage
Average millet consumption per month per family	< 1 kg	25.00
	1-2 kg	42.50
	3-4 kg	19.50
	4-6 kg	7.50
	7-8 kg	2.00
	9-10 kg	0.50
	> 10 kg	3.00
	The most preferred readily available processed form of millet	Flakes
Idly/Dosa mix (Flour)		67.50
Vermicelli		11.50
Noodles/Pasta		2.00
Semolina		6.00
Puffed Varieties		2.50
Other		3.50

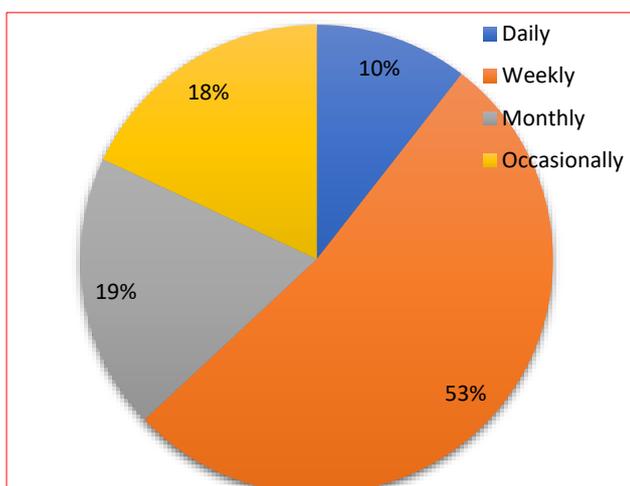


Figure 2: Frequency of consuming millets

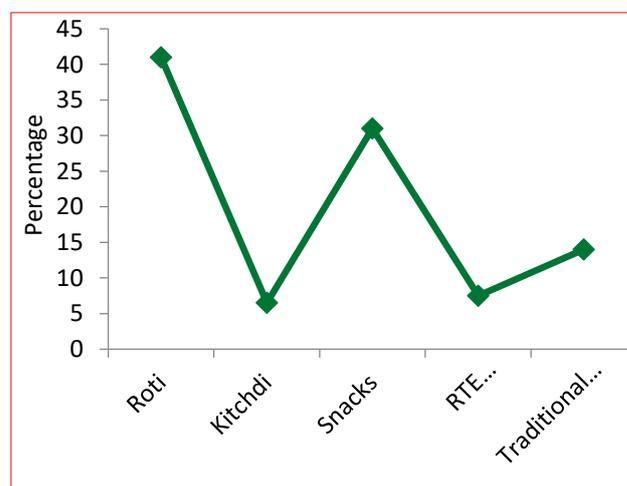


Figure 3: Most popularly consumed dish

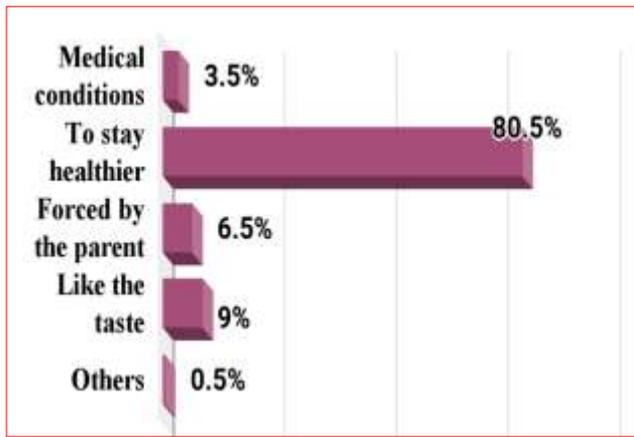


Figure 4: Reason for consuming millets

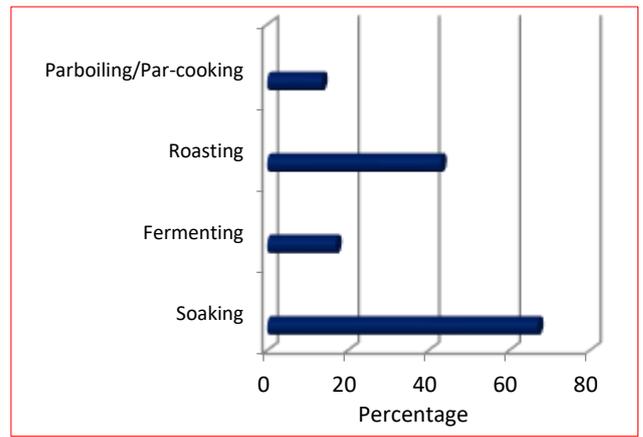


Figure 5: Pre-cooking methods used for millets

Methods of cooking millet at home

This survey analysis revealed the most prevalent pre-cooking methods used for millet cooking, were soaking (67%)

and roasting (43%) (Figure 5). The most common methods of cooking millet at home were steaming (49%), pressure cooking (24%) and roasting (14%) (Table 4).

Table 4 Methods of cooking millets

Parameters	Variables	Percentage
Method of cooking millet at home	Pressure cooking	24.00
	Sauteing	3.00
	Steaming	49.00
	Baking	3.50
	Stewing	4.50
	Frying	1.50
	Roasting	14.00
	Other	0.50

Table 5 Purchasing practices of millets

Parameters	Variables	Percentage
Buying outlets	Online retailer	2.00
	Local shop	40.50
	Speciality natural store	14.50
	Local grocery store	41.00
	Other	3.00

Purchasing practices of millets

It was identified that the majority of individuals preferred local grocery stores (41%) and local shops (38.5%) for the purchase of millets. Similarly, most of the people (54.5%) preferred to buy whole grains and 30 per cent preferred flours and 15 per cent as ready to eat foods like noodles, pasta, vermicelli, porridge mix etc., which were represented in (Table 5, Figure 6).

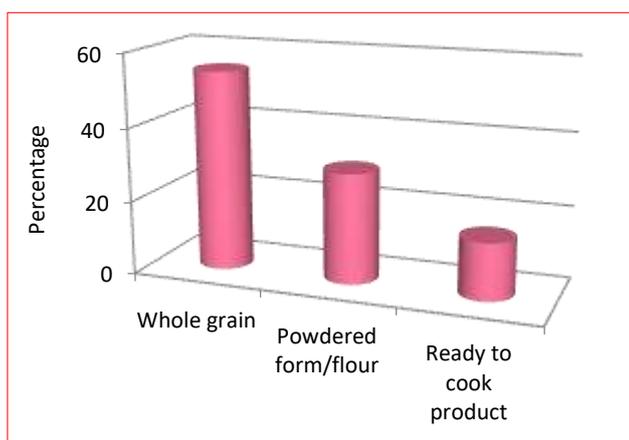


Figure 6 Form of buying millets

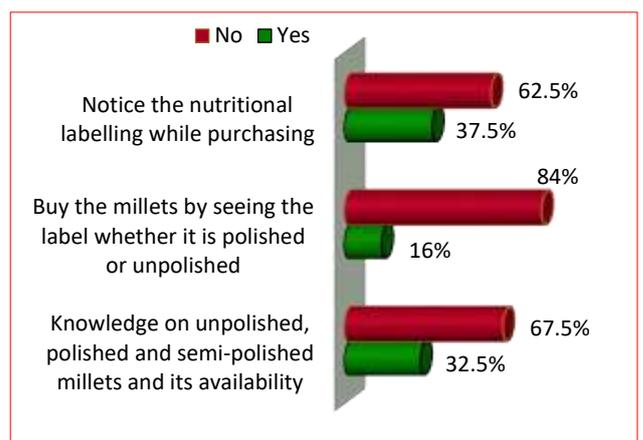


Figure 7 Awareness about the polishing of millets

Awareness about the polishing of millets and labelling information

The significant finding of this study is that the majority of the public (67.5%) was unaware that the millets were polished and their rate of processing. More than three fourth (84%) of them are unaware of the availability and sale of polished and unpolished millets while purchasing. Sixty-three per cent of them informed that they would read the label

information only for the date of packing and they don't read the nutrient information. Figure 7 depicts this significant information of the study.

With increased milling time, the bran part of the millet was removed, resulting in a decrease in head rice production and an increase in the bran and broken grains portion. The grains polished for 60 seconds were regarded as fully polished since they had a brighter colour, and after another 80 seconds

of polishing, the proportion of fractured grains was higher (7.46 per cent). As a result, grains polished in 30 seconds were considered semi-polished (Karakannavar *et al.* 2021).

CONCLUSION

As per this study, millet consumption practices have increased among people nowadays. This could be because people are aware that millets were nutrient-rich, which aids in the prevention of diabetes mellitus, CVD, cancer, and so on. Polished and semi-polished varieties were now available in the market. According to the survey results, the majority of the population prefers to buy whole grain millet from the markets. The people were unaware that polished varieties were being

sold in the market, and there is a possibility of nutrient reduction due to the degree of polishing. However, public education must focus on the degree of polishing, the form sold in the markets and ways to identify those millets. Consuming unpolished millet will foster good health and well-being.

Financial support and sponsorship:

The author(s) acknowledge Tamil Nadu State Council for Science and Technology (TNSCST) for the financial support under the Students Project Scheme (2021-2022) (Project code: AS-087)

Conflicts of Interest: The author(s) declares no conflict of interest.

LITERATURE CITED

1. Anil, K., Kumar, T. M., & Dinesh, J. 2021. *Millets and Millet Technology*. <https://doi.org/10.1007/978-981-16-0676-2>
2. Brightman, Marc, and Vanessa Grotti. 2020. "The ethics of anthropology." *Handbook of Research Ethics and Scientific Integrity*: 817-834.
3. Dayakar Rao, B., Bhaskarachary, K., Arlene Christina, G. D., Sudha Devi, G., Vilas, A. T., & Tonapi, A. 2017. Nutritional and health benefits of millets. *ICAR Indian Institute of Millets Research (IIMR), Rajendranagar, Hyderabad, 112*, 33.
4. Kane-Potaka, J., Anitha, S., Tsusaka, T. W., Botha, R., Budumuru, M., Upadhyay, S., Kumar, P., Mallesh, K., Hunasgi, R., Jalagam, A. K., & Nedumaran, S. 2021. Assessing Millets and Sorghum Consumption Behavior in Urban India: A Large-Scale Survey. *Frontiers in Sustainable Food Systems*, 5(August), 1–12. <https://doi.org/10.3389/fsufs.2021.680777>
5. Karakannavar, S. J., Nayak, G., & Hilli, J. S. 2021. Effect of different levels of polishing on Physico-chemical characteristics of barnyard millet (*Echinochloa frumentacea*). *The Pharma Innovation Journal*, 10(3), 50–54.
6. Kothari, C. R. 2004. *Research methodology: Methods and techniques*. New Age International Publishers, New Delhi.
7. Joseph, M. R., Stanly, D. P., & Hanmugam, A. 2013. A Study on Millets Based Cultivation and Consumption in India. *International Journal of Marketing Financial Services and Management Research*, 2, 49–58.
8. Pushpavalli, K. 2015. Overview on Millets (Nutri Cereals). *Trends in Bioscience*, 8, 3269-3273.
9. Rao, B. S. N. 2012. Millets in Indian Diets : An Overview. *Bulletin of the Nutrition Foundation of India*, 33(3).
10. Verma A, Khurana SC. 2019. *Millets - The Nutri-Cereals*. https://fssai.gov.in/upload/uploadfiles/files/Guidance_Notes_Version_2_Millets_29_01_2020.pdf

Nutrient Intake, Physical Activity and Menstrual Pattern of Female Students from Selected Schools and College

Deepikhaa K¹, Afeefah Firdaus², Rufinaroshini³ and Gowri Ramesh*⁴

¹⁻⁴Department of Home science, Women's Christian College, Chennai - 600 006, Tamil Nadu, India

Correspondence to: Gowri Ramesh, Department of Home science, Women's Christian College, Chennai - 600 006, Tamil Nadu, India, Tel: +91 9962525136; E-mail: gramesh@wcc.edu.in

Abstract

Awareness on healthy practices among adolescent females is necessary to manage lifestyle related disorders or irregular menstrual cycles. This study was undertaken to assess dietary, physical activity and menstrual pattern of female students aged 13 to 21 years from select schools and colleges in Chennai city. A survey method was adopted to disseminate questionnaires to 750 participants who were selected based on convenience sampling. Experimental design using a pre-test post-test was implemented for the nutrition education program. Sixty percent of the participants were found to skip breakfast, and a majority (84.4%) had the habit of snacking, and consumed less fruits and vegetables. Mean nutrient intake of the participants was found to be less than the recommended dietary allowances for protein, iron and calcium. Many of the participants did not indulge in any physical activity, and 36.8 per cent were found to have irregular menstrual cycles. A significant increase in the knowledge levels of the participants was observed ($p < 0.01$) at the end of the study. Regular assessment of dietary, physical activity and menstrual pattern among adolescents is important in planning nutrition interventions for a healthy lifestyle, and help with the management of menstrual irregularities and lifestyle disorders.

Key words: Females, School and college students, Nutrient intake, Physical activity, Menstrual pattern

Adolescence is a period of rapid growth and maturation which requires extra nutrients and energy-rich foods. Food habits of adolescents in the recent past have changed with respect to their nutrient intake, skipping of meals or widespread consumption of fast foods.[18] Nutrition pattern is one of the important factors predicting menstrual distress, which varies among different cultures and countries and includes physical, psychological and behavioral signs. Unhealthy eating habits such as skipping breakfast and excessive intake of foods with high carbohydrate and fat content are the main factors causing nutritional problems [19].

The world is now facing a double burden of malnutrition that includes both undernutrition and overnutrition, especially in low-income and middle-income countries [2]. Undernutrition in adolescence can disrupt normal growth and puberty, and increase the risk of infectious diseases [16]. At the same time, overweight and obesity affecting one-third of adolescents globally are linked to poor dietary quality. Obesity is a major factor that can lead to insulin resistance or hyperlipidemia which can contribute to the development of polycystic ovarian disorder, and in turn affect the quality of life [11]. Higher prevalence of obesity has also shown a decreased age at menarche [4].

Studies have shown menstrual disorders to be significantly associated with an increase in BMI, consumption of junk foods and lack of physical exercise [27]. A healthy and

balanced diet with consumption of fruits, vegetables, fish and dairy products will help provide the right amount of macro and micronutrients, especially iron and calcium, which will help maintain a normal menstrual cycle, reduce pain during menstruation, and also prevent malnutrition related problems. An inadequate calorie intake as a result of dieting may cause energy imbalance which can lead to alterations in menstrual cycles, and is also an important risk factor in the etiology of lifestyle related disorders [11]. Fast foods or junk foods may also increase the risk of dysmenorrhea, irregular or excessive menses [26].

Studies have indicated regular physical activity to decrease the risk of chronic diseases, severity and occurrence of depression and stress levels. In a study, signs and symptoms of dysmenorrhea was significantly lower in physically active women than in a sedentary group. Analyzing the behavior of Pre-menstrual symptoms (PMS) in relation to the practice of physical exercises, it was observed that the signs and symptoms of depressed mood, fatigue, difficulty to concentrate, lack of interest in social and home activities were more significant in sedentary women [20].

With the increase in the prevalence of menstrual irregularities among adolescents and young women, the need for educating and creating awareness regarding healthy dietary habits and physical activity also increases [17]. The period of transition from adolescence to adulthood marks sudden changes

in dietary habits, mealtime and lifestyle, especially owing to concern regarding body weight. Most of the students who are quite active during school days, switch to a sedentary lifestyle after college. Thus, the importance of balanced nutrition and physical activity on regularity of menstruation should be emphasized since nutrients in food play an important role in the production of hormones that regulate menstruation. Being physically active improves the blood flow at the pelvis and promotes the release of endorphins which function as non-specific analgesics [3], [20]. Therefore, with this focus, the objective of the study was to assess the nutrient intake, physical activity and menstrual pattern of adolescent students aged 13 to 21 years from select schools and colleges in Chennai.

MATERIALS AND METHODS

The study comprised of a survey design conducted via both online and offline mode. Online mode was adopted in institutions that had not opened up completely due to the Covid-19 pandemic situation. It also involved an experimental design where a pre-test post-test was used to assess the impact of a nutrition education program on the knowledge levels of participants from a select institution in an offline mode. Purposive sampling was used to include 750 female participants in the age group of 13 to 21 years from three schools and one college in Chennai, which had given permission for the conduct of the study. The necessary assent and consent were obtained from the respective participants and authorities to disseminate the questionnaires in the online and offline mode, and for the conduct of a nutrition education program. The study protocol after obtaining ethical clearance from the Institutional Ethical committee, was explained in detail to the respective authorities and the participants.

A questionnaire was used to elicit information on socio-demographic, dietary, physical activity and menstrual pattern of the participants, both in the offline and online mode. A 24-hour dietary recall was used to estimate the nutrient content in the diet of the participants. The quantitative data obtained from the questionnaire was analyzed using Microsoft Excel and the data obtained from 24-hour dietary recall was analyzed using Nutrifly India, an App developed by National Institute of Nutrition for nutrient estimation.

A one-time nutrition education program was conducted in the select college, and the impact of program on the knowledge levels of the participants was assessed using a pre-

test and post-test. The duration between these tests were 30 days. The nutrition education program focused on the importance of good nutritional status, balanced diet, meals, consequences of skipping breakfast, exercise and other lifestyle habits, and the impact on menstrual pattern. The schools did not give permission for the nutrition education program due to examinations. However, a pamphlet containing the relevant information was designed and distributed to the participants from various institutions.

RESULTS AND DISCUSSION

Socio-demographic characteristics

A total of 750 students participated in the study, out of which 400 were in the age group of 13-17 years and 350 in the age group of 18-21 years. The socioeconomic status classification was based on education level and occupation of the head of the family and total family income defined by Kuppuswamy (2019). Almost 37% of the participants belonged to upper middle class while 30% were from upper lower class.

Self-reported anthropometric measurements such as height and body weight were used to calculate the Body Mass Index (BMI) of the participants, and categorized based on WHO- Asian Classification (2021). Almost 50 per cent of the participants had normal BMI. About 17% and 8% were overweight and obese respectively, and 23% of the participants belonged to underweight category. This is represented in the (Figure 1).

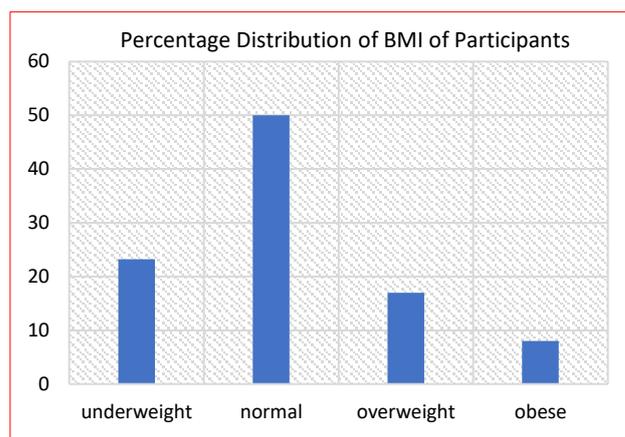


Fig 1: BMI categories of participants

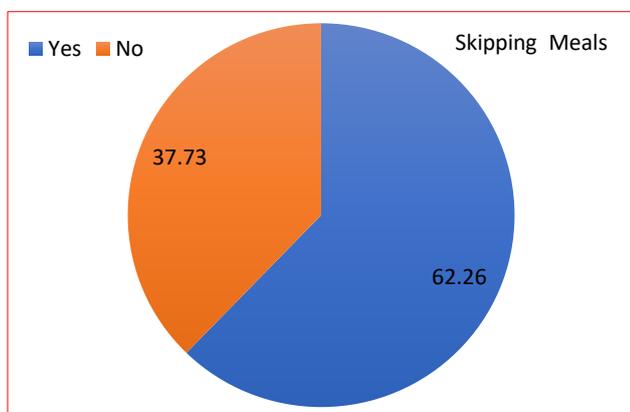


Fig. 2: Skipping of meals by the participants

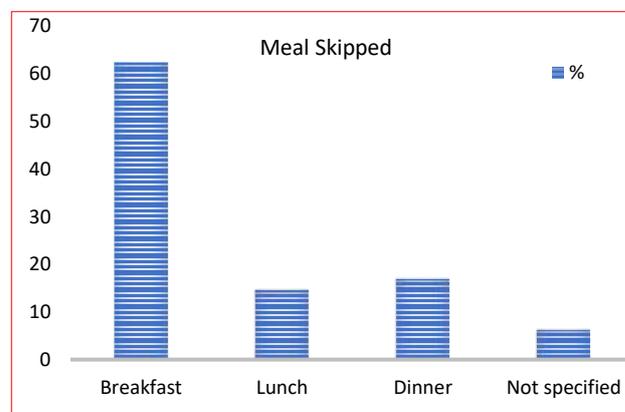


Fig. 3: Type of meal skipped by the participants

Dietary pattern of the participants

With regard to the dietary pattern, a majority of the participants were found to be non-vegetarians. Around 62 % of the participants were found to skip meals, of which breakfast

was the most skipped meal (60 %). Lack of time (58.02%) was reported as the most common reason for skipping meals. Exam preparations and strategies for weight loss was also reported by a few participants, as to why they skipped breakfast. Skipping

of meals by the participants is represented in figures 2 and 3. A majority (84.4 %) of the participants were found to snack between meals. About 28 per cent of the participants consumed fruits every day, followed by 24 per cent who consumed fruits once a week. Eating out was found to be quite common among the participants, where 44 % of them ate out at least once a week. With regard to water consumption, many participants were found to consume less than the recommended amount of water every day.

Mean nutrient intake

Percentage distribution of participants based on age group, mean nutrient intake, and comparison with the Recommended Dietary Allowance (RDA) is presented in (Table 1).

Table 1 Mean nutrient intake of participants based on age group and RDA

Age Group	Nutrients	Mean ± SD	RDA*	Percentage (Increase or Decrease) of Nutrient intake against RDA
13 – 15 years	Energy (kcal)	1160.8 ± 310.05	2330 (kcal/d)	↓ 50.2
	Carbohydrates (g)	160.3 ± 46.28	582.5 (kcal/d)	↓ 72.5
	Protein (g)	37.8 ± 11.7	55.1 (g/d)	↓ 33.4
	Fat(g)	40.5 ± 19.9	40 (g/d)	↑ 1.25
	Calcium (mg)	335.7 ± 189.19	800 (mg/d)	↓ 58.1
	Iron (mg)	6.6 ± 2.47	27 (mg/d)	↓ 75.56
16 – 17 years	Energy (kcal)	1116.03 ± 355.30	2440 (kcal/d)	↓ 54.27
	Carbohydrates (g)	161.55 ± 60.351	610 (kcal/d)	↓ 73.52
	Protein (g)	36.835 ± 11.894	55.5 (g/d)	↓ 33.64
	Fat(g)	34.769 ± 13.633	35 (g/d)	↓ 0.66
	Calcium (mg)	289.993 ± 169.883	800 (mg/d)	↓ 33.76
	Iron (mg)	6.318 ± 4.4738	26 (mg/d)	↓ 75.7
18 - 21 years	Energy (kcal)	1365.47 ± 369.28	1900kcal/d	↓ 28.14
	Carbohydrates (g)	180.23 ± 52.5	475gm/d	↓ 62.1
	Protein (g)	46.163 ± 21.25	55gm/d	↓ 17.43
	Fat(g)	46.919 ± 18.67	20gm/d**	↑ 134.55
	Calcium (mg)	299.17 ± 189.87	600mg/d	↓ 50.14
	Iron (mg)	7.98 ± 5.56	21mg/d	↓ 62

*RDA: National Institute of Nutrition, ICMR, 2020.

** RDA for sedentary adult women

From the above table, it is observed that the energy, protein, iron and calcium intake of all the participants were found to be much less (around 50 %) than the RDA. However, fat intake was almost similar to the RDA. Among college goers, fat intake was much more than the RDA (for visible fats) which could be due to their access to unhealthy snacks on campus.

Physical activity pattern of the participants

- With regard to children studying in schools, play during free class hours, break hours or during games period, was more frequent when compared with participants from college. In most participants of all ages, structured exercises or any form of physical activity were found to be less common.
- About 40.5 per cent of the participants from schools spent two to five hours per day as screen time, while 37.1 per cent of the older participants used phone or television more than five hours in a day. This increase in screen time could have also been due to online classes during the Covid-19 pandemic.
- Sleep hours among 55.5 per cent of the younger participants was found to be around 7-8 hours a day, while a majority of the older participants (60.7%) were found to sleep only 5 to 6 hours a day.

Menstrual pattern of the participants

Percentage distribution of participants based on details pertaining to their menstrual pattern is presented in (Table 2).

It is observed that most participants had regular menstrual cycles, with half of them reporting on normal menstrual flow lasting for 4-5 days. Almost half the participants

had their cycle between 20-30 days, and a majority suffered from menstrual cramps.

Table 2 Menstrual pattern of the participants

Menstrual Pattern	Participants (n=750)		
	No.	%	
Regular menstrual cycle	No.	%	
	Yes	474	63.2
	No	276	36.8
Period of menstrual cycle	No.	%	
	<10 days	87	11.6
	10-20 days	63	8.4
	20-30 days	371	49.46
	>30 days	229	30.53
Length of menstrual cycle	No.	%	
	<3 days	168	22.4
	4-5 days	409	54.53
	6-7 days	139	18.53
	>7 days	34	4.53
Flow of menstrual cycle	No.	%	
	Heavy	97	12.93
	Normal	417	55.6
	Light	65	8.66
Keeps changing	171	22.8	
	Menstrual cramps	No.	%
		Yes	540
No		210	28

Assessment of pre-test post-test

The impact of nutrition education program was assessed using a pre-test and post-test KAP questionnaire. A total of 80 participants from the select college attended the program out of which 70 responded to the test. Mean scores obtained by the participants is presented in (Table 3).

Table 3 Means pre-test post-test scores of participants

Scores of participants (n = 70)		't' value	'p' Value
Mean ± SD			
Pre-test	Post-test		
8.25 ± 0.8	13.0 ± 1.18	1.667	0.000

P < 0.001

The mean scores at post-test showed a significant ($p < 0.001$) increase among the participants. This shows that the nutrition education program had created a positive impact on the participants

Adolescence represents a critical period of development during which personal lifestyle choices and behavior patterns such as diet and exercise are established [15], [18]. Prevalence of impaired nutritional status or deficiency is more common among adolescents and college goers, contributed by limited access to healthy foods, lack of finances, peer pressure, and lifestyle changes, students resorting to high-fat, high sugar and salty snacks, skipping meals and substituting energy dense foods for nutritious foods [28].

In the present study, with regard to the dietary pattern of the participants, a majority of them were found to be non-vegetarians. A study by Jain *et al.* (2009) reported no significant change in menarche of the adolescents with food habits of vegetarians and ovo-vegetarians, however, early menarche was reported among girls who were non-vegetarians [13]. Another observation in the study was the presence of prolonged menstrual cycle and menses in non-vegetarian group. There was also a significant increase in BMI among non-vegetarian girls when compared to ovo-vegetarian and vegetarian girls, which suggested that non-vegetarians could be more prone to being overweight and obese. Therefore, girls with a higher mean body weight were more prone to earlier onset of menarche.

With regard to skipping breakfast, lack of time was reported as the most common reason for skipping meals. Exam preparations and strategies for weight loss was also reported by a few participants, as to why they skipped breakfast. Two systematic reviews looking at breakfast consumption and body weight outcomes found that the prevalence and risk of overweight was lower in adolescents who consumed breakfast regularly compared to those who ate breakfast infrequently. Breakfast skipping was also frequently associated with poor productivity and cognitive performance [14]. Based on a study finding by Eittah (2014), there was an increase in the percentage of menstrual regularity in participants who had breakfast than those who skipped breakfast [9]. Premenstrual abdominal pain, anorexia and premenstrual cramps also showed a decrease in participants who consumed breakfast. A majority of the participants (84.4%) had the habit of snacking foods high in salt, sugar and fat. Dysmenorrhea was considerably found to be higher in girls who consistently ate fast foods. Junk foods which may contain more saturated fatty acids could affect the metabolism of progesterone in the menstrual cycle. Studies have also shown lack of micronutrients in junk foods to be responsible for triggering dysmenorrhea, premenstrual symptoms and menstrual irregularities [18].

Nutrient requirements are increased in adolescence due to increased growth and body size. These changes have direct effects on the nutritional status, and thus there is a significant

increase in the requirements for energy, protein, vitamins and minerals.[6] In this study, energy, protein, iron and calcium intake was found to be less than 50% of the RDA in the diet of the participants. Nutrition and body weight plays an important role in the development of puberty. Chronic diseases, malnutrition, eating disorder, consumption patterns and heavy physical activity can interfere with the process of menarche and menstrual cycle. High prevalence of nutritional deficiencies among women and girls can cause menstrual irregularities, and girls who have nutritional deficiencies will experience delay in menarche compared to girls with good nutritional status. The hormonal fluctuation that is associated with the menstrual cycle affects appetite control and eating behaviour of a person [24]. Alternatively, significant changes in the diet have also resulted in changes in hormone production and consequently led to menstrual irregularity and early age at menarche [12]. Low energy intake along with low iron and calcium intake can affect the menstrual pattern of these adolescents. During the adolescent growth spurt, protein needs are high and utilization of protein is dependent on adequate energy intake. When protein intake is consistently inadequate, reduction in linear growth, delays in sexual maturation and reduced accumulation of lean body mass may be seen. Subgroups of adolescents may be at risk for marginal or low protein intakes, including those from food-insecure households, or who severely restrict calories, and consume vegetarian diets devoid of any protein sources [6].

Iron requirement is very high for the post menarche adolescent girls due to menstrual blood losses [10]. Iron deficiency anemia is also caused by low serum hemoglobin levels. Without proper dietary iron supplementation, monthly menstrual iron losses gradually depletes the body's iron stores, resulting in iron deficiency identified by a low serum ferritin level [22]. The World Health Organization therefore recommends weekly iron and folic acid (IFA) supplementation for all menstruating adolescent girls and women where the prevalence of anemia among women of reproductive age is >20%, and daily iron supplementation where the prevalence is >40% [6]. Calcium deficiency is also linked to irregular menstruation and excessive bleeding in women. The mineral has a key role in the development of the uterus and ovarian hormones in women [5].

Physical activity pattern of the participants revealed that most of them were not engaged in any form of exercise. Physical activity is well-known to provide multiple health-related benefits in children and adolescents. However, 81% of adolescents aged 11–17 years are not physically active globally, with significant differences in the prevalence of insufficient physical activity across genders, regions, and countries [8]. Several reports and reviews have confirmed physical activity and exercises to alleviate menstrual pain and other symptoms [20]. A study states that women with sedentary lifestyle have higher levels of dysmenorrhea compared to physically active women. In similar studies conducted in Iran, researchers found a very significant role of physical activity in reducing the severity of dysmenorrhea and premenstrual syndrome [20].

Menstrual issues can cause a considerable amount of discomfort to the sufferer. If left undiagnosed and untreated, may have serious long-term effects on quality of life [23]. With respect to menstrual cycle, it was observed that 36.8 per cent of the participants had irregular menstrual cycles. Studies have shown dysmenorrhea, PMS, and menstrual irregularities to be associated with improper dietary habits and physical activities. Dysmenorrhea was associated with eating junk food (66.10%), and PMS with lack of physical activities (78.94%) [18]. These problems deserve careful evaluation; they may reflect normal

ovulatory menstrual symptoms or be suggestive of significant pathology that can have a major impact on future reproductive and general health [1]. Studies have also highlighted the potentially protective role of increased consumption of fruits, vegetables, fish and dairy products against menstrual pain [21].

Although there are many intervention studies focusing on life style changes regarding dietary habits and menstrual pattern, prevalence of improper lifestyle preferences still continues to persist among society, especially among adolescents. These unhealthy preferences will affect the menstrual pattern and overall health status of female students. The need for increasing awareness and knowledge about good dietary habits is very high. It is necessary to bring in a behavioural change among students, so that they refuse to comply with unhealthy food habits, lifestyle choices and substitute it with better nutritious and lifestyle choices. In this study, the nutrition education program had shown a significant improvement in the knowledge levels of participants at post-test. These programs help individuals make healthier food choices and choose a physically active lifestyle acquiring knowledge, skills, attitude to make the necessary behavioural changes [25].

CONCLUSION

From this study, it was observed that a majority of the participants were found to skip breakfast, consume snacks high in salt, sugar and fat. Skipping meals, especially breakfast owing to lack of time, was reported by most participants. Recommended Dietary Allowances (RDA) for energy, carbohydrate, and protein intake was not met by the participants, and was found to be much lower than the required amounts. However, fat intake was on par with the RDA. Calcium and Iron intake did not meet the RDA by a large percentage of the participants. A balanced nutrition is crucial during adolescence, as it is a period of growth and development. This study also indicated that a majority of the participants were not physically active and did not take part in any structured or unstructured activities. The participants also had an increased screen time and irregular sleep pattern during exams. Although most of the participants had a regular menstrual cycle, a majority of them had menstrual cramps and mood swings. The Covid-19 lockdown period could also have been a contributing factor in developing unhealthy dietary habits and leading a sedentary lifestyle. An increase in the usage of gadgets especially mobile phones and video games might have decreased time spent on physical activity. Online classes during

the pandemic may have led to an increase in screen time among students. Unhealthy snacking behaviour and eating habits along with low levels of physical activity might also be a risk factor for obesity. Menstrual cramps were also found in a majority of the participants which could have been due to their sedentary behaviour and unhealthy food choices. Various studies have revealed that the nutritional status and physical activity have an impact on the menstrual irregularities of adolescent girls. Nutritional needs of school girls change during menstruation and the pattern of menstrual cycle can have a significant impact on the reproductive life of an adolescent girl. The cycle length, regularity of periods, and severity of dysmenorrhea have also exhibited a positive association with improvement in physical activity. Although there are studies emphasizing the need for a healthy diet, the current Covid-19 pandemic has resulted in improper eating habits, and thus affected the overall well-being of children and adolescents. However, by conducting nutrition education programs, an awareness can be created on healthy lifestyle behaviours to alleviate menstrual distress and problems. In this study, post-test showed an improvement in the knowledge levels of the participants. Thus, knowledge when put into practice can promote better dietary choices and physical activity, and reduce problems associated with menstrual cycles. Therefore, it is important to educate adolescents on good nutrition and benefits of physical activity in order to modify or reduce menstrual cycle disturbances, and prevent or postpone the onset of lifestyle related disorders.

Limitations

Due to the Covid-19 pandemic, it was difficult to obtain information from all the participants using a physical questionnaire. There were quite a few incomplete responses due to the examination schedule in institutions. It was not possible to conduct a Nutrition Education Program for the school students as it was difficult to get permission from educational institutions due to the examination schedule.

Financial support and Sponsorship

'Tamil Nadu State Council for Science and Technology' (TNSCST) grant under Students Project Scheme, 2021-2022.

Acknowledgement

We are extremely grateful to TNSCST for having funded our research topic. We are also thankful to the institutions which gave us permission to conduct the study, and to all the participants for their cooperation, both online and offline.

LITERATURE CITED

1. Adams Hillard, P. J., & Deitch, H. R. (2005). Menstrual disorders in the college age female. *Pediatric clinics of North America*, 52(1), 179–x. <https://doi.org/10.1016/j.pcl.2004.10.004>
2. Alzahrani, S. I., Aljamaan, I. A., & Al-Fakih, E. A. (2020). Forecasting the spread of the COVID-19 pandemic in Saudi Arabia using ARIMA prediction model under current public health interventions. *Journal of infection and public health*, 13(7), 914-919.
3. Amgain, K. (2019). Effects of BMI and Food Habits on Menstrual Characteristics among Adolescent Girls. *Europasian Journal of Medical Sciences*, 1(1), 53-61.
4. Barde, S., Upendra, S., and Devi, S., (2014): Influence of body mass index on menstrual irregularities in adolescent girls Int J Med Health Sci. Vol-4; PP. 2277-4505 Available at: <http://www.ijmhs.net>.
5. Beals, K. A. (2002). Eating behaviors, nutritional status, and menstrual function in elite female adolescent volleyball players. *Journal of the American Dietetic Association*, 102(9), 1293-1296.
6. Brown, K. A., Patel, D. R., & Darmawan, D. (2017). Participation in sports in relation to adolescent growth and development. *Translational pediatrics*, 6(3), 150.
7. Canavan, C. R., and Fawzi, W. W. (2019). Addressing knowledge gaps in adolescent nutrition: toward advancing public health and sustainable development. *Current developments in nutrition*, 3(7), nzz062.

8. Chaput, J. P., Willumsen, J., Bull, F., Chou, R., Ekelund, U., Firth, J., ... & Katzmarzyk, P. T. (2020). 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: summary of the evidence. *International Journal of Behavioral Nutrition and Physical Activity*, 17(1), 1-9.
9. Eittah, H. F. A. (2014). Effect of breakfast skipping on young females & menstruation. *Health Science Journal*, 8(4), 0-0.
10. Food and Nutrition Board, 2001.
11. Gupta, D. S., Jadhav, N. A., & Kanase, S. B. (2021). Effect of Diet, Physical Activity, and Psychosocial Factors, on Menstrual Cycle Abnormalities in College Students of Karad, Maharashtra, India. *Journal of Evolution of Medical and Dental Sciences*, 10(15), 1048-1054.
12. Jahangir, A. (2018). Do nutritional deficiencies lead to menstrual irregularities. *Int J Nutr Sci & Food Tech*, 4(3), 27-31.
13. Jain, M., Mathur, A., Sawla, L., Choudhary, G., Kabra, K., Duraiswamy, P., and Kulkarni, S. (2009). Oral health status of mentally disabled subjects in India. *Journal of oral science*, 51(3), 333-340.
14. Keats, E. C., Rappaport, A. I., Shah, S., Oh, C., Jain, R., & Bhutta, Z. A. (2018). The dietary intake and practices of adolescent girls in low-and middle-income countries: a systematic review. *Nutrients*, 10(12), 1978.
15. Kumar, B., Robinson, R., & Till, S. (2015). Physical activity and health in adolescence. *Clinical medicine (London, England)*, 15(3), 267–272. <https://doi.org/10.7861/clinmedicine.15-3-267>
16. Kumar, P., Srivastava, S., Chauhan, S., Patel, R., Marbaniang, S. P., and Dhillon, P. (2021). Associated factors and socio-economic inequality in the prevalence of thinness and stunting among adolescent boys and girls in Uttar Pradesh and Bihar, India. *PloS one*, 16(2), e0247526.
17. Mohamadirizi, S., Hasanzadeh, A., Ghasemi, G., and Mohamadirizi, S. (2015). The relationship between social physique anxiety and obsessive-compulsive disorders with eating problems among adolescent.
18. Negi, P., Mishra, A., and Lakhera, P. (2018). Menstrual abnormalities and their association with lifestyle pattern in adolescent girls of Garhwal, India. *Journal of family medicine and primary care*, 7(4), 804.
19. Neslişah, R., & Emine, A. Y. (2011). Energy and nutrient intake and food patterns among Turkish university students. *Nutrition research and practice*, 5(2), 117-123.
20. Omidvar, S., Amiri, F. N., Firouzbakht, M., Bakhtiari, A., and Begum, K. (2019). Association between physical activity, menstrual cycle characteristics, and body weight in young south indian females. *Int J Women's Health*, 7(3).
21. Onieva-Zafra, M. D., Fernández-Martínez, E., Abreu-Sánchez, A., Iglesias-López, M. T., García-Padilla, F. M., Pedregal-González, M., & Parra-Fernández, M. L. (2020). Relationship between diet, menstrual pain and other menstrual characteristics among Spanish students. *Nutrients*, 12(6), 1759.
22. Peuranpää, P., Heliövaara-Peippo, S., Fraser, I., Paavonen, J., & Hurskainen, R. (2014). Effects of anemia and iron deficiency on quality of life in women with heavy menstrual bleeding. *Acta obstetrica et gynecologica Scandinavica*, 93(7), 654-660.
23. Proctor, M., & Farquhar, C. (2006). Diagnosis and management of dysmenorrhoea. *BMJ (Clinical research ed.)*, 332(7550), 1134–1138. <https://doi.org/10.1136/bmj.332.7550.1134>
24. Rogers, P. J., & Smit, H. J. (2000). Food craving and food “addiction”: a critical review of the evidence from a biopsychosocial perspective. *Pharmacology Biochemistry and Behavior*, 66(1), 3-14.
25. Sampat, F., Desai, D. and Sengupta, R. (2021). Impact of Nutrition Education Program on Dietary Pattern and Menstrual Cycle in Adolescent in Mumbai
26. Shinde, P., Vyas, K., & Goel, S. (2017). Effects of junk food/fast food study. *International. Ayurvedic Medical*, 2(1).
27. Sreelakshmi, U., Tushara, B. V., Subhashini, T., & Saritha, K. (2019). Impact of dietary and lifestyle choices on menstrual patterns in medical students. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, 8(4), 1271-1277.
28. World Health Organization, 2006.

Estimation of Heavy Metals in *Bryophyllum pinnatum*

Irfin Fathima S¹ and Beautlin Mistica Paul M. D²

^{1,2} P. G. and Research Department of Nutrition and Dietetics, Muslim Arts College, Thiruvithancode, Kanyakumari District, Manonmaniam Sundarnar University, Thirunelveli - 629 174, Tamil Nadu, India

Correspondence to: M. Velvizhi, P. G. and Research Department of Nutrition and Dietetics, Muslim Arts College, Thiruvithancode, Kanyakumari District, Manonmaniam Sundarnar University, Thirunelveli - 629 174, Tamil Nadu, India, Tel: +91 7708187578; E-mail: velvizhi.nima@gmail.com

Abstract

Bryophyllum pinnatum belongs to the family crassulaceae. It is an evergreen plant with salty and sour flavour, tribal people used these plants leaves against kidney stones, because of it has many phytochemicals such as steroids, flavonoids, terpenoids, fatty acid, bufadienolides, protein and peptides, vitamins, polysaccharide and others. In this present study *B. pinnatum* leaves were analysed for the content of heavy metals such as Mercury, Lead, Arsenic, Cadmium, Nickel using five different extracts such as methanol, ethanol, aqueous, acetone and chloroform. The results showed that the heavy metals contents were less than 0.05 ppm. Thus, our present study is concluded that the leaves of *B. pinnatum* can be consumed to gain various health benefits.

Key words: *Bryophyllum pinnatum*, Crassulaceae, Taraxasterol, Heavy metals, Diseases

The hill chain of Western Ghats recognized as a region of high level of biodiversity is under the threat of rapid loss of genetic resources (Gadgil, 1996). It is a matter of great pride that, among the 16 hot spots known for rich flora in the world, two are located in India (Mohan et al., 2010). They are the Eastern Himalayas and the Western Ghats (Khoshoo, 1996). The Kanikkars are typical hill tribals. The kanikkars are also commonly known as the Kanis. The *Kanikkars* are the dominant tribal group inhabiting this locality. The *Kanikkars* belong to the southern tribal zone. They are distributed along the Southeastern slopes of altitude regions of Western Ghats in large numbers. *Kanikkars* means hereditary proprietor of land thus recognizing their ancient rights over the forest's lands. The *Kanikkars* are generally very short in stature and meager in appearance. Some have markedly negroid features. They are traditionally a nomadic community. They speak in their own dialect, *Kanikkar Bhasha* or *Malampashi*, which is close to the Dravidian language *Malayalam*.

Most of the *Kanikkar* tribals have a general knowledge of medicinal plants that are used for first aid remedies, to treat cough, cold fever, headache, poisonous bites and some other simple ailments. *Kanis* still supplement their food by gathering roots and tubers from the nearby forest areas. They eat tubers like *Manihot esculenta* and *Dioscorea oppositifolia*, etc (Sutha et al., 2010). Traditional medicine occupies an important place in the health care systems of developing countries. The World Health Organization (WHO) estimates that more than 80% of health care needs in these countries are met through traditional health care practices (Chendurpandy et al., 2010). The people in developing countries depend on traditional medicine, because it is cheaper and more accessible than Orthodox

Medicine (Sofowora, 1993; Luoga et al., 2000; World Health Organization, 2002). Traditional medicine is also acceptable than Orthodox Medicine because, it blends readily into the people's socio-cultural life (Tabuti et al., 2003).

Many infectious diseases are known to be treated with herbal remedies throughout the history of mankind. Even today, plant materials continue to play a major role in primary health care as therapeutic remedies in many developing countries (Zakaria, 1991). Plants still continue to be almost the exclusive source of drugs for a majority of the world's population (Hamburger & Hostettman, 1991).

Bryophyllum pinnatum plant belongs to family Crassulaceae, commonly used as traditional medicines. *Bryophyllum pinnatum* is derived from Greek word Bryo means to sprout and phyllon means leaf (Gand K and Gupta R 1983). The plant, *Bryophyllum pinnatum* (Crassulaceae) is commonly known as air plant, love plant, miracle leaf, life plant, Zakham-e-hyat, panfutti, Ghayamari (Jain VC 2010), has been accepted as a herbal remedy in almost all parts of the world (Igwe SA and Akunyili DN 205; Olajide OA 1998) etc. *Bryophyllum pinnatum* (Lam.) Oken plant is an environmental weed from the family Crassulaceae, but commonly used traditionally as a medicine in different regions of India mainly to treat urinary stones, as well as in other parts of world. The traditional practitioners in various parts of world use this plant in numerous conditions like hypertension, skin disorders, asthma, cold, insect stings, abscesses etc. (Vaidhya B. 2010; Chunekar KC and Pandey GS 2010). The secondary metabolites which are obtained from different parts of plant such as alkaloid, flavanoid, tannin, glycoside, phenolic compounds, which have therapeutic value (Gand K and Gupta R 1983).

Leaves of *B. pinnatum* are variable & decussate lower are usually simple / compound, upper ones are 3-5/7 foliolate with long petioled. Petioles are united by a ridge around the stem. Leaflets are ovate/ elliptic with crenate/ serrate margin. The leaves and bark of *B. pinnatum* are bitter tonic, astringent, analgesic and carminative, ethanopharmacologically used for the treatment of diarrhea and vomiting, earache, burns, abscesses, gastric ulcers, insect bites, and lithiasis. (Agoha RC 1974; Chopra RN et al., 1956; Ofokansi KC et al., 2005) Leaves powder used as wound dressing and sold as 'Jakhmehayat'. In Southeastern Nigeria, the herb is used to facilitate the dropping of the placenta of newly born baby. (Okwu DE 2007; Dalziel JM 1955). The juice from fresh leaves is used to treat smallpox, otitis, cough, asthma, palpitations, headache, convulsion and general debility (Jain VC). Leaf juice is also used in the treatment of bronchial affections, blood dysentery, jaundice and gout (Ghani A 2003).

In traditional medicine, the leaves of the plant also have been used for antifungal, potent antihistamine and anti-allergic activity. (Okwu DE and Josiah C 2006; Siddhartha Pal and Chaudhuri AKN 1991) This is also applied on the bodies of young children when they are ill. (Agoha RC 1974) It is largely used in folk medicines for the treatment of hypertension and kidney stones, 41 pulmonary infections, rheumatoid arthritis etc. (Majaz QA et al., 2011). Thukotali is the local name in poojapura (Kerala), people use crushed leaves externally to apply over the burn wound. In West Bengal & Andhra Pradesh the matured leaves are made warm and are placed over the wounds and tied (An appraisal of tribal folk medicine 1999). In konkan the leaf juice is used in dysentery with ghee. Two teaspoon of leaf juice is given in renal calculi (Melookunnel S 1995). In Chota Nagpur the steamed leaf juice is used in cough along with ghee/ garlic. The leaves are treated with palm oil & used externally in sore eyes (Kirthikar KR and Basu B).

The plant contain alkaloid, flavonoid, tannin, phenolic compound, saponin glycoside (Chauhan MG et al., 2007), macro element such as magnesium, calcium, potassium, sodium, phosphorous, micro-element such as iron, zinc, vitamin, ascorbic acid, riboflavin, thiamin, niacin. It also contains syringic acid, caffeic acid, 4 hydroxy -3-methoxy cinnamic acid, 4-hydroxy benzoic acid, parahydroxy cinnamic acid, para coumaric acid, ferulic acid, protocatechuic acid, phospoenolpyruvate, the leaves of plant also contain protocatechuic acid, astragalol, luteolin, rutin, kaemferol, quercetin, kaemferol-o-glycosides. (Microscopical character of *Bryophyllum pinnatum*, 2010.) Three flavonoid was isolated from plant responsible for antileishmanial activity. It also contains Bufadienolides such as Bryophyllin A, B, C, Bryophyllon.

Juice of the fresh leaves is used very effectively for the treatment of jaundice in Bundelkhand region of India. In 2005 Yadav *et al.*, studied that the juice of leaves was found more effective than ethanolic extract as evidenced by invivo and invitro histopathological studies for hepatoprotective activity of plant and justifies the use of juice of plant leaves in folk medicine for jaundice. The protective effect of the juice of fresh leaves on gentamicin-induced nephrotoxicity in rats which may involve its antioxidant and oxidative radical scavenging activities (G.V. Haslalka et al., 2007).

Pal *et al.* revealed that a methanolic fraction of leaves was found to possess significant antiulcer activity. Premedication tests in rats revealed that the extract possessed significant protective action against the gastric lesions induced by aspirin, indomethacin, serotonin, reserpine, stress and ethanol; also significant protection for aspirin-induced ulcer in pylorus-ligated rats and for histamine-induced duodenal lesions

in guinea pigs; and also significant enhancement of the healing process was also found to occur in acetic acid-induced chronic gastric lesions in rats (S. Pal, and A.K. Nag Chaudhari. 1991).

The presence of phenolic compounds indicate that the plant possesses anti-microbial activity. Obaseiki-Ebor et al investigated the invitro antibacterial activity of leaf juice. The extract at 5% v/v was found to bactericidal to a wide spectrum of gram-positive and gram-negative bacteria such as *B. subtilis*, *S. aureus*, *S. pyogenes*, *S. faecalis*, *E. coli*; *Proteus spp*; *Klebsiella spp*; *Shigella spp*; *Salmonella spp*; *S. marcescens*; and *P. aeruginosa* including the clinical isolates of these organisms possessing multiple antibiotic resistance (E.E. Obaseiki-Ebor. 1985).

Ojewole evaluated the antihypertensive efficacy of leaf extracts. The effects of aqueous and methanolic leaves extracts were examined on arterial blood pressures and heart rates of normal and spontaneously hypertensive rats, using invasive and non-invasive techniques. Both the extracts produced dose related, significant decreases in arterial blood pressures and heart rates of anaesthetized normotensive and hypertensive rats. The hypotensive effects of the leaf's extracts were more pronounced in the hypertensive than in normotensive rats. The leaves extract also produced dose dependent, significant decreases in the rate and force of contractions of guinea-pig isolated atria, and inhibited electrical field stimulation (ES)-provoked, as well as potassium and receptor-mediated agonist drugs-induced contractions of the rat isolated thoracic aortic strips in a non-specific manner. cardiodepression and vasodilation would appear to contribute significantly to the antihypertensive effect of the herb (J.A.O. Ojewole. 2002).

Dra Amalia et al investigated the anti-inflammatory activity of the fluid extract of the leaves against the edema caused by carrageen in rats. It was confirmed that the fluid extract with 4.5 % of total solids at doses of 100 mg/kg of weight has an anti-inflammatory effect (Dra. Amalia, 2002). The high saponin content justifies the use of the extracts to stop bleeding and in treating wounds. Saponin has the property of precipitating and coagulating red blood cells. Some of the characteristics of saponins include formation of foams in aqueous solutions, hemolytic activity, cholesterol binding properties and bitterness (D.E. Okwu, and M.E. Okwu. J. 2004; M. Khan *et al.* 2004). These properties bestow high medicinal activities on the extracts from *B. pinnatum*. Tannins have astringent properties, hasten the healing of wounds and inflamed mucous membranes. These perhaps, explain why traditional medicine healers in South-eastern Nigeria often use herb in treating wounds and burns (Agoha1974).

Objectives of Study

- To find the medicinal plants used by the tribals.
- To bring out the health benefits of *Bryophyllum pinnatum*.
- To analyse the heavy metals, present in the leaves of *Bryophyllum pinnatum*.

MATERIALS AND METHODS

Selection of area

A survey was conducted in the tribes of Papanasam in Tirunelveli District. It is located in south-eastern slopes of western Ghats, Tirunelveli district, Tamil Nadu. Around fifty respondents randomly chosen. A good communication was done in local language among the tribal people and with the practitioners in Servalaru, Chinnamayilaru, Periyamayilaru, Agasthiyar Kudiiruppu and Injikuzhi.

Collection of data

Tribal people usually depend on the Traditional Medicines than that of Orthodox Medicines. Most commonly used medicinal plants and their uses were gathered through interviews followed by interview schedule. More than thirty medicinal plants are in use such as *Adhatoda vasica* (Adathodai), *Andrographis paniculata* (Nilavembu), *Asystasia gangetica* (Valukkai keerai), *Achyranthes aspera* (Naayuruvi), *Aegle marmelos* (Vilvam), *Datura metel* (Oomathai), *Bryophyllum Pinnatum* (Ranakalli), *Solanum torvum* (Sundaikkai), *Clerodendrum inerme* (Piei nari sangu), *Lippia nodiflora* (Poduthalai), *Morinda tinctoria* (Manjanathi), *Tinospora cordifolia* (Seendil) etc... among that *Bryophyllum Pinnatum* (Ranakalli) was studied.

Selection of sample

The leaves of *Bryophyllum pinnatum* was selected as the sample for the present study. The reason of choosing this leaf is that, more awareness is need to be given to the public.

Collection of samples

Bryophyllum pinnatum leaves were observed and identified with the help of local Nattu Vaithiyar. The local name of *Bryophyllum pinnatum*, mode of use, medicinal uses such as internal and external uses were collected from the native tribal people. The samples were collected from Papanasam in Tirunelveli District.

Heavy metal analysis

The leaves were washed and cleaned. Fresh leaves of *Bryophyllum pinnatum* were analysed for the heavy metals such as Lead, Arsenic, Cadmium, Mercury, Nickel using Atomic Absorption Spectrophotometer (AAS). Five different extracts were used to estimate the heavy metal content in the fresh leaves.

Analysis of data

All the collected data were analysed for further study.

RESULTS AND DISCUSSION

Population of the survey area

Table 1 shows the population of the Tribes in Papanasam. Servalaru Kani Kudiruppu have 29 families with the population of 81, among them 22 families consume *Bryophyllum pinnatum*. Agasthiyar Kani Kudiruppu have 51 families with the population of 148, among them 36 families consume *Bryophyllum pinnatum*. Chinnamaylaru Kani Kudiruppu have 55 families with the population of 166, among them 45 families consume *Bryophyllum pinnatum*. Periyamaylaru Kani Kudiruppu have 11 families with the population of 28, among them 20 families consume *Bryophyllum pinnatum*. Injikuzhi Kani Kudiruppu have 29 families with the population of 81, among them 22 families consume *Bryophyllum pinnatum*.

Table 1 Population of the survey area

S. No.	Areas	No. of Family	No. of Population	No. of Families using <i>Bryophyllum pinnatum</i>
1	Servalaru Kani Kudiruppu	29	81	22
2	Agasthiyar Kani Kudiruppu	51	148	36
3	Chinnamaylaru Kani Kudiruppu	55	166	45
4	Periyamaylaru Kani Kudiruppu	11	28	20
5	Injikuzhi Kani Kudiruppu	7	24	3

Table 2 Heavy metal analysis

S. No.	Name of the sample	Pb (<1.0 ppm)	As (<0.5 ppm)	Cd (<0.2 ppm)	Hg (<0.5 ppm)	Ni (<0.2 ppm)
1	Methanol Extract	0.04 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
2	Ethanol Extract	0.02 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm
3	Aqueous Extract	<0.01 ppm				
4	Acetone Extract	<0.01 ppm				
5	Chloroform Extract	0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm	<0.01 ppm

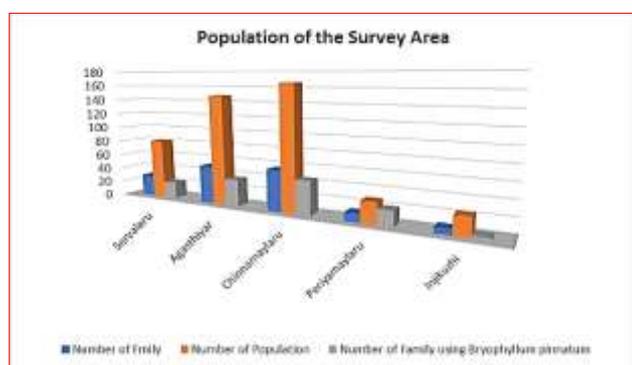


Figure 1 Population of the survey area

CONCLUSION

In order to conclude our present study, the leaves of *Bryophyllum pinnatum* has very low number of heavy metals. Therefore, consuming these medicinal leaves gives us its full health benefits without leaving any side effects. leaves of *Bryophyllum pinnatum* used by the traditional practitioner for treating various ailments like renal calculi, hypertension, asthma, cold, abscesses, bleeding disorders. These leaves have considerable amount of nutrients, rich in phytochemicals and has good antioxidant activity. Awareness has to be given to the public about this medicinal leaf.

LITERATURE CITED

1. Agoha RC. 1974. Medicinal Plants of Nigeria, Offset Drakkerij. Faculfcitder Wiskunde in Naturwetenschappen. The Netherlands 33: 41.

2. An appraisal of tribal folk medicine. Central Council for Research in Ayurveda and Siddha, New Delhi, Edition 1st, 1999; 3(39): 308-17.
3. Bijauliya RK, Alok S, Singh M and Mishra SB: Morphology, phytochemistry and pharmacology of *Syzygium cumini* (Linn.) - An overview. *Int J Pharm Sci Res* 2017; 8(6): 2360-71.
4. Chendurpandy, P, V.R. Mohan and C. Kalidass 2010. An ethnobotanical survey of medicinal plants used by the *Kanikkars* tribe of Kanyakumari District of Western Ghats, Tamil Nadu for the treatment of skin diseases. *Jr. Herbal Medicine and Toxicology*, 4: 179-190.
5. Chunekar KC and Pandey GS: Editor. Bhavaprakasha Nighantu of Bhavamishra, Chaukambha Bharati Academy, Varanasi, 2010: 101-05.
6. Chauhan MG, Pillai AP and Wijaay Asriwardana C: Microscopic Profile of powdered drugs used in Indian System of Medicine. Institute of PG, Training and Research in Ayurveda, Gujarat 2007; 2: 251.
7. Dalziel JM: The useful Plants of West Tropical Africa. Crown Agents for Oversea Governments and Administrations 1955: 28, 53, 415.
8. Gadgil, M 1996. Documenting diversity: An experiment. *Current Science*, 70: 1-152.
9. Gaiid K and Gupta R: Alkanes and alkanols, triterpenes, sterols from *Kalanchoe pinnata*. *Phytochemistry* 1983; 11: 150-02.
10. Ghani A. 2003. Medicinal plants of Bangladesh. The Asiatic Society of Bangladesh, Dhaka 2003; 2: 382.
11. Gupta R, Lohani M and Arora S. Anti-inflammatory activity of the leaf extracts/fractions of *Bryophyllum pinnatum*. *International Journal of Pharmaceutical Sciences Review and Research* 2010; 3(1): 16-18.
12. Hamburger, M and K. Hostettmann 1991. Bioactivity in plants: The link between phytochemistry and medicine. *Phytochemistry* 30: 3864-3874.
13. Igwe SA and Akunyili DN: Analgesic effects of aqueous extracts of the leaves of *B. pinnatum*. *Pharmaceutical Biology* 2005; 43(8): 658-61.
14. Jain VC. 2010. Antioxidant and antimicrobial activities of *Bryophyllum calycinum* Salisb leaf. *Pharmacologyonline* 2010; 1: 393-05.
15. Khoshoo, T.N 1996. India needs a National biodiversity conservation board. *Current Science*, 71: 506-513.
16. Kirthikar KR and Basu B: Indian Medicinal Plants, Lelitmohan basu, Allahabad, Vol. 2, 999-00.
17. Louga, E.J., E.T.F. Witkowski and K. Balkwill 2000. Differential utilization and ethnobotany of trees in Kitulanghalo forest reserve and surrounding communal lands, Eastern Tanzania. *Economic Botany*, 54: 328-343.
18. Majaz QA, Tatiya AU, Khurshid M and Nazim S: The miracle plant (*Kalanchoe pinnata*): A photochemical and pharmacological review. *International Journal of Research in Ayurveda and Pharmacy* 2011; 2(5): 1478-82.
19. Melookunnel S: Home remedies with Materia Medica. Hafa Publication, Secunderabad, Edition 2nd, 1995, 103-04.
20. Mohan, V.R., C. Kalidass and D. Amish Abragam 2010. Ethno medico botany of the Palliyars of Saduragiri hills, Western Ghats, Tamil Nadu. *J. Economic Taxonomic Botany*. 34: 639-658.
21. Ofokansi KC, Esimone CO and Anele CK: Evaluation of the in vitro combined antibacterial effect of the leaf extracts of *Bryophyllum pinnatum* (Fam: Crassulaceae) and *Ocimum gratissimum* (Fam: Labiatae). *Plant Product Research Journal* 2005; 9: 23-27.
22. Okwu DE and Njoku EE: Chemical composition and in- vitro antifungal activity screening of seed and leaf extracts from *Aframomum meleguata* and *Monodora myristica* against *Sclertium rolfsii* of cow pea plant *Vigna unguiculata* L. *Walp Pest Technology* 2009; 3(1): 58-62.
23. Okwu DE: Nigerian medicinal plant 11. *Medicinal and Aromatic Plant Science and Biotechnology* 2007; 1(1): 97-102.
24. Olajide OA: Analgesic, anti-inflammatory and antipyretic effects of *Bryophyllum pinnatum*. *Fitoterapia* 1998; 69(3): 249-52.
25. Okwu DE and Josiah C. 2006. Evaluation of the chemical composition of two Nigerian medicinal plants. *African Journal of Biotechnology* 2006; 5(4): 357-361.
26. Siddhartha Pal and Chaudhuri AKN. 1991. Studies on the anti-ulcer activity of a *Bryophyllum pinnatum* leaf extract in experimental animals. *Journal of Ethanopharmacology* 33: 97-102.
27. Sofowara, A 1993. Medicinal plants and traditional medicine in Africa, 2nd ed. Spectrum Books Ltd. Ibadan. Sutha, S., V.R. Mohan, S. Kumaresan, C. Murugan and T. Athiperumalsami 2010. Ethnomedicinal plants used by the tribals of Kalakad-Mundanthurai Tiger Reserve (KMTR), Western Ghats, Tamil Nadu for the treatment of rheumatism. *Indian J. Traditional Knowledge*, 9: 502-509.
28. Tabuti, J.R.S., S.S. Dhillion and K.A. Lye. 2003. Traditional medicine in Bulamogi country, Uganda: its practitioners, users and viability. *J. Ethnopharmacology*, 85: 119-129. World Health Organization (WHO), 2002. Vaidhya B: Some controversial drugs in Indian Medicine. Chaukhambha Orientalia, Varanasi, Edition 3rd, 2010, 3-5.
29. Thorat SS: A review on *Bryophyllum pinnatum*. *Int Res J Pharm* 2017; 8(12): 1-3. <http://dx.doi.org/10.7897/2230-8407.0812243>
30. WHO traditional medicine strategy 2002. World Health Organization, Geneva. WHO/ EDM/TRM/2002.1.
31. www.phcog.com. Microscopical character of *Bryophyllum pinnatum*, 2010.
32. Yadav NP, Dixit VK. 2003. Hepatoprotective activity of leaves of *Kalanchoe Pinnata Pers*. *Journal of Ethnopharmacology* 86: 197-202.
33. Zakaria, M 1991. Isolation and characterization of active compounds from medicinal plants. *Asia Pacific Jr. Pharmacology* 6: 15-20.
34. Pal S, Nag Chaudhari AK. 1991. Studies on the anti-ulcer activity of a *Bryophyllum pinnatum* leaf extract in experimental animals. *Jr. Ethnopharmacology* 33: 97-102.
35. Haslalka GV, C.R. Patil, M.R. Patil. *Indian Jr. Pharmacol.* 39(4): 201-205 (2007).
36. E.E. Obaseiki-Ebor. Preliminary report on the invitro antibacterial activity of *Bryophyllum pinnatum* leaf juice. *Afr J Med Med Sci.* 14(3-4):199-202 (1985).
37. D.E. Okwu, and M.E. Okwu. *J. Sustain Agric. Environ.* 6(2): 140-147 (2004).

38. M. Khan, P.A. Patil, and J.C. Shobha. Influence of *Bryophyllum pinnatum* (Lam.) leaf extract on wound healing in albino rats. *J. Natural Remedies*. 4:41-46 (2004).
39. R.C. Agoha. Medicinal Plants of Nigeria. Offset Drakkerij. Faculteit der Wiskunde in Naturwetenschappen, the Netherlands. 41, 33 (1974).
40. S. Pal, A.K. Nag, and N. Chaudhari, Anti-inflammatory action of *Bryophyllum pinnatum* leaf extract. *Fitoterapia*. 61: 527-533 (1990).
41. N. Salah, N.J. Miller, G. Pagange, L. Tijburg, G.P. Bolwell, E. Rice, and C. Evans. Polyphenolic flavonoids as scavenger of aqueous phase radicals as chain breaking antioxidant. *Arch Biochem. Biophys.* 2: 339-346 (1995).
42. Dra. Amalia Dominguez Suarez Tec. Maritza Bacallao. Actividad Antiinflamatoria de extracto fluido de hojas de siempreviva (*Bryophyllum Pinnatum*). *Rev Cubana Invest Biomed.* 21(2):86-90 (2002).
43. P. Siddharta, and A.K.N. Chaudhuri. Further studies on the Antiinflammatory profile of the Methanolic Fraction of the fresh leaf extract of *Bryophyllum Pinnatum*. *Fitoterapia*. 63(5): 451-459 (1992).
44. Ojewole JAO. 2002. Antihypertension properties of *Bryophyllum pinnatum* (Lam) (oken) leaf extracts. *Am J. Hypert.* 15(4): A34-A39 (2002). 20. Chem Abstr. 105: 158797m (1986).

Assessment of Heavy Metal Accumulation in Pomegranate and Orange Fruits Available in Local Market

Hannah Jessie Francis T^{*1} and Vasantha Esther Rani²

¹Madurai Kamaraj University, Madurai, Tamil Nadu, India and St. Ann's College for Women (Autonomous), Hyderabad - 500 027, India

²Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India

Correspondence to: Hannah Jessie Francis T, Madurai Kamaraj University, Madurai, Tamil Nadu, India and St. Ann's College for Women (Autonomous), Hyderabad - 500 027, India, Tel: +91 9000544325; E-mail: hannahjessie_22@yahoo.co.in

Abstract

This study aimed to evaluate the potential presence of heavy metals in pomegranate and orange fruits purchased in the study area's food stores. The levels of chromium (Cr), cobalt (Co), cadmium (Cd), nickel (Ni), and lead (Pb) in fruit samples were measured. All five metals in two fruit juices were found at levels far below the World Health Organization's permissible limits. One possible explanation for this is less industrialization and less pesticide applications. The heavy metals found are comparable with the literature-reported values. Statistical analysis was applied to the collected heavy metal data to look for trends and identify potential sources of heavy metal contamination in fruits. Cr, Co, Cd, Ni, and Pb all have HRIs (health risk indexes) below 1.0, indicating no health risks. Target hazard quotient (THQ) and hazard index (HI), and Cancer risk (CR) assessment show that these metals were found within the acceptable limit.

Key words: Fruit juices, Pomegranate, Orange, Heavy metals, Health risk assessment

Nutritionists, ecologists, and scientists all have a legitimate interest in knowing the levels of heavy metals in the food we consume. Inadequate attention has been paid to the problem of heavy metal contamination in fruits and vegetables, despite the fact that these foods play crucial roles in the human diet. Vitamins, protein, and minerals abound in these foods, and their antioxidant properties are crucial for healthy development and growth (Salvatore *et al.* 2009). Chemical applications, preservatives, industrialization, mining activities, fertilizer, and the usage of wastewater have all contributed to heavy metal contamination in food sources (Hellen *et al.* 2014). The significant factors of food quality are the presence of heavy metal contamination in produce. Human industrialization and agricultural activity have contributed to heavy metal contamination of the environment in recent years (Khan *et al.* 2019). Environmentalists are concerned about the existence of toxic elements and are trying to understand its biological implications on human health, and the greatest source of these metals is food. Toxic metal pollution in food is an issue that has been studied from multiple angles (Ibrahim *et al.* 2017).

Metals with lengthy biological half-lives are the most common non-biodegradable contaminants, and they have a high propensity to accumulate in different body organs, where they can have devastating impacts on human health (Habib *et al.* 2012). Vegetables and fruits have a high level of cobalt, copper cadmium, and lead, which can cause renal failure, damage the reproductive system, increase the probability of developing cancer of the throat, abdomen, and/or bone, and contribute to

hypertension. Heavy metals are toxic to living things still at minimal dilutions, and prolonged exposure to even trace amounts can be hazardous. Toxicity studies have shown that these metals can disrupt human brain function by stimulating the release of neurotransmitters and altering a wide variety of metabolic processes (Randhawa *et al.* 2014). Lead and cadmium are the most harmful substances to humans (Volpe *et al.* 2009). Nowadays, people have it worse than ever before when it comes to health issues caused by these metals. This is because of the widespread use of fossil fuels and the burning of coal and other waste products around the world (Igwegbe *et al.* 2013). The WHO (World Health Organization) and the FAO (Food and Agriculture Organization) have proposed safe limits intended for heavy metals (Elbagermi *et al.* 2012).

Fruits and vegetables, in particular, can be a major source of heavy-metal exposure for humans because of their high consumption in the human diet (Farooq *et al.* 2008). Plants take in heavy metals through their roots when they grow in contaminated soil or water, or when they are exposed to the metals in the air. Vegetables are also contaminated with heavy metals because they are irrigated with sewage and industrial effluent (Karpiak *et al.* 2016). Experiments have confirmed that eating a diet elevated in fruits and vegetables reduces the possibility of improving persistent infections such as hypertension, diabetes, cataracts, cancer, cardiovascular disease (Bagdatlioglu *et al.* 2010). Fruits may have variable concentrations of essential and nonessential components, which may have an effect on human health. A recent study found that

industrial pollutants and effluents had significantly contaminated the land and irrigation water in the province of Markazi (Wang *et al.* 2015). Lead and cadmium are two heavy metals that provide a significant environmental health risk to humans. Lead intoxication can affect anyone, including animals, but it disproportionately affects children. Cd is a human carcinogen, according to the International Agency for Research on Cancer. It is the interface of lead and cadmium with biological electron-donor groups such as sulfhydryl groups that causes poisoning (Prakash *et al.* 2012).

Regular testing for these substances is a standard part of quality assurance for fruit juices (Grembecka *et al.* 2013, Sajib *et al.* 2014). However, when the levels of hazardous substances, environmental contaminants (particularly pesticides), polychlorinated bisphenols (PCB's), and heavy metals (notably lead and cadmium) increase, so does the degradation in the quality of fruit products. Researchers have found potentially cancer-causing chemicals in the juices (Sun *et al.* 2015, Clarkson *et al.* 1991). It is crucial to assess the safety of commercially produced fruit juices (Ghasemidehkordi *et al.* 2018, Phuong Truong *et al.* 2014) in light of these incidents and the widespread consumption of fruit juices. Heavy metal toxins are the most harmful type of contaminant because they accumulate in the body when absorbed in large quantities over time through food or water (Krejpcio *et al.* 1997). Heavy metals in foods like fruits and vegetables can build up over time, posing health risks in the form of mutations, cancers, and birth defects in organs all over the body. Metal poisoning has been linked to a variety of human diseases, illnesses, deformities, and organ failures (Satarug *et al.* 2004, Salama *et al.* 2005). Some of these metals pose serious risks to human health, including arsenic, cadmium, lead, tin and mercury (Minich *et al.* 2007, Dehelean *et al.* 2013).

Some unfavourable medical impacts have been recorded at concentrations below the regulatory limits (Adrian *et al.* 2005, Husam *et al.* 2010, Hughes *et al.* 1997), so it is clear that simply comparing contaminant concentrations with standard limits does not provide a true reflection of the health status of consumer groups. For this reason, it is essential to conduct a health risk assessment to ascertain possible health concerns while taking uncertainties into account. Thus, the objective of this research was to identify and assess Cr, Cd, Pb, Co, and Ni levels in Pomegranate and Orange fruit purchased from a local market in the study area. Target hazard quotient (THQ) and cancer risk (CR) occurred also evaluated towards measure health risks in both adults and children.

MATERIALS AND METHODS

Sample collection

We purchased one kilogramme of Pomegranate and orange fruit samples each from stores and local markets at various farmers' markets around study area.

Preparation of samples

To lessen environmental impact, the gathered fruit was quickly transported from the local markets to the lab in polyethylene bags. Fruit was metabolized using the revised procedure (Marsh *et al.* 2007).

To prepare the samples for analysis, they were first rinsed thoroughly with regular water and then with ultrapure water before being finely chopped the edible parts of the fruits. We dried every sample in a 70°C oven for 48 hours. Then, the pieces were crushed and placed in opaque polyethylene bottles for later use. After adding 15 mL of the 3 acid blends, namely Nitric acid (70%), Sulphuric acid (65%), and Perchloric acid

(70%), in a 5:1:1 ratio, 1 gram of dried fruit samples were digested using a high-pressure microwave-assisted apparatus. The residual solution was brought up to a volume of 25 mL by adding ultrapure water. An ICP-OES analyzer was used to complete the process. The edible weight and fresh weight of the fruits were used in all computations.

Chemicals, Stock Solutions

To generate the calibration curves, we used element standard solutions produced from a Merck standard stock solution of 1000 PPM. Standard and stock solutions of analytical quality have been made using compounds purchased from Merck and diluted in ultra-pure water.

Estimated daily intake

The calculation of estimated daily intake (EDI) ($\mu\text{g}/\text{kg}\cdot\text{d}$) was done according to the following equation:

$$\text{EDI} = \frac{C \times \text{IR} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{ATn}}$$

C represents the overall quantity of an element existing in the body; IR, the rate at which it is consumed; EF, the frequency with which it is exposed; ED, the length of time over which it is exposed; BW, the individual's weight; ATn, the average length of life expectancy; and CF, the conversion factor.

Noncarcinogenic risk assessment

THQ was applied to estimate the absence of carcinogenic risk in fruit samples using the following formula:

$$\text{THQ}_i = \frac{\text{EDI}}{\text{RfD}}$$

Due to the oral route of absorption, RfD is the reference dosage of important components, while EDI is the estimated daily intake (in milligrammes per kilogramme per day). The EPA 2017 publication provides the oral RfD for the subject. Similarly, the TTHQ was estimated by using the below equation.

$$\text{TTHQ} = \sum_{i=1}^n \text{THQ}_i$$

When THQ and/or TTHQ are greater than 1, the health risk is high; when they are less than 1, there is little to no risk. where TTHQ is the sum total of THQ of every vital ingredient in fruits. The quota of essential elements in TTHQ was estimated by using below formula.

$$Q = \frac{\text{THQ}_e}{\text{TTHQ}} \times 100$$

where Q is a quota of important elements (%), THQ is THQ of any element, and TTHQ is the total THQ.

For an assessment, carcinogenic risk, (R) was estimated using the Calculation.

$$\text{CR} = \text{CDI} \times \text{CSF} \times \text{ADAF}$$

Cancer Slope Factor ($\text{kg}\cdot\text{day}/\text{mg}$) = the probability that a single chemical would raise cancer risk when exposed to it orally; ADAF = the age-related adjustment factor (for adults=1 and children=3value). The As-related CSF intake is 1.5 $\text{kg}/\text{day}/\text{mg}$. There was a lack of CSF for Cd, Hg, Sn, and Al. The estimated CR value was compared to the USEPA-recommended maximum allowable risk of $1\text{E}-6$ in this investigation.

Operating conditions for ICP OES

We used an inductively coupled plasma optical emission spectrometer for all of our fruit juice and fruit in a can analyses.

The ICP-OES torch utilized was a Flared end EOP Torch 2.5 mm type from Thermo Scientific. Argon was used as the plasma, auxiliary, and nebulizer gas, and an RF generator (1400 W) provided the necessary power. The plasma gas flow was 14.5 L/min, the auxiliary gas flow was 0.9 L/min, and the nebulizer gas flow was 0.85 L/min. After that, there was no delay or time between replicate analyses, and the times it took to take in a sample, rinse it, and stabilize it initially were a combined 240 seconds, 45 seconds, and 45 seconds, respectively.

The RF generator frequency was set at 27.12 MHz, and there were three sets of measurements taken (resonance frequency). We used a CCD solid-state detector and a Cyclonic, Modified Lichte spray chamber. The four-channel, software-controlled peristaltic pump used for sample delivery allowed for highly precise sample flows. After 15 seconds at 60 rpm and 30 rpm for the remaining 30 seconds of the prewash, the final 45 seconds of the prewash were spent at 30 rpm while the sample injection pump was slowed to a trickle.

RESULTS AND DISCUSSIONS

Heavy metal concentration

The mean with standard deviation concentration for cobalt (Co), chromium (Cr), cadmium (Cd), lead (Pb) and nickel (Ni) in pomegranate fruit juices were stated as 0.0068 ± 0.0022 mg/kg, 0.0088 ± 0.00018 mg/kg, 0.0027 ± 0.0054 mg/kg, 0.0043 ± 0.0009 mg/kg, 0.0032 ± 0.0002 mg/kg, individually. In orange fruit had the mean values of 0.0019 ± 0.0002 , 0.0043 ± 0.0006 , 0.0602 ± 0.0013 , 0.0096 ± 0.0002 , 0.0062 ± 0.0020 mg/kg, respectively.

The range of quantities for Cr, Co, Cd, Ni, and Pb in pomegranate fruit juices were described as 0.0068 (0.0044–0.0089), 0.0088 (0.0072–0.0098), 0.0027 (0.0012–0.019), 0.0043 (0.0109–0.00956), 0.0032 (0.0017 – 0.00856) µg/kg, respectively. Where in orange juice were reported as 0.0019 (0.0008–0.0066), 0.0043 (0.0002–0.012), 0.0602 (0.0012–0.018), 0.0096 (0.009–0.0124), 0.0062 (0.0027 – 0.00986) µg/kg, respectively (Figure 1).

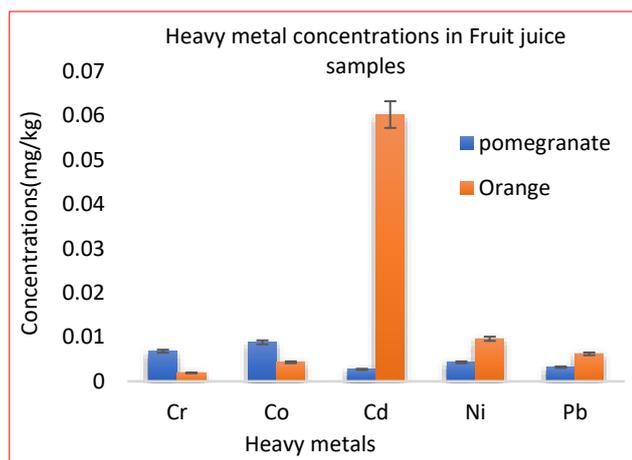


Figure 1 The Heavy metal concentrations in the fruit juices

Comparatively the ranges for Cu, Fe, and Zn in mango juices were as follows: 3.17-17.86, 1.2-6.64, 5.2-13.64, 0.91-1.24, 0.48-2.51, and 0.31-0.823 g/g. Fe, Cu, and Zn concentrations were between 3.3 and 16.48, 0.8 and 4.66, 1.24 and 4.31, 0.16 and 0.93, 0.32 and 1.62, and 0.39 and 0.83 g/g, respectively, in orange juices.

Consistent with similar research conducted all over the world, the data show that orange juice has the most lead contamination (0.2 mg/kg) whereas mango juice has the lowest

(0.012 mg/kg) (Salma *et al.* 2015). Massadeh and Fakhri showed that different types of fruit juice commonly eaten in Saudi Arabia were highly contaminated with heavy metals. Based on their findings, it was estimated that the average sample concentration of cobalt was 7.93 ± 1.02 g/L (Mendil *et al.* 2012). Pb and Cd levels in bottled fruit samples were observed to vary from 0.06 to 1.93 and 0.002-0.49 mg/L, respectively (Shahsavani *et al.* 2017). 4 pineapple fruit juices, 8 citrus fruit juices, 1soya drink, 3 cola carbonated brews, 1 apple fruit juice, and 6 cocktail fruit juices were tested for heavy metal concentrations by Adegbola *et al.* (2015).

Health risk assessment

Non-carcinogenic risk

Cd (2.20) > Cr (1.09) > Pb (0.51) > Co (0.08) > Ni (0.06) was found to be the most abundant heavy metal in pomegranate fruit juice among adults, but in orange juice it was Cd (2.48 > Cr (1.15) > Pb (0.65) > Co (0.24) > Ni (0.06). (0.04). Orange juice has a 95% THQ that is 1.12 times greater than pomegranate juice, among adults. Cd (3.42), Cr (0.98), Pb (0.45), Co (0.11), and Ni (0.08), in order, were found in the fruit juices tested, with Cd being the most prevalent in orange juice (2.12), followed by Cr (0.82), Pb (0.33), Co (0.20), and Ni (0.08). (0.11). Because Cd's concentration was more than that of other metals and its Rfd was extremely low (0.0004 mg/kg.d) (Shahsavani *et al.*, 2017), the THQ of Al was greater than that of other heavy metals. Juice from pomegranates had a 95% confidence interval THQ 1.12 times that of juice from oranges among youngsters. The TTHQ levels in the adults who drank pomegranate fruit juice and orange fruit juice were 20.18 and 38.16, respectively, whereas the TTHQ levels in the youngsters were 22.50 and 28.26. Fruit purees had 1.20 times more TTHQ than fruit juice among consumers of all ages, including adults and children.

Carcinogenic risk

The Cr content of pomegranate and orange juices had a 95% CR percentile of $1.120E-6$ and $1.14E-6$, respectively, in adult consumers. Child CR attributable to Cr in pomegranate fruit juice and orange fruit juice were $1.42E-6$ and $1.56E-6$, respectively, at the 95% confidence interval. Also, because youngsters have a higher average daily activity level, their Cr-related CR is higher than that of adults.

Several metals included in infant formula, including chromium, cadmium, lead, cobalt, and nickel, are extremely toxic to the human body (Adegbola *et al.* 2015, Ahmadi *et al.* 2015). Even at low doses, Cd and Cr are hazardous to the human biosystem. Heavy metal poisoning is widely seen as a main risk to people health and food deliveries.

Pb has adverse impacts on both humans and animals, but it is especially harmful to youngsters. Toxic and potentially cancer-causing, cadmium is an extremely dangerous metal. Lead from food and tobacco use has a cumulative and bioavailable effect on the human body. About eighty to ninety percent of daily exposures of lead and cadmium in humans come from food (Dehelean *et al.* 2013, Jafari *et al.* 2018).

Heavy metal levels in produce are fluctuating due to pollution from vehicles, factories, and farms. Exhaust fumes are likely one of the roadside vegetation's polluting constituents. Heavy metals may accumulate in plants that thrive in urban and industrial settings, such as along the roadside or in a factory. Moreover, because their mineral contents change depending on their growth environment, water, and soil, fruits shouldn't pick from contaminated environments (USEPA 2007). Equipment for juice manufacturing, serving boxes, and storing cans might be considered significant supplies of heavy metal

contamination, however this would rely on the replanting natural environment for farming crops. Heavy metal levels in fruit juices may be lowered by using suitable packing, stainless steel jars, and cultivated goods produced in environments and soils with low levels of heavy metal pollution.

Statistical analysis

Principal component analysis (PCA)

In order to compare the compositional patterns of the heavy metals in the fruit juice samples and to determine the factors impacting the pollutant levels, PCA was performed on the normalized data. Two Principal Components with Eigen values >1 was identified by PCA of the pomegranate data

(Figure 2), and they accounted for around 72.24% of the overall variation in the heavy metals. The first PC was associated with Cr, Co, and Ni, accounting for 59.68% of the total variance. The results for all heavy metals showed a correlation between Pb and Cd in the second principal component, which accounted for 12.56 percent of the overall variance. In contrast, the heavy metals data from the PCA of orange juice (Figure 3) showed two principal components with Eigen values below 1, which accounted for around 86.14% of the entire variation in the heavy metals. The first PC was linked with Cd, Ni, and Pb and accounted for 69.88% of the total variance. Co and Cr were associated with the second principal component, which accounted for 16.26% of the overall variance.

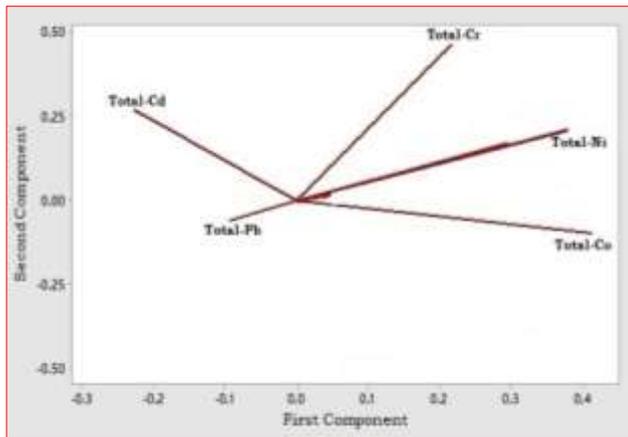


Figure 2: Principal component analysis of heavy metal concentrations in the pomegranate fruit juices

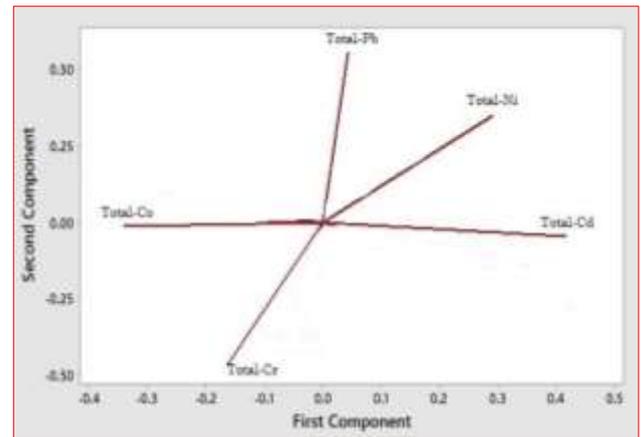


Figure 3: Principal component analysis of heavy metal concentrations in the orange fruit juices

Correlation matrix

The correlation coefficient matrix for heavy metals in fruit juices is displayed in the tables below. only correlation coefficient values more than 60% are taken into account and highlighted. High correlation coefficient values between the

two metals Cobalt and Chromium, which were identified in pomegranate juice (Table 1), suggest higher linkages between these two. Pb and Ni have the highest correlation coefficient (0.624), followed by Ni and Cr (0.618).

Table 1 Pearson Correlation matrix of heavy metals in pomegranate fruit juice sample

Correlation matrix (Pearson): Pomegranate					
Variables	Cd	Co	Cr	Ni	Pb
Cd	1	0.563	-0.102	0.204	0.124
Co		1	0.715	0.226	0.323
Cr			1	0.618	0.505
Ni				1	0.624
Pb					1

Values in bold are different from 0 with a significance level alpha=0.05

(Table 2) results of heavy metals in orange juice also revealed high values for the correlation coefficients between the two metals nickel and cadmium, indicating that these two

metals have significant relationships. Ni and Cd have the highest correlation coefficient (0.781), followed by Cd and Co (0.761) and Cr and Pb (0.644).

Table 2 Pearson Correlation matrix of heavy metals in orange fruit juice sample

Correlation matrix (Pearson): Orange fruit					
Variables	Cd	Co	Cr	Ni	Pb
Cd	1	0.761	0.231	0.781	0.530
Co		1	0.532	-0.398	0.453
Cr			1	0.016	0.644
Ni				1	-0.336
Pb					1

Values in bold are different from 0 with a significance level alpha=0.05

Analysis of Variance (ANOVA) test

To analyze the significant differences of heavy metals identified in fruit juice samples (p 0.05), one-way Anova was used. Using Pearson's coefficient, relationships between the

findings of the pomegranate and orange fruit juices were examined. Statistical significance was set at p 0.05. (Table 3). All heavy metals displayed significant fluctuations during the analysis (ANOVA, p= 0.0001).

Table 3 Analysis of Variance (ANOVA) for the heavy metals in fruits juice samples

Analysis of Variance (ANOVA) test Pomegranate (Y):					
Source	DF	Sum of squares	Mean squares	F	Pr> F (p-value)
del	5	181469.661	97683.708	10.015	<0.0001
Error	84	647451.957	4055.2		
Corrected Total	89	5828921.618			
Analysis of Variance (ANOVA) test orange fruit (Y):					
Source	DF	Sum of squares	Mean squares	F	Pr> F (p-value)
Model	5	314681001.9	19516454.72	20.025	<0.0001
Error	84	9809334.105	65607.412		
Corrected Total	89	344490336			

Computed against model $Y=Mean(Y)$

CONCLUSION

Using ICP-OES, the researchers in this study quantified the levels of heavy metals present in commercially available fruit juices and bottled fruits sold in local markets, and they calculated the potential dangers these substances pose to the health of both children and adults. Heavy metal contents were discovered to be significantly elevated in fruit juices compared to fruit juices overall. Heavy metal levels were found to be highest in the orange juices. $Cd > Cr > Pb > Co > Ni$ describes the measured rank order of heavy metals in two distinct fruit juices. The statistical analysis like PCA, Correlation coefficient and ANOVA was also found similar significant results with the obtained results in the study. The quantities of heavy metals found in most samples were far lower than threshold levels. Corresponding to the THQ-based health risk assessment, the

ranking of most dangerous heavy metals is as follows: $Cr > Pb > Cd > Co > Ni$. Both adults and children are at high risk of non-carcinogenic effects from Cr and Pb ($THQ > 1$) in both fruit juices. The levels of the heavy metals detected are consistent with those reported in the literature. It may be concluded that eating fruits is safe from a health perspective because their elemental concentrations were below the criteria. Adults and children are not at noncarcinogenic risk, corresponding to the probabilistic health risk assessment (95% THQ and TTHQ 1). The present experiment found that the content of trace metals in fruits purchased at local markets in the research area posed no health concern. All of the measured concentrations of the heavy metals under study were fairly less than the threshold considered dangerous by the WHO. The levels of trace metals tested for varied.

LITERATURE CITED

- Salvatore, MD. Carratù, G. Carafa, A. 2009. "Assessment of heavy metals transfer from a moderately polluted soil into the edible parts of vegetables"; *J. Food Agric. Environ.* 7, 683-688,2009.
- Hellen, LE. Othman, OC. 2014. "Levels of selected heavy metals in soil, tomatoes and selected vegetables from Lushoto District-Tanzania."; *Int. J. Environ. Monitor. Anal.* 2, 313-319.
- Khan, H. Khan, S. Khan, N. Ali, I. Achakzai, AB. 2019. "Physicochemical and spectroscopic elemental analysis of ground water in thickly populated and industrial area of Quetta valley Pakistan"; *Al-Nahrain J. Sci.* 22, 18-25.
- Ibrahim, LH. Abed, SA. 2017. "Accumulation detection of some heavy metals in some types of fruits in the local market of Al-Diwaniyah City, Iraq"; *Rasayan J. Chem.* 10, 339-343.
- Habib, HR. Awadh. SM. Muslim, MZ. 2012. "Toxic heavy metals in soil and some plants in Baghdad, Iraq"; *Al-Nahrain J. Sci.* 15, 1-16.
- Randhawa, M. Ahmad, G. Anjum, F. Asghar, A. Sajid, M. 2014. "Heavy metal contents and their daily intake in vegetables under peri-urban farming system of Multan, Pakistan"; *Pak. J. Agric. Sci.* 51.
- Volpe, M. La-Cara, F. Volpe, F. De-Mattia, A. Serino, V. Petitto, F. Zavalloni, C. Limone, F. Pellecchia, R. De-Prisco, P. 2009. "Heavy metal uptake in the enological food chain"; *Food Chemistry* 117, 553- 560.
- Igwegbe, AO. Agukwe, CH. Negbenebor, CA. 2013. "A survey of heavy metal (lead, cadmium and copper) contents of selected fruit and vegetable crops from Borno State of Nigeria"; *Res. Inv. Int. J. Eng. Sci.* 2, 1-5.
- Elbagermi MA. Edwards, H. GM. Alajtal, AI. 2012. "Monitoring of Heavy Metal Content in Fruits and Vegetables Collected from Production and Market Sites in the Misurata Area of Libya"; *ISRN Analytical Chemistry* , 1-5.
- Farooq, M. Anwar, F. Rashid, U. 2008. "Appraisal of heavy metal contents in different vegetables grown in the vicinity of an industrial area"; *Pak. J. Botany* 40, 2099-2106.
- Karpiuk, UV. Al-Azzam, KM. Abudayeh, ZHM. Kislichenko, V. Naddaf, A. Cholok, I. Yemelianova, O. 2016. "Qualitative and quantitative content determination of macro-minor elements in *Bryonia alba* L. roots using flame atomic absorption spectroscopy technique"; *Advanced pharmaceutical Bulletin* 6, 285.
- Bagdatlioglu, N. Nergiz, C. and Ergonul, PG. 2010. Heavy metal levels in leafy vegetables and some selected fruits. *Journal für Verbraucherschutz und Lebensmittelsicherheit* 5: 421–428. <https://doi.org/10.1007/s00003-010-0594-y>.
- Wang, Q. Liu, J. and Cheng, S. 2015. Heavy metals in apple orchard soils and fruits and their health risks in Liaodong Peninsula, Northeast China. *Environmental Monitoring and Assessment* 187: 4178. <https://doi.org/10.1007/s10661-014-4178-7>
- Prakash, D. Upadhyay, G. Gupta, C. Pushpangadan, P. and Singh, K. 2012. Antioxidant and free radical scavenging activities of some promising wild edible fruits. *International Food Research Journal* 19: 1109–1116.
- Grembecka, M. and Szefer, P. 2013. Comparative assessment of essential and heavy metals in fruits from different geographical origins. *Environmental Monitoring and Assessment* 185: 9139– 9160. <https://doi.org/10.1007/s10661-013-3242-z>
- Sajib, M. Jahan, S. Islam, M. Khan, T. and Saha, B. 2014. Nutritional evaluation and heavy metals content of selected tropical fruits in Bangladesh. *International Food Research Journal* 21: 609.

17. Sun, H. Brocato, J. and Costa, M. 2015. Oral chromium exposure and toxicity. *Current Environmental Health Reports* 2: 295–303. <https://doi.org/10.1007/s40572-015-0054-z>
18. Clarkson, PM. 1991. Nutritional ergogenic aids: chromium, exercise, and muscle mass. *International Journal of Sport Nutrition* 1: 289–293. <https://doi.org/10.1123/ijsn.1.3.289>
19. Ghasemidehkordi, B. Malekirad, AA. Nazem, H. Fazilati, M. Salavati, H. Shariatifar, N. Rezaei, M. Fakhri, Y. and Khaneghah, AM. 2018b. Concentration of lead and mercury in collected vegetables and herbs from Markazi province, Iran: a non-carcinogenic risk assessment. *Food and Chemical Toxicology* 113: 204–210. <https://doi.org/10.1080/19315260.2017.1356896>
20. Phuong Truong, John Cauduro, 2014. Determination of major elements in fruit juices using the Agilent 4200 MP-AES with the Agilent 4107 Nitrogen Generator, Agilent Technologies, Inc., Publication number: 5991-3613EN, http://hpst.cz/sites/default/files/uploaded_files/5991-3613en.pdf.
21. Krejpcio Z, Gawecki J. 1997. Influence of dietary fiber on lead-intoxicated rats. *Polish J. Food Nutr. Sci.* 47, (2), p.87.
22. Satarug S., Moore M. R. 2004. Adverse health effects of chronic exposure to low-level cadmium in foodstuffs and cigarette smoke. *Environ. Health Perspect.* 112, (10), p. 1099.
- 23.. Salama A and Mohamed A. 2005. Heavy metals (Cd, Pb) and trace elements (Cu, Zn) contents in some foodstuffs from the Egyptian market. *Emirates journal of food and agriculture.* 2005: 34-42.
- 24.. Minich M and Jeffrey S. 2007. Acid-alkaline balance: role in chronic disease and detoxification. *Alternative therapies in health and medicine.* 2007; 13(4): 62.
- 25.. Dehelean A and Dana A. 2013. Analysis of mineral and heavy metal content of some commercial fruit juices by inductively coupled plasma mass spectrometry. *The Scientific World Journal.*
- 26.. Adrian F. Robert C. Susanne H. Laurie C. Bioavailability and antioxidant effects of orange juice components in humans. *Journal of agricultural and food chemistry.* 2005; 53(13): 5170-5178.
- 27.. Husam G. Chang S. Mannish U. Kelly K. Prabhakar V. Sanaa Abuaysheh, Priya M, Paresh D. 2010. Orange juice neutralizes the proinflammatory effect of a high-fat, high-carbohydrate meal and prevents endotoxin increase and Toll-like receptor expression. *The American journal of clinical nutrition.* 91(4): 940-949.
- 28.. Hughes W. *Essentials of Environmental Toxicology: The Effects of Environmentally Hazardous Substances on Human Health.* Environment International. 1997; 3(23): 422.
- 29.. Marsh K and Betty B. Food packaging roles, materials, and environmental issues. *Journal of food science.* 2007; 72(3): R39-R55.
- 30.. Mendil D. Determination of Cd (II), Cu (II), and Pb (II) in some foods by FAAS after preconcentration on modified silica gels with thiourea. *Journal of food science.* 2012; 77(9), T181-T186.
31. Salma, I. Sajib, M. Motalab M. Mumtaz, B. Jahan, S. Hoque, M. Saha, B. 2015. Comparative evaluation of macro and micro-nutrient element and heavy metal contents of commercial fruit juices available in Bangladesh. *Am. J. Food Nutr.* 3, 56–63.
32. Massadeh, AM. Allah, A. Al-Massaedh, T., 2018. Determination of heavy metals in canned fruits and vegetables sold in Jordan market. *Environ. Sci. Pollut. Control Ser* 25, 1914–1920.
33. Fakhri, Y. Mousavi Khaneghah, A. Hadiani, MR. Keramati, H. Hosseini Pouya, R. Moradi, B. da Silva, BS. 2017. Non-carcinogenic risk assessment induced by heavy metals content of the bottled water in Iran. *Toxin Rev.* 36, 313–321.
34. Shahsavani, A. Fakhri, Y. Ferrante, M. Keramati, H. Zandsalimi, Y. Bay, A. Hosseini Pouya, SR. Moradi, B. Bahmani, Z. Mousavi Khaneghah, A. 2017. Risk assessment of heavy metals bioaccumulation: fished shrimps from the Persian Gulf. *Toxin Rev.* 36, 322–330.
35. Adegbola, RA. Adekanmbi, AI. Abiona, DL. Atere, AA. 2015. Evaluation of some heavy metal contaminants in biscuits, fruit drinks, concentrates, candy, milk products and carbonated drinks sold in Ibadan, Nigeria. *Int. J. Brain Cognit. Sci.* 9, 1691–1696.
36. Ahmadi, A. Ziarati, P. 2015. Chemical composition profile of canned and frozen sweet corn (*Zea mays* L.) in Iran. *Orient. J. Chem.* 31, 1065–1070.
37. Dehelean, A. Magdas, D. Puscas, R. Lung, I. Stan, M. 2016. Quality assessment of some commercial Romanian juices. *Rom. Rep. Phys.* 68, 746–759.
38. Jafari, A. Kamarehie, B. Ghaderpoori, M., Khoshnamvand, N. Birjandi, M. 2018. The concentration data of heavy metals in Iranian grown and imported rice and human health hazard assessment. *Data in brief* 16, 453–459.
39. USEPA, 2017. Exposure Assessment Tools by Routes - Ingestion. <https://www.epa.gov/expobox/exposure-assessment-tools-routes-ingestion#self>.

Standardization of Herbal Tea to Promote Sleep

Rathi Devi O. S¹, Vaishnavi R² and Mouna D*³

^{1,3}The Research Centre of Home Science, Fatima College (A), Madurai - 625 018, Tamil Nadu, India

Correspondence to: Mouna D, The Research Centre of Home Science, Fatima College (A), Madurai - 625 018, Tamil Nadu, India, Tel: +91 9442957514; E-mail: mounabala2000@gmail.com

Abstract

Sleep, much like eating, is an essential part of healthy living and human functioning. Poor dietary habits, increased stress & anxiety due to work pressure, changes in sleep patterns and poor quality of sleep. Thus, sleep assessment and sleep quality improvement, are among the most important care measures. Chamomile (*Matricaria chamomilla* L.) is a well-known medicinal plant belongs to Asteraceae family, native to Europe. Approximately, 120 bioactive constituents including 28 terpenoids and 36 flavonoids were identified. Studies showing that chamomile improves sleep quality and alleviates depression and anxiety. Tulsi (*Ocimum sanctum*) is an aromatic shrub in the basil family Lamiaceae, native to India. Tulsi enhances the ability to adapt to both psychological and physical stress thus it has a calming effect, therefore it helps to manage stress-related disorders like sleep. In this present study, the amount of Flavonoids and Terpenoids present in dried Chamomile flower is 8.2mg/g and 6.5mg/g, and Eugenol present in dried Tulsi leaves is 4.7mg/g. The sensory evaluation of Chamomile tea and Tulsi tea with different variation like 0.5g, 1g and 1.5g has been done. As per the evaluation, 1g of Chamomile tea and Tulsi tea was selected to prepare the tea bag for future supplementation.

Key words: Chamomile, Tulsi, Phytochemicals, Sleep promotion, *Matricaria chamomilla* L., *Ocimum sanctum*

Sleep is an essential part of survival as food and water. Sleep is a highly complex state that arises from an interaction between various neurotransmitters pathway, brain regions and hormones. As one of the basic and essential biological processes sleep plays vital role in brain function, immunity, cardiovascular system etc. It also helps to maintain emotional well-being for optimal cognitive performance, including attention, emotional reactivity, learning and memory. Human spend one third of their lives in sleeping as it is a naturally recurring state. As a complex process sleep affects almost every type of tissue and system in our body, therefore proper sleep (sufficient sleeping hours, appropriate sleep timing) is essential for healthy life (Watson et al., 2015).

The biological function of sleep remains the greatest mystery of all times, although it is known that sleep is essential and that sleep deprivation, either resulting from lifestyle or sleep disorders (e.g., sleep apnoea, insomnia, medical, psychological, psychiatric, medication-related or neurological diseases) will cause short-term and long-term consequences. Short-term effect leads to impaired attention and concentration, impaired quality of life, increase rates of absenteeism with reduced productivity and accidents at work, home or on the road. Long-term consequences of sleep deprivation include morbidity and mortality from heart failure, high blood pressure, obesity, type 2 diabetes mellitus, stroke and memory impairment as well as depression. People in present days can't sleep properly due to busy schedule and work overload, which affect their health and cause various illnesses. One of the

common sleep related issues among people in today's world is sleep disruption (Muhammed Amin Wani, 2018).

Chamomile (*Matricaria recuitta chamomilla*) of the Asteraceae family is an annual plant indigenous to Europe and Asia, possessing branched, erect, and smooth stems. Its other names are chamomile or chamomile, Italian camomilla, German chamomile, wild chamomile, Hungarian chamomile. Chamomile is useful for treatment of stomachache, irritable bowel syndrome, and insomnia. It possesses anti-inflammatory and bactericidal, relaxant activities (Sepide Miraj & Samira Alesaeidi, 2016). The bioactive compound present in chamomile are as follows: apigenin, apigenin-7-O-glucoside, caffeic acid, chlorogenic acid, luteolin, and luteolin-7-O-glucoside, terpene bisabolol, farnesene, chamazulene, flavonoids (including apigenin, quercetin, patuletin and luteolin) and coumarin (Sepide Miraj & Samira Alesaeidi, 2016).

Tulsi (*Ocimum sanctum* L.) in Hindi or Tulasi in Sanskrit (holy basil in English) is an exceptionally adored culinary and restorative fragrant herb from the family Lamiaceae that is indigenous to the Indian subcontinent and been utilized inside Ayurvedic medications over 3000 years. Tulsi is abundant in essential oils and antioxidants, which are tremendously effective in reducing the effect of stress and insomnia. Tulsi has the property of acting as an adaptogen. It balances different processes in the body and is of great help in stress and sleep management (Lopamudra Sethi & Preetha Bhadra, 2020). While the concept of an "adaptogen", or herb that helps with

the adaption to stress and quality sleep and the promotion of homeostasis, is not widely used in western medicine, western science has revealed that Tulsi does indeed possess many pharmacological actions that fulfill this purpose (Marc Maurice Cohen, 2014). The major constituents identified are Eugenol, Benzene, 1, 2-dimethoxy- 4- (2- propenyl), α - Farnesene and Cyclohexane, 1, 2, 4- triethenyl. These phyto-chemicals are known to possess antiseptic, analgesic, anti-inflammatory, antimicrobial, antistress, immunomodulatory, hypoglycemic, hypotensive and antioxidant properties (Borah R, Biswas, 2018). The objectives of the present study are as follows:

To analyze the phytochemical contents in dried Chamomile flowers and dried Tulsi leaves, To prepare Chamomile tea /Tulsi tea & To prepare the Chamomile and Tulsi tea bags for future supplementation.

MATERIALS AND METHODS

The dried Chamomile flowers was purchased from the e-commerce website. The fresh Tulsi leaves were purchased from the local market and dried. The dried Chamomile flowers and dried Tulsi leaves were analyzed for the phytochemical contents. The amount of phytochemical concentration like flavonoids and terpenoids present in Chamomile are analyzed by using UV – VIS Spectrophotometer. The amount of Eugenol present in Tulsi is analyzed by using UV – VIS Spectrophotometer.

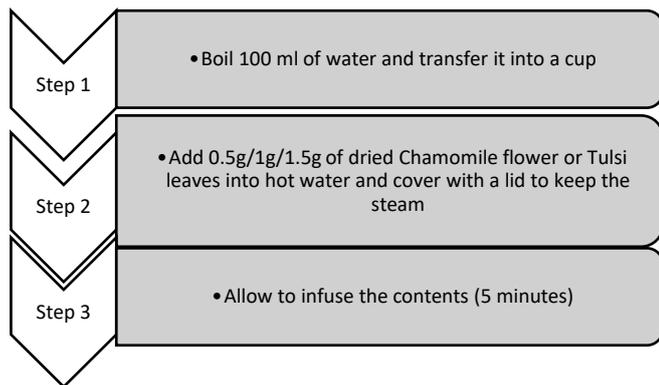


Fig 1 Flowchart on preparation of chamomile and tulsi tea

Method of preparation of Chamomile/Tulsi tea

Table 3 Evaluation on sensory characteristics of different variations of Chamomile tea and Tulsi tea

Sensory characteristics	Chamomile tea			Tulsi tea		
	0.5 g	1g	1.5g	0.5g	1g	1.5g
Appearance	7.1	8.7	7.3	6	8.5	7.2
Taste	7	8.5	7	6.3	8.5	7
Flavor	7	8.5	7.8	6.1	8.0	6.5
Overall acceptability	7	8.5	7.3	6	8.5	7
Overall Mean score	7.0	8.5	7.2	6.1	8.3	6.9

Values in parenthesis represent percentage

Table 3, depicts that the mean score for appearance, Taste, Flavor and overall acceptability of 0.5g variation of chamomile tea is 7.1, 7, 7 and 7 and for Tulsi tea it was 6, 6.3, 6.1 and 6 respectively. The mean score for appearance, Taste, Flavor and overall acceptability for 1g variation of Chamomile tea were as 8.7, 8.5, 8.5 and 8.5 and for Tulsi tea it was 8.5, 8.5, 8.0 and 8.5 respectively. The mean score for appearance, Taste, Flavor and overall acceptability for 1.5g variation of

For the preparation of Chamomile tea and Tulsi tea, 100 ml of water has to be taken and boiled. Pour the boiled water into a tea cup. Then, 0.5 /1g/ 1.5g of dried Chamomile flower or dried Tulsi leaves has to be added into the hot water and to be covered with a lid for 5 minutes to allow the contents for infusion. Drink the tea after 2 minutes of infusion. It can be served before one hour to bed time. Figure no. 1 shows the flowchart on preparation of Chamomile and Tulsi tea.

Sensory evaluation of chamomile tea and tulsi tea

The Sensory evaluation of Chamomile tea and Tulsi tea with three different variations (0.5g, 1g and 1.5g) has been done.

Preparation of tea bag

One Chamomile tea bag / Tulsi tea bag contains 1g of dried chamomile flower or 1g of dried Tulsi leaves.

RESULTS AND DISCUSSION

Phytochemical contents in dried Chamomile flowers and dried Tulsi leaves were analyzed and the quantity present in it was tabulated.

Table 1 Quantitative analysis of phytochemicals present in dried Chamomile flower

Phytochemicals in dried Chamomile flower			
S. No	Name of the test	Result	Test Method
1	Flavonoids	8.2mg/g	BY UV – VIS
2	Terpenoids	6.5mg/g	Spectrophotometer

From the Table 1, it was inferred that the amount of flavonoids and Terpenoids present in dried Chamomile flower are 8.2mg/g and 6.5mg/g respectively.

Table 1 Quantitative analysis of Eugenol present in dried Tulsi leaves

Phytochemicals in dried Tulsi leaves			
S. No	Name of the test	Result	Test Method
1	Eugenol	4.7mg/g	BY UV – VIS Spectrophotometer

From the Table 2, it was inferred that the amount of Eugenol present in dried Tulsi leaves are 4.7mg/g.

Chamomile tea were as 7.3, 7, 7.8 and 7.3 and for Tulsi tea it was 7.2, 7, 6.5 and 7 respectively. The overall mean score for Chamomile tea of 0.5g, 1g and 1.5g variations were 7.0, 8.5 and 7.2 and overall mean score for Tulsi tea of 0.5g, 1g and 1.5g variations were 6.1, 8.3 and 6.9 respectively.

From the assessment of sensory characteristics, 1g of Chamomile tea and 1g of Tulsi tea got the highest mean score of 8.5 and 8.3 respectively when compared to 0.5g and 1.5 g

variations. And also, Chamomile tea and Tulsi tea with 1g of variation have been useful for the promotion of sleep.



Figure 2 Chamomile tea bag and tulsi tea bag

Preparation of tea bag

Dried Chamomile flowers or dried Tulsi leaves were packed in a tea bag for the future purpose of supplementation. One Chamomile tea bag / Tulsi tea bag contains 1g of dried Chamomile flower or 1g of dried Tulsi leaves. Figure 2 shows that, Chamomile tea bag and Tulsi tea bag.

CONCLUSION

Tea is most common drink that most adults prefer. So, the preparation of Chamomile flower and Tulsi leaves for sleep promotion in the form of tea was selected. The amount of phytochemicals like Flavonoid and Terpenoid present in Chamomile dried flower is 8.2mg/g and 6.5mg/g respectively. The amount of Eugenol present in dried Tulsi leaves is 4.7mg/g. The sensory evaluation of Chamomile tea and Tulsi tea with different variations has been done. 1g of Chamomile tea and Tulsi tea got the highest mean score 8.5 and 8.3 respectively than 7.0 and 6.1 mean score of 0.5g of Chamomile tea and Tulsi tea and 7.2 and 6.9 mean score of 1.5g of Chamomile tea and Tulsi tea. Hence, Both Chamomile and Tulsi leaves have potent sleep enhancing properties because of the phytochemical constituents present in it.

LITERATURE CITED

1. Borah R, Biswas. 2018. Chloroplast DNA phylogeography of holy basil (*Ocimum tenuiflorum*) in Indian subcontinent. *Scientific World Journal*. 2018; 2018: 847–482.
2. Brown, D. 1995. The Royal Horticultural Society – Encyclopedia of Herbs and Their uses. London, Darling, Kindersley Limited.
3. Buddhadev SG. 2014. A review article on *Ocimum sanctum* Linn. *Int. Peer Revd. Ayur. J.* 2014; 2(2):1-6
4. Chatterjee, Gautam. 2001. Sacred Hindu Symbols. Abhinav Publications. pp. 93. ISBN 9788170173977. Simoons, pp. 17-18.
5. Claus, Peter J.; Sarah Diamond, Margaret Ann Mills. 2003. South Asian Folklore: An Encyclopedia. Taylor and Francis. p. 619. ISBN 9780415939195
6. Das SK and Vasudevan DM. 2006. Tulsi: The Indian holy power plant. *Natural Product Radiance*. 2006. 5: 279-83.
7. Sepide Miraj & Samira Alesaeidi. 2016. Variability of the essential oil content and composition of chamomile (*Matricaria recutita* L.) affected by weather conditions. *Nat Prod Commun*. 2010;5(3):465–70.
8. Kothari, S K; Bhattacharya, A K, et al. 2005. "Volatile Constituents in Oil from Different Plant Parts of Methyl Eugenol-Rich *Ocimum tenuiflorum* L.f. (syn. *O. sanctum* L.) Grown in South India". *Journal of Essential Oil Research: JEOR*. Retrieved 2008-09-05
9. Kunde R, Isaac O. 2019. Review on the flavones of chamomile (*Matricaria chamomilla* L.) and a new acetylated apigenin-7-glucoside. *Planta Med*. 1980; 37: 124-130.
10. Lopamudra Sethi & Preetha Bhadra. 2020. Pharmacological actions of *Ocimum sanctum* review article, *International Journal of advances in Pharmacy, Biology and Chemistry*, Vol. 1(3), Jul- Sep, 2012.
11. Muhammed Amin Wani. 2018. "Herbal medicine for insomnia: A systematic review and meta-analysis". doi:10.1016/j.smr.2014.12.003. ISSN 1087-0792. PMID 25644982.
12. Watson et al. 2015. "A review of the bioactivity and potential health benefits of chamomile tea (*Matricaria recutita* L.)". *Phytotherapy Research*. 20 (7): 519-130.

A Study on the Physio-Chemical Analysis of *Borassus flabellifer* and *Artocarpus heterophyllus* and its Incorporation in the Formulation of Functional Food Products for Adolescents

Poornima Jeyasekaran¹, U. Divyashree², S. Shahid Akeel², S. Manoranjani², M. Jeyadharshini², R. Gandhimathy³, C. Mabel Joshaline⁴ and D. Mouna⁵

¹⁻² Department of Food Science and Nutrition, The American College, Tallakulam, Madurai - 625 002, Tamil Nadu, India

³ Child Development Project Officer, Thirumangalam, Madurai, Tamil Nadu, India

⁴ Department of Rural Development Science, Arul Anandar College, Karumathur, Madurai, Tamil Nadu, India

⁵ Department of Human Nutrition and Nutraceuticals, Fatima College, Madurai, Tamil Nadu, India

Correspondence to: Poornima Jeyasekaran, Department of Food Science and Nutrition, The American College, Tallakulam, Madurai - 625 002, Tamil Nadu

Abstract

This study is aimed to identify the functional compounds present in Jackfruit (*Artocarpus heterophyllus*) seeds and Palm sprout (*Borassus flabellifer*) using FTIR (Fourier transform infrared) spectroscopy and to analyze the nutritional content. To formulate Functional food products using jack fruit seed and palm sprout in the form of pasta and supplement drink suitable for adolescent. Jackfruit seeds and Palm sprout samples are collected from different parts of Madurai, dried into fine powder using hot air oven and pelletized using Potassium bromide. These pellets were used to detect the characteristic peak values and their functional group using FTIR Pellet method and on sampler KBr accessory on a JASCO FTIR spectrometer (FTIR- 4600). Macronutrients such as energy, carbohydrates, proteins, fat, and micronutrients such as vitamins, calcium, and iron were analyzed. The dried powder of Jackfruit seeds and Palm sprout were incorporated for the formulation of nutritive product of Pasta (PJP) and Supplement drink (PJD). Two different varieties of pasta were tried out White sauce pasta (PJP1) and red sauce pasta (PJP2). The crude powder of the seeds (Jackfruit seeds, Palm sprout) using FTIR analysis confirmed the presence of amides, aromatics, alkanes, ethers, alkenes, alkyl halides, Fluoro compounds respectively. It contains alkene as a functional compound and has a peak value of *Borassus flabellifer* palm sprout is 1641.13 cm⁻¹ and *Artocarpus heterophyllus* seeds are 1633.41 cm⁻¹. The calculated nutritive value of formulated Pasta (100g) provides 14.15% of energy, 52.58% of carbohydrates, 28.82% of protein, 2.54% of fat, 62.60% of crude fibre, of an adolescent girl as per RDA. The calculated nutritive value of formulated supplement drink (100ml) meets the daily requirement of 3.08% energy, 5.8% protein, 12.2% fat, 15% calcium, 0.76% iron of an adolescent girl as per RDA suggested by ICMR. As per the sensory evaluation and statistical analysis results of the formulated products We came to know that the product PJP1 is better in texture, colour, and flavour when comparing with PJP2. The sensory evaluation results for PJP1 white sauce pasta stored: appearance (8.16±0.8), colour (8.28±1.3), flavour (8.12±0.7), taste (8.32±0.8), texture (8.32±0.6) and overall acceptability (8.56±0.5). For PJP2 red sauce pasta appearance (8.48±0.6), colour (8.6±0.5), flavour (8.32±0.6), taste (8.56±0.5), texture (8.52±0.5), and overall acceptability is (8.8±0.4). On the comparison, PJP2 was accepted by many panel members, because of its enhancing sensory attribute. The supplement drink PJD1 scored higher rating for the parameters like appearance (8.56±0.5), colour (8.32±0.6), flavour (8.64±0.4), texture (8.52±0.5) and overall acceptability (8.60±0.5). The Result of the present study produced the FTIR spectrum profile and confirms the presence of functional compounds in both palm sprout and Jackfruit seed. The nutritive value shows that the pasta is a rich source of energy and the sensory evaluation of red sauce pasta scored the highest score and accepted by the adolescent group.

Key words: Jackfruit seeds, Palm sprout, White sauce pasta, Red sauce pasta, Supplement drink, Functional compounds, FTIR (Fourier transform infrared) spectroscopy, Sensory evaluation

Functional foods are defined as foods that have positive physiological effects beyond their nutritional function of providing nutrients. Nutraceutical substances with commercial

value can be obtained from functional foods which have demonstrated a physiological benefit or are capable of providing some sort of protection against chronic or infectious

diseases (Lojalo, 2002). Palm fruit has anti-inflammatory and antioxidant properties. The antioxidant activity could be attributed due to the presence of high content of crude flavonoids, saponins and phenolic compounds (Pramod et al., 2017). The *Artocarpus* species have been used as traditional medicines. The plants have been used as anti-bacterial, anti-diabetic, antioxidant, anti-inflammatory, and anti-helminthic agents (Bapat, 2010).

The study entitled “A study on the physio-chemical analysis of *Borassus Flabellifer* & *Artocarpus Heterophyllus* and its incorporation in the formulation of functional food products for Adolescents” was discussed under the following headings.

Taxonomy

Taxonomy of *Borassus flabellifer*

Borassus flabellifer commonly known as Palmyra palm got its name from Greek word namely 'Borassus' and 'flabellifer' which means fruit with leather covering and fan-bearer respectively. Palmyra tree is a tall in stature commonly known as “*Borassus flabellifer*”. The word ‘Borassus’ is a Greek word means the leathery covering of the fruit and ‘flabellifer’, which means fan-bearer. Sap from the flower of the matured tree stalk is prized as a tonic, diuretic agents, stimulant, laxative and anti-phlegmatic and amebicide that are considered to be the best for day-to-day life. Sugar made from this sap is said to counteract poisoning, and it is fairly prescribed for liver disorders. The ethanolic extract of male flowers (inflorescences) of *Borassus flabellifer* is obtained by tapping the top shoots and collecting the dripping juice in hanging earthen pots tied with the trees. The juice early morning is refreshing and is light. The drink has high nutrient value and is good for health (Bhaskar et al., 2017).

Taxonomy of *Artocarpus heterophyllus*

Artocarpus heterophyllus, which is commonly known as jackfruit is a tropical climacteric fruit, belonging to Moraceae family, is native to Western Ghats of India and common in Asia, Africa, and some regions in South America. It is known to be the largest edible fruit in the world. It is a nonseasonal fruit and had a major contribution to the food supply of the people and their livestock when there were short supplies of staple food grains. Therefore, it is referred to as poor man’s food (Rahman, 1999).

MATERIALS AND METHODS

The study entitled “A study on the physio-chemical analysis of *Borassus Flabellifer* & *Artocarpus Heterophyllus* and its incorporation in the formulation of functional food products for Adolescents” was discussed under the following phases.

Phase 1

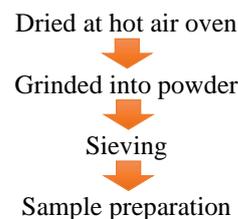
Collection of samples

The palm sprouts collected in Simmakal, Madurai, Tamilnadu, India and Jackfruit seeds collected in Yanaikaal, Madurai, Tamil Nadu, India.

Preparation of samples for FTIR analysis

For FTIR spectroscopy analysis dried leaves and petals were finely powdered separately and then using sieve, ground samples should be sieved. All the samples should be kept separately in the watch glasses with labelling. Each and every material should be cleaned with acetone like poulder, watch glass.

Samples of *Borassus flabellifer* and *Artocarpus heterophyllus*



Flow chart of FTIR spectroscopy analysis process

Phase 2

Formulation of functional food using *Borassus flabellifer* and *Artocarpus heterophyllus*

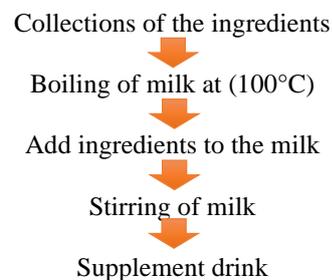
Based on the above benefits we have decided to incorporating the dried *Borassus flabellifer* and *Artocarpus heterophyllus* for preparation of recipes. For the formulation of recipe 5g of *Borassus flabellifer* and 5g of *Artocarpus heterophyllus* of the sample was incorporated.

Formulation of pasta



Flow chart for pasta formulation

Formulation of supplement drink



Flow chart for supplement drink formulation

Phase 3

Analysis of nutrient content

Macronutrients such as energy, carbohydrates, proteins, fat, and micronutrients such as vitamins, calcium, and iron were analyzed, using the method mentioned in (Table 1).

Table 1 Nutrient analysis of pasta

Parameters	Units	Method
Moisture	%	IS 1155:1968 Reaffirmed Year 2015
Total ash	%	IS 1155:1968 Reaffirmed Year 2015
Protein	%	FSSAI MANUAL-2016
Fat	%	IS 4684:1975 Reaffirmed Year 2015
Crude fibre	%	IS 1155:1968 Reaffirmed Year 2015
Carbohydrate	%	IS 1656:2007 Reaffirmed Year 2018
Energy	Kcal/100g	IS 14433:2007 By calculation method

Moisture is analyzed by IS 1155 method and energy estimated by IS 14433 methods, carbohydrate is analyzed by IS 1656 method, fat estimated by IS 4684 method and crude fiber by IS 1155 method.

Phase 4

Sensory evaluation of the formulated product

Sensory attributes were assessed based on the quality descriptions, i.e. Appearance, color, flavor taste, texture and overall acceptability. The 9-point Hedonic scale ranging from 1 to 9, were used to evaluate the acceptability of the formulated product (pasta). Products were evaluated by a panel of 25 semi trained judges from the Department of Food Science and Nutrition, The American College, Madurai (Stone, 2004).

RESULTS AND DISCUSSION

The results of the present study entitled “A study on the physio-chemical analysis of *Borassus Flabellifer* and *Artocarpus Heterophyllus* and its incorporation in the

formulation of functional food products for Adolescents” based products was discussed under the following headings.

Identification of functional compounds in Borassus flabellifer

The peak at 1641.13 cm⁻¹ represents the *Borassus flabellifer* and it indicates the presence of alkene.

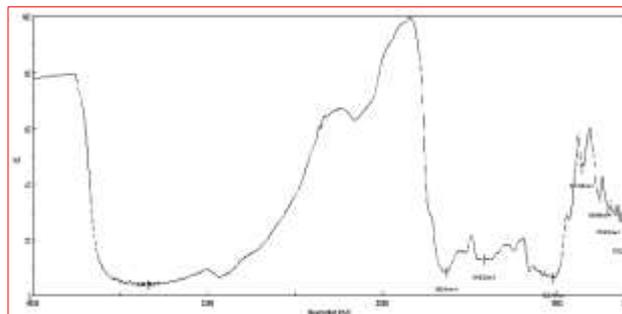


Fig 3 Identification of functional compounds in *Borassus flabellifer* (palm sprout) using FTIR

Table 2 FTIR peak value for *Borassus flabellifer*

S. No.	Absorption	Functional group	Functional compound	Intensity
1.	3336.28 cm ⁻¹	C-H stretching	Amides	Medium
2.	1633.41 cm ⁻¹	C=N stretching	Alkenes	Variable
3.	1419.35cm ⁻¹	C-H stretching	Alkanes	Strong
4.	1020.16cm ⁻¹	C-F stretching	Fluro compounds	Medium
5.	858.168cm ⁻¹	C-H blending	Aromatic	Medium
6.	705.819cm ⁻¹	C-Cl stretching	Alkyl halides	Medium
7.	755.959 cm ⁻¹	C-Cl stretching	Aromatic	Medium
8.	612.288 cm ⁻¹	C-Br stretching	Alkyl halides	Medium

The peak values of the *Borassus flabellifer* reveal the presence of amides 3336.28cm⁻¹, alkene 1633.41cm⁻¹, alkanes 1419.35cm⁻¹, fluro compounds 1020.16cm⁻¹, aromatic compounds 858.168cm⁻¹, alkyl halides 705.819cm⁻¹, aromatic 755.959 cm⁻¹, alkyl halides 612.288 cm⁻¹ mentioned in (Table 2).

Identification of functional compound in Artocarpus heterophyllus

The peak at 1633.41 cm⁻¹ represents the *Artocarpus heterophyllus* and it indicates the presence of alkene.

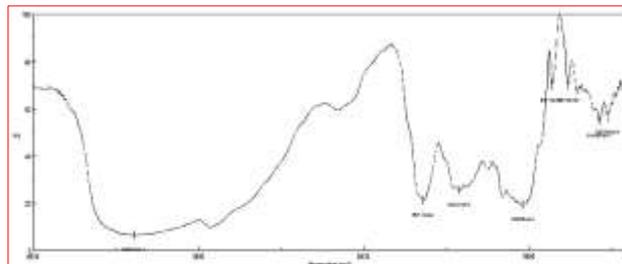


Fig 4 Identification of functional compounds in *Artocarpus heterophyllus* (jack fruit seed) using FTIR

Table 3 FTIR Peak value for *Artocarpus heterophyllus*

S. No.	Absorption	Functional group	Functional compound	Intensity
1.	3390.25 cm ⁻¹	C-H stretching	Amides	Medium
2.	1641.13 cm ⁻¹	C=N stretching	Alkenes	Variable
3.	1423.21 cm ⁻¹	C-H stretching	Alkanes	Strong
4.	1036.55 cm ⁻¹	C-O stretching	Ethers	Strong
5.	850.132 cm ⁻¹	C-H blending	Aromatic	Medium
6.	574.683 cm ⁻¹	C-Cl stretching	Alkyl halides	Medium
7.	762.709 cm ⁻¹	C-Cl stretching	Aromatic	Medium

The peak values of the *Artocarpus heterophyllus* reveal the presence of amides 3390.25cm⁻¹ alkene 1642.13cm⁻¹, alkanes 1423.21 cm⁻¹, ethers 1036.55 cm⁻¹, aromatic compounds 850.132 cm⁻¹, alkyl halides 574.683 cm⁻¹, aromatic 762.709 cm⁻¹ mentioned in (Table 3).

Results of the nutritive value for the formulated pasta

Nutrient analysis of the formulated pasta (PJP)

Table 4 Nutrient analysis of pasta

Parameters	Units	Method
Moisture	%	14.07
Total ash	%	0.68
Protein	gm	16.0
Fat	gm	0.89
Crude fibre	gm	1.44
Carbohydrate	gm	68.36
Energy	Kcal/100g	345.45

As per the nutrient analysis mentioned in the above table 5, the formulated pasta, provides 14.15% energy, 2.54% carbohydrates, 62.60%, 28.82 of protein, fat 52.58% crude fiber and of an adolescent girl as per RDA suggested by ICMR.

As per the nutritive analysis mentioned in the above table 9, the formulated supplement drink (100ml) meets the daily requirement of 3.08% energy, 5.8% protein, 12.2% fat, 15% calcium and 0.76% iron of an adolescent girl as per RDA suggested by ICMR.

Parameters	Units	Method
Energy	Kcal	75.35
Protein	G	3.291
Fat	G	4.28
Calcium	mg	120.14
Iron	mg	0.2

Table 6 Mean and standard deviation for pasta

Sample code	Appearance	Color	Flavor	Taste	Texture	Overall acceptability
PJP1	8.16±0.8	8.28±1.3	8.12±0.7	8.32±0.8	8.32±0.6	8.56±0.5
PJP2	8.48±0.6	8.6±0.5	8.32±0.6	8.56±0.5	8.52±0.5	8.8±0.4

Sensory evaluation of the formulated products

Sensory evaluation of the formulated pasta

The result of sensory evaluation of *Artocarpus heterophyllus* and *Borassus flabellifer* incorporated in pasta for adults revealed that majority of the subjects like extremely the taste (8.32±0.8) in PJP1 and PJP2 appearance (8.48±0.6) and color (8.6±0.5) of *Borassus flabellifer* and *Artocarpus heterophyllus* incorporated pasta. According to the taste and texture aspects of palm sprout and jackfruit seeds incorporated

pasta got most preference for and high level of preference for texture (8.32±0.6) and taste (8.32±0.8) in PJP1. The high preference for color (8.6±0.5) and taste (8.56±0.5) in PJP2 is like extremely. In case of texture and color very good response given to incorporated of *Artocarpus heterophyllus* and *Borassus flabellifer* pasta and overall acceptability given as best for of *Artocarpus heterophyllus* and *Borassus flabellifer* incorporated pasta mean and standard deviation for PJP2 is (8.82±0.4). The statistical report of the formulated pasta was interpreted in (Table 6).

Table 7 Mean and standard deviation for supplement drink

Sample code	Appearance	Color	Flavor	Taste	Texture	Overall acceptability
PJD1	8.56±0.5	8.32±0.6	8.64±0.4	8.64±0.4	8.52±0.5	8.60±0.5

Sensory evaluation of the supplement drink

The result of sensory evaluation of *Artocarpus heterophyllus* and *Borassus flabellifer* mixed in milk and recommended as a supplement for adults. Majority of the subjects like the taste moderately (8.64±0.4) in PJD1. According to the taste (8.64±0.4) and flavor (8.64±0.4) of *Artocarpus heterophyllus* and *Borassus flabellifer* supplement it is mostly preferred. PJD1 incorporated of *Artocarpus heterophyllus* and *Borassus flabellifer* the mean and standard deviation for PJD1 (8.64±0.4) and the overall acceptability is (8.60±0.5). The statistical report of the formulated pasta was interpreted in (Table 7).

41.75, selling amount were Rs. 50 and then the profit gain from this red sauce pasta is RS.8.25. the above estimate cost for 150g of finished pasta is Rs.50.

Cost estimation of formulated products

Table 8 Cost estimation of red sauce pasta

Ingredients	Quantity	Cost
Rava (flour)	100g	Rs.10
Palm sprout powder	5g	Rs.4.5
Jackfruit seeds powder	5g	Rs.4.5
Salt	0.5g	Rs.0.25
Water	10ml	Rs.0.5
Red sauce	15g	Rs.3.0
Oil	10ml	Rs.1.50
Onion	3g	Rs.1.5
Pepper	2g	Rs.1.0
Other expenses (EB, labor charge, rent, etc)		Rs.15
Total		Rs. 41.75
Profit earns		RS.8.25
Selling cost		Rs.50

It is used for estimating and valuating the internal cost of the product. The total cost estimation of red sauce pasta is Rs.

Table 9 Cost estimation of white sauce pasta

Ingredients	Quantity	Cost
Rava (flour)	100g	Rs.10
Palm sprout powder	5g	Rs.4.5
Jackfruit seeds powder	5g	Rs.4.5
Salt	0.5g	Rs.0.25
Water	10ml	Rs.0.5
Milk	50ml	Rs.5.0
Maida (flour)	5g	Rs.1.5
Pepper	2g	Rs.1.0
Other expenses (EB, labor charge, rent, etc)		Rs.15
Total		Rs.41.25
Profit earns		Rs.8.75
Selling cost		Rs.50

It is used for estimating and valuating the internal cost of the product. The total cost estimation of white sauce pasta is Rs. 41.25, selling amount were Rs.50 and then the profit gain from this red sauce pasta is RS.8.75.

CONCLUSION

Jackfruit seeds are a great source of iron which is a component of hemoglobin. Jackfruit seeds contain a lot of benefits such as it helps in curing mental stress and skin diseases. Palm Sprout contains a lot of fiber. It is most well-known for its ability to prevent or cure constipation by regulating bowel motions. We incorporated *Borassus flabellifer* palm sprout powder and *Artocarpus heterophyllus*, seeds

powder in milk and provided it as a supplement for the nutritional growth of adolescents. The formulated *Borassus flabellifer* palm sprout powder and *Artocarpus heterophyllus*, seeds powder on milk supplement were evaluated for

appearance, taste, texture, flavor, and overall acceptability on 9-point hedonic scale and numerical score card. The prepared samples were given to 25 panel members of people for sensory evaluation of supplement.

LITERATURE CITED

1. Bapat and Lojalo 2010. Minerals and functional groups present in the jackfruit seed: a spectroscopic investigation. *International Journal of Food Sciences and Nutrition* 55 (6): 479-483. 10.1080/09637480400015810.
2. Chowdhury BA, M. Azizur Raman, and A. Jabbar Mian. (1997). "Distribution of free sugars and fatty acids in jackfruit (*Artocarpus heterophyllus*)". *Food Chemistry*. 60 (1): 25–28. 10.1016/S03088146(96)00294-4
3. Fernando and R. Chacrabati. (2016). In "M. S. J. Simmonds and V. R. Preedy (Eds) Nutritional composition of fruit cultivars". Elsevier. 10.1016/B978-0-12-4081178.000143.
4. Rahaman MA, A. Rahman, M. G. Miah, M. A. Hoque, and M. M. Rahman. (2018). "Productivity and profitability of jackfruiteggplant agroforestry system in the terrace ecosystem of Bangladesh". *Turkish Journal of Agriculture - Food Science and Technology*. 6 (2): 124. 10.24925/turjaf.v6i2.124-129.1330.
5. Stone, Ketut K, Ketut SI. 2017. Developing merchandise for tourism using palmyra palm leaf ribs, palmyra palm leaves and palmyra palm sap. *Russian Journal of Agricultural and Socio-Economic Sciences* 62(2).

Standardization of *Vitex negundo* Leaves Powder Incorporated Food Products

Sankari K^{*1} and K Karthiga²

^{1,2}The Research Centre of Home Science, Fatima College (Autonomous), Madurai, Tamil Nadu, India

Correspondence to: Sankari K, The Research Centre of Home Science, Fatima College (Autonomous), Madurai, Tamil Nadu, India, Tel: +91 8110006074; E-mail: sankarikannamma9@gmail.com

Abstract

Vitex negundo linn (*Verbenaceae*) is commonly known as five - leaved chaste tree or monk's pepper. It is most familiar in unani medicine. This plant is a small tree. Each part of the plant has discrete medicinal properties & phytochemical constituents. The powdered leaves of *Vitex negundo* were incorporated in five different products like rasam powder, dhal powder, tamarind rice powder, amchoor powder and kasuri methi. The products were prepared by grinding the necessary ingredients with the incorporation of *Vitex negundo* powder at a level of 3% and 3.5% respectively. The Organoleptic parameters like appearance, colour, taste, texture, flavor and overall acceptability of 3.5% of VNLIP secured highest scores than 3% of VNLIP (*Vitex Negundo* Leaves Incorporated Products). Nutrient analysis like moisture, carbohydrate, protein, fat, crude fibre, calcium, phosphorous, iron and vitamin-C were analyzed in control and 3.5% *Vitex negundo* powder products. The results revealed that the nutrients were high in 3.5% *Vitex negundo* powder incorporated products than control samples. The *Vitex negundo* incorporated products can be suggested generally for all age groups because they contain antioxidant, anti – inflammatory, anti – convulsant and especially these leaves of *Vitex negundo* contains an iridoid glycoside component called agnuside exposed the estrogen like activity.

Key words: *Vitex negundo*, Monk's Pepper, Phytochemical constituents, Agnuside, Estrogen

The traditional foods are totally depends upon the herbs and medicinal plants but now in modern life we cross over the herbs only when we are in illness. We can include the medicinal plants in our day today food products. *Vitex negundo* is a Traditional medicinal plant comprises of nearly 250 species. Nirgundi the Sanskrit word of *Vitex negundo* literally means the plant which protects the body from diseases (Ahuja *et.al.*, 2015).

About the plant

Vitex negundo (*Verbenaceae*) is a small tree growing from 2 - 8 metre in height with quadrangular branchlets. The bark is reddish brown in color. The leaves of *Vitex negundo* are 4 - 10 centimeter in length. The flowers are bluish purple in color. The fruit is succulent drupe having 4 millimeter in diameter, rounded to egg shaped (Bano Uzma, *et. al.* 2015). The plants are found throughout India. It is common in waste places around villages, river banks, and moist localities and in the deciduous forests. It is found in China, Nepal, and Thailand (Ahuja, *et.al.*, 2015).

Vernacular names

The other names of *Vitex negundo* is Chinese chaste tree & five leaved chaste tree, Shivari & sawbhalu, Nirgundi, Vellainocchi & nirnuchi, Vaavili in English, Hindi, Sanskrit, Tamil & Telugu.



Figure 1 *Vitex negundo* leaves

Medicinal properties

Vitex negundo get its common name from the ancient Greece. The Vitex was used as an herbal supplement for numerous effects upon the reproductive system of both men and

women. The whole plant is used during the period of puberty rituals (Ahuja *et al.*, 2015). Traditionally it is reported to have multifarious activities such as analgesic, antioxidant, anti-inflammatory, insecticidal, antimicrobial, anticancer, galactagogue, tonic, febrifuge, expectorant and diuretic properties (Basri *et al.*, 2014). The nutrients present in the leaves of five leaved chaste tree are ash content, moisture, crude fat, crude fibre, crude carbohydrate and crude protein. The quantified amount of percentage present in *Vitex negundo* leaves are 5.4 ± 0.35 of ash content, 16.50 ± 1.2 moisture content, 7 ± 0.7 crude fat, 28.02 ± 1.03 crude fiber, 8.5 ± 0.45 carbohydrate and 13.7 ± 1.04 % of crude protein. The energy estimated from *Vitex negundo* leaves is 151.80 Cal/100g (Kumar *et al.*, 2013). The plant *Vitex negundo* showed significant antioxidant activity. The plant extracts possess potent antioxidant activity, which might be helpful in preventing or slowing the progress of various oxidative stress-related diseases. The methanol leaf extract showed highest (68.72%) DPPH scavenging activity at a concentration of 100 $\mu\text{g/mL}$ (Prakash *et al.*, 2017). The phytochemical test of medicinal plant found to have many bioactive compounds which are potent source of anticancer property (Roshni *et al.*, 2019). The hepatoprotective activity of Negundoside & agundoside from *Vitex negundo* used in combination with one or more pharmaceutical additives which prevent and treat hepatic diseases (Venkateshwarlu, 2012). *Vitex negundo* possesses significant antimicrobial activity against *S. aureus*. The antibacterial activity of fresh and aqueous extracts of leaves in various dilutions of water, chloroform and methanolic leaf extracts of *Vitex negundo* against *E. Coli*, *S. aureus* and *K. pneumoniae*. Oral administration of the leaves claims to have antihyperglycemic, antibacterial, antipyretic, antihistaminic agents, anti-implantation activity (Roshni *et al.*, 2019). The oral administration of leaves used for intestinal worm infestation, spleen disorder, abdominal tumour and useful in anorexia, improves intelligence, relieves anxiety, protect from eye diseases, carminative, improves hair quality. It possesses anti-poisonous, anti-spasmodic. The leaves are also useful against cholesterol, wounds, running nose, asthma, bronchitis, and cold cough (Kumar *et al.*, 2018). Toxicity levels for *Vitex Negundo*

- Doses recommended, in adults are: *Vitex negundo* leaves powder - 1.5 - 3g; dry leaves extract of *Vitex negundo*, 300-600mg (Venkateshwarlu, 2012).

Considering these points, the present study was carried out to standardize the *Vitex negundo* leaves powder incorporated products with the following objectives:

- To standardize the *Vitex negundo* leaves powder incorporated food products.
- To find out the acceptability of the standardized food products.
- To analyze the nutrient content of the developed food products.

MATERIALS AND METHODS

The list of equipment's used for the study and their purpose is mentioned inside the (Table 1). Fresh leaves of *Vitex negundo* were collected and it was cleaned and washed to remove the undesirable materials. The cleaned and washed leaves were dried under the direct sunlight at a temperature of 37°C during the month of February for 6 hours for three consecutive days and it was made into a fine powder by using mixer grinder. Finally, the dried powder was sieved using sieve. *Vitex negundo* leaves powder was incorporated in different products like rasam powder, dhal powder, tamarind rice powder, amchoor powder, kasuri methi at a level of 3% and 3.5% respectively.

Table 1 List of equipment's

Equipment's	Purpose
Weighing balance	To weigh the raw materials
Electronic balance	To weigh the chemicals
Mixer grinder	For powdering the ingredients
Laminar air flow chamber and incubator	To determine the microbial load of the products
Hot air oven	To determine the moisture content

Utensils like Stainless steel vessels, bowls, ladle, frying pan were used for the study.



Figure 2-4: Fresh, dried and powdered leaves of *Vitex negundo*

Flowchart for the preparation of *Vitex negundo* powder

Collection of fresh *Vitex negundo* leaves

Cleaning and washing

Sundry the leaves at 37°C for 3 days

Powdered the dried leaves and sieve to get a fine powder

Vitex negundo powder

Flowchart for the preparation of *Vitex negundo* powder incorporated rasam powder

Dry roast the ingredients such as coriander seeds, cumin seeds, red chilli, black pepper, curry leaves & asafoetida separately

Powdering the dried ingredients

Cool it to room temperature

Incorporating *Vitex negundo* leaves powder at a level of 3% and 3.5%

Vitex negundo leaves powder incorporated rasam powder

Flowchart for the preparation of *Vitex negundo* powder incorporated dhal powder

Dry roast all the ingredients (Red gram dhal, roasted Bengal gram dhal, cumin seeds, red chilli, curry leaves & asafoetida separately and finally add rock salt)

Powdering the dried ingredients

Cool it to room temperature

Incorporating *Vitex negundo* leaves powder at a level of 3% and 3.5%

Vitex negundo leaves powder incorporated Dhal powder

Flowchart for the preparation of *Vitex negundo* powder incorporated tamarind rice powder

Dry roast all the ingredients (Bengal gram dhal, black gram dhal, black gram dhal, coriander seeds, fenugreek seeds, sesame seeds, black pepper, red chilli, curry leaves & asafoetida separately)

Powdering the dried ingredients

Cool it to room temperature

Incorporating *Vitex negundo* leaves powder at a level of 3% and 3.5%

Vitex negundo leaves powder incorporated tamarind rice powder

Flowchart for the preparation of *Vitex negundo* powder incorporated amchoor powder

Collection of fresh raw mango

Cleaning and washing

Peeling

Slicing

Sun drying for 2 days at 50°C

Making into fine powder

Incorporating *Vitex negundo* powder at a level of 3% and 3.5%

Vitex negundo leaves powder incorporated amchoor powder

Flowchart for the preparation of *Vitex negundo* powder incorporated kasuri methi

Collection of fresh fenugreek leaves

Cleaning and washing

Chopping

Sun drying for 3 days at 37°C

Rub the dried leaves to get a coarse powder

Incorporating *Vitex negundo* leaves powder at a level of 3% and 3.5%

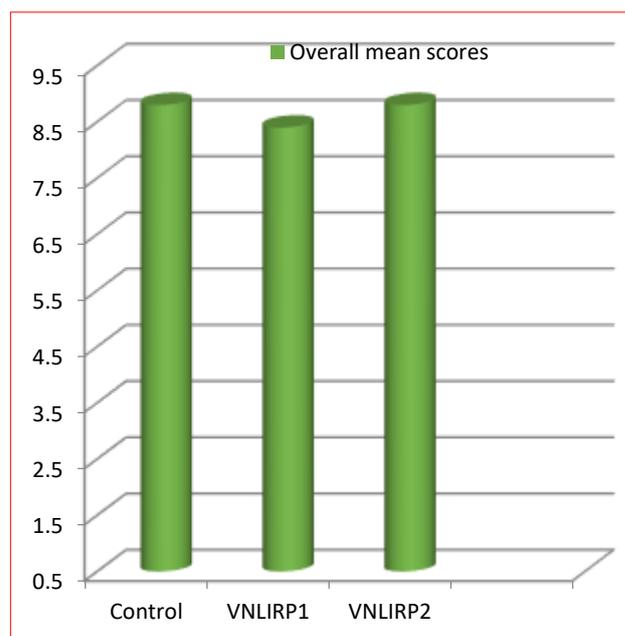
Vitex negundo leaves powder incorporated kasuri methi

Nutrient analysis

The control and 3.5% *Vitex negundo* leaves powder incorporated products were subjected to nutrient analysis. Calculated by the nutritive value calculation method with the reference of Nutritive Value of Indian Foods (ICMR) 1935 and few nutrients like moisture, carbohydrate and energy were analyzed.

RESULTS AND DISCUSSION

The products like rasam powder, dhal powder, tamarind rice powder, amchoor powder, kasuri methi were prepared by incorporating *Vitex negundo* leaves powder at a level of 3% and 3.5% respectively. The results of the acceptability trial are discussed below.

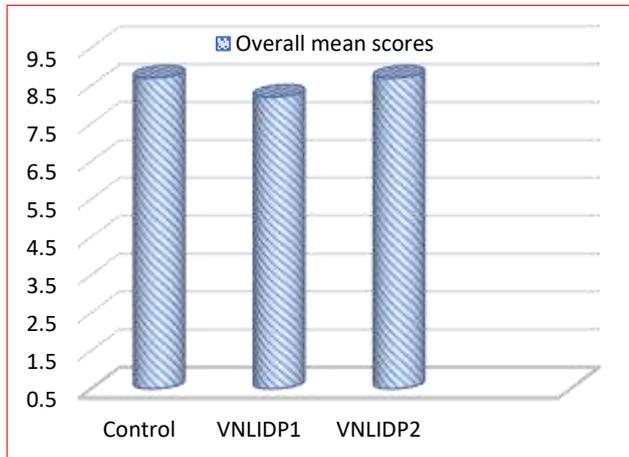


VNLIRP1-3% *Vitex negundo* leaves powder incorporated Rasam Powder
VNLIRP2-3.5% *Vitex negundo* leaves powder incorporated Rasam Powder

Figure 5 Overall mean scores obtained for control and *Vitex negundo* leaves powder incorporated rasam powder

Acceptability of control and Vitex negundo leaves powder incorporated rasam powder

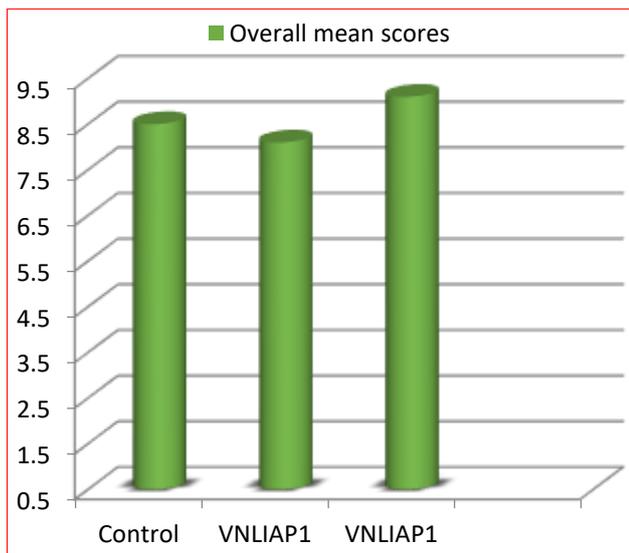
Among the *Vitex negundo* leaves powder incorporated rasam powder, the overall acceptability scores for Control, VNLIRP1 and VNLIRP2 were 8.8, 8.5 and 8.6 respectively. The result shows that 3.5% *Vitex negundo* leaves incorporated rasam powder (VNLIRP2) was highly acceptable in all the sensory attributes when compared to the VNLIRP1 and overall mean scores of VNLIRP2 was more than the overall mean scores of control sample.



VNLIDP1 – 3% *Vitex negundo* Leaves Powder Incorporated Dhal Powder
 VNLIDP2 – 3.5% *Vitex negundo* Leaves Powder Incorporated Dhal Powder
 Figure 6 Overall mean scores obtained for control and *Vitex negundo* leaves powder incorporated dhal powder

Acceptability of control and Vitex negundo leaves powder incorporated dhal powder

Among the *Vitex negundo* leaves powder incorporated dhal powder, the overall mean acceptability scores for Control, VNLIDP1 and VNLIDP2 were 8.7, 8.6 and 8.5 respectively. The overall mean scores obtained for Control, VNLIDP1 and VNLIDP2 were 8.7, 8.2 and 8.5 respectively. The result shows

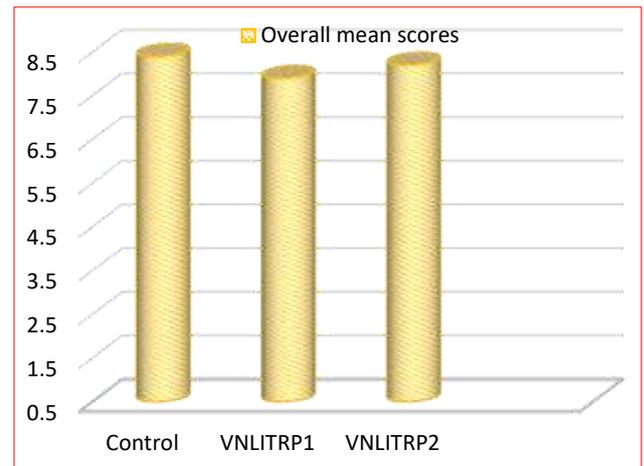


VNLIAPI1-3% *Vitex negundo* leaves powder incorporate amchoor powder
 VNLIAPI2-3.5% *Vitex negundo* leaves powder incorporated amchoor powder
 Fig 8 Overall mean scores obtained for control and *Vitex negundo* leaves powder incorporated amchoor powder

Acceptability of control and Vitex negundo leaves powder incorporated amchoor powder

Among the *Vitex negundo* leaves powder incorporated amchoor powder, the overall mean acceptability scores for

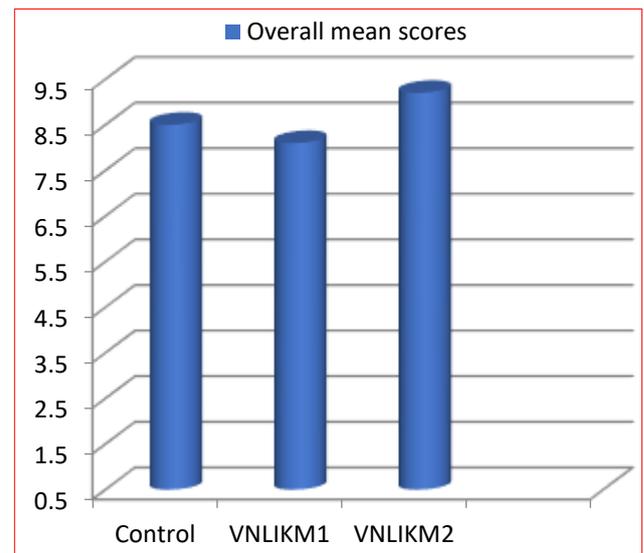
that 3.5% *Vitex negundo* leaves incorporated rasam powder (VNLIDP2) was highly acceptable in all the sensory attributes when compared to the VNLIDP1 and overall mean scores of VNLIDP2 was more than the overall mean scores of the control sample.



VNLITRP1 – 3% *Vitex negundo* leaves powder incorporated tamarind rice powder
 VNLITRP2 – 3.5% *Vitex negundo* leaves powder incorporated tamarind rice powder
 Figure 7 Overall mean scores obtained for control and *Vitex negundo* leaves powder incorporated tamarind rice powder

Acceptability of control and Vitex negundo leaves powder incorporated tamarind rice powder

Among the *Vitex negundo* leaves powder incorporated tamarind rice powder, the overall mean acceptability scores for Control, VNLITRP1 and VNLITRP2 were 8.6, 8.0 and 8.4 respectively. The overall mean scores obtained for Control, VNLITRP1 and VNLITRP2 were 8.4, 7.9 and 8.2 respectively. The result shows that 3.5% *Vitex negundo* leaves incorporated puliyogare powder (VNLITRP2) was highly acceptable in all the sensory attributes when compared to the VNLITRP1 and overall mean scores of VNLITRP2 was more than the overall mean scores of the control sample.



VNLIKM1-3% *Vitex negundo* Leaves Powder Incorporate Kasuri Methi
 VNLIKM2-3.5% *Vitex negundo* leaves powder incorporated kasuri methi
 Fig 9 Overall mean scores obtained for control and *Vitex negundo* leaves powder incorporated kasuri methi

Control, VNLIAPI1 and VNLIAPI2 were 8.6, 8.6 and 8.6 respectively. The overall mean scores obtained for Control, VNLIAPI1 and VNLIAPI2 were 8.5, 8.1 and 8.41 respectively. The result shows that 3.5% *Vitex negundo* leaves incorporated

amchoor powder (VNLIAP2) was highly acceptable in all the sensory attributes when compared to the VNLIAP1 and overall mean scores of VNLIAP2 was more than the overall mean scores of the control sample.

Acceptability of control and Vitex negundo leaves powder incorporated kasuri methi

Among the *Vitex negundo* leaves powder incorporated kasuri methi, the overall mean acceptability scores for Control, VNLIK1 and VNLIK2 were 8.5, 8.6 and 8.4 respectively. The overall mean scores obtained for Control, VNLIK1 and VNLIK2 were 8.5, 8.1 and 8.4 respectively. The result shows that 3.5% *Vitex negundo* leaves incorporated amchoor powder (VNLIK2) was highly acceptable in all the sensory attributes when compared to the VNLIK1 and overall mean scores of VNLIK2 was more than the overall mean scores of the control sample.

Nutrient analysis of control and Vitex negundo leaves powder incorporated rasam powder

The nutrient content of control and 3.5% *Vitex negundo* leaves powder incorporated rasam powder is mentioned in (Table 2).

Table 2 Nutrient content of control and VNLIRP2

Nutrients	Control	VNLIRP2
Moisture (g%)	12.26	12.89
Energy (Kcal)	248	248
Carbohydrate (g)	35.25	40.45
Fat (g)	10.31	10.51
Protein (g)	15.15	15.45
Fibre (g)	19.63	20.1
Calcium (mg)	113.6	604.2
Phosphorous (mg)	351.4	416.8
Iron (mg)	9.47	9.97
Vitamin – C (mg)	8.25	8.95

VNLIRP2-3.5%*Vitex negundo* leaves powder incorporated rasam powder

Nutrient analysis of control and Vitex negundo leaves powder incorporated dhal powder

The nutrient content of control and 3.5% *Vitex negundo* leaves powder incorporated dhal powder is mentioned in (Table 3).

Table 3 Nutrient content of control and VNLIDP2

Nutrients	Control	VNLIDP2
Moisture (g%)	11.01	11.6
Energy (Kcal)	300	300
Carbohydrate (g)	48	53.2
Fat (g)	5.31	5.51
Protein (g)	18.4	18.7
Fibre (g)	12.22	12.7
Calcium (mg)	405	937.7
Phosphorous (mg)	317	383
Iron (mg)	7.21	7.71
Vitamin – C (mg)	10.4	11.15

VNLIDP2-3.5%*Vitex negundo* leaves powder incorporated Dhal powder

Nutrient analysis of control and Vitex negundo leaves powder incorporated tamarind rice powder

The nutrient content of control and 3.5% *Vitex negundo* leaves powder incorporated tamarind rice powder is mentioned in (Table 4).

Nutrient analysis of control and Vitex negundo leaves powder incorporated amchoor powder

The nutrient content of control and 3.5% *Vitex negundo* leaves powder incorporated amchoor powder is mentioned in (Table 5).

Table 4 Nutrient content of control and VNLITRP2

Nutrients	Control	VNLITRP2
Moisture (g%)	10.9	11.54
Energy (Kcal)	290	290
Carbohydrate (g)	44.5	49.7
Fat (g)	7.67	7.87
Protein (g)	17.18	17.48
Fibre (g)	12.18	13.3
Calcium (mg)	354	887.17
Phosphorous (mg)	326.9	392.3
Iron (mg)	7.10	7.60
Vitamin – C (mg)	7.7	8.4

VNLITRP2 - 3.5%*Vitex negundo* leaves powder incorporated tamarind rice powder

Table 5 Nutrient content of control and VNLIAP2

Nutrients	Control	VNLIAP2
Moisture (g%)	1.02	1.65
Energy (Kcal)	307	307
Carbohydrate (g)	58.2	63.4
Fat (g)	0.6	0.8
Protein (g)	1.4	1.7
Fibre (g)	5.0	5.5
Calcium (mg)	9.65	542
Phosphorous (mg)	18.3	83.7
Iron (mg)	0.3	0.8
Vitamin – C (mg)	1.67	2.37

VNLIAP2 - 3.5%*Vitex negundo* leaves powder incorporated amchoor powder

Nutrient analysis of control and Vitex negundo leaves powder incorporated kasuri methi

The nutrient content of control and 3.5% *Vitex negundo* leaves powder incorporated kasuri methi is mentioned in (Table 6).

Table 6 Nutrient content of control and VNLIK2M

Nutrients	Control	VNLIK2M
Moisture (g%)	7.4	7.4
Energy (Kcal)	311	311
Carbohydrate (g)	55	60.2
Fat (g)	5.7	5.9
Protein (g)	22.1	22.4
Fibre (g)	1.06	1.56
Calcium (mg)	38.6	571.0
Phosphorous (mg)	49.2	114.6
Iron (mg)	179.4	179.9
Vitamin – C (mg)	12.2	12.2

VNLIK2M - 3.5%*Vitex negundo* leaves powder incorporated kasuri methi

CONCLUSION

A brief summary of the result of the study carried out to analyze the *Vitex negundo* leaves powder incorporated products are concluded here. The data in nutrient content and sensory attributes of *Vitex negundo* leaves powder incorporated products have been summarized and concluded. The acceptability of *Vitex negundo* leaves powder incorporated products at the level of 3 and 3.5% per cent were evaluated for the Colour, Flavour, Taste, Texture and overall acceptability. The *Vitex negundo* leaves powder incorporated food products

were accepted up to the level of 3.5% of incorporation. The result stated that 3.5% *Vitex negundo* leaves powder incorporated rasam powder (VNLIRP2) is highly acceptable and the overall mean scores of the VNLIRP2 is more or less equal with the overall mean scores of the control sample, whereas VNLIRP1 are less acceptable with moderate taste, texture, and flavour. The result stated that 3.5% *Vitex negundo* leaves powder incorporated dhal powder (VNLIDP2) is highly acceptable and the overall mean scores of the VNLIDP2 are more or less equal with the overall mean scores of the control sample, whereas VNLIDP1 is less acceptable with moderate taste, texture, and flavour. The result stated that 3.5% *Vitex negundo* leaves powder incorporated tamarind rice powder (VNLITRP2) is highly acceptable and the overall mean scores of the VNLITRP2 is more or less equal with the overall mean scores of the control sample, whereas VNLITRP1 are less acceptable with moderate taste, texture, and flavour. The result stated that 3.5% *Vitex negundo* leaves powder incorporated amchoor powder (VNLIA2) is highly acceptable and the overall mean scores of the VNLIA2 are more or less equal with the overall mean scores of the control sample, whereas VNLIA1 is less acceptable with moderate taste, texture, and flavour. The result stated that 3.5% *Vitex negundo* leaves powder incorporated kasuri methi (VNLIKM2) is highly acceptable and the overall mean scores of the VNLIKM2 is more or less equal with the overall mean scores of the control sample, whereas VNLIKM1 is less acceptable with moderate

taste, texture, and flavour. The organoleptic characters like colour, flavour, texture, taste and overall acceptability in 3.5% VNLIP are found to be good than 3% VNLIP. The overall mean scores for 3.5% *Vitex negundo* leave powder incorporated products are more or less equal with the control samples. The moisture and energy content of control rasam powder are slightly higher than the VNLIRP2 and the protein, fat, crude fibre, calcium, iron, phosphorus and vitamin – C are higher in VNLIRP2 than the control sample. Nutrients like energy, protein, fat, crude fibre, calcium, iron, phosphorus and vitamin – C content of VNLIDP2 were higher than the control sample of dhal powder. Nutrients like energy, protein, fat, crude fibre, calcium, iron, phosphorus and potassium content of VNLITRP2 were higher than the control sample of tamarind rice powder. Nutrients like energy, protein, fat, crude fibre, calcium, iron, phosphorus and potassium content of VNLIA2 were higher than the control sample of amchoor powder. Nutrients like energy, protein, fat, crude fibre, calcium, iron, phosphorus and potassium content of VNLIKM2 were higher than the control sample of kasuri methi. The *Vitex negundo* leaves incorporated food products can be recommended for all age group especially for the individuals who were suffer from hormonal imbalance like estrogen because it contains an iridoid glycoside component agnuside which possess estrogen like activity and also it contains glycoside which play major role in hormonal imbalance.

LITERATURE CITED

1. Ahuja SC, *et. al.* 2015. Nirgundi (*Vitex negundo*) – Nature's gift to mankind. Asian- agri history, 19, 5- 32.
2. Basri fauziya, *et. al.* 2014. A Review of Ethnomedicinal Plant – *Vitex negundo* Linn. International Journal of Advanced Research. 882-894.
3. Bano Uzma, *et. al.* 2015. Therapeutic Uses of *Vitex Negundo*. World Journal of Pharmaceutical Research, 4(12), 589-606.
4. Kumar Dharmendra, *et. al.* 2018. Medicinal property of Nirgundi. Journal of Pharmacognosy and Phytochemistry. 2147-2151.
5. Prakash ved, *et. al.* 2017. Studies on Analysis of Antioxidant and Enzyme Inhibitory Activity of *Vitex negundo* Linn. International Journal of Pharmacognosy and Phytochemical Research. 9(6): 833-839.
6. Roshni Richa, *et. al.* 2019. *Vitex Negundo*: An Important Traditional Medicinal Herb with Multiple Curative Properties. International Journal of Pharmaceutical Sciences Review and Research. 56(1): 133- 138.
7. Venkateshwarlu Kambham. 2012. *Vitex Negundo*: Medicinal Values, Biological Activities, Toxicity Studies and Phytopharmacological Actions. International Journal of Pharmaceutical and Phytopharmacological Research. 2(2): 126-133.

Effects of Defatted Soy Flour Incorporation on Nutritional and Storage Properties in Common Snacks of Regional Preference

Anitha C.*¹ and Vasantha Esther Rani²

¹Seethalakshmi Ramaswami College (Autonomous), Tiruchirappalli - 620 002, Tamil Nadu, India

²Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India

Correspondence to: Anitha C., Seethalakshmi Ramaswami College (Autonomous), Tiruchirappalli - 620 002, Tamil Nadu, India, Tel: +91 9842119011; E-mail: ceeanitha4@gmail.com

Abstract

Healthy snacks satisfy hunger and recharges energy between meals. They typically contain foods from two or more food groups. Healthy snacks can provide health benefits viz increasing the intake of essential nutrients for growth of young children. The present study was conducted to standardize the levels of defatted soy flour in Omapodi and Mysore pak preparations. The defatted soy flour was incorporated in the traditional recipe to replace gram flour at levels with defatted soy flour by 0, 10, 20, and 30 percent in preparation. The prepared snacks were evaluated for its nutritional properties and their storage behavior was studied. Result of sensory (appearance, color, flavor, texture, taste, and overall acceptability) evaluation of Omapodi showed that 30% addition of defatted soy flour and Mysore pak showed that 20% addition of defatted soy flour had higher overall acceptability, taste, texture and flavor. The nutritional values of the snacks were determined for moisture, energy, carbohydrate, protein, fat, iron and calcium. They were packed in two packaging materials (200 and 400 gauge thickness) and their storage stability was studied for a period of 15 days.

Key words: Defatted soy flour, Besan flour, Phytoestrogens, Isoflavones, Organoleptic evaluation

Legumes are a nutritious staple diet around the world. They are an affordable source of fibre, complex carbohydrates, protein, and vitamins. Any member of the Fabaceae family of plants, including its leaves, stems, and pods, is referred to as a legume. The edible seed of a legume plant is known as a pulse. Peas, lentils, and beans are examples of pulses. Pulses include numerous types of beans, including kidney, pinto, navy, black, and chickpeas.

A balanced diet includes the essential nutrients protein along with carbohydrates, fats, vitamins, minerals and fiber. Proteins are used to maintain the wear and tear of the body cells. The proteins are made up of amino acids with good source of nitrogen. Adequate intake of protein is essential for normal functioning of all the systems in the body. Inadequate intake of protein leads to malnutrition in both children and adults. Hence it is required to find the good source of quality protein which is inexpensive and essential for good health. Meat the nutritious protein food is expensive. Among the legumes, soybean has the highest protein and fat content. It has the lowest carbohydrate content of all grains. The English word "soy" is derived from the Japanese pronunciation of "shoyu", the Japanese word for soy sauce. Soya is derived from the same term in Dutch. Soybean (*Glycine max*) is known to be the world's widely cultivated and economically successful legume. Dry soybean contains 35 per cent protein, 19 per cent oil, 28 per cent carbohydrates, 5 per cent minerals and considerable quantities

of several vitamins. It is therefore extensively used for manufacture of meat substitutes.

Soybean is the miracle crop of this millennium. It is known as the Cinderella crop of the west (Kannaiyan, 2002). Soybean is also known as "Vegetable meat", "Golden Bean of Land" in ancient China (Singh *et al.*, 2006). Soybean is popular for its unique taste and high nutritive value (Haripriya, 2003). Soybean is considered to be a good dietary source of protein and oil. It is the only vegetarian food that contains all essential amino acids in the amounts needed for human health. Soybeans are the only common plant food that contains complete protein. It contains a lot of essential fatty acids but with little saturated fat. In addition to containing good quality nutrients, soybean has other beneficial compounds such as phytosterols (isoflavones), lecithin etc. The main food products of soybean are full-fat and defatted soy flour, soy splits, soy flakes, soy milk, soy paneer (tofu), soy fortified bakery products, soy sprouts, fermented products and oil (Waggle and Potter 2000). Soybean is not readily relished and accepted by people in our country because of its extraordinary beany flavor. This draw back can be overcome by blending soy flour to a certain extent with cereals or millets or other legume flours. Soy products mainly provide protein, energy and vitamins, protect the heart, fight cancer, improve mood and mental health, improve mental state, reduce the symptoms of osteoporosis, diabetes, alleviate menopause problems and reduce Gastro- intestinal disorders (Itapu, 2000).

Vegetarians prefer soy and soy foods as their nutritional solutions because of their high protein content and functional property in the production of milk and meat substitutes. Hence soy products were taken for the study. Soy protein can be used as a source of high-quality protein with good biological value to help satisfy the higher need for protein during muscle-building by providing the necessary essential amino acids for physical and muscular development (John W. Carbone and Stefan M. Pasiakos, 2019). The phytoestrogens and bioactive compounds in soy namely isoflavones are polyphenols having estrogenic properties which are rich in soy bean having remarkable characteristics in soy are noteworthy for vegetarians. (Rizzo G, Baroni L, 2018). The effect of substituting 50 per cent of the pulse fraction of Indian recipes with defatted soybean flour on quality and nutritive value was found to have higher carbohydrate, calorie, calcium, phosphorus, iron and protein contents (Kaveri and R. Bindhu, 2004). The research studies aid in comparing Bengal gram flour, legume flour, to defatted soybean flour (DFSF) in terms of quality and nutritional content. The development of functional meals might help consumers' nutritional status. The findings of this study culminate in creating protein-enriched formulations to meet community demands, which in future could be sustainable recommendation for food technologists.

The present study focuses on Standardization of soy products for better utilization. There is a relationship between nutrition and wellbeing. Soy, the wonder bean bridges these fields, focusing standardized recipes with soy, for better

utilization in day-to-day life during any time of a day's menu and achieving the perceptions of nutrition and health.

Objectives

The present study focuses on Effects of Defatted Soy Flour Incorporation on Nutritional and Storage Properties in Common Snacks of Regional Preference. The general objective of the study was to develop and standardize recipes with defatted soy flour. Specific objectives were to:

- Study the chemical composition of defatted soy flour.
- Standardization of defatted soy flour-based recipes.
- Assess the nutrient content of the standardized recipes
- Study the storage stability (chemical, sensory and microbial changes) of the standardized products.

MATERIALS AND METHODS

The study was conducted in Madurai and Tiruchirappalli, Tamil Nadu, India. Raw materials were prepared and processed at R.K.Soy Foods, Sivakasi while the chemical, microbial and sensory analysis was done at Madurai and Tiruchirappalli. The product defatted soy flour was procured from R.K. Soy Foods, Sivakasi, Tamil Nadu, India.

Materials

The list of equipment's used for analyzing the physico-chemical characteristics is given in (Table 1).

Table 1 Equipments used for analytical work

S. No.	Equipment	Purpose
1.	Triple beam balance	Triple beam balance was used to weigh the samples accurately in gram up to the third decimal.
2.	Electronic balance (Shimadzu BL-120-H)	To weigh samples in decimals for nutrient estimation and also to weigh chemicals.
3.	Avery balance (India) (2 kg capacity)	To weigh raw ingredients for the development of the products.
4.	Electric hand sealer (Preethi)	To pack the developed products.
5.	Muffle furnace (Biotronics, India) (with thermostatic control between 100°C and 1000°C)	To estimate the ash content of the sample.
6.	Hot air oven (Biotronics, India)	To estimate the moisture content of the sample.
7.	Kjel-plus (Pelican Equipments, Chennai)	To estimate the protein content of the sample.
8.	Sox plus (Pelican Equipments, Chennai)	To estimate the fat content of the sample.
9.	UV-VIS Spectrophotometer at a wavelength of 458 nm	To estimate the iron content of the sample.
10.	Atomic Absorption Spectrophotometry (Pelican Equipments, Chennai)	To estimate the calcium content of the sample.
11.	Laminar air flow chamber	To determine microbial quality of the product.
12.	Thermometer (0–200° C)	To measure the temperature of hot air oven for microbiological study.
13.	pH meter (Coronation pH meter)	To assess the pH of the RTE products.
14.	Autoclave (M/s. Biotronics Instruments, Madurai)	Used to sterilize the culture media and glassware used for microbiological studies.
15.	Centrifuge (10000 rpm Universal model II)	To collect the supernatant of sample extract.
16.	Electric hand sealer (Preethi)	To seal the products.
17.	Water bath	Water bath was used to maintain the temperature during the experiments.
18.	Glassware	Glassware such as burettes, conical flasks, volumetric flasks, measuring cylinders, funnels, beakers, petri dishes, test tubes and boiling tubes were used for the study.

Table 2 Nutrient analysis adopted in the study

Parameters	Methods	References
Moisture	Hot air oven	AOAC (1995)
Energy	Bomb Calorimetric System	Srilakshmi (2021)
Carbohydrate	Anthrone method	Sadasivam and Manickam (1996)
Protein	Nitrogen estimation	Ma and Zuazaga(1942)
Fat	Solvent extraction	Cohen (1917)
Ash	Ashing in electric muffle furnace	Hart and Ficher (1971)
Fibre	Acid and alkali digestion	Maynard (1970)
Iron	Triple acid digestion method followed by measurement	Boudieb et al. (2019)
Calcium	using AAS	
Peroxide value	Titration	Ranganna (1995)

Methods

Formulation of Defatted soy flour incorporated Omapodi

Carom seeds were boiled in little water, filtered and kept aside. In a bowl, Bengal gram flour, raw rice flour and defatted soy flour were incorporated at 0, 10, 20, 30 and 40 per cent levels, leaving one part as control (T_0) and mixed well with required amount of salt. Turmeric powder and asafetida powder were added. The filtered carom water was used to knead the dough to desired consistency (soft non sticky dough). Oil was heated in pan. The mould was greased with oil and filled with the dough. It was then squeezed out in the hot oil, deep fried until cooked and served. The quality of the prepared product was assessed organoleptically by hedonic scale for color, flavor, texture, taste and over all acceptability. The standardized defatted soy flour incorporated Omapodi was packed in the packaging materials (P_1 and P_2). Nutritive changes and microbial changes on storage were studied.

Formulation of Defatted soy flour incorporated Mysore pak

Sugar was powdered in a mixer. Bengal gram flour and defatted soy flour were sieved together and toasted. Around 50ml ghee was heated separately; the toasted flour was added and stirred without lumps. In a thick bottom vessel, powdered sugar, was added to water and boiled to dissolve. Then the flour mixed in ghee was added continuously stirred. Remaining ghee was added little by little until the stage was set. (Stage – When it starts to leave the sides of the pan). It was then removed from fire, poured it into a greased tray and made into pieces when it is warm. It was then subjected to organoleptic evaluation.

Soy Mysore pak was formulated by incorporating defatted soy flour in different proportions (10%, 20%, 30% and 40%) along with other ingredients. Bengal gram flour, sugar and ghee were added with defatted soy flour at four levels (10%, 20%, 30% and 40%) and the sweets were prepared. The four samples of soy Mysore pak namely A (10% DFSF incorporation), B (20% DFSF incorporation), C (30% DFSF incorporation), D (40% DFSF incorporation) was formulated and one level of incorporation was standardized by sensory evaluation.

Defatted soy flour incorporated Omapodi and Mysore pak were packed in polyethylene packets of 200- and 400-gauge thickness and the shelf life were studied.

Nutritional components such as moisture, energy, carbohydrate, protein, fat, iron, calcium and fiber of the developed products were analyzed. The microbial load of the stored sample was enumerated during the storage period by the method described by Istavankiss (1984). Defatted soy flour incorporated Mysore pak and Omapodi for two weeks. For blank, approximately 10g of the sample was taken in 90 ml sterile water and mixed thoroughly in a rotary shaker for 10 minutes. From the solution, a series of 10⁻⁴ solution were obtained using serial dilution techniques. Dilution of 10⁻³ and 10⁻¹ was taken for enumerating bacterial count, yeast and

fungal count respectively. One ml of dilutions was taken in petri-plates and appropriate media (Nutrient agar was used for enumeration of bacteria, yeast extract malt agar was used for enumeration of yeast, Martin's rose Bengal agar medium was used for enumeration of fungi) and rotated clockwise and anticlockwise for uniform spreading and allowed to solidify. The plates were incubated at $28 \pm 2^\circ\text{C}$ for 24 to 48 hours for bacteria, 3 days for yeast and 4 days for fungi and number of colonies were counted after the period incubation.

The data obtained were subjected to statistical analysis to find out the impact of the different treatments, storage periods and packaging materials on the quality of the prepared products before and during storage. Data from all experiments were performed in triplicate for each sample. The results of the three replicates were pooled and expressed as mean \pm standard deviation. Data were analyzed using Data Entry Module for AGRES Statistical Software (Version 3.01). Analysis of variance (ANOVA) was used to compare fresh and stored products by using Factorial Completely Randomized Design (FCRD) method as described by Gomez, K. H. and Gomez, A. A., (1984).

RESULTS AND DISCUSSION

Soybeans can be consumed in a variety of mouth-watering and delightful ways. The goal of the current study was to assess the viability of creating convenient dishes with defatted soy flour (DFSF).

The experiment's results were statistically examined, and the following subheadings were used to discuss them.

- Nutritional composition comparison of the defatted soy flour with Bengal gram flour.
- Nutrient analysis and sensory evaluation of the freshly prepared defatted soy flour (DFSF) incorporated products for standardization of recipes.
- Storage behavior and sensory evaluation of defatted soy flour (DFSF) incorporated convenience foods.

Nutritive value of Bengal gram flour vs Defatted soy flour

Table 3 shows the statistical analysis for the nutritive value of Bengal gram flour and defatted soy flour (DFSF) was carried out. Protein and iron content is almost doubled in DFSF, energy, carbohydrate and fat is lesser in DFSF with high amount of calcium and fiber when compared with Bengal gram flour. High-protein flour called soy flour is made by grinding roasted soybeans. In addition to having high protein content, this bean flour also has calcium, iron, B vitamins, and particularly soy isoflavones. The defatted soy flour retains fat, yet it is produced from defatted soybeans. To maximize its shelf life, the flour can be kept inside an air-tight container and store it in the freezer or refrigerator. As per Kevin Richard, 2021, the soy flour will stay good for up to one year. It was stated in

Kitchen Habitthat chickpea flour, also known as besan, garbanzo bean flour, or gram flour, is a common gluten-free,

high fiber ingredient in Indian cooking. In baking or cooking, soy flour can be used to substitute other flour.

Table 3 The nutritive value of Bengal gram flour vs Defatted soy flour

S. No	Nutrients	Values / 100g.	
		Bengal Gram Flour	Defatted Soy Flour (DFSF)
1.	Moisture (%)	8±0.98	7±0.12
2.	Energy (Kcal)	387±12.73	329±11.12
3.	Carbohydrate (g)	58±2.62	10.50±1.52
4.	Protein (g)	23.5±1.11	51.28±0.99
5.	Fat (g)	6.2±0.12	0.93±0.17
6.	Iron (mg)	4.86±0.14	9.2±0.08
7.	Calcium (mg)	45±2.12	241±1.52
8.	Fiber (g)	1.3±0.07	18±0.98

Nutrient Analysis of the formulated DFSF incorporated Omapodi

The nutritional content viz., moisture, energy, carbohydrate, protein, fat, iron, calcium and crude fiber of the DFSF incorporated cake at 10, 20, 30 and 40 per cent level of incorporation with T₀ as control were analyzed and the data has been presented in table 4. The statistical analysis of the data for nutrient composition revealed significant difference (p ≤ 0.05) among the DFSF Omapodi. Bharti Jain and Alpana Khangarot (2010) stated that the value-added traditional products from soy

flour act as a good source of protein and minerals per cent increase in nutrient content of soy incorporated traditional products revealed that percentage of nutrient content increased with increased in the replacement with soy flour. Soy incorporation increases energy, protein, iron and calcium with increase in the level of soy concentration as it is a good source of the above-mentioned nutrients. Increase in protein content of soy based traditional products was found with increase in soy incorporation. In the present study protein, iron and calcium increased with the increase in incorporation level.

Table 4 Nutrient Analysis of the formulated DFSF incorporated Omapodi (100g)

Particulars	T ₀	T ₁	T ₂	T ₃	T ₄
Moisture (%)	1.98	1.95	1.96	1.98	1.97
Energy (Kcal.)	195	228	261	294	327
Carbohydrate (g)	9	10.05	11.1	12.15	13.2
Protein (g)	0.5	0.55	0.6	0.65	0.7
Fat (g)	16	16.09	16.18	16.27	16.36
Iron (mg)	0.05	0.97	1.89	2.81	3.71
Calcium (mg)	1	25	49	73	97
Fiber (g)	0.2	0.4	0.5	0.7	0.9

	T ₀ T ₁	T ₀ T ₂	T ₀ T ₃	T ₀ T ₄
SED	1.416	0.380	1.447	1.929
CD (p≤0.05)	2.893**	0.776**	2.956**	3.940**

T₀ Bengal gram flour (100%)

T₂ Bengal gram flour + DFSF (80% + 20%)

T₄ Bengal gram flour + DFSF (60%+40%)

T₁ Bengal gram flour + DFSF (90% + 10%)

T₃ Bengal gram flour + DFSF (70% + 30%)

Sensory evaluation of freshly prepared DFSF incorporated Omapodi

T₀ and T₃ was found to be higher than the other levels of treatment (Table 5). The color and appearance, flavor and taste were extremely good as the incorporation level increased and T₀ and T₃ had the highest score value of 9.0 compared to

remaining treated T₁, T₂ and T₄. The score for consistency (texture) in T₀ and T₃ had the highest score value of 8.8 and T₄ decreased to 8.4 and T₁ and T₂ had maintained the score value of 8.6. Among the samples T₀ and T₃ were found to have the higher score for taste. For overall acceptability T₀ and T₃ had the highest score value of 8.8 and T₄ had the lowest score.

Table 5 Mean scores for sensory evaluation of formulated DFSF incorporated Omapodi

Treatments	Sensory characteristics				
	Color and appearance	Flavor	Consistency/ Texture	Taste	Over all acceptability
T ₀	9.0	9.0	8.8	9.0	8.8
T ₁	8.6	8.6	8.6	8.6	8.4
T ₂	8.6	8.6	8.6	8.8	8.4
T ₃	9.0	9.0	8.8	9.0	8.8
T ₄	8.4	8.4	8.4	8.4	8.2

T₀ Bengal Gram Flour (100%)

T₁ Bengal Gram Flour + DFSF (90%+10%)

T₂ Bengal Gram Flour + DFSF (80%+20%)

T₃ Bengal Gram Flour + DFSF (70%+30%)

T₄ Bengal Gram Flour + DFSF (60%+40%)

According to Bharti Jain and Alpana Khangarot (2010) no significant difference was observed in 25 per cent soy

incorporated raabri. Significant difference was observed in taste and color of 50 per cent and 75 per cent soy incorporated raabri.

In the present study thirty per cent level of DFSF incorporated Omapodi was standardized and subjected to storage study.

Nutrient analysis of the formulated DFSF incorporated Mysore pak

Table 6 below shows significant difference ($p \leq 0.05$) among the control Mysore pak and DFSF incorporated Mysore pak. The amounts of all the nutrients analyzed have increased as the level of DFSF incorporation increases. Indu *et al.*, (2022) stated that in India, a number of snack food items are prepared from different raw materials like besan (Bengal gram flour),

maida (refined wheat flour), Urd (black gram) dhal, moong (green gram) dhal, alone or in combination with other cereals, legumes/ pulses. The medium of cooking is different kinds of fat/oil. Many foods contain fats and oils as essential components. Their most important function is to improve texture and palatability and contribute to the tenderness of most food products. Ghee is found to be the ideal option for preparation of Mysore pak especially due to its rich flavor and texture. In the present study 20% incorporation of DFSF has significant difference in the nutrient content.

Table 6 Nutrient analysis of the formulated DFSF incorporated Mysore pak (100g)

Particulars	T ₀	T ₁	T ₂	T ₃	T ₄
Moisture (%)	1.38	1.37	1.39	1.39	1.38
Energy (Kcal.)	322	388	453	520	585
Carbohydrate (g)	30.2	33.7	37.38	41	44.5
Protein (g)	3.3	7.8	12.19	16.5	21
Fat (g)	21.4	26.28	31.16	36	41
Iron (mg)	0.08	0.58	1.09	1.5	2
Calcium (mg)	7	16	24	34	42
Fiber (g)	9.9	10.71	11.52	12.3	13

	T ₀ T ₁	T ₀ T ₂	T ₀ T ₃	T ₀ T ₄
SED	0.781	1.739	1.595	1.493
CD ($p \leq 0.05$)	1.595**	3.551**	3.257**	3.0499**

T₀ Bengal Gram Flour (100%)

T₁ Bengal Gram Flour +DFSF (90% +10%)

T₂ Bengal Gram Flour + DFSF (80% + 20%)

T₃ Bengal Gram Flour + DFSF (70% + 30%)

T₄ Bengal Gram Flour + DFSF (60%+40%)

Sensory evaluation of freshly prepared DFSF incorporated Mysore pak

Among the samples T₀ and T₂ were found to be higher than the other levels of treatment. The color and appearance and taste were extremely good as the incorporation level increased and T₂ had the highest score value of 9.0 compared to remaining control (T₀) and treated T₁, T₃ and T₄. The score value of 9.0 and

8.8 was found for flavor of T₀ and T₂, whereas T₁, T₃ and T₄ had maintained the score value of 8.6, 8.6 and 8.4 respectively. T₀ and T₂ had the score value of 8.8 for consistency and 9.0 for overall acceptability. Among the samples T₀ and T₂ were found to have the higher score for taste. Hence twenty per cent DFSF incorporated Mysore pak was standardized and subjected to storage study (Table 7).

Table 7 Mean scores for sensory evaluation of formulated DFSF incorporated Mysore pak

Treatments	Sensory characteristics				
	Color and appearance	Flavor	Consistency/ Texture	Taste	Over all acceptability
T ₀	9.0	9.0	8.8	9.0	9.0
T ₁	8.6	8.6	8.6	8.6	8.4
T ₂	9.0	8.8	8.8	9.0	9.0
T ₃	8.6	8.6	8.6	8.8	8.4
T ₄	8.4	8.4	8.4	8.4	8.2

T₀ Bengal Gram Flour (100%)

T₁ Bengal Gram Flour +DFSF (90% + 10%)

T₂ Bengal Gram Flour + DFSF (80% + 20%)

T₃ Bengal Gram Flour + DFSF (70% + 30%)

T₄ Bengal Gram Flour + DFSF (60%+40%)

Bharti Jain and Alpana Khangarot (2010) stated that the value-added traditional recipes of Rajasthan from soy flour act as a good source of protein and minerals, and the cost of formulations were also affordable. Thus, formulation of traditional products serves the dual purpose of convenience and ensuring nutritional security. In the present study, incorporation of DFSF incorporation in traditional sweets enhanced its sensory score on par with the control.

Storage behavior of DFSF incorporated Omapodi packed in polyethylene packets (200- and 400-gauge thickness)

The change in the moisture content of DFSF incorporated Omapodi during storage was estimated once in 7

days for a period of two weeks and is presented in Table 8. Statistical analysis showed no significant difference in moisture among the packaging conditions and storage days. The above results for energy ($p \leq 0.05$) are in accordance with Bharti Jain and Alpana Khangarot (2010) who noted as the soy incorporation increases energy with increase in the level of soy concentration as it is a good source of nutrient. Shirsat *et al.*, 2008 reported that soybean can make significant nutritional contribution if supplemented in typical traditional foods and in combination with cereals. Full fat soy flour is one of the simplest soy-based food products to be used in combination with cereals and pulses.

Table 8 Changes in the moisture and energy content of the standardized DFSF incorporated Omapodi during storage period (100g)

Storage Period (days)	Moisture (%)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂			
0	1.98	1.98	1.98	1.98	P	0.02085	0.04325 _{NS}
7	1.98	1.98	1.98	1.98	S	0.02554	0.05297 _{NS}
14	2.0	1.99	2.0	1.99	TP	0.02949	0.06116 _{NS}
					PS	0.03612	0.07491 _{NS}
					TS	0.03612	0.07491 _{NS}
					TPS	0.05108	0.10594 _{NS}
Storage Period (days)	Energy (Kcal.)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂			
0	195	195	294	294	P	1.21265	2.51489 ^{**}
7	195	195	294	294	S	1.48519	3.08010 _{NS}
14	194	194	292	294	TP	1.71495	3.55660 _{NS}
					PS	2.10037	4.35592 _{NS}
					TS	2.10037	4.35592 _{NS}
					TPS	2.97037	6.16021 _{NS}

T: Treatment; S: Storage; P: Packaging; TP: Treatment & Packaging; PS: Packaging & Storage; TS: Treatment & Storage
TPS: Treatment, Packaging & Storage

The statistical analysis of the data revealed significant difference ($p \leq 0.05$) for carbohydrates among the treatments. Laxmi Pandey and Veenu Sangwan (2020) stated that soy incorporation increases the carbohydrate content thereby

increasing the energy. In the present study there was significant difference for protein and fat ($p \leq 0.05$) among the treatments. The table 9 exhibited ($p \leq 0.01$) level of significance in protein during storage.



T₀ Bengal Gram flour (100%); T₃ Bengal Gram flour + DFSF (70% + 30%)
P₁ Polyethylene bags 200-gauge thickness; P₂ Polyethylene bags 400-gauge thickness

Plate 1 Defatted Soy Flour incorporated Omapodi

In the present study, per cent increase in nutrient content of soy incorporated traditional product Omapodi (Fig. 1) revealed that percentage of iron, calcium and fiber increased with increase in the replacement with soy flour. The statistical analysis of the data revealed significant difference ($p \leq 0.05$) for nutrient content viz., iron and calcium among the treatments and no significant difference for fiber. According to Laxmi Pandey and Veenu Sangwan (2020) the value-added traditional products from soy flour act as a good source of minerals.

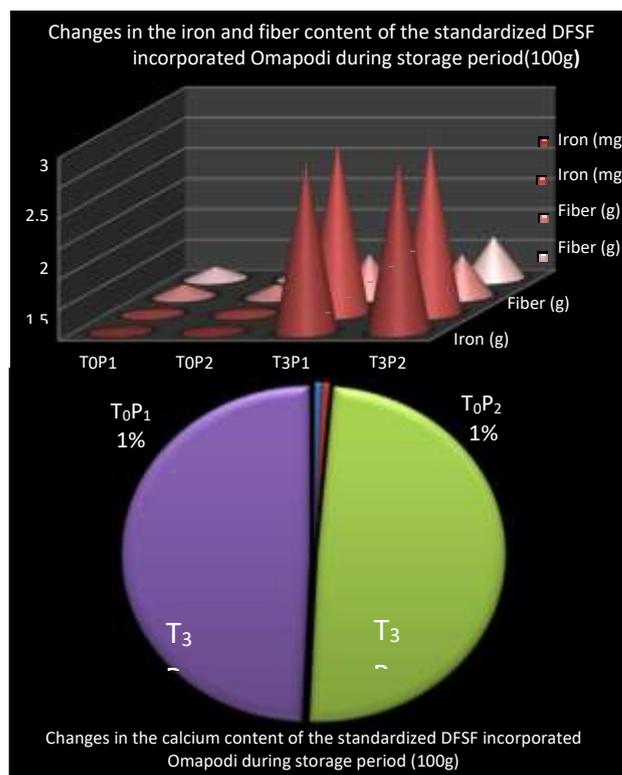


Fig 1 Changes in the iron, calcium and fiber content of the standardized DFSF incorporated Omapodi during storage period (100g)

Storage behavior of DFSF incorporated Mysore pak packed in polyethylene packets (200 and 400 gauge thickness)

The change in the moisture content of DFSF incorporated Mysore pak during storage was estimated once in 7 days for a period of two weeks and is presented in Table 10. Statistical analysis showed no significant difference in moisture among the treatments and statistical analysis of the data revealed significant difference ($p \leq 0.05$) among the packaging material and storage days.

Table 9 Changes in the carbohydrate, protein and fat content of the standardized DFSF incorporated Omapodi during storage period (100g)

Storage Period (days)	Carbohydrate (g)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂			
0	9	9	12.15	12.15	P	0.06550	0.13584 **
					S	0.08022	0.16637 _{NS}
					TP	0.09263	0.19210 _{NS}
7	9	9	12.14	12.15	PS	0.11345	0.23528 _{NS}
					TS	0.11345	0.23528 _{NS}
14	8	9	12.14	12.15	TPS	0.16044	0.33273 _{NS}
Storage Period (days)	Protein (g)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂			
0	0.5	0.5	0.65	0.65	P	0.01124	0.02330 **
					S	0.01376	0.02854 *
					TP	0.01589	0.03296 _{NS}
7	0.5	0.5	0.64	0.65	PS	0.01946	0.04036 _{NS}
					TS	0.01946	0.04036 _{NS}
14	0.4	0.5	0.63	0.65	TPS	0.02752	0.05708 **
Storage Period (days)	Fat (g)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂			
0	16	16	16.27	16.27	P	0.08941	0.18542 **
					S	0.10950	0.22709 _{NS}
					TP	0.12644	0.26223 _{NS}
7	16	16	16.27	16.27	PS	0.15486	0.32116 _{NS}
					TS	0.15486	0.32116 _{NS}
14	15.5	16	16.16	16.26	TPS	0.21900	0.45419 _{NS}

T: Treatment; S: Storage; P: Packaging; TP: Treatment & Packaging; PS: Packaging & Storage; TS: Treatment & Storage
TPS: Treatment, Packaging & Storage

Table 10 Changes in the moisture and energy content of the standardized DFSF incorporated Mysore pak during storage period (100g)

Storage Period (days)	Moisture (%)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂			
0	1.38	1.38	1.39	1.39	P	0.00991	0.02055 _{NS}
					S	0.01214	0.02517 **
					TP	0.01401	0.02906 _{NS}
7	1.36	1.37	1.37	1.38	PS	0.01716	0.03560 _{NS}
					TS	0.01716	0.03560 _{NS}
14	1.33	1.35	1.34	1.36	TPS	0.02427	0.05034 _{NS}
Storage Period (days)	Energy (Kcal.)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂			
0	324	324	453	453	P	3.15728	6.54782 **
					S	3.86686	8.01941 _{NS}
					TP	4.46506	9.26002 _{NS}
7	322	323	452	453	PS	5.46856	11.34116 _{NS}
					TS	5.46856	11.34116 _{NS}
14	320	323	450	453	TPS	7.73372	16.03882 _{NS}

T: Treatment; S: Storage; P: Packaging; TP: Treatment & Packaging; PS: Packaging & Storage; TS: Treatment & Storage
TPS: Treatment, Packaging & Storage

Indu *et al.* (2022) stated that the low moisture content of a food product provides better storage stability, processing conditions, and food quality. The mean values of moisture contents for Mysore pak were studied during the storage periods of days 0, 7, 14, and 21. The Mysore pak prepared using Whole Gir ghee, Market ghee and S30 incorporated samples showed a decreasing trend in the moisture content during the storage. In the present study also decreasing trend in the moisture content during the storage was noted. In the present study the statistical analysis of the data revealed significant difference ($p \leq 0.05$) for energy among the treatments. There was no significant difference among the packaging materials and storage period for both the treatments in moisture and energy.

In the present study increase in nutrient content of soy incorporated Mysore pak (Table 11) revealed that percentage of carbohydrate, protein and fat increased with increase in the replacement with soy flour. The statistical analysis of the data revealed significant difference ($p \leq 0.05$) for nutrient content *viz.*, carbohydrate, protein and fat content is almost higher than control at 20 per cent incorporation, among the treatments making the product nutritious. Anjani Kumar, Tiwari (2009) stated that the fat content varied between 37.65 to 46.32%. The protein percentage in the Mysore pak samples ranged between 4.03% and 10.16% which is almost similar with the present study. There was no significant difference among the packaging materials and storage period in both the treatments.

Table 11 Changes in the carbohydrate, protein and fat content of the standardized DFSF incorporated Mysore pak during storage period (100g)

Storage Period (days)	Carbohydrate (g)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂			
0	30.2	30.2	37.38	37.38	P	0.24295	0.50385 ^{**}
7	30	30.1	37.37	37.38	S	0.29755	0.61708 ^{NS}
14	29.8	29.9	37.35	37.38	TP	0.34358	0.71254 ^{NS}
					PS	0.42080	0.87269 ^{NS}
					TS	0.42080	0.87269 ^{NS}
					TPS	0.59510	1.23416 ^{NS}
Storage Period (days)	Protein (g)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂			
0	3.3	3.3	12.19	12.19	P	0.06588	0.13663 ^{**}
7	3.2	3.3	12.19	12.19	S	0.06588	0.13663 ^{NS}
14	3.2	3.2	12.17	12.19	TP	0.08069	0.16734 ^{NS}
					PS	0.09317	0.19323 ^{NS}
					TS	0.11411	0.23666 ^{NS}
					TPS	0.11411	0.23666 ^{NS}
Storage Period (days)	Fat (g)				T	SED	CD (p≤0.05)
	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂			
0	21.4	21.4	31.16	31.16	P	0.19002	0.39408 ^{**}
7	21.2	21.3	31.15	31.16	S	0.19002	0.39408 ^{NS}
14	20.9	21.1	31.14	31.16	TP	0.23273	0.48265 ^{NS}
					PS	0.26873	0.55732 ^{NS}
					TS	0.32913	0.68257 ^{NS}
					TPS	0.32913	0.68257 ^{NS}
						0.46546	0.96530 ^{NS}

T: Treatment; S: Storage; P: Packaging; TP: Treatment & Packaging; PS: Packaging & Storage; TS: Treatment & Storage
TPS: Treatment, Packaging & Storage



T₀Bengal Gram flour (100%); P₁Polyethylene bags 200 gauge thickness
T₂Bengal Gram flour + DFSF (80% + 20%); P₂Polyethylene bags 400 gauge thickness
Plate 2 Defatted Soy Flour incorporated Mysore pak

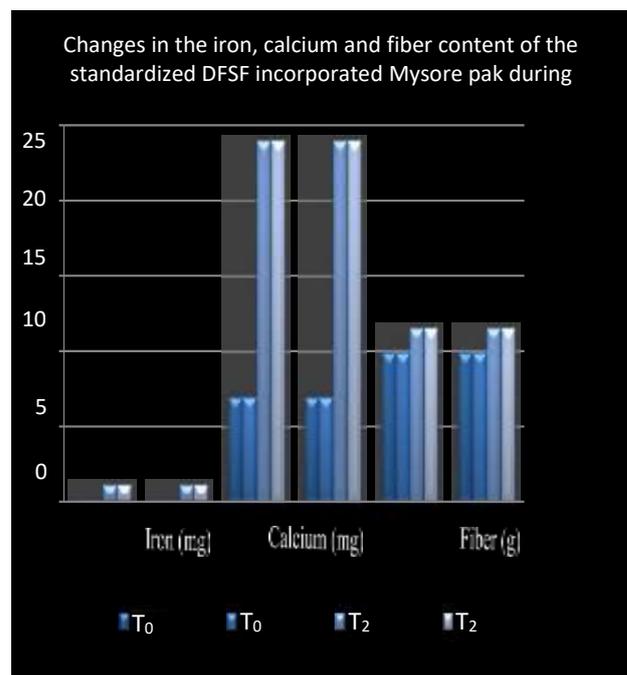


Fig 2 Changes in the iron, calcium and fiber content of the standardized DFSF incorporated Mysore pak during storage period (100g)

The statistical analysis of the data for minerals and fiber revealed significant difference ($p \leq 0.05$) among the treatments (T₀ and T₂) for the minerals and fiber. The changes noted in the iron, calcium and fiber content of the DFSF incorporated Mysore pak during the storage period for both the packaging materials are given in Figure 2. There was no significant difference observed among treatments, storage periods and packaging condition.

Changes in organoleptic characteristics of DFSF incorporated snack foods products during storage

The sensory scores of products stored in polyethylene packets (two packaging material) of 200- and 400-gauge thickness are presented in Table 12. The scores for colour and appearance for products under room temperature were 9.0 for all the samples of Omapodi and Mysore pak. The flavour was 9.0 and 8.8 for T₀P₁, T₀P₂ and T₂P₁, T₂P₂ respectively.

Table 12 Changes in organoleptic characteristics of DFSF incorporated Omapodi and Mysore pak during storage

Quality attributes	Storage days	DFSF incorporated							
		Omapodi				Mysore pak			
		T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂
Colour and Appearance	0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	7	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	14	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Flavour	0	9.0	9.0	9.0	9.0	9.0	9.0	8.8	8.8
	7	9.0	9.0	9.0	9.0	9.0	9.0	8.8	8.8
	14	9.0	9.0	9.0	9.0	9.0	9.0	8.8	8.8
Texture / Consistency	0	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
	7	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
	14	8.6	8.8	8.6	8.8	8.6	8.8	8.6	8.8
Taste	0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	7	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	14	8.8	9.0	8.8	9.0	8.8	9.0	8.8	9.0
Overall acceptability	0	8.8	8.8	8.8	8.8	9.0	9.0	9.0	9.0
	7	8.8	8.8	8.8	8.8	9.0	9.0	9.0	9.0
	14	8.6	8.8	8.6	8.8	8.8	9.0	8.8	9.0

The quality of texture was 8.8 for all the samples throughout the storage period except for all the samples packed in P₁ (200-gauge thickness) were decreased on the 14th day of storage 8.6. This indicated that P₂(400-gauge thickness) packaging material was better than P₁(200-gauge thickness). This in turn brought changes in the scores of tastes and overall acceptability for the samples packed in P₁ (200-gauge

thickness). Under this storage conditions, the 30% DFSF incorporated Omapodi and 20% DFSF incorporated Mysore pak packed in P₂ (400-gauge thickness) found to be superior for color, texture, flavor and taste, and overall acceptability than the samples packed in P₁(200-gauge thickness). Because of no major difference, it can be said that all products were acceptable for 14 days.

Table 13 Changes in microbial load of DFSF incorporated Omapodi and Mysore pak during storage

Quality attributes	Storage days	DFSF incorporated							
		Omapodi				Mysore pak			
		T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂
Total bacterial count	0days	1.04	1.02	1.03	1.01	1.08	1.06	1.07	1.05
	7 days	1.1	1.09	1.11	1.1	1.26	1.23	1.24	1.18
	14days	1.19	1.12	1.18	1.17	1.37	1.3	1.31	1.26
Yeast and Mold	0days	-	-	-	-	-	-	-	-
	7 days	-	-	-	-	-	-	-	-
	14days	-	-	-	-	-	-	-	-
Coliform	0days	-	-	-	-	-	-	-	-
	7 days	-	-	-	-	-	-	-	-
	14days	-	-	-	-	-	-	-	-

Changes in microbial load of DFSF incorporated snacks during storage

Table 13 reveals the microbiological quality of the Omapodi and Mysore pak samples prepared. The Total plate count, Coliform count, and Yeast and Mould Count (log₁₀ cfu/g) of Omapodi and Mysore pak were recorded during the storage period. The total bacterial count values were 1.04, 1.02, 1.03, 1.01 cfu/g. for Omapodi and, 1.08, 1.06, 1.0, 1.05 cfu/g for Mysore pak on zero day. On the 14th day the values were 1.19, 1.12, 1.18, 1.17 cfu/g. for Omapodi and 1.37, 1.3, 1.31

and 1.26 cfu/g. for Mysore pak. Yeast and mould and coli forms were found nil throughout the study. The samples were good up to fourteen days of storage at ambient temperature conditions. Qualities of raw materials, preparation conditions, and packaging conditions are the factors that affect the microbial analysis of savories and sweets. Low microbial load in the products indicated the hygienic and careful making in a cleaner environment of the product. The study was supported by the findings of Indu *et al.*, 2020 who revealed an increment in the microbial population of Mysore pak during storage.

Table 14 Changes in peroxide value (m.eq. of O₂/kg fat) of DFSF incorporated products during storage

Storage days	DFSF incorporated							
	Omapodi				Mysore pak			
	T ₀ P ₁	T ₀ P ₂	T ₃ P ₁	T ₃ P ₂	T ₀ P ₁	T ₀ P ₂	T ₂ P ₁	T ₂ P ₂
0days	0	0	0	0	0	0	0	0
7days	0	0	0	0	0	0	0	0
14days	0.63	0.57	0.72	0.55	0.87	0.73	0.99	0.68

Changes in peroxide value (m.eq. of O₂/kg fat) of DFSF incorporated products during storage

Two products, Omapodi and Mysore pak, made using DFSF that were packaged in polyethylene packets with gauge

thicknesses of 200 and 400, had their peroxide value during storage examined (Table 14). There was an influence of storage time on the peroxide development in the Mysore pak and Omapodi on 14th day of storage at room temperature, the

peroxide value of control and DFSF incorporated goods started to develop. The peroxide development was observed only to a lesser extent. Packaging materials differ in permeability to environmental factors that may affect the rate of fat oxidation. The results revealed the product had good oxidation stability as it was within the permissible limit. The findings of the current study closely match those of Laxmi Pandey and Veenu Sangwan, (2020). The peroxide value did not alter much during storage.

CONCLUSION

A brief conclusion of the results and discussion is listed below:

The Nutritive Value of Bengal gram flour vs Defatted soy flour

The statistical analysis of the data revealed significant difference ($p \leq 0.05$) in the nutritive value of Bengal gram flour and defatted soy flour (DFSF). Protein and iron content is almost doubled in DFSF, when compared with Bengal gram flour.

Nutrient Analysis of the formulated DFSF incorporated Omapodi

The nutrient components of DFSF incorporated Omapodi at 10, 20, 30 and 40 per cent level of incorporation with T_0 as control were analyzed and the statistical analysis revealed significant difference ($p \leq 0.05$) among the DFSF Omapodi.

Sensory evaluation of freshly prepared DFSF incorporated Omapodi

T_0 and T_3 were found to be higher than the other levels of treatment. The color and appearance, flavor and taste were extremely good for T_0 and T_3 with the score value of 9.0. The score for consistency (texture), taste and overall acceptability in T_0 and T_3 had the highest value of 8.8. In the present study, thirty per cent level of DFSF incorporated Omapodi was standardized and subjected to storage study.

Nutrient Analysis of the formulated DFSF incorporated Mysore pak

Significant difference ($p \leq 0.05$) among the treatments of Mysore pak and DFSF incorporated Mysore pak was observed. The nutrients were analyzed and found to have increased as the level of DFSF incorporation increases. In the present study, 20% incorporation of DFSF has significant difference in the nutrient content.

Sensory evaluation of freshly prepared DFSF incorporated Mysore pak

Among the treatments T_2 were found to be higher than the other levels of treatment. The color and appearance taste and overall acceptability was extremely good for T_0 and T_2 with the score value of 9.0. The score value of 9.0 and 8.8 was found for flavor of T_0 and T_2 , and the score value of 8.8 for consistency T_0 and T_2 . Hence twenty per cent DFSF incorporated Mysore pak was standardized and taken up for storage study.

Storage behavior of DFSF incorporated Omapodi packed in polyethylene packets (200- and 400-gauge thickness)

The change in the moisture content of DFSF incorporated Omapodi during storage was estimated once in 7 days for a period of two weeks. Statistical analysis showed no significant difference in moisture among the packaging

conditions and storage days. The energy increases with increase in the level of soy concentration.

The statistical analysis of the data revealed significant difference ($p \leq 0.05$) for carbohydrates, protein and fat among the treatments.

In the present study, it is revealed the percentage of iron, calcium and fiber increased in the soy incorporated traditional product Omapodi with increase in the replacement with soy flour. The statistical analysis of the data revealed significant difference ($p \leq 0.05$) for nutrient components viz., iron and calcium among the treatments and no significant difference for fiber.

Storage behavior of DFSF incorporated Mysore pak packed in polyethylene packets (200- and 400-gauge thickness)

The change in the moisture content of DFSF incorporated Mysore pak during storage was estimated once in 7 days for a period of two weeks and the statistical analysis showed no significant difference in moisture and energy among the treatments but revealed a significant difference ($p \leq 0.05$) among the packaging material and storage days.

The statistical analysis of the data revealed significant difference ($p \leq 0.05$) for the nutrient components viz., carbohydrate, protein and fat content which are higher than control at 20 per cent incorporation, among the treatments making the product nutritious. There was no significant difference among the packaging materials and storage period.

There was a significant difference ($p \leq 0.05$) among the treatments (T_0 and T_2) for the minerals and fiber and no significant difference was observed among treatments, storage periods and packaging condition.

Changes in organoleptic characteristics of DFSF incorporated Omapodi and Mysore pak during storage

The sensory scores of products stored in stored in polyethylene packets (two packaging material) of 200- and 400-gauge thickness were studied. The quality of texture was 8.8 for all the samples throughout the storage period except for all the samples packed in P_1 (200-gauge thickness) were decreased on the 14 day of storage 8.6. This indicated that P_2 (400-gauge thickness) packaging material was better than P_1 (200-gauge thickness). This in turn brought changes in the scores of tastes and overall acceptability for the samples packed in P_1 (200-gauge thickness).

Under this storage conditions, the 30% DFSF incorporated Omapodi and 20% DFSF incorporated Mysore pak packed in P_2 (400-gauge thickness) found to be superior for colour, texture, flavour and taste, and overall acceptability than the samples packed in P_1 (200-gauge thickness). Because of no major difference, it can be said that all products were acceptable for 14 days.

Changes in microbial load of DFSF incorporated Omapodi and Mysore pak during storage

The microbiological quality of the Omapodi and Mysore pak samples were assessed for Total plate count, Coliform count, and Yeast and Mould Count (\log_{10} cfu/g) and were recorded during the storage period. The total bacterial counts were very meagerly noted for both the products in all the packaging material. Yeast and mould and coli forms were found nil throughout the study. The samples were good up to fourteen days of storage at ambient temperature conditions.

Changes in peroxide value (m.eq. of O_2 /kg fat) of DFSF incorporated products during storage

The two products Omapodi and Mysore pak, made using DFSF that were packaged in polyethylene packets with gauge thicknesses of 200 and 400, had their peroxide value during storage examined. On the 14th day of storage at room temperature, the peroxide value of control and DFSF incorporated food products were detectable and it was within the permissible limit.

Based on the results of the study the following conclusions are drawn:

1. The defatted soy flour incorporated products are having high potential for commercialization and marketability

- in India.
2. The storage stability of convenience food products was found to be good at room temperature.
3. The peroxide value was not found for two weeks in the DFSF incorporated Omapodi and Mysore pak.

Recommendations

Traditional snack foods like Omapodi and Mysore pak were prepared with incorporation of DFSF. Similarly, Bengal gram flour products like kara boondi, ribbon pakoda can be prepared incorporating DFSF.

LITERATURE CITED

1. Anjani Kumar, Tiwari (2009). Sensory Profiling and Positioning of Selected Commercial Sweet (Mysore pak). Central Food Technological Research Institute (CFTRI), Mysore
2. Bharti Jain and Alpana Khangarot. (2010). Sensory and nutritional assessment of soya value added traditional products from Rajasthan. *Food Science Research Journal*; Volume 1 Issue 2 (October, 2010) Page: 213-217
3. Gianluca Rizzo, Luciana Baroni (2018) *Nutrients* Soy, Soy Foods and Their Role in Vegetarian Diets Jan 5;10 (1):43. Doi: 10.3390/nu10010043.
4. Gomez, K. H. and Gomez, A. A. (381AD). Statistical procedures for Agricultural Research (2nd Edn. John Wiley and Sons.). In: Oser, B. K. (Eds), 14th edn. P. 1094.
5. Haripriya, (2003) Soybean for Nutrition Security and Soil Sustainability, *Kisan world* P.26.
6. Indu.B, H.M. Jayaprakasha, Prabha. R, B.P.Pushpa. (2022). Effect of Fractionation on the Physicochemical Properties and on the Storage Stability of Mysore pak. *International Research Journal of Modernization in Engineering Technology and Science*. Volume:04 / Issue:05/May-2022 Impact Factor- 6.752. e-ISSN: 2582-5208
7. Istawankiss. (1984). Testing methods in food microbiology, Elsevier Publication. Ltd., P. 395-397.
8. Itapu, (2000). Soyflour in Bakery products, Human Nutrition, American Soybean Association, New Delhi. P.1-8
9. John W Carbone, Stefan M Pasiakos (2019) *Nutrients* Dietary Protein and Muscle Mass: Translating Science to Application and Health Benefit 22; 11 (5):1136.
10. Kannaiyan, (2002) Abstract - Value addition of Soya for better utilization. Tamil Nadu Agricultural University, Madurai. P 54.
11. Kaveri, R.Bindhu. N.V.U. (2004). Value addition and acceptability of Selected Indian recipes with whole and defatted soyafLOUR, *Indian Journal of Nutrition Dietetics*. 41(10) Pp 426 – 436.
12. Kevin Richard (2021) List of Substitutes for Soy Flour for Your Perfect Cooking Recipes, Richard's Pantry <https://richardpantry.com/soy-flour-substitute/>
13. Laxmi Pandey and Veenu Sangwan. (2020). Development and Quality Evaluation of Sorghum and Soybean Incorporated Value Added Sev. *International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706 Special Issue-11 pp. 1209-1223
14. Shirsat, B. S., Thakor, N. J. and Swami, S. B. (2008). Use of soybean for decreasing malnutrition in Maharashtra. In: Souvenir of Fifth International Soybean processing and Utilization Conference, Soybean processing and utilization centre, Central Institute of Agricultural Engineering, Bhopal.II -61.
15. Singh, Dr.ParamjitChawda and Dr.Rita Jain (2006). Soybean Promotes Health, *Kisan world*. 33(1), Pp. 40 – 41.
16. Waggle D.H, and Potter S.M. 2000. Soy protein and Health. *Journal of Food Science and Technology* 44(4): 31-36.

Impact of Nutrition Education in the Management of Hypercholesterolemia on Selected Mild Hypercholesterolemic Adults in Kottayam

Lincy P^{*1} and Anooja Thomas K²

¹ Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641 043, Tamil Nadu, India

⁵ Department of Home Science, CMS College, Tamil Nadu, India

Correspondence to: Lincy P, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641 043, Tamil Nadu, Tel: +91 98946263041; E-mail: lincyp_fsmd@avinuty.ac.in

Abstract

The increasing prevalence of cardio vascular diseases are growing burden in India. Hypercholesterolemia is considered as a major risk factor for cardiovascular diseases. The present study carried out with the objective to find out the impact of nutrition education on the management of hypercholesterolemia. Interview method was adopted to collect data on socio economic status, dietary pattern and lifestyle habits from selected subject using an interview schedule and all the subjects were screened for total cholesterol. All the data collected were tabulated and analyzed to draw conclusion. Nutrition education was imparted to the experimental group of mild hypercholesterolemic adults. The impact of nutrition education was assessed by evaluating the nutrition knowledge and total cholesterol before and after the intervention. Lack of awareness on the foods that contributes to high cholesterol and physical inactivity was identified as the major reason for hypercholesterolemia in adults.

Key words: Adults, Hyperchoelsterolemia, Nutrition education

India is a developing country with rapid developments in all era. There are uncountable diseases prevalent in India and they are broadly classified as communicable and non-communicable diseases. The NCDs include hypertension, diabetes, cancer, cardiovascular diseases etc. According to ICMR (2020), the disease burden of India due to non-communicable diseases increased from 48% to 75% between the years 1990 and 2016 and it was found that 63 percent of death in India due to NCDs (WHO 2018).

Adulthood is the period in human lifespan that complete physical and intellectual maturity have been attained. In early adulthood and middle adulthood, there are slow and gradual declines in the body functioning and accelerated the attainment of old age. There is a progressive deposition of cholesterol in the arteries, throughout in the adulthood period and eventually increases the risk of cardiovascular diseases. The contributing factors for the growing burden of CVDs are increasing prevalence of cardiovascular risk factors especially hypertension, hypercholesterolemia, diabetes, overweight or obesity, physical inactivity and tobacco use. Hyperlipidemia in young adults increases the risk of coronary heart disease in significant manner. Adults with extended exposure to even moderate elevations in non-high-density lipoprotein cholesterol have prominent risk for future coronary heart disease (Navar-

Boggan et al. (2015). In India there are approximate 11.7 percent of adults age between 20 to 39 and 41 percent of adults age between 40 to 64 years had elevated low density lipoprotein cholesterol are a major concern (Pencina et al., 2014). American Heart Association (2010) declared that the prevalence of risk factors is high even in rural Kerala, with diabetes (20%), high blood pressure (42%) and high cholesterol (72%). Lack of awareness on the foods that contributes to high cholesterol and changing life style are major concern. Hence the present study carried out to educate the population on the management of hypercholesterolemia.

MATERIALS AND METHODS

The subjects selected for the present study were adult population in and around Kottayam district. Sample size was determined by the proportion of problem based on the study conducted by Thangapan et al. (2010) on the prevalence of hypercholesterolemia in Kerala. A well-structured interview schedule was formulated to collect the background information of the selected subjects (n=500). Nutritional status of the subjects was assessed by means of anthropometric, biochemical and dietary assessment. A sub sample of mild hypercholesterolemia (total cholesterol: 200 to 239 mg/dl)

adults (n=40) were selected for the intervention study based on inclusion criteria. Their knowledge on high cholesterol and its harm full effects was assessed by a separate questionnaire and nutrition education was imparted to the experimental group (n=20) by means of lectures, demonstrations and individual counseling. The control group (n=20) did not get any treatment. The impact of nutrition education was assessed by comparing the nutrition knowledge and total cholesterol level of the selected subjects before and after nutrition education.

RESULTS AND DISCUSSION

Background information of the selected subjects

The background information of the subjects pertaining to their age, gender, family income and education status are presented in (Table 1).

Table 1 Background Information of the selected subjects

Particulars	Number	Per cent
Age Category		
15-30	52	10
31-45	225	45
46-60	223	45
Gender		
Male	105	21
Female	395	79
Monthly Income *		
Economically weaker section (Rs. ≤3300)	16	3
Low-income group (Rs.3301-7300)	284	57
Middle income group Rs.7301-14500)	185	37
High income group (Rs.>14500)	15	3
Educational Level		
High School	393	78
Under Graduate	79	16
Post Graduate	28	6

*HUDCO (2007)

The data revealed that an equal percent (45%) of subjects belonged to 31-45 and 46-60 years. Hypercholesterolemia increases among 25-64 years in both male and female (Costa et al., 2003). The subjects were purposively selected from women's association programme like 'Ayalkootam' in Kottayam, Kerala and the percent of distribution of female subjects are more (79%) than 21 per cent were males subjects. According to HUDCO family monthly classification 57 per cent were belonged to low-income group followed by 37 per cent were belonged to middle income group. The cholesterol level of low-income group and middle-income group was found to be little higher than that of high-income group (Figure 1). These results are coherent to reports by Gupta et al. (2016) who proposed the prevalence of dyslipidemias (borderline total cholesterol, high LDL cholesterol and low HDL cholesterol) is high in middle income men and women.

All the subjects were educated and seventy-eight per cent were completed primary level education up to high school.

Anthropometric data of the selected subjects

Body Mass Index (BMI) of the selected subjects were derived from the recorded values of height and weight and classified as underweight, normal, overweight and obese based on (WHO,2010) standard and presented in (Table 2).

Table 2 Distribution of selected subjects according to BMI

BMI Category *	Number	Per cent
Under weight (<18.50)	35	7
Normal (18.50 - 24.99)	251	50
Over weight (≥25.00)	181	36
Obese (≥30.00)	33	7

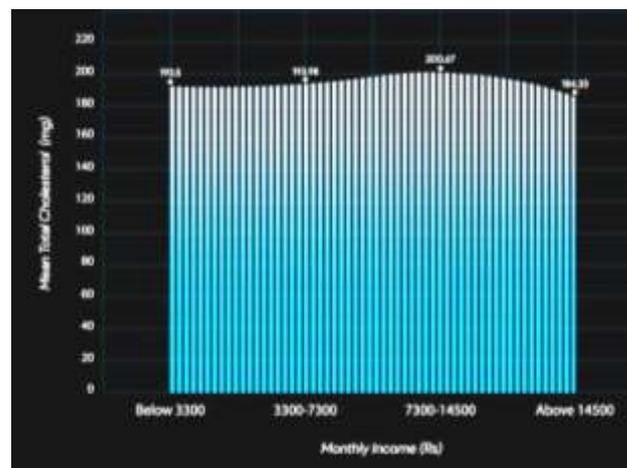


Figure 1 Total cholesterol level of the selected subjects based on monthly income

Among the selected subjects 50 per cent were found to be normal BMI (18.50-24.99) category. Malnutrition was found among another 50 percent of selected subjects with 7 percent of under nutrition and 43 per cent of over nutrition. Among the over-nutrition category, 36 per cent were in overweight category and 7 per cent obese. Various studies analyzed by Ahirwar and Mondal (2019) found that globally, more than 1.9 billion adults are overweight and 650 million are obese and about 2.8 million deaths are reported as a result of being overweight or obese.

The waist to hip ratio of the subjects showed that thirty-four per cent of the male subjects were in the border line of risk of abdominal obesity (WHR=0.90 -0.95) and among females 49 per cent were in boarder line of risk of abdominal obesity.

Dietary assessment

Food habit of the selected subjects presented in (Table 3).

Table 3 Food habit of the selected subjects

Category	Criteria	Number	Per cent
Type of meal	Vegetarian	19	4
	Non-vegetarian	457	91
	Ovo-vegetarian	1	1
	Lacto-vegetarian	23	5

From the (Table 3) it is clear that 91 per cent of the subjects are non-vegetarians. The total cholesterol level of non-vegetarians and vegetarians were analyzed and found that the total cholesterol level of non-vegetarians were higher when compared with vegetarians.

The mean nutrient intake of energy, calcium, iron, vitamin C and fibre was significantly lower ($p<.05$) than Recommended Dietary Allowances of Indian adults (RDA-ICMR, 2010) among the selected subjects. Increased intake of fat was observed among the subjects.

Total cholesterol levels of the selected subjects

All the subjects were screened for total cholesterol and the results are presented in the (Table 4).

Table 4 Percentage distribution of selected subjects according to total cholesterol

Total cholesterol category*	Number	Per cent
Desirable (<200 mg/dl)	261	52
Borderline (200-239 mg/dl)	108	22
High (≥240 mg/dl)	131	26
Total Cholesterol Category*	Number	Per cent

*WHO, 2010

It was evident that twenty six per cent of subjects were in high cholesterol category (≥240 mg/dl) followed by 22 per cent were in borderline category (200-239 mg/dl).

Impact of nutrition education on total cholesterol

The nutrition knowledge of Experimental Group and Control Group before and after education was noted and presented in (Table 5).

Table 5 Comparison of nutrition knowledge of the selected subjects before and after nutrition education

Nutrition Knowledge	Experimental group (20)	Control group (20)	't' value
Before education	11.40±1.95	11.27±2.25	0.137 ^{ns}
After education	15.67±1.79	11.67±2.35	5.234*

*Significant

^{ns}Not significant

The (Table 5) shows that the knowledge level of Experimental Group improved after nutrition education and is statistically significant at 5% level.

Total cholesterol level of selected subjects before and after nutrition education presented in (Figure 2).

The total cholesterol level of Experimental Group had decreased after nutrition education when compared with the Control Group.

CONCLUSION

Hypercholesterolemia is the leading causative factor for atherosclerosis and other cardiovascular diseases in adults. The hypercholesterolemia can be managed by creating awareness to the community on the importance of healthy diet and physical activity.

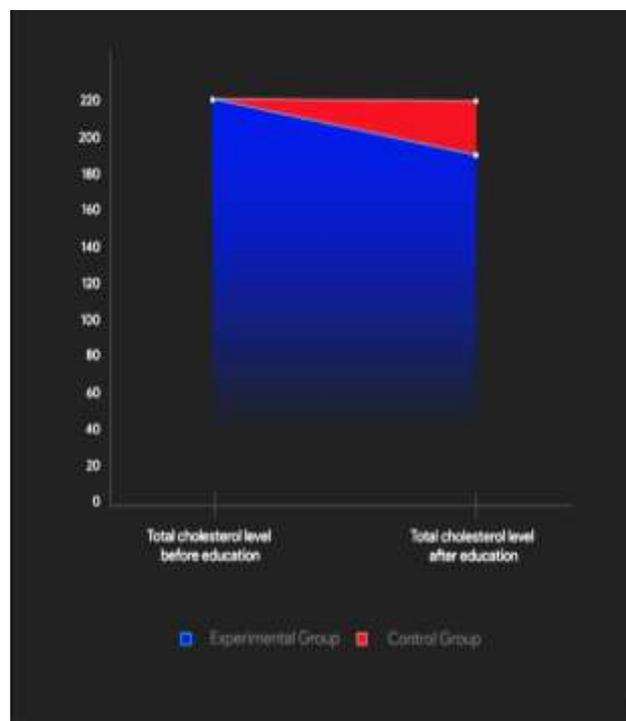


Figure 2 Comparison of total cholesterol before and after nutrition education

LITERATURE CITED

- Ahirwar, R., & Mondal, P. R. 2019. Prevalence of obesity in India: A systematic review. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 13(1): 318-321.
- American Heart Association. 2010. Environmentally attributable costs of cardio vascular in origin. *Indian Journal of Medical Science*. vol.38: 678-69
- Costa, J., Borges, M., Oliveira, E., Gouveia, M., & Carneiro, A. V. 2003. Incidence and prevalence of hypercholesterolemia in Portugal: a systematic review. Part III. *Portuguese journal of cardiology*. 22(6): 829-836.
- HUDCO (Housing and Urban Development Corporation Ltd). 2007. Board meeting. vide item no.4.
- Navar-Boggan, A. M., Peterson, E. D., D'Agostino Sr, R. B., Neely, B., Sniderman, A. D., & Pencina, M. J. 2015. Hyperlipidemia in early adulthood increases long-term risk of coronary heart disease. *Circulation*. 131(5): 451-458.
- Pencina, M. J., Navar-Boggan, A. M., D'Agostino Sr, R. B., Williams, K., Neely, B., Sniderman, A. D., & Peterson, E. D. 2014. Application of new cholesterol guidelines to a population-based sample. *N Engl J Med*. 370: 1422-1431.
- Thankappan, K. R., Shah, B., Mathur, P., Sarma, P. S., Srinivas, G., Mini, G. K., ... & Vasana, R. S. 2010. Risk factor profile for chronic non-communicable diseases: results of a community-based study in Kerala, India. *Indian Journal of Medical Research*. 131(1): 53.
- WHO. World Health Organization. 2018. Non-communicable diseases country profiles 2018.

A Study on Probing the Therapeutic effects of Bamboo Rice Supplementation on Reducing Hyperlipidemia on Female Adults

Kamali C*¹ and Kavitha Devi U²

^{1,2}Government Arts College for Women, Sivagangai - 630 561, Tamil Nadu, India

Correspondence to: Kamali C, Government Arts College for Women, Sivagangai - 630 561, Tamil Nadu, India, Tel: +91 7550344480; E-mail: kamalisubbu@gmail.com

Abstract

Dietary habits and lifestyle play a major role in a person's health, as in modern era people are more prone to eat extra processed food and high sugar drinks which is one of the leading causes in weight gain and causing hyperlipidemia. So, it was the need of the study to conduct a study on the therapeutic role of bamboo rice as a dietary fiber in reducing cholesterol levels. Bamboo rice is used for various purposes to reduce cholesterol level, to control diabetes, to regulate normal blood pressure, and also used to control rheumatic pain. The main aim of the study is assessing the lipid profile of females both before and after administration of Bamboo rice gruel for a period of 3 months. The respondents were selected by purposive sampling method and was carried out by the 50 hyperlipidemia adults (30-60yrs) from Karaikudi. The study revealed that the mean WHR of 31 to 45 years of age and 46 to 60 years had 0.92 and 0.96. The selected subjects had significant higher serum levels of TC, TGL, VLDL, LDL and lower HDL. There is a significant reduction in mean total cholesterol level (16.18%), Triglycerides (23.07%) and LDL (20.53%) when compared to initial values.

Key words: Bamboo rice, Total cholesterol, Triglycerides, Low density lipoprotein, High density Lipoprotein, Waist hip ratio

Dietary habits and lifestyle play a major role in a person's health as in modern era people are more prone to eat extra processed food and high sugar drinks which is one of the lead causes in weight gain and causing hyperlipidemia. Bamboo rice is used for various purposes to lower cholesterol, to control diabetes, to regulate blood pressure and also to control rheumatic pain and joint pain. Bamboo rice, also known as mulayari or moongil arisi is a safe and lesser-known rice variety, it is grown from dried bamboo shoot. When a bamboo shoot completes its life expectancy, it begins to flow in mass and produce seeds for the growth of new plants. Few portions of young bamboo plants are used as an herbal medicine by human beings but there is a lack of scientific study on its medical significance.

Bamboo belongs to the grass family. Bamboo seeds also look very similar in size and shape to paddy rice seeds. Bamboo rice can be cooked and consumed just like the regular variety, but has a nice chewy taste. This rice is not the same as the rice we eat. It is aromatic, short grain rice produced from bamboo seeds. The pale green seed has a sticky texture and leafy bamboo flavor.

Bamboo rice contains multiple nutritive materials such as starch, fiber, amino acids, iron, calcium, phosphorus, vitamin-A and vitamins-B. Bamboo rice also contains anti-inflammatory, anti-diabetic, antioxidant properties. It is low or no fat so it is a healthy substitute for overweight and obese

people. Regular consumption of bamboo rice in diet helps lower cholesterol levels.

Studies show that these are rich in nutrients and probiotic properties which reduce blood cholesterol and LDL, moreover also help in weight loss. It is the best food for children and adults as well.

Bamboo rice is commonly known to the tribal people of southern India where it is locally known as moongil arisi. Bamboo is a perennial grass and its flower once in its lifetime (40 years). After the maturity of the flower seeds which are actually in the shape of rice. This rice tastes similar to wheat. It is 25 times more costly than normal standard rice (a kg of bamboo rice costs Rs.400 as compared to normal rice which costs Rs.25). This rice is becoming popular among health-conscious people and now adoption is increasing (Kumari *et al.* 2020).

The increasing demand of modern food particularly junk foods, fried foods and pastries to face major health problems such as diabetes mellitus, obesity, hypertension, cardiovascular disease has paved the way for the formulation of a food product that is nutrient dense and of highly therapeutic values. Being a normal rice, bamboo rice contains high amounts of essential amino acids and also contains calcium and phosphorus. Phosphorus enhances the absorption of calcium which helps for the maintenance of bone health. Cardiovascular disease patients can use bamboo rice instead of normal rice because the high

content of essential amino acids usually increases the HDL cholesterol in the bloodstream.

Bamboo rice is uncommon in our country and in particular it is not available for the general population. Hence it is considered an exotic luxurious food product. Since bamboo rice is packed with medicinal and nutritional benefits, it should be popularized among individuals to have a faster healthy eating pattern (Evangeline and Himayun 2019).

Bamboo rice tree is a woody tree with a hollow stem and the leaves are slender, thin, and have a long leaf margin. The botanical name of the bamboo tree is *Phyllostachys bambusoides*. It is commonly seen in countries like India, China, Myanmar, and most of the Southern Asian Countries. There are almost 1250 species with 70-75 types of bamboo trees (Ran 2017). In type 2 diabetics due to insulin resistance, dietary fiber helps to maintain blood glucose levels, gut motility, enhancement of bowel health and reduce in weight as an adjunct therapy. The study proved that bamboo rice is an excellent source of fiber (Wu *et al.* 2020). Another study revealed the therapeutic role of dietary fibers in the disease of diverticulosis via reduction of pressure in the large intestine. For this kind of patient, the author recommended bamboo rice be used in a regular diet. (Rezapour *et al.* 2018).

Process of storing bamboo rice

The unpredictable flowering and thorniness of the bamboo makes rice harvest a challenging task. To get perfect polished bamboo rice, the area around the base of each bamboo is cleaned and all the debris formed is removed, the base is then smoothed with a clay and kept to dry. Once dried, the bamboo rice is stored in the prepared surface and gathered for consumption. Bamboo rice is an indigenous rice that is being harvested from the drying bamboo shoots in the forests. At the end of its life span bamboo shoots yield a flower which produces seeds, which is a rare indigenous and exotic variety of bamboo rice. It has been said that the tribal community residing in the forest depends on the harvesting of bamboo rice and selling the seeds as a major source.

Aims and Objectives

- The main aim of the study is assessing lipid profile of the selected respondents both before and after administration of formulated product for a period of three months.
- To popularize the nutritive value of bamboo rice among obese adults by assessing their knowledge, awareness and practices of the bamboo rice consumption.
- To develop a traditional recipe using bamboo rice and analyzing the sensory characteristics of formulated recipe.
- To standardize the formulated product in different variations and assess the sensory score of the same product.
- To examine major factors caused by the hyperlipidemia among the selected respondents.

MATERIALS AND METHODS

The present study was planned to obtain general information such as socio demographic profile, knowledge, awareness, and practices of consumption of bamboo rice among hyperlipidemia female adults in karaikudi. Bamboo rice gruel was prepared, standardized to assess sensory characteristics of the formulated recipe. This study is an exploratory research in which a questionnaire is prepared to collect data from hyperlipidemia female adults to assess their knowledge, awareness and practices of bamboo rice among them. Five-point hedonic scales were used to assess the sensory characteristic of the formulated bamboo rice gruel.

Design of the study

Bamboo rice gruel was formulated using bamboo rice, buttermilk, and cumin seeds. Sensory characteristics including appearance, taste, texture, color, flavor and consistency of the bamboo rice gruel were assessed. Five-point hedonic scale was used to assess the sensory characteristics of the formulated recipe and questionnaire structured into knowledge, awareness and practices was used to collect data among the prospective respondents.

Selection of the respondents

About fifty hyperlipidemia female adults were randomly selected proportionate to its size, the respondents was purposively selected for this study. Fifty samples were divided into three groups

Experimental group 1 consists of 15 respondents. They were strictly followed given a dietary pattern with bamboo rice gruel. Experimental group 2 consists of 10 respondents. They were given only bamboo rice gruel.

The remaining was a control group who did not follow any specialized diet in day-to-day life.

Anthropometric measurements (Height, Weight, WHR, and BMI) and Biochemical examination of lipid profile were calculated before and after supplementation during the intervention period (Three months).

Place of the study

This experimental research was carried out by fifty hyperlipidemia female adults between 30 – 60 years of age residing in karaikudi using a questionnaire.

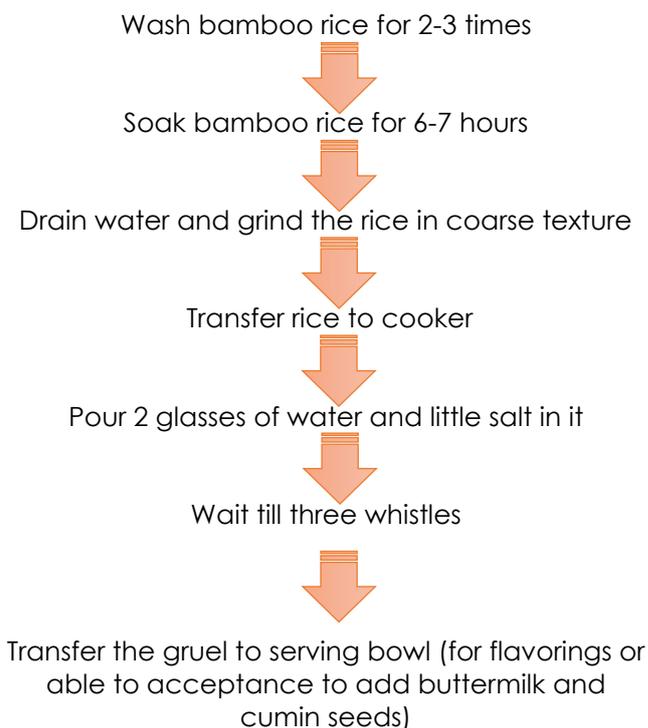


Fig 1 Flow chart for making bamboo rice gruel

RESULTS AND DISCUSSION

The majority of twenty-eight respondents have seen bamboo rice and twenty-two respondents have not seen bamboo rice. The studies reveal that bamboo rice is uncommon in our country since it takes years of cultivation; hence it has not gained as much importance as normal white rice even though it is packed with nutrients.

Table 1 Number of respondents who have seen bamboo rice (N = 50)

Respondents' response	Number of respondents
Yes	28
No	22

Table 1 Number of respondents who have been using bamboo rice (N = 50)

Respondents' response	Number of respondents
Yes	15
No	35

Subhadra Nayak, president of panchapada village said that bamboo rice was last collected in 1979, after 40 years this rare rice variety has been harvested in panchapada village. The bamboo forest is littered with the rice variety. It is not commonly available because it takes many years for a bamboo tree to flower and this is the reason localities use it to preserve the rice as they believe it has medicinal values. The forest department took initiative to protect the indigenous variety of rice. The forest officer added that "The forest department purchased around 80 quintals from rice collectors for Rs 15 per kilogram. The department will use bamboo rice to germinate bamboo trees in other areas of the state (Senapathi 2019).

The majority 35 respondents did not use bamboo rice in cooking and only 15 respondents used bamboo rice in cooking. Out of fifty, only fifteen respondents use bamboo rice in their cooking because over the last century the consumption pattern of the respondents has changed dramatically. Most people prefer to eat junk food since it is inexpensive, affordable, and convenient and also tastes good. But bamboo rice tastes bitter, expensive, resembles wheat and has high medicinal value enriched with carbohydrate, fiber, protein and B vitamins. This may be one of the reasons bamboo rice is not popular among the community (Vinodha Evangeline 2019).

Table 3 Mean Anthropometric measurements of adults (N=50)

Groups	Height (cm)	Weight (kg)	BMI	WHR
Experimental group I (N = 15)	159	75.6	31.5	1.4
Experimental group II (N = 10)	155	70.7	29.5	1.5
Control group (N = 25)	157	71.3	30.1	1.8

*Significant at 1 percent level

The mean height in experimental group I (159 cm) was higher than the experimental group II (155 cm) and the Control group (157cm) however, the difference in the height was not statistically significant. The mean weight was higher in hyperlipidemia females of the Experimental group I (75.6 kg) compared to the Experimental group II had (70.7 kg) and the Control group had (71.3 kg). However, the difference in the weight was statistically significant. The mean body mass index

(BMI) was 31.5, 29.5, and 30.1. The mean Waist Hip Ratio (WHR) value was 1.4, 1.5 and 1.8.

Bamboo rice is a good source of edible fiber (6 – 8 g per 100g fresh weight), which helps in lowering the blood cholesterol fat content is extremely low in bamboo rice's (2.46g per 100g) that are, therefore very good for weight-conscious and dieting people (Nirmala Chongtham 2011).

Table 4 Classification of female adults based on BMI (N = 50)

BMI Classes	Presumptive diagnosis	Exp. group I (N=15)		Exp. group II (N=10)		Control group (N=25)	
		Freq.	Percent.	Freq.	Percent	Freq.	Percent.
25 - 30	Obese – grade I	4	26.6	3	30	11	44
>30	Obese – grade II	11	73.3	8	80	14	56

Among 15 respondents in Experimental group I, 26.6 percent were obese grade I (25-30). 73.3percent were obese grade II (>30). From the Experimental group II, 30 percent of them belonged to BMI range 25 – 30 (obese grade I), 80 percent belonged to BMI range in > 30 (obese grade II). The rest of the

control group, 44 percent of them were in BMI range 25 – 30 (obese grade I), 56 percent of them were in BMI range in > 30 (obese grade II). The high cellulose content of bamboo rice stimulates appetite and has a high content of amino acids so that it provides satiety (Tapiero *et al.* 2001).

Table 5 Impact of bamboo rice supplementation on lipid profile of hyperlipidemia female (N=50)

Lipid profile	Experimental group I (N = 15)				Experimental group II (N = 10)				Control group (N = 25)			
	Initial	Final	"t" value	%	Initial	Final	"t" value	%	Initial	Final	"t" value	%
TC	228.38	201.38	3.42**	27	260.50	216.12	3.12**	44.38	257.73	257.62	3.12**	0.11
TGL	181.50	137.32	3.95**	44.18	179.31	170.23	0.82 ^{ns}	22.08	172.47	170.31	3.4 ^{ns}	2.16
HDL - C	43.05	54.30	1.08*	-11.25	39.84	42.11	1.02*	-7.91	47.16	46.59	1.2*	0.57
VLDL - C	32.7	29.72	0.9 ^{ns}	1.6	37.13	35.4	0.7 ^{ns}	7.41	39.93	39.43	2.1 ^{ns}	0.5
LDL - C	168.30	152.29	0.81 ^{ns}	16.01	149.87	140.37	0.65 ^{ns}	9.5	133.72	132.97	0.9 ^{ns}	0.75

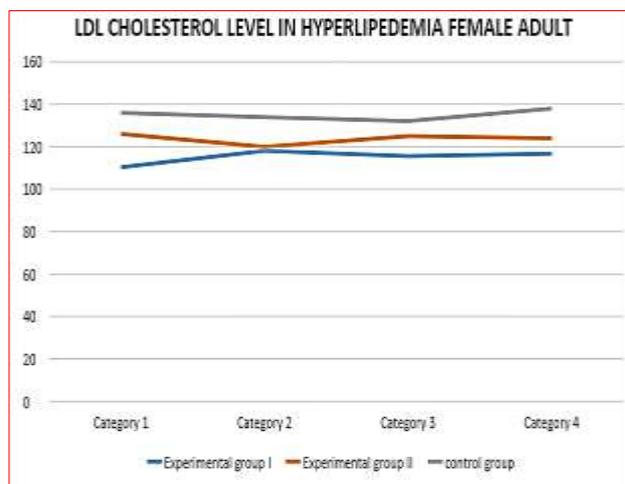
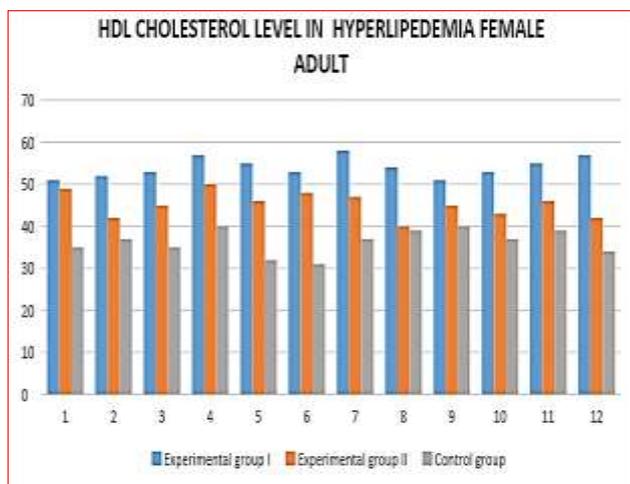
*=significant at 1 % level, **=significant at 5% level, ^{ns}=non-significant

The mean serum total cholesterol level of experimental group I before supplementation was 228.38 mg/dl, and had reduced to 201.38 mg/dl, the difference showing statistically significance at p (<0.01) level. The mean serum total cholesterol level of experimental group II before supplementation was 260.50 mg/dl and gradual reduction to 216.12 mg/dl was observed after three months of

supplementation, with regard to the control group no such significant change was observed. Experimental Group I revealed a better significant decrease in the serum total cholesterol level when compared with experimental group II and control group, which concluded that the intake of 200ml of bamboo rice gruel is highly effective in lowering serum total cholesterol level.

The mean serum triglyceride level of experimental group I before supplementation was 181.50mg/dl and had decreased to 137.32mg/dl after the supplementation period of three months, the difference showing statistical significance at $p < 0.01$ level. There were no tremendous changes among experimental group II and control group. The mean serum VLDL cholesterol level

in experimental group I before supplementation was 32.7mg/dl and had reduced to 29.72mg/dl after supplementation for a period of three months, the difference showing statistical significance. The mean serum VLDL cholesterol level of experimental group II was 37.13mg/dl and a gradual reduction was 35.4 mg/dl observed, during the supplementation period.



The mean serum HDL cholesterol level in experimental group I was 43 mg/dl and had increased to 54.30mg/dl, the difference showing the statistical significance at the $p < 0.01$ level. The mean serum HDL cholesterol level of experimental group II before supplementation was 39.84mg/dl and slowly increased to 42.11mg/dl was observed after three months of supplementation. There were no changes in the control group.

The mean serum LDL cholesterol level in experimental group I before supplementation was 168.30mg/dl and a progressive reduction to 152.29mg/dl was observed, which was

significant at the $p < 0.01$ level. The mean serum LDL cholesterol level of experimental group II was 149.87mg/dl before supplementation and had reduced to 40.37mg/dl after the supplementation period. The Bamboo Rice incorporated products usually reduce heart related diseases.

Bamboo rice is a good source of edible fiber (6 – 8 g per 100g fresh weight), which helps in lowering the blood cholesterol. fat content is extremely low in bamboo rice's (2.46g per 100g) that are, therefore very good for weight-conscious and dieting people (Nirmala Chongtham 2011).

Table 6 Related health problems in hyperlipidemia female adult (N = 50)

Problems	Experimental group I (N = 15)		Experimental group II (N = 10)		Control group I (N = 25)	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Cardiovascular disease	3	20	1	10	5	20
Hypertension	7	46.6	6	60	11	44
Diabetes mellitus	3	20	3	30	7	28
Rheumatic pain	1	6.66	-	-	2	8

About 46.6 percent of experimental group I and 60 percent of group II and 20 percent of control group of hyperlipidemia female adult had hypertension. 20 percent of experimental group I, 60 percent of experimental group II, and 44 percent of control group were suffered from the CVD. 20 percent experimental group I, 30 percent experimental group II and 28 percent of control group were suffered from the diabetes mellitus. 6.66 percent of experimental group I and 8 percent from the control group are affected by rheumatic pain.

Bamboo rice functions as a nutraceutical with high amounts of fiber and phytosterols. These components can qualify as natural medicines. Phytosterols has cholesterol-

lowering activity (Brufau *et al.* 2008). When we compared the mean weight before and after supplementation weight was reduced to a maximum in experimental group I, minimum in experimental group II and no changes in control group similarly BMI was reduced in experimental group I, and II.

The increased demand for modern foods particularly junk foods, fried foods and pastries to face major health problems such as hyperlipidemia, obesity, hypertension, cardiovascular disease has paved the way for the formulation of a food product that is sweet in taste, appetizing and of high nutritive value (Vinodha Evangeline 2019).

Table 7 Impact of bamboo rice gruel supplementation of BMI levels of hyperlipidemia female adults (N = 50)

BMI Classes	Presumptive diagnosis	Exp. group I (N = 15)		Exp. group II (N = 10)		Control group (N = 25)	
		Freq.	Percent	Freq.	Percent	Freq.	Percent
25 - 30	Obese – grade I	9	60	7	70	16	64
>30	Obese – grade II	6	40	3	30	9	36

CONCLUSION

It can be concluded from the above results that the bamboo rice gruel is reported to lower lipid profile and very effective for treating hypercholesterolemia and high blood pressure patients. In today's modernized world, the number of drugs available in the market to cure various health disorders have increased alarmingly but the majority of these drugs have side effects which are to cure and control diseases. Nowadays, the adolescent's consumption pattern has been opened out to junk foods which have empty calories, for switching out of these concepts to introduce novelty foods like bamboo rice related products. Bamboo rice is packed with nutrients such as carbohydrates, vitamins, protein, and fiber and has medicinal value hence it is used for ayurvedic treatment. The concept of taking high fiber diet of bamboo rice gruel in correlation with food for lowering plasma concentration of bad cholesterol, reduction in weight along with enhanced gut motility and prebiotic activity should be appreciated and adopt to prevent hyperlipidemia female adult this practice should be

adopted in our risk of metabolic syndromes. Bamboo rice is chewy when it is consumed, hence it is mostly used to prepare desserts. Regular consumption of bamboo rice reduces lipid profile and controls cardiovascular disease and also increases the bone strength in the body. Bamboo rice has low glycemic index and is considered to be a good healthier option to the hyperlipidemia female adults. Hence this study is conducted to incorporate and to popularize the consumption of bamboo rice.

Limitation

Hence a detailed thorough study is also advised on physicochemical properties of bamboo rice components in lowering the lipid profile.

Recommendation

There is only very little information available about bamboo rice, hence this research can be extended by gathering information from the tribes in the forest whose living and income is based on cultivation of bamboo rice. In future, if possible, the bamboo rice will be cultivated and marketed so that it is easily available and low in cost.

LITERATURE CITED

1. Kumari Rekha, Dr.Ravi Shankar Singh, Komal Shekhawat (2020), "Centurion Bowl of Rice: Bamboo Rice" Bihar Agricultural University. (www.agri food magazine.co.in)
2. Nirmala Chongtham, Madho Singh Bisht, and Sheena Haorongbam (2011), Nutritional properties of bamboo rice: potential and prospects for utilization as a healthy food.
3. Rezapour M, Ali S, Stollman N. Diverticular disease: an update on pathogenesis and management. Gut and liver. 2018; 12(2):125.
4. Rana S, NDTV food dated May 01, 2017.
5. Vinodha Evangelina J and Syed Himayum (2019) To assess the Sensory Characteristics of Bamboo Rice Cake among College Students", International Journal of Home science, Chennai`IJHS 2019; 5(3):05-08 (www.home science journal.com).
6. Wang Y, Chen J, Wang D, Ye F, He Y, Hu Z, et al. A systematic review on the composition, storage, processing of bamboo shoots: Focusing the nutritional and functional benefits. Journal of Functional Foods. 2020; 71:104015. DOI: 10.1002/2327-6924.12447
7. Wu W, Hu J, Gao H, Chen H, Fang X, Mu H, et al. The potential cholesterol-lowering and prebiotic effects of bamboo shoot dietary fibers and their structural characteristics. Food Chemistry. 2020; 332:127372.
8. www.downtoearth.org.in, senapathi, A dated on April 09, 2019

Incorporation of Whey Water in Sugar, Palm Jaggery and Jaggery Syrup and its Acceptability

J. Mahalakshmi¹ and J. Merlin Rani²

^{1,2}Department of Nutrition and Dietetics, The Standard Fireworks Rajaratnam College for Women, Sivakasi, Tamil Nadu, India

Correspondence to: J. Mahalakshmi, Department of Nutrition and Dietetics, The Standard Fireworks Rajaratnam College for Women, Sivakasi, Tamil Nadu, India

Abstract

Milk whey is one of the highly nutritious by-products obtained from the dairy industry and left unused over years and years. The study aims to formulate the proportion of whey and sugar syrups for best sensory quality and to maximize the utilization of whey protein and an effective substitute for water in the preparation of different syrups. The whey water has been isolated from the milk by using 10% citric acid and the clarified and processed whey has been used to formulate nine syrups with varying levels of whey and sugar, jaggery and palm jaggery in 25%, 50% and 100% respectively. Finally, the formulated samples have been analyzed for sensory characteristics using descriptive statistical methods. The overall mean acceptability and SD for sugar syrup is 8.04 ± 0.63 , 7.8 ± 0.79 and 7.9 ± 0.79 respectively. For Jaggery syrup it is 8.5 ± 0.81 , 7.6 ± 1.04 and 7.2 ± 1.3 and for palm jaggery syrup, it is 8.1 ± 0.8 , 8.1 ± 0.9 and 8.3 ± 0.8 . 25% incorporation of whey is more highly acceptable in sensory characteristics, among all the syrups. The sugar syrup forms the base for beverages and sweets, it's incorporation with whey water would show significant increase in protein content of the foods.

Key words: Whey protein, Value addition, Jaggery

Milk whey is one of the highly nutritious by-products obtained from the dairy industry and left unused over years and years. Whey was discovered about 3000 years ago. Apart from being valued as a medicinal agent in the 17th and 18th centuries, whey has primarily been considered a waste by the dairy industry, and thus destined for the 'cheapest gutter'. In the late 20th century, regulations prevented disposal of untreated whey. At the same time, recognition of the value of whey components accelerated. Modern science has unraveled the secrets of whey proteins and other components, and established a sound basis for their nutritional and functional value. In parallel, technology developments exploited this underpinning knowledge, manifested as advanced whey-processing regimes. These advances have continued through the early 21st century with the focus more on the biological functionality of whey components. This whey water contains all the essential amino acids, so it was called as Complete protein. Essential amino acids present in whey water has highly biological value when comparing to other complete proteins. (Farnfield, 2009). Due to multi-nutritional benefits it was used for more therapeutic treatments. It also used by the bodybuilders and athletes who need more amount of protein in their diet. (Gangurde, 2011) Besides the nutritional properties, the whey proteins have functional properties which impart beneficial physical properties when used as ingredients in food (Minj, 2020), mainly due to its high solubility, water absorption, gelatinization and emulsifying capacities. (Ha, 2003). In this study, the whey water has been

extracted from the standardized milk and it was incorporated into Sugar syrup, Jaggery syrup and palm jaggery syrup at different proportions. Sugar syrup is a sweetener, preservative widely used in food industries and it has major role in preparation of sweets in various occasions and festivals of India and other countries. Meanwhile it was consumed by various age group people. When we add the whey water, its nutritional quality will be increased. The study aims to formulate whey water incorporated sugar syrup, jaggery syrup and palm jaggery syrup by different proportions This study focus to maximize the utilization of whey protein and an effective substitute for water in the preparation of different syrups. Whey water is functional food and it has lactoferrin, betalactoglobulin, alpha-lactalbumin, glycomacropeptide, and immunoglobulins, demonstrate a range of immune-enhancing properties. (Kareb, 2019) In addition, whey has the ability to act as an antioxidant, antihypertensive, antitumor, hypolipidemic, antiviral, antibacterial, and chelating agent. Due to fermentation the whey water also has some probiotic activity (Turkmen, 2019), so it prevents the heart related diseases. The chief amino acids present in whey syrup is cysteine to glutathione. This formulated whey syrup will be useful to eradicate the malnutrition.

Objectives:

- This study aims,
- to isolate whey water from standardized milk.

- to incorporate the whey water in sugar, palm jaggery and jaggery in different proportion.
- to find out the acceptability of formulated different proportions of whey water in sugar, palm jaggery and jaggery syrups through sensory evaluation.

MATERIALS AND METHODS

This study has the following materials and Methodology:

Materials

- Measuring Cup
- Weighing Scale
- Standardized Milk
- Citric acid
- Sugar, Jaggery and Palm Sugar
- Muslin Cloth
- Storage Glass Container

Measuring Cup

1000 ml Moulded in Polypropylene Measuring Cup was used to measure water and milk it was bought from local super market.

Weighing Scale

Potable Electronic weighing scale (mg) was used to weighing citric acid, sugar, jaggery and palm jaggery.

Standardized Milk

From nearby aavin milk booth standardized milk was brought for the isolation of whey water.

Citric acid

Bakers citric acid was used to coagulation of milk and it was obtained from the nearest super market.

Sugar, Jaggery and Palm Jaggery

These are ingredient used for the preparation syrups granulated sugar, jaggery and palm jaggery was bought from the nearest store. Jaggery and palm Jaggery powderer was prepared by using smasher on granulated jaggery and plam jaggery.

Muslin Cloth

For the filtration of prepared whey weater incorporated syrups fresh muslin cloth was used.

Storage Glass Container

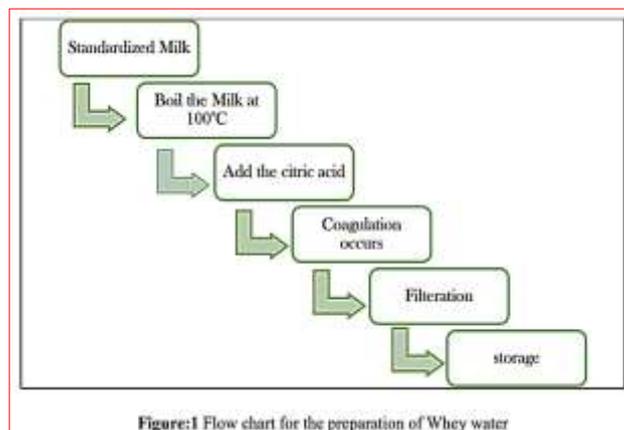
Fresh Glass Container was used store the prepared whey water incorporated syrups.

Methodology

- Isolation the whey water from Standardized Milk
- Incorporate the whey water in Sugar, jaggery and palm jaggery syrups in various proportion
- Sensory Analysis the formulated whey water incorporated syrups
- Analyze the standard deviation of sensory evaluation of whey water incorporated syrups.

Isolation the whey water

The collected standardized milk subjected into the boiling process and add citric acid. When Whole milk coagulated the substances was filtered by the strainer. The isolated whey water is stored in sterilized glass bottle.

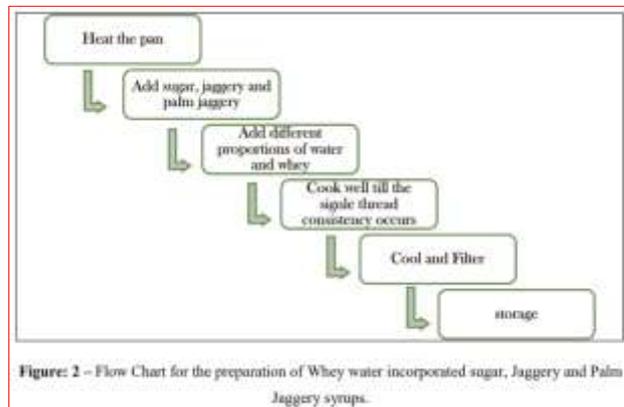


Incorporate the whey water in Sugar, jaggery and palm jaggery syrups in various proportion

The isolated whey water was incorporated is sugar, jaggery and palm jaggery syrup by different proportions as follows.

Table 1 Preparation of whey water incorporated sugar, Jaggery and palm Jaggery syrups

S.No	Ingredients	Sugar			Jaggery			Palm Jaggery		
		SV1	SV2	SV3	JV1	JV2	JV3	PV1	PV2	PV3
1.	Water (ml)	75	50	-	75	50	-	75	50	-
2.	Whey Water (ml)	25	50	100	25	50	100	25	50	100
3.	Sugar (g)	100	100	100	-	-	-	-	-	-
4.	Jaggey (g)	-	-	-	100	100	100	-	-	-
5.	Palm Jaggey (g)	-	-	-	-	-	-	100	100	100



Sensory Analysis of the formulated whey water incorporated syrups

The formulated whey syrup subjected into the sensory analysis by the semi trained panel members of The Standard Fireworks Rajaratnam College for Women, Sivakasi. The formulated samples were sensorically evaluated on the following sensory characteristics like colour, appearance, consistency, flavor, taste and over all acceptance on 9-point hedonic rating scale. The panel members gave ratings according their preferences. The coded samples were randomly presented to them for evaluation.

Statistical analysis

The mean and standard deviation of the different variation of the samples were analyzed through the statistical calculation in SPSS. The results are presented as follows.

RESULTS AND DISCUSSION

Sensory Analysis the formulated whey water incorporated syrups

Formulated whey water incorporated syrups were subjected into sensory evaluation by untrained panel members and mean score was found out and statistically analyzed. The whey water has been isolated from the milk by using 10% citric

acid and processed whey has been used to formulate nine syrups with varying levels of whey and sugar, jaggery and palm jaggery in 25%, 50% and 100% respectively. Finally, the formulated samples have been analyzed for sensory characteristics using descriptive statistical methods and its values are listed in (Table 2-4).

<i>Whey water incorporated sugar syrup</i>	Colour	Appearance	Consistency	Flavour	Taste	Over all Acceptance
<i>Variation I</i>	8.25 ± 0.25	8 ± 0.12	7.75 ± 0.27	8.08 ± 0.25	8.16 ± 0.27	8 ± 0.32
<i>Variation II</i>	7.41 ± 0.25	7.91 ± 0.2	7.75 ± 0.25	7.75 ± 0.21	8.16 ± 0.24	8.25 ± 0.17
<i>Variation III</i>	7.33 ± 0.33	7.83 ± 0.32	8.25 ± 0.21	7.91 ± 0.33	8.16 ± 0.32	8.33 ± 0.22

Table: 2 Sensory Evaluation of formulated whey water incorporated sugar syrup

<i>Whey water incorporated jaggery syrup</i>	Colour	Appearance	Consistency	Flavour	Taste	Over all Acceptance
<i>Variation I</i>	8.66 ± 0.15	8.73 ± 0.11	8.13 ± 0.25	8.53 ± 0.33	8.46 ± 0.16	8.6 ± 0.23
<i>Variation II</i>	7.46 ± 0.30	7.86 ± 0.16	7.53 ± 0.21	7.6 ± 0.36	7.4 ± 0.32	7.93 ± 0.74
<i>Variation III</i>	7 ± 0.39	7.4 ± 0.25	7.6 ± 0.32	6.9 ± 0.44	7 ± 0.35	7.33 ± 0.33

Table: 3. Sensory Evaluation of formulated whey water incorporated jaggery syrup

<i>Whey water incorporated jaggery syrup</i>	Colour	Appearance	Consistency	Flavour	Taste	Over all Acceptance
<i>Variation I</i>	8.6 ± 0.16	8.46 ± 0.16	7.73 ± 0.28	7.86 ± 0.23	8.2 ± 0.22	8.26 ± 0.20
<i>Variation II</i>	8.26 ± 0.30	8 ± 0.21	8 ± 0.32	8.2 ± 0.27	8.13 ± 0.25	8.33 ± 0.18
<i>Variation III</i>	8.2 ± 0.22	8.13 ± 0.21	8.53 ± 0.29	8.13 ± 0.23	8.53 ± 0.19	8.4 ± 0.23

Table: 4. Sensory Evaluation of formulated whey water incorporated palm jaggery syrup

The sensory parameters like colour, taste, flavor, consistency and appearance were evaluated. The overall mean acceptability and SD for different formulation incorporated with 25%, 50% and 100% are given as follows, for sugar syrup it is 8.04±0.63, 7.8 ± 0.79 and 7.9 ± 0.79 respectively. For jaggery syrup it is 8.5±0.81, 7.6±1.04 and 7.2±1.3 and for palm jaggery syrup, it is 8.1±0.8, 8.1±0.9 and 8.3±0.8. 25% incorporation of whey is more highly acceptable in sensory characteristics, among all the syrups and its values are listed in (Figure 3).

The above (Figure 3) shows the comparison of overall acceptability of different syrups. The acceptability of sugar and palm jaggery syrup increases with increase in the concentration of whey water. This is because in case of sugar syrups are mild

in flavor, while incorporating the whey water, it goes well with the sugar syrup whereas palm jaggery syrup has strong flavors it suppresses the flavor of whey water. Thereby whey water goes well with palm sugar syrup. The acceptability of jaggery syrup decreases with increase in the concentration of whey water, as the syrup becomes sour while incorporating it with whey water. The sugar syrup forms the base for beverages and sweets, it's incorporation with whey water would show significant increase in protein content of the foods.

CONCLUSION

From the present study, it can be concluded that the sugar syrup forms the base for beverages and sweets, it's

incorporation with whey water would show significant increase in protein content of the foods. The incorporation of whey with the natural sweeteners are accepted well among the people

based on its sensory parameters. The samples SV3, JV1, PV3 has the high acceptability rate compared to other samples.

LITERATURE CITED

1. Gangurde, H., Chordiya, M., Patil, P., & Baste, N. (2011). Whey protein. *Scholars' Research Journal*, 1(2).
2. Ha, E., & Zemel, M. B. (2003). Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people. *The Journal of nutritional biochemistry*, 14(5), 251-258.
3. Jovanović, S., Barać, M., & Maćej, O. (2005). Whey proteins-properties and possibility of application. *Mljekarstvo*, 55(3): 215-233.
4. Kareb, O., & Aider, M. (2019). Whey and its derivatives for probiotics, prebiotics, synbiotics, and functional foods: a critical review. *Probiotics and antimicrobial proteins*, 11, 348-369.
5. Kenny, S., Wehrle, K., Stanton, C., & Arendt, E. K. (2000). Incorporation of dairy ingredients into wheat bread: effects on dough rheology and bread quality. *European food research and technology*, 210, 391-396.
6. Keri Marshall, N. D. (2004). Therapeutic applications of whey protein. *Alternative medicine review*, 9(2), 136-156.
7. Minj, S., & Anand, S. (2020). Whey proteins and its derivatives: Bioactivity, functionality, and current applications. *Dairy*, 1(3), 233-258.
8. Parate, V. R., Kawadkar, D. K., & Sonawane, S. S. (2011). Study of whey protein concentrate fortification in cookies variety biscuits. *International journal of food engineering*, 7(2).
9. Pennings, B., Groen, B., de Lange, A., Gijsen, A. P., Zorenc, A. H., Senden, J. M., & Van Loon, L. J. (2012). Amino acid absorption and subsequent muscle protein accretion following graded intakes of whey protein in elderly men. *American Journal of Physiology-Endocrinology and Metabolism*, 302(8), E992-E999.
10. Poonia, A., & Arti, K. (2018). Development and shelf-life evaluation of functional Rabadi (a fermented pearl millet product) by incorporation of whey. *Indian J Nutr Diet*, 55(3), 318-333.
11. Sharma, R., Choudhary, R., Thakur, N. S., & Thakur, A. (2019). Development and quality of apple-whey based herbal functional ready-to-serve beverage. *Journal of Applied and Natural Science*, 11(2), 291-298.
12. Turkmen, N., Akal, C., & Özer, B. (2019). Probiotic dairy-based beverages: A review. *Journal of Functional Foods*, 53, 62-75.
13. Visalakshi, G., & Mohanasundari, P. (2002). Incorporation of whey protein concentrate in maida based snacks and its consumer acceptability. *The Indian Journal of Nutrition and Dietetics*, 333-336.
14. Wani, S. H., Gull, A., Allaie, F., & Safapuri, T. A. (2015). Effects of incorporation of whey protein concentrate on physicochemical, texture, and microbial evaluation of developed cookies. *Cogent Food & Agriculture*, 1(1), 1092406.
15. Zhou, J., Liu, J., & Tang, X. (2018). Effects of whey and soy protein addition on bread rheological property of wheat flour. *Journal of texture studies*, 49(1), 38-46.

Formulation of *Centella asiatica* Incorporated Functional Ice Cream

Revathi P*¹ and Vasantha Esther Rani²

¹ Department of Food Science and Technology, Arul Anandar College, Karumathur, Madurai- 625514, Tamil Nadu, India, Food Science and Nutrition, Madurai Kamaraj University, Madurai, Tamil Nadu, India

² Research Centre of Home Science, Fatima College, Madurai - 625018, Tamil Nadu, India

Correspondence to: Revathi P, Department of Food Science and Technology, Arul Anandar College, Karumathur, Madurai- 625514, Tamil Nadu, India, Food Science and Nutrition, Madurai Kamaraj University, Madurai, Tamil Nadu, India, Tel: +91 9791606876; E-mail: revathi.rpr@gmail.com

Abstract

Functional food is defined as any fresh or processed food that delivers health advantages beyond typical nutrition and is believed to have a health-promoting or disease-preventing quality in addition to delivering nutrients. In the development of functional foods, milk and dairy products hold a major position. *Centella asiatica* (CA) is an odourless, tasteless herb. It is commonly used for the treatment of high blood pressure, memory enhancement, and longevity promotion. The frozen dessert ice cream was liked by everyone; hence this study was planned to formulate *Centella asiatica* incorporated ice cream. Ice cream was prepared in accordance with ISI (IS: 2802, 1964) specification. The milk was heated to a boil. The measured required ingredients like butter and *Centella asiatica* were homogenized and then pasteurized at 80 °C for 30 seconds. The mixtures were cooled to 5°C and matured at the same temperature for four hours and kept in freezer. After freezing ice cream stored at -18°C to -23°C until further usage. The functional ice cream sample developed will meet the needs of the consumer by providing both nutritional and functional value. Thus, the consumption of herbs incorporated functional Ice cream will contribute to the overall wellness of all the age groups.

Key words: Functional foods, *Centella asiatica*, Ice cream

Functional food is defined as any fresh or processed food that delivers health advantages beyond typical nutrition and is believed to have a health-promoting or disease-preventing quality in addition to delivering nutrients (Das *et al.* 2010). Functional food comprises recognized biologically-active chemicals that, when consumed in the appropriate quantity and quality, give a clinically demonstrated and well-documented health benefit. Thus, Functional Foods are essential in the modern prevention, management, and treatment of chronic diseases (Danik 2011). Their primary objective is to reduce disease risk (Berner and Donell, 1998). Functional foods are distinct from medical foods and dietary supplements; however, they may overlap with special diet foods and fortified foods. They are one of the most rapidly expanding sections of the food industry as a result of rising customer demand for foods that promote health and well-being (Mollet and Lacroix 2007). Functional foods are foods that, when consumed, play a crucial role in reviving the physiological functioning of the body (beyond that of basic sustenance), hence reducing the risk of illness and disease. Functional foods must generally be made available to consumers in forms that are consumed as part of the target population's typical daily diet. Consumers anticipate that functional foods will have comparable organoleptic attributes (such as aroma, flavour, texture, and appearance) to traditional foods on the market (Klont 1999; Augustin, 2001; Kwak and Jukes 2001; Klahorst 2006). Functional foods are distinct from

medical foods and dietary supplements; however, they may overlap with special diet foods and fortified foods. They are one of the most rapidly expanding sections of the food industry as a result of rising customer demand for foods that promote health and well-being (Mollet and Lacroix 2007).

Centella asiatica (CA), a clonal, perennial herbaceous vine belonging to the Umbellifere (Apiceae) family, is widespread in India (Bown D, 1995). It is an odourless, tasteless plant that flourishes near water. It features little green leaves in the shape of a fan, white or light purple-to-pink or white flowers, and small oval fruit. The entire plant is utilised medicinally (Singh P. and Singh JS., 2002). It is commonly used as a blood purifier, as well as for the treatment of high blood pressure, memory enhancement, and longevity promotion. It was indicated for the treatment of many skin problems, including leprosy, lupus, varicose ulcers, eczema, psoriasis, diarrhoea, fever, amenorrhoea, and diseases of the female genitourinary tract (Montvale 1999) (Brinkhaus *et al.* 2000). The triterpene saponins and associated saponinins are primarily responsible for the wound healing effects of California poppy (*Centaurea asiatica*). Other isolated components of CA, such as brahmoside and brahminoside, may be responsible for CNS and uterorelaxant effects. (Heidari *et al.* 2007).

Amaravathi *et al.* (2002) reported that ingesting food products containing brahmi leaves (nutri balls mix, puttu mix,

health drink mix, cookies and soup mix) is beneficial to health. Fresh leaves that have undergone minimum processing can be fed to children as a memory enhancer and tonic. However, youngsters may find it difficult to swallow the bitter ayurvedic food product, which is widely accepted by people of all ages primarily due to its health benefits. Ice cream is a frozen dairy product prepared by freezing and agitating the ice cream mixture. It consists of a mixture of culinary ingredients, including milk products, sweeteners, stabilisers, colours, and flavours, as well as egg products. Originating in Europe, ice cream was eventually imported to the United States, where it blossomed into an industry. (Deosarkar 2016). Ice creams are unique frozen foods in that they are enjoyed in the frozen state, typically as scooped products or single-serving items, sometimes on a stick, and frequently with other sweets. These items rely on a simultaneous freezing and whipping procedure to provide the necessary structure and texture (Goff 2006).

Similar production processes are utilized for the majority of these items. It entails preparing a liquid mixture by combining the necessary ingredients, then pasteurizing, homogenizing, and maturing it. The mixture is then dynamically whipped and frozen under high shear to create a semi frozen, semiliquid slurry. The flavouring components are then added to the mixture. The material is then pressed into moulds and packaged. It is also susceptible to freezing (hardening) under static, still conditions. Forced convection freezers, such as air blast tunnels or chambers, or plate type conduction freezers are utilized for the second freezing stage (Walstra *et al.* 2006). Ice cream is produced by simultaneously freezing and aerating a mixture of fat, sugar, milk solids, an emulsifier, flavouring, and sometimes colouring. The fat might be derived from milk, cream, or butter, or it can come from a non-dairy source. However, the composition of ice cream is regulated by law in numerous nations. 'Dairy' ice cream must include a minimum of 5% milk fat and a minimum of 2.5% milk protein (from casein or whey solids). 'Standard' ice cream must contain at least 5% milk fat and 2.5% milk protein (from casein or whey solids).

Ice creams are made with a vast assortment of ingredients. Even a single type of ice cream can be created by blending ingredients in a variety of ways. Mixture for ice cream is the unfrozen mixture of ingredients, excluding air and flavourings. Typically, the composition of ice cream is given as a proportion of its elements, such as milk fat, milk solids-not-fat, sugar, egg solids, stabilisers, and total solids. Fats enhance the richness of the ice cream's flavour, provide a silky texture, add "body" to the ice cream, and contribute to its excellent melting capabilities. Non-fat milk solids are incorporated as skim milk powder or whole milk powder. They enhance the body and texture of ice cream, permit a greater overrun (below), and create a thicker, less frosty product. Adding sweeteners to ice cream improves its flavour, texture, and palatability. They contribute to a lower freezing point, so that some of the water in the ice cream remains unfrozen. Without it, ice cream would be difficult to consume. In addition, they diminish the "fattiness" of ice cream and aid in producing a smooth texture.

Stabilizers are used to assist combine the complex mixture of fats, carbohydrates, air, and microscopic ice crystals present in ice cream and give it a smooth consistency. They enhance the viscosity of the unfrozen water in order to make an ice cream that is more solid and resistant to melting by increasing the viscosity of the unfrozen water. Emulsifiers produce a silky consistency and excellent melting properties. Egg yolk was formerly used as an emulsifier in ice cream, although mono- and di-glycerides and Polysorbate 80 are currently employed in the majority of ice cream recipes. For the

manufacturing of ice cream, both synthetic and natural flavours are utilised. Generally, the colouring complements the flavour (e.g. green colour with mint flavour or orange with mango). The flavours and colours must meet "food grade" specifications. Since Ice cream has been the favourite delicious food for all the age groups, the present study focuses on formulation of the functional food products ice cream with the incorporation of low cost, locally available functional food ingredients like, palm jaggery, *Centella asiatica*, in addition to the basic ingredients.

Objective of the study

The present study was carried out with the objective: Formulation of *Centella asiatica* added functional Ice cream.

MATERIALS AND METHODS

The Methodology employed in the present study named "Formulation of *Centella asiatica* incorporated Functional Ice Cream" is outlined below.

Procurement of Ingredients used for *Centella asiatica* incorporated Functional Ice cream.

Formulation of *Centella asiatica* incorporated Functional Ice cream.

Dairy Ingredients

For the manufacture of Jigardhanda and ice cream, fresh standardised milk and full cream milk were sourced from Aavin, Madurai.

Skimmed milk powder

Skimmed milk powder obtained from Aavin Co-operative Milk Marketing Federation Ltd., Madurai was used to standardize the Milk Solids Not Fat content of ice cream.

Butter

To standardize the fat percentage of the ice cream, high-quality frozen sweet cream butter from Aavin, Madurai was utilized.

Unsweetened milk kova

Fresh, unsweetened Kova was procured from Jayaram Bakery in Madurai for the preparation of Jigardhanda.

Cane sugar

Big Bazaar supermarket was shopped for food-grade sugar cane; Madurai was utilised in the creation of numerous ice cream flavours.

Palm sugar

Ice cream was prepared with palm sugar acquired from the Khadi Craft store in Madurai and of high quality.

Stabilizer and emulsifier

Ice cream was prepared using the stabilizer and emulsifier (Bakers Eceemix- Emulsifying and Stabilizing agent containing edible gums, starch, and emulsifying ingredients) manufactured by Bakers products India, Coimbatore.

Flavour

Vanilla flavour obtained from Sarasvathy Essence Mart in Madurai was added to the ice cream samples to enhance their flavour.

Cups, lids, and a disposable spoon

Ice cream was packaged with disposable cups, lids, and spoons of food-grade quality that were obtained from a local market.

Centella asiatica Powder

Centella asiatica (Vallarai) powder was acquired from a authorized herbal merchant in Madurai.

Formulation of Centella asiatica incorporated Ice cream

Table 1 Quantity of ingredients used in the preparation of functional ice cream

Ingredients	Control (TC) (g)	Sample (T1) (g)
Milk	711.67	711.67
Sugar	150	0
Palm sugar	0	150
Butter	89	89
Skim Milk Powder	46	26
Stabilizer and Emulsifier	3.33	3.33
Centella asiatica	0	20
Total	1000	1000

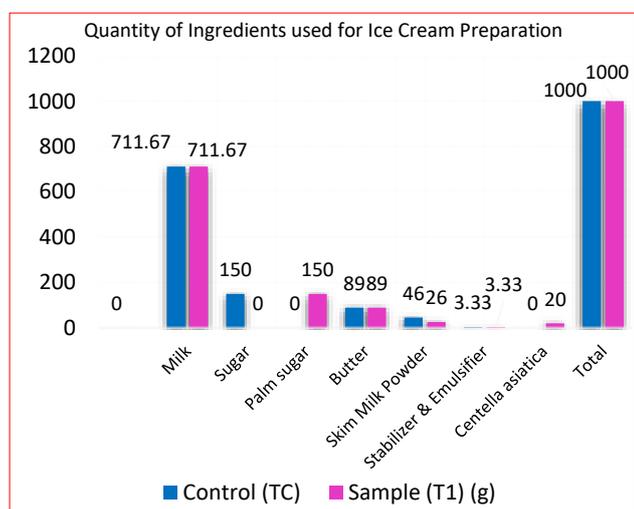


Figure 1 Quantity of ingredients used in the preparation of Functional Ice Cream

Formulation of Centella asiatica incorporated Ice Cream

Ice cream mix was prepared to comprise a final composition of 10% fat, 36% total solids, 15% sugar, and 0.5% stabiliser and emulsifier, in accordance with ISI (IS: 2802, 1964) specification (Sukumar De, 1980). Table 1 displays the amounts of ingredients necessary to prepare one kilogramme of ice cream mix for the various treatment combinations. The milk was heated to a boil. The (Table 1, Figure 1) ingredients were

homogenized according to Arbuckle's (1986) method and then pasteurised at 80 °C for 30 seconds, as advised by Rothwell (1976). The mixtures were cooled to 5°C and matured at the same temperature for four hours. For each treatment, the ice cream mixture was moved to a batch freezer and frozen individually. After freezing, 50 ml food quality paper cups were filled with ice cream, capped with food grade lids, and stored at -18°C to -23°C until further usage.

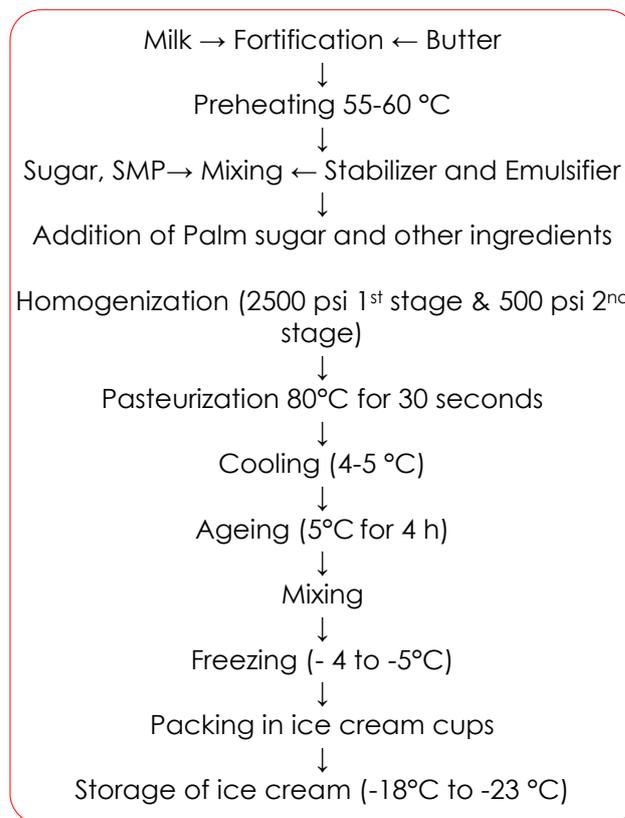


Fig 2. Flow chart for the preparation of ice cream

CONCLUSION

Ice cream, is a nutritious and delicious milk-based dessert, it has been that almost everyone's favourite food. Hence, as vehicles for incorporating functional food, Ice cream was chosen. In which, Functional herb Centella asiatica (Vallarai) powder was incorporated. In this study, functional Ice cream formulated by using standard procedure. The formulated Ice cream has good appearance and taste. Consequently, it is recommended that the functional ice cream samples developed will meet the needs of the consumer by providing both nutritional and functional value. Thus, the consumption of functional Ice cream will definitely contribute to the overall wellness of all the age groups.

LITERATURE CITED

1. Amaravathi T, PS Geetha, M Murugan, S Selvam and S Kanchana, (2020), Traditional value added products from Indian penny wort (*Centella asiatica*) and water hyssop (*Bacopa monnieri*) to alleviate ADHD , *The Pharma Innovation Journal* 2020; 9(7): 432-441.
2. Arbuckle, W.S. (1986) *Ice Cream*. 4th Edition, AVI Publishing Co. Inc., Westport Moreno, M. D. L., Comino, I., Sousa, C. "Alternative grains as potential raw material for gluten-free food development in the diet of celiac and gluten- sensitive patients," *Austin J Nutr Food Sci*, 2(3). 1016. 2014.
3. Augustin, M.A. (2001). Functional foods: an adventure in food formulation. *Food Australia*, 53, 428–432.
4. Berner LA, O'Donnell JA (1998) Functional foods and health claims legislation: applications to dairy foods. *Int Dairy J* 8: 355-362.
5. Bown D. *Encyclopaedia of Herbs and their Uses*. London: Dorling Kindersley; 1995. pp. 361–5.
6. Brinkhaus B, Lindner M, Schuppan D, Hahn EG. Chemical, pharmacological and clinical profile of the East Asian medical plant *Centella asiatica*. *Phytomedicine*. 2000;7: 427–48.

7. Danik, (2011) Functional foods and chronic Diseases, Science and Practice, Functional food center www.studymore.com/essays/1342236.html
8. Das. D.R, Vimala and Nilanjana Das, “Functional foods of natural origin – An overview”, Indian Journal of Natural Products and Resources, Vol. 1(2), (2010). pp. 136-142.
9. Deosarkar S.S., Kalyankar S.D., Pawshe R.D. and Khedkar C.D. (2016) Ice Cream: Composition and Health Effects. In: Caballero, B., Finglas, P., and Toldrá, F. (Eds.) The Encyclopedia of Food and Health, vol. 3, pp. 385- 390. Oxford: Academic Press.
10. FSSAI, 2012. Food Safety and Standard Authority of India, Ministry of Health & Family Welfare, FDA Bhavan, Kotla Road, New Delhi-110002.
11. Goff. H.D. (2006), Ice Cream, Advanced Dairy Chemistry, Volume 2 Lipids, 3rd Edition, Edited by P.F.Fox, pp 441–450.
12. Heidari M, Jamshedi AH, Akhondzadeh SH, Ghaffari NM, Sadeghi MR, Khansari GM, et al. Evaluating the effects of *Centella asiatica* on spermatogenesis in rats. *Med J Reprod Infertility*. 2007;7:367–74.
13. Kwak, N.S. & Jukes, D.J. (2001). Functional foods. Part 2: the impact on current regulatory terminology. *Food Control*, 12, 109–117.
14. Klahorst, S.J. (2006). Flavour and innovation meet. *World of Food Ingredients*, June, 26–30
15. Klont, R. (1999). Healthy ingredients driving innovation. *World of Food Ingredients*, March/April, 43– 23.
16. Mollet B, Lacroix C. (2007), *Journal of Agriculture and Food Chemistry* 48: 2476–2482. A comparative analysis of the regulatory framework affecting *functional food* development and commercialization in Canada, Japan, the European.
17. Montvale, NJ , (1999), *PDR for herbal medicine*. 1st ed.: Medical Economics Co; p p. 729.
18. Rothwell.J., (1976) Ice Cream-its Present-Day Manufacture and Some Problems, *International journal of Dairy Technology*, <https://doi.org/10.1111/j.1471-0307.1976.tb00442>.
19. Walstra. P, T.J. Geurts, A. Noomen, A. Jellema, M.A.J.S. Van Boekel (Eds.), (1999) *Dairy Technology –Principles of milk properties and processes*, Marcel Dekker, New York, NY , pp. 485-515.

Nutritional Knowledge and Practice to Enhance Health and Sporting Performance Among Sports Professionals – A Consensus Study

S. Selvanayaki*¹ and R. Saravana Prabha²

^{1,2}Department of Physical Education, Avnashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641 043, Tamil Nadu, India

Correspondence to: S. Selvanayaki, Department of Physical Education, Avnashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641 043, Tamil Nadu, India, Tel: +91 9843076286; E-mail: prabha_phys@avinuty.ac.in

Abstract

Major scientific progress happened in the recent years in the field of sports training and sports nutrition has brought direct impact on one's health and sports performance. An attempt to assess the nutritional knowledge and practice to enhance the health and sporting performance among sports professionals. The cross-sectional study with the purposive sampling involved sixty selected Bachelor of Physical Education (PE) Students and Professional Athletes. Using the researcher made Nutrition Knowledge and Practice (NKP) questionnaire consists of four quarters namely Micro and Macro nutrients (Q1.7), Weight management (Q2.7), Sports nutrition (Q3.7) and Supplements awareness (Q4.7). The questionnaire segments and scores were validated by the nutrition experts and PE trainers. The Pearson correlation was used to find out the relationship and differences among the selected groups. The level of statistical significance was $p < 0.05$ and $p < 0.01$. Further identification was done with help of computation of Mean and its score on Percentile. From the above study it was summarized as nutritional knowledge and practices are found to be satisfactory among the selected group. Hence it was concluded that the athletes focus towards performance in their own sport emphasize the importance of nutrition and they translate their knowledge into practice than the physical education professionals.

Key words: Nutritional knowledge, Nutritional practice, Sporting Performance, Health, Physical Education, Athletes

Major scientific progress happened in the recent years in the field of sports training and sports nutrition has brought direct impact on one's health and sports performance. Procedural dietary manipulation, supplementations and few food restrictions before, during and after training results increase in sports performance and health stature. Varied sports components demand strenuous stress on the specific Psychomotor, Biochemical and Nutritional aspects. It is estimated that an hour of HIIT training or high intensity training will disburse 40% of an individual's total 24-hour energy release. The higher energy requirements lay impact on water and energy substrate. The additional nutrient requirements and its knowledge and practice in day today life of the sportsmen towards health and performance have become imperative nowadays. As the non-caloric and junk foods takes the top wish list of most of the individual's lifestyle. Many studies support that high carbo, high protein, low fat diets stimulates muscle tone, bone and joint strength its growth and development, repair and rejuvenate.

Indeed, nutrition affects almost every process in the body involved in energy production and recovery from exercise. To understand and apply the principles of sport nutrition, some basic understanding of nutrition is necessary. This includes the knowledge of biochemical and physiological processes that

occur in different cells and tissues as well as how these processes are integrated throughout the body. College athletes have misconception about nutrition, and have poor nutrition knowledge and attitude, College students are an appropriate target audience for nutrition education, because their lives are in transition and have the potential for positive changes (Wong *et al.* 1999).

There are many reasons why nutritional advice is not followed. It may be due to the lack of knowledge or information, and interest of making a change in one's diet, or certain perceived or encountered barriers that may prevent people from eating healthier diets such as the lack of money (cost), lack of time (too busy with work) or taste. Athletes may often rely on coaches for nutrition guidance in certain sports. Therefore, when coaches are misinformed about nutrition, this becomes a potential problem for athletes, as well. Nutrition training can be conveyed to the individuals through regular and wide educational programs as well as the individual training in own settings. Various studies focused on the necessity of nutrition training.

Objectives of the study

- Assess the nutritional knowledge and practice to enhance the health and sporting performance among physical education students and athletes.

- Asses the influence of demographic components on the nutritional practice towards enhancing health and performance
- Ensure the vitality of nutritional knowledge and practice into application their lifestyle among the selected physical education students and athletes

Hypotheses

It was hypothesized that:

- There might be significant differences between the selected groups towards the nutritional knowledge and practice
- The level of significance might vary between the selected segments due to the performance focus of varied sports

Bakhtiar *et al.* (2021) stated that Nutrition knowledge was significantly correlated with attitude and practices the promotion of nutrition knowledge through nutrition training subsequently can improve the attitude and practices. Another study found that collegiate students, who completed a nutrition course in college, demonstrated greater nutritional knowledge than those who did not complete a nutrition course. Improving a nutrition education program for non-physical education majors could be an effective way to improve college athlete's nutrition knowledge and attitudes. The importance of nutrition in various college curriculums and improvement of the learning environment, relate to nutrition need to be emphasized on college campuses (Azizi *et al.* 2010).

Naeeni *et al.* (2014) showed that adolescents failed to meet sufficient nutritional requirements, and they had an imbalanced diet, which was considerably low in several essential nutrients and high in some food materials. Nutritional knowledge was positively correlated with age, economic status and locality (Ruka *et al.* 2005). Folasire *et al.* (2015) pointed that good nutrition knowledge or practice did not directly determine athletic performance. However, there is the need for nutrition education interventions, to improve athlete's performance by promoting adequate energy intake, lean muscle mass and appropriate weight gain in athletes. concluded that students should pay more attention to nutrition. Therefore, an improvement in the learning environment related to nutrition, need to be emphasized on college campuses. College students are an appropriate target audience for nutrition education, because the lives are in transition and have the potential for positive changes (Wong *et al.* 1999). Prospective teachers and coaches receiving education at higher schools of sports increase their knowledge on nutrition and transfer their knowledge to next generations. Therefore, the knowledge and practice and the quality of the education they receive in relation to nutrition becomes important. Hence the purpose of the study was to investigate the consensus of collegiate students' nutritional knowledge and practice to enhance their health and performance.

MATERIALS AND METHODS

Study design

The cross-sectional study involved sixty selected Bachelor of Physical Education Students and professional athletes. To achieve the purpose of the study, Purposive sampling was used

Study site and participants

The participants are students from the Department of Physical Education (n=30) who were studying Bachelor of Physical Education and Professional athletes (n=30) who have

represented the institution in various sports and games at Inter Collegiate and Inter University level of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. In total, the study was carried out with 60 students with two groups and their age ranged from 17 to 25 yrs. A structured and validated teacher made nutritional knowledge and practice questionnaire with four sections namely Weight management, Micro and Macro nutrients, Supplements and Sports nutrition to test their knowledge and practice. The study protocol was approved by the Institutional Human Ethics Committee.

Data collection procedure

Using the researcher made Nutrition Knowledge and Practice (NKP) questionnaire consists of four quarters of Knowledge of Micro and Macro nutrients (Q1.7), Weight management (Q2.7), Sports nutrition (Q3.7) and Supplements awareness (Q4.7). The questionnaire segments and scores were validated by the nutrition experts and PE trainers.

Technique of analysis

The Pearson correlation was used to find out the relationship and differences among the selected groups. The inclusion criteria adds the samples from selected under graduation of PE department and athletes from other departments. The level of statistical significance was $p < 0.05$ and $p < 0.01$. Further to testify the Hy.2, to identify the level of significance vary was coined with help of Sum of Mean and its score in Percentile. It was an attempt to clarify the influences of nutritional knowledge and practice on sporting performance among professionals.

RESULTS AND DISCUSSION

The score more than mean was considered as good in nutritional knowledge and practice, while less than mean was considered as poor nutritional knowledge and practice. Questionnaire was distributed to both the groups. A cover letter was attached to explain the need of the study to the participants and to indicate their rights as participants through the informed consent. The demographical details were collected to elicit their perception and practice towards nutrition. The mean nutritional knowledge scores of both the groups were correlated in (Table 1) according to variables:

Understanding the scores of the respondents

Computation of Pearson's correlation was administrated to assess the association of Nutritional Knowledge among both PE and athletes groups. The complete correlation was expressed positive relation between both sports professionals. The collected data's were computed with Pearson Correlation and the results of nutritional knowledge $0.022 \geq 0.015$, weight management $0.023 \geq 0.012$, sports nutrition $0.022 \geq 0.007$ and supplements $0.02 \geq 0.004$ were significant at 0.01 level (2-tailed). As the variables have positive linear correlation between two groups the null hypothesis was rejected and researcher Hypothesis was accepted.

Percentile was used to identification of varied the level of significance in all segments of the responses. 54.4% of PE and 89% of athletes showed conscious on managing their body weight. The majority of physical education (74.0%) and athletes (75.0%) students correctly answered the statement. The response to the statement of carbohydrates and the relationship between carbohydrates and body fat are encouraging, as many believe that those trying to improve body composition should avoid carbohydrates.

The majority of the participant students 69.8% from PE and 73% of athletes answered the statement “protein is the main energy source for the muscle” as false. The students should be

informed about the fact that proteins are not the main energy source for the muscles. The adequate energy must be consumed in the form of carbohydrate to replenish glycogen stores.

Table 1 Pearson correlation among Nutritional Questionnaire Scores

Variables		Nutritional Knowledge (in Percentile)	Weight Management (in Percentile)	Sports Nutrition (in Percentile)	Supplement Awareness (in Percentile)
Physical Education	Pearson Correlation	0.385	0.451	0.399	0.513
	Sig (2 Tailed)	0.022*	0.012**	0.007*	0.004**
	No. of Subjects (n)	30	30	30	30
Professional Athletes	Pearson Correlation	0.408	0.321	0.385	0.585
	Sig (2 Tailed)	0.015**	0.023*	.022*	0.02**
	No. of Subjects (n)	30	30	30	30

*Correlation was Significant at 0.05 level of confidence

**Correlation was Significant at 0.01 Level of Confidence

The general consensus among nutritionists is that calories from fat should be maintained at approximately 30% of energy intake. A significant proportion of the participants 61.4% of PE and 84% of athletes correctly answered the statement “fats have important roles in the body”. Body fats have many functions like providing fuel to most tissues, working as an energy reserve, insulating the body and nerve fibers, supporting and protecting vital organs, lubricating body tissues, and creating an integral part of cell membranes. Athletes gained higher score than Physical education students.

Iron plays an important role for formal routine life and for exercise as it is required for the formation of hemoglobin and myoglobin, which bind oxygen in the body, and for enzymes involved in energy production. Iron depletion (low iron stores) is one of the most prevalent nutrient deficiencies observed in women, and also especially among female athletes. Over half of the participants 68.9% of PE and 73.4% of athletes correctly answered the statement “Iron-deficiency anemia results in a decrease in the amount of oxygen that can be carried in the blood”. Over half of the students 56.6% of PE and 69.2% correctly answered the statement “the body can synthesize vitamin D upon exposure to the sun”. The two primary sources of vitamin D are fortified foods like milk, and ultraviolet conversion in the skin, which produces the vitamin. Over half of the students 67.9% of PE and 71% of athletes correctly answered the statement “vitamin supplementation is recommended for all physically active people” as false. Physical education and Athletes believe that for extra winning edge can be met only with supplements, as 88.6% are residing in the university hostel and have a feel that hostel food does not meet the requirements.

Food that is easily digested and absorbed by body should be preferred soon after the training. This includes fruit, bread, cereal, skimmed milk, yoghurt, juice, and sports drinks which are richer than carbohydrate and include low fat. On the other hand, some other foods including coke, chocolate, biscuits, chips should not be consumed as they are flatulent and remain in the stomach for a long time. Only a small proportion of the participant 25.1% of PE and 32.4% of athletes answered that “the food like chocolate, biscuit and chips are not appropriate

for consuming after the training”. This indicated that students did not have enough knowledge about the food they consumed after the training or any strenuous work. However related courses such as exercise physiology, sport nutrition and exercise science are required for physical education students and special orientation classes are needed for the athletes too. A background in exercise physiology, sport nutrition and exercise science may be one of the reasons for better performances on the knowledge test, but possible relationship between nutrition knowledge and these courses needs further investigation.

Computation of demographical data

This is an attempt to identify the other influences in their NKP. The results showed that 65% of the selected subjects were in the age group of 17 to 20 years and 35% of them belongs to the age group of 21 and above. The locality of the selected athletes were 52.8 % from the urban and 47.2 from the rural area. The economic status of the selected subjects were 80.3 % of them are from very poor economic background and 20.7% from average status. The majority of the students (88.6%) were residing in institute hostel while others live with their families. Almost all the students actively participating in regular PE activities and rigorous physical trainings.

CONCLUSION

From the above study it was summarized as nutritional knowledge and practices are found to be satisfactory among the selected group. But athletes showed higher interest and attention towards nutrition practice. Hence it was concluded that the athletes focus towards performance in their own sport emphasize the importance of nutrition and they translate their knowledge into practice than the physical education professionals. It is appropriate to provide intensified nutrition educational training and intervention to sporting professionals to maximize their performance. The complete assessment can include anthropometry, body composition, bio chemical testing and nutritional based clinical examination to make the study further more reliable.

LITERATURE CITED

1. Azizi M, Rahmani-Nia F, Malaee M, Malaee M, Khosravi N. 2010. A study of nutritional knowledge and attitudes of elite college athletes in Iran. *Brazilian Journal of Biomotricity* 4(2): 105-112.
2. Bano R, AlShammari E, Fatima SB, Al-Shammari NA. 2013. A comparative study of knowledge, attitude, practice of nutrition and non-nutrition student towards a balanced diet in Hail University. *Journal of Nursing and Health Science* 2(3): 29-36.

3. Bakhtiar, M., Masud-ur-Rahman, M., Kamruzzaman, M., Sultana, N., & Rahman, S. S. (2021). Determinants of nutrition knowledge, attitude and practices of adolescent sports trainee: A cross-sectional study in Bangladesh. *Heliyon*, 7(4), e06637.
4. Folasire, O. F., Akomolafe, A. A., & Sanusi, R. A. (2015). Does nutrition knowledge and practice of athletes translate to enhanced athletic performance? Cross-sectional study amongst Nigerian undergraduate athletes. *Global journal of health science*, 7(5), 215.
5. Naeeni, M. M., Jafari, S., Fouladgar, M., Heidari, K., Farajzadegan, Z., Fakhri, M., ... & Omid, R. (2014). Nutritional knowledge, practice, and dietary habits among school children and adolescents. *International journal of preventive medicine*, 5(Suppl 2), S171.
6. Ruka, S., Kenji, T., Rie, A., Chuan-Jun, L., & Naotaka, S. (2005). Nutritional knowledge, food habits and health attitude of Chinese university students—a cross sectional study—. *Nutrition Journal*.
7. Wong, Y., Huang, Y. C., Chen, S. L., & Yamamoto, S. (1999). Is the college environment adequate for accessing to nutrition education: A study in Taiwan. *Nutrition Research*, 19(9), 1327-1337.

A Study on the Challenges of Middle Adulthood Years Especially Menopause

Sivakami P.*¹ and S. Kavitha Maithily²

¹ Seethalakshmi Ramaswami College (Autonomous), Tiruchirappalli - 620 002, Tamil Nadu, India

² Gandhigram Rural Institute (Deemed to be University), Gandhigram - 624 302, Tamil Nadu, India

Correspondence to: Sivakami P, Seethalakshmi Ramaswami College (Autonomous), Tiruchirappalli - 620 002, Tamil Nadu, India, Tel: +91 9943475975; E-mail: sivakamipm1985@gmail.com

Abstract

The phenomenon of studying middle age is relatively new. In fact, in 1900 the average life expectancy was 47 years. Between the ages of 35- 60 people in general and women in particular face lot of problems during the transitory age of middle adulthood years. During these days they undergo lot of physical and mental changes. Menopause is the major part of women in middle adulthood years. Menopause is a natural biological process not a medical illness although it's associated with hormonal physical and psychosocial changes in our life. Woman may spend as much as half of their life after menopause. So, a need is felt essential to understand the health problems of women in middle adulthood years and the treatment they have taken the study was carried out in Dindigul district. The data were collected from urban and rural area. Interview method was used to collect the data from the 100 respondents. Problems experienced during menopause reveals that both rural and urban women experienced one or other problem during their menopause, the problem experienced by rural women were more than that of urban women. Treatment undergone by women reveals that, rural respondents are seeking medical advice compare to urban respondents. Pre-mature menopause was noticed among rural women. Awareness needs to be created to seek medical and nutritional counseling during menopausal period. Government can take measures to fulfill the medical and nutrition needs of women in midlife.

Key words: Middle adulthood, Health, Menopause, Symptoms, Medical advice

Studying middle adulthood is a relatively recent phenomenon. In fact in 1900 the average life expectancy was 47 years. It has only been since and more people lived longer and longer that professionals became interested in studying life during this age period. Middle age is usually considered to occur approximately between the ages of 40 and 60. Midlife is a more critical period in the life cycle of women. The Indian women who face a multiple discrimination crosses the middle adulthood with stresses in various spheres like family life, health, occupation, poverty, hunger, etc., India, As adults, women get less health care than men. They tend to be less likely to admit that they are sick and they will wait until their sickness has progressed before they seek help. Women's health is harmed by lack of access to and the poor quality of reproductive services among the health problems of middle adulthood years. The most common health problems experienced during middle age are arthritis, asthma, bronchitis, coronary heart disease, diabetes, genitourinary disorders, hypertension (high blood pressure), mental disorders, and strokes (cerebrovascular accidents). All the women invariably have to bear the sufferings of menopause marks the end of female fertility.

Menopause has a natural place in the aging process of women in Sri Lanka, making the symptoms easier to handle. At

the same time, normalizing and ignoring menopausal symptoms, risk leading women to suffer in silence. Moreover, the detection of menopause-related health risks such as cervical and breast cancer may be ignored despite women's awareness of the importance of attending to menopausal symptoms and related-health risks. To make consistent and reliable information available about the developmental changes and challenges associated with menopause will be beneficial to women in Sri Lanka. This could be done by implementing community-based health centers led by nurses and/or midwives who could provide information about hormonal therapy, refer to a gynecologist, and thereafter facilitate follow-up and evaluation. Future research needs to bring together qualitative findings about the menopausal experiences of this population with quantitative data (Ilankoon *et al.*).

The menopause signals the end of a woman fertile life and results from decreasing production of sex hormones by the ovaries. It normally occurs between the mid-40s and late 50s. The hormonal changes associated with menopause can affect physical, emotional, mental, and social well-being. The symptoms experienced during and following the menopausal transition vary substantially from person to person. Some have few if any symptoms. For others, symptoms can be severe and

affect daily activities and quality of life. The problems faced by women during menopause are many and it is noticed worldwide. But the number of women who seek medical advice to this problem is very minimum in our country to cater the physical or psychological needs of this transitory stage (i.e.,) middle adulthood years of women.

Objectives

- (i) Know the personal profile of the respondents.
- (ii) Understand the common health problems noticed among the respondents.
- (iii) Identify the specific problems related to menopause.
- (iv) Understand the type of treatment undergone by the Women to alleviate the problem.
- (v) Give suggestions to women in middle adulthood years to cope up with menopause related problem.

MATERIALS AND METHODS

In general, middle adulthood is described as a “Time or Crisis It extends from 40-60 years, people in general and women in particular face s of problems during this transitory age. As women bear a triple burden of reproduction, production and domestic work, they also face a complexity of health problems. During these years, they undergo lot of physical and mental changes. In ‘Menopause the cessation of menstrual period for women, 75 percent of women experience some problem or discomfort. The health problems noticed among women during these years are many. So, a need is felt essential to understood the health problems of women in middle adulthood years and the treatment they have taken with this intention the study was carried out.

Area of the study

Dindigul district was chosen for the study. The data were collected from urban and rural area. Dindigul town and Nilakottai were the places elected for collecting information from urban and rural areas respectively. Investigator’s familiarity and proximity to this area were the Bain reasons for selecting this area.

Sample studied

One hundred women those who were in the age group of 40-60 years were purposively selected for the study among them 50 respondents were from urban area and another 50 were from rural area.

Table 1 Sample studied

Residential area	Respondents No
Rural	50
Urban	50
Total	100

Data collection procedure

Interview method was used to collect the data from the respondents. Interview method it may be seen as an effective, informal, verbal, non-verbal conversation initiated for specific purposes and focused on certain planned content area (Young, P.V.). Initial rapport was established with the women and the purpose of the study was explained to them. Their doubts were classified and then the interview was conducted.

Tools used

The interview schedule is the name usually applied to a set of questions which are asked and filled in by the investigator in a face to e situation with another person (Goode and Halt).

A pretested interview schedule given in Appendix I was used for collecting the data. Analysis and interpretation of the data. The data collected were edited, coded and tabulated, percentage was used for analysis.

RESULTS AND DISCUSSION

Personal profile of the middle adulthood women

The personal background of the respondents is tabulated in (Table 2).

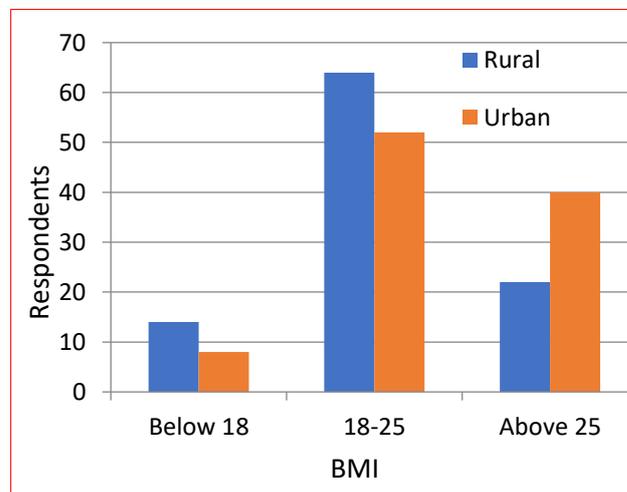
Table 2 Personal profile

Variables	Respondents	
Age (in years)	40-45	25
	45-50	20
	50-55	22
	55-60	27
	Total	100
Marital status	Married	89
	Unmarried	11
	Total	100
Educational status	Illiterate	32
	Primary	22
	Middle	30
	Higher Secondary	11
	Degree	5
Total	100	
Food pattern	Non - Veg	75
	Veg	25
	Total	100

The above table reveals the personal background of the respondents. One fourth of the respondents were in the age group of 40-45 years. 26 percent, 22 percent, 27 percent of the respondents are in the age group of 45-50 years, 50-55 years, 55-60 years respectively. 89 percent of the respondents were married and the rest unmarried. Around one third of the respondents were illiterates, 22 percent and 30 percent of the respondents had completed their primary and middle school education. Only five percent had entered into the tertiary education. Three fourth of the respondents were non vegetarian and the rest were vegetarian.

Health profile of the selected women

The health profile of the respondents is given below (Figure 1).



*BMI = Weight (kg). height² (m)

Figure 1 Health profile

The chart reveals the Body Mass Index (BMI) of the respondents. 64 percent of rural respondents and 52 percent of urban respondents BMI was in normal Range i.e., 18-25. Obesity was noticed more in urban area than in rural area.

Food pattern of the respondents

The food pattern of the respondents is tabulated in (Table 3).

*Variables	Consumption Pattern		
	Daily No	Weekly No	Occasionally No
Rice	100	-	-
Pulses/ grains	30	49	-
Vegetables	70	30	-
Greens	8	27	19
Fruits	3	5	49
Non - veg	5	10	30

*Multiple respondents

The above table reveals the food consumption pattern of the respondents. All the respondents had taken rice daily. But only 30 percent consumed pulses / grains daily and rest consumed pulses once in a week or twice in a week. The consumption of greens was still poor.

Health complaints of the Middle Adulthood Women

The health complaints of the respondents are tabulated in (Table 4).

*Health complaints	Respondents	
	Rural	Urban
Anaemia	46	28
Eye problem	24	12
Heart problem	16	18
Blood Pressure	14	30
Peptic Ulcer	14	6
Diabetes	10	12
Respiratory Problem	8	6
Goiter	8	10
Cancer	6	10
Piles	4	4

*Multiple responses

The table reveals the health complaints reported by women in middle adulthood years. In rural area, 46 percent of respondents were affected by Anaemia, 24 percent of respondents were affected by eye problem. In urban area, 30 percent of the respondents were affected by Blood pressure and 28 percent of respondents were affected by Anaemia. Anaemia and eye related problems were noticed more among rural women than urban women whereas blood pressure was found more among urban women than rural women.

Physiological symptoms experienced by the respondents

As the estrogen level drops, the blood vessels may expand rapidly, Cling the skin temperature to rise. Night sweats are often a consequence of hot flashes and the tissues lining the vagina and urethra opening to bladder becomes drier, thinner and decreased lubrication woman may experience burning or itching along with increased risk of infections in the urinary tract or vagina.

Physiological Symptoms experienced by the respondents are tabulated in (Table 5).

*Symptoms	Respondents	
	Rural	Urban
Hot flashes	52	20
Urinary frequency	50	28
Sweating	40	30
Sleep disturbances	28	24
Heavy bleeding	28	12
Urinary urgency	20	18
Urinary incontinence	14	10
White Discharge	12	24
Itching Vagina	8	18

*Multiple respondents

This table reveals the Physiological symptoms experienced by the respondents during menopause. In Rural areas the highest 52 percent of the respondents experienced hot flashes where as in urban areas 30 percent of respondents experienced Sweating. Even though both rural and urban respondents are experienced one or other symptoms during their menopause, the symptoms experienced by rural women were more than that of urban women.

Psychological symptoms experienced by the respondents

Woman may experience irritability, fatigue decreased memory and loosed concentration as the approach menopause. These symptoms have sometimes been attributed to hormonal fluctuations. Psychological Symptoms experienced by the respondents are tabulated in (Table 6).

*Symptoms	Respondents	
	Rural	Urban
Irritability	54	38
Decreased Libido	46	22
Memory loss	40	38
Depression	38	22
Lonely Feeling	30	12
In secured feeling	14	8
Mood disturbances	8	8

*Multiple respondents

This table reveals the psychological symptoms experienced by rural and urban respondents during the time of menopause. More than 50 percent of rural respondents and 38 percent of urban respondents experienced irritable feeling during cessation of menstrual cycle. Memory loss was reported by 40 percent of rural respondents and 38 percent of urban respondents. Experience of psychological symptoms was reported more by rural women than by urban women.

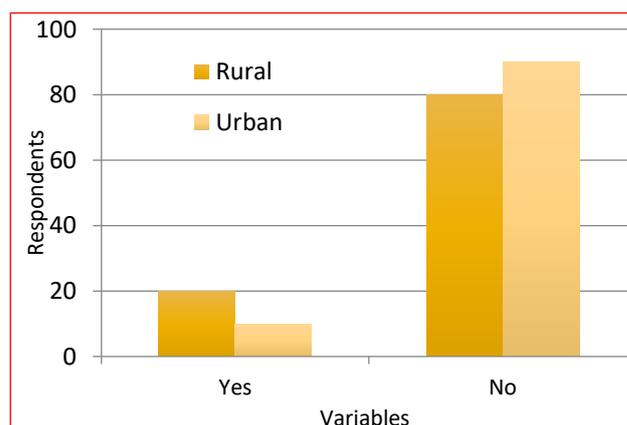


Figure 2 Treatment taken

Treatment taken for menopausal symptoms by the respondents

Treatment taken for menopausal symptoms by the respondents is given below the (Figure 2).

The chart reveals that treatment undergone by women reveals that, 20 percent of rural respondents and ten percent urban respondents had gone for treatment for the problems related menopause.

Table 7 Suggestions

*Symptoms	Respondents	
	Rural	Urban
Rest	58	28
Nutritious food	42	26
Medical Counseling	34	14
Support from family members	30	16
Recreation	22	12

**Multiple respondents*

Suggestions given by the respondents

Suggestions given by the respondents are tabulated in (Table 6).

The above table reveals the suggestions given by the women to overcome their problems the special needs of women during the menopause stage. 58 percent of respondents suggested for adequate rest. 42 percent of rural respondents and 26 percent of urban respondents suggested nutritious food. A crave for recreation was also noticed among 22 percent of rural and 12 percent of urban respondents.

CONCLUSION

Menopause is a painful period for both rural and urban women. Pre-mature menopause was noticed among rural women. Even though women experienced problems during menopause, all of them did not seek medical advice. Awareness need to be created among to seek medical and nutritional counseling during menopausal period Government can take measures to fulfill the medical and nutrition needs of women in midlife.

LITERATURE CITED

1. Burns, A August (1997) "Where Women Have No Doctor", USA. MacMillan Education Ltd. PA, 50.279-285
2. Harlock and Elizabeth B (1981). "Development Psychology A Life- Spain Approach, New Delhi Tata McGraw Hill Publishing Company Limited, pp.334-339
3. Jonhson (1981). "Sarup Dictionary of Diseases and Symptoms, New Delhi Sarup & Sons, Pp.289-290
4. Michard By Ellen (1995) Total Health for Women Pennsylvania Rodale Press, Inc. Pp.348
5. Row & Horper (1982) "Psychology", INC Horper & Row Publishers, P.50, 452
6. Selmon, AC (1976). "Health and Congevity". Poona Oriental Watchman Publishing House. Pp.279-285
7. Anand Meenir (Oct-Dec 2006), "Women's Link. Social Action Trust". Vol 12 pp. 4-6
8. Ms Friedli Lyure, (Sep 1999) Health Action, Women's Health Beyond Reproductive Care ISSN No 0970-471 Vol. 12. pp. 19-20.
9. Samarasinghe.K, I. M. P. S. Ilankoon et al (2021). Menopause is a natural stage of aging:a qualitative study. *BMC Women's Health*.

Incorporation of Powdered Jackfruit (*Artocarpus heterophyllus* Lam) Seed in Snacks for Juvenile Diabetes

Yamuna Valli S^{*1} and Vasantha Esther Rani²

¹Arul Anandar College (Autonomous), Karumathur, Madurai - 625 514, Tamil Nadu, India

²Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India

Correspondence to: Yamuna Valli S, Arul Anandar College (Autonomous), Karumathur, Madurai - 625 514, Tamil Nadu, India, Tel: +91 9092212315; E-mail: yamutharusundar@gmail.com

Abstract

Diabetic Mellitus is a chronic metabolic disorder. One in 10 people are suffering from diabetes. Tamil Nadu ranks second in Diabetes. Diabetes can be controlled by means of therapeutic food and healthy life style. One such functional food is Jackfruit (*Artocarpus heterophyllus* Lam) Seeds. They are rich source of protein and rich source of antioxidants and minerals. As the Jackfruit has bio-active components that maintains blood sugar are Beta carotene - 5, 6 Epoxide, Quercitrin and Glibenclamide. In this study we have formulated three products panyaram, Adai and laddoo by incorporating Jackfruit seed paste or powder. A low-cost food supplement that can be made at home has been formulated for the Juvenile diabetic children. Organoleptic evaluation was done for the products to know the better preferences. In Jackfruit seed Panyaram and Adai acceptable variation was 30g of Jackfruit seed incorporated products, whereas in Jackfruit seed laddoo the acceptable incorporation was 10g. Nutrient content of the selected product was analyzed; incorporated products shown to have higher nutritive value. Thus, it could be concluded that the Standardized product incorporated with jackfruit seed was therapeutic food product which provides essential nutrients, functional components and low-cost food supplement to combat *Diabetes mellitus*.

Key words: *Diabetes mellitus*, Jackfruit seed, Beta carotene - 5, 6 Epoxide, Quercitrin and Glibenclamide, Low-cost food supplements

Diabetes is largest prevalent condition caused due to impairment of Carbohydrate metabolism. Diabetes is the largest global emergency of this Century. According to WHO, about 422 million people worldwide are suffering from diabetes. People of low- and middle-income countries are more prevalent to this condition. International Diabetes Federation estimated that 72.9 million adult people in India were suffering with Diabetes in the year 2017. Rate of diabetes is more in urban areas due to change pattern of food, Life style, sedentary work and Improper diet and exercise leading to type 2 diabetes condition. It is estimated to be about 11.2 percent in urban areas. It is estimated to be increased to 134 million living with diabetes in 2045. (Leonor Guariguata, 2011). Nowadays, children below the age of 10 years are prevalent to such condition which is influenced by improper secretion of insulin. About 1.1 million of children are suffering from Juvenile diabetes. Presently, there are many synthetic oral hypoglycemic index doses, insulin doses and other herbal medicine to control diabetes. But, there are many natural and locally available foods that have anti-diabetic activity. They are hidden from the eyes of the people. There is increased demand for such products. One of such product is *Artocarpus heterophyllus* Lam. Seeds. (Md Amdadul Haque, 2019).

Jackfruit is the tropical fruit variety. Origin of the fruit is from Western Ghats of Tamil Nadu. In Tamil literature Jackfruit plays a major role as "Mukkani" – Ma, Pazha and Vazhai. (Prajakta Mandave *et al.*, 2018) Each part of Jackfruit is filled with many medicinal values like Bark, rind, rags, seeds can be used in treating many diseases. Jackfruit bark and rind can be used in treating dysentery and intestinal disorders. (Md Amdadul Haque, 2019) Almost 60% of seed and other parts have been dumped as waste. Based on researches, Jackfruit is a pack of many pharmaceutical properties namely – antidiabetic, antimicrobial, antioxidant properties. This can be helpful in preparing the low cost and easily affordable product for all economic groups. (Butool Shadab and Butool Masrath, 2015).

MATERIALS AND METHODS

In this study, three products were developed namely, Jackfruit seed panyaram, Jackfruit seed Adai and Jackfruit seed Laddoo in various proportions. Jackfruit seed paste and powder and incorporated in these products.

Procurement of Raw materials

Good quality seeds of *Artocarpus heterophyllus* were procured from nearby villages and vendors. Infected and spoiled seeds are sorted manually. Ingredients like Ragi flour, raw rice, black gram dhal, onion, carrot, cumin seeds, fenugreek and other ingredients were brought from local market. Steps in preparing Jackfruit seed paste and powder are:

- Jackfruit seed are allowed to be in open air for a day.
- Cleaning and sorting of seeds and then soaked for 5 minutes.
- Peel the outer coat and blanch it.
- To prepare the paste it is cooled and blended using mixer
- To prepare powder, the seed is dried in the cabinet dryer and made into powder

Jackfruit Seed Paniyaram preparation

Jackfruit seed paniyaram was prepared was prepared with three variations. Ingredients used were Paniyaram Batter (Raw rice, Black gram dhal, Fenugreek), Carrot, cumin seeds, chilli, coriander leaves and Salt. Prepare a batter using raw rice and black gram dhal, mix the batter with Jackfruit seed paste in different composition of 15g, 20g and 30g and add all other ingredients to the batter. Pour the batter in paniyaram loop and cook for 5 minutes.

Sensory evaluation was done for Jackfruit seed paniyaram by the trained panelist in Food Science and Nutrition lab of Fatima College using Hedonic rating test for all the three samples of with composition of 15g, 20g and 30g. Products were evaluated based on 6 attributes like colour, texture, taste, odour and overall acceptability. Then the selected sample was standardized.

Jackfruit Seed Adai preparation

Jackfruit seed Adai was prepared was prepared with three variations. Ingredients used were Ragi flour, Carrot, cumin seeds, chilli, coriander leaves and Salt. Firstly, prepare

the batter using Ragi flour and mix Jackfruit seed paste in different composition of 15g, 20g and 30g respectively. Add other ingredients in the batter, now it should be in pouring consistency. Use tava for preparing adai and cook it for 8 to 10 minutes.

Sensory evaluation was done for Jackfruit seed Adai by the trained panelist in Food Science and Nutrition lab of Fatima College using Hedonic rating test. Products were evaluated based on 6 attributes like colour, texture, taste, odour and overall acceptability. Then the selected sample was standardized.

Jackfruit seed Ladoo preparation

Jackfruit seed paniyaram was prepared was prepared with three variations. Ingredients used were Health mix (Ragi flour, whole wheat flour, Roasted Bengal gram flour) and powdered sugar. Sieved the wheat flour, ragi flour and blended roasted Bengal gram flour. Added 10g of brown sugar and mixed all the ingredients. Added powdered Jackfruit seed in different proportions of 7g, 10g and 15g and prepared ladoo.

Sensory evaluation was done for Jackfruit seed ladoo by the trained panelist in Food Science and Nutrition lab of Fatima College using Hedonic rating test for all the three samples of with proportions of 7g, 10g and 15g. Products were evaluated based on 6 attributes like colour, texture, taste, odour and overall acceptability. Then the selected sample was standardized.

The selected samples were analyzed for essential nutrients like Moisture, Energy, Protein, Fat, carbohydrates, Ash content, Vitamin A, Crude fibre, Iron, Phosphorus and qualitative analysis of Flavonoids, Phytosterols and polyphenols. The Microbial load of the sample is analyzed using the laminar air flow chamber. The microbial counts of formulated Jackfruit seed product was analyzed for Jackfruit seed Adai, Jackfruit seed Paniyaram, Jackfruit seed Ladoo were analyzed on the 0th day of preparation. The bacterial count estimated by using Nutrient agar.



Fig 1 JFSA



Fig 2 JFSP



Fig 3 JFSL

RESULTS AND DISCUSSION

The study was undertaken in three phases; Data interpretation and statistical analysis of Organoleptic evaluation, Nutrient analysis of selected variation and Microbial analysis of sample.

In organoleptic evaluation of the sample, there were three variations along with the control. For Jackfruit seed paniyaram, Kara paniyaram was taken as control, Jackfruit seed adai ragi roti was taken as control and for Jackfruit seed ladoo, health mix ladoo was taken as its control sample. The results of

the organoleptic evaluation have showed that, incorporated Jackfruit seed products have better acceptability. Proportion of Jackfruit was made as 15g, 20g and 30g. The acceptable proportion was 20g and 30g of Jackfruit seed pulp, whereas 15 g of Jackfruit seed pulp is less acceptable for Kara Paniyaram and Adai. Proportion of Jackfruit seed incorporated in Ladoo was 7g, 10g and 15g respectively. 10g of Jackfruit seed powder along with other ingredients scored the overall acceptability than the other proportions. Jackfruit seed products were organoleptically evaluated with three proportions along with control samples (Kara paniyaram, Ragi adai, Ladoo).

- 30g of Jackfruit seed incorporation scored high value in sensory evaluation of Jackfruit seed paniyaram and selected for further analysis.

- 30g of Jackfruit seed incorporation scored high value in sensory evaluation of Jackfruit seed Adai and selected for further analysis.

Table 1 Mean score of organoleptic evaluation of sample

Attributes	JFSP			JFSA			JFSL		
	(Amount of Incorporated Jackfruit seed Paste)			(Amount of Incorporated Jackfruit seed Paste)			(Amount of Incorporated Jackfruit seed Powder)		
	A	B	C	A	B	C	A	B	C
	(20g)	(30g)	(15g)	(30g)	(20g)	(15g)	(7g)	(15g)	(10g)
Appearance	8.01	8.65	7.87	8.51	8.15	7.87	8.22	8.37	8.49
Colour	8.25	8.58	8.14	8.25	8.28	8.14	8.27	8.55	8.62
Odour	8.42	8.86	8.24	8.42	8.36	8.24	8.33	8.36	8.34
Taste	8.18	8.42	7.23	8.18	8.22	7.23	8.35	8.28	8.45
Texture	8.26	8.44	8.02	8.26	8.04	8.02	8.50	8.44	8.67
Overall acceptability	8.29	8.60	7.95	8.29	8.01	7.95	8.49	8.62	8.87
Mean	8.23	8.59	7.90	8.31	8.17	7.90	8.36	8.43	8.57

10g of Jackfruit seed incorporation scored high value of sensory evaluation of Jackfruit seed Ladoo and selected for further analysis.

Jackfruit seed Paniyaram with acceptable proportion of 30 g of Jackfruit seed along with 60g of Paniyaram batter and 20g of other ingredients scored higher acceptability of 8.14%. Jackfruit seed Adai with acceptable proportion of 30 g of Jackfruit seed along with 60g of Ragi flour and 20g of other ingredients, scored a higher acceptability of 8.31%. Jackfruit seed Ladoo with acceptable proportion of 10 g of Jackfruit seed along with 80g of Health mix and 10g of other ingredients

(sugar) had a higher acceptability of 8.57%. Nutrient content of the selected variation was evaluated.

Nutrient content analysis

Jackfruit seeds are rich source of micronutrients. Certain nutrients like energy, carbohydrate, protein, fat, crude fibre, moisture content, ash content, iron, phosphorus and beta carotene were analyzed for selected sample of Jackfruit seed Paniyaram, Adai and Ladoo. The results are tabulated in Table 4.2 and 4.3

Table 2 NUTRIENT CONTENT OF INCORPORATED PRODUCTS AND ITS CONTROL

Nutrients	JFSP	Control	JFSA	Control	JFSL	Control
Energy (kcal)	253.75	278	329	294	339.5	380
Carbohydrate (g)	38.5	30.5	42.9	84.4	55.9	76
Protein (g)	0.9	1.7	0.5	1.6	9	9.8
Fat (g)	1.2	2.29	0	3.5	0	3.4
Moisture (%)	50.4	48.6	43.2	40.89	39	42
Ash content (%)	1	0.8	2.8	1.2	3	1.2
Crude fibre (%)	2.2	0.6	1.7	0.8	2.3	1.1
Iron (mg)	19.5	0.1	18.4	0.9	16.9	0.8
Phosphorus (mg)	560	36	576	89	592	86
Beta carotene (µg)	192.9	56	617	157.1	925.9	133

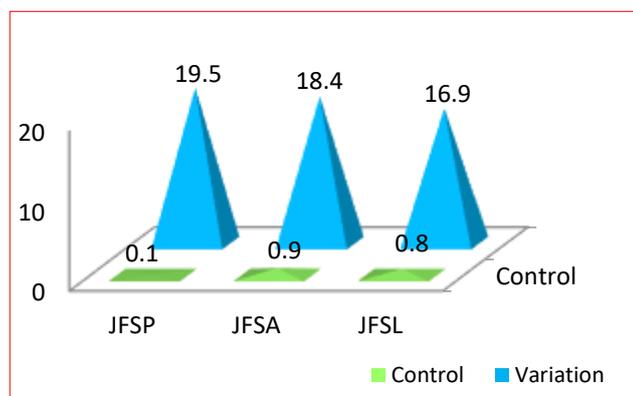


Fig 4 COMPARISON OF IRON CONTENT OF INCORPORATED PRODUCT AND CONTROL

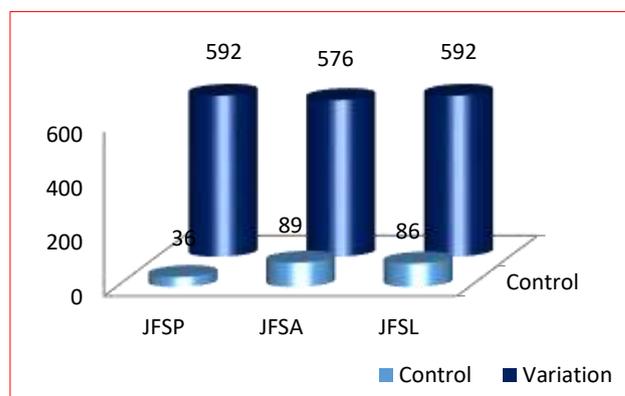


Fig 5 COMPARISON OF PHOSPHORUS CONTENT OF INCORPORATED PRODUCT AND CONTROL

Nutrient content of the all the formulated and standardized products were analyzed. Energy produced by Jackfruit seed products - Paniyaram, Adai and Ladoo were 253.75, 329 and 339.5 kilocalories respectively. Protein content present in Jackfruit seed products viz Paniyaram, Adai and

Ladoo were 0.9, 0.5 and 9 g respectively. Moisture content in Jackfruit seed products - Paniyaram, Adai and Ladoo were about 50.4%, 43.2%, 39% and micronutrients like Iron, Phosphorus and Vitamin A were analyzed. Jackfruit seed Paniyaram contains Micronutrient content viz Iron,

Phosphorus, Vitamin A of about 19.5 mg, 560 mg and 192.9 µg respectively. Jackfruit seed Adai contains micronutrient content - Iron, Phosphorus, Vitamin A of about 18.4 mg, 576 mg and 617 µg respectively. Jackfruit seed Ladoo contains micronutrient content - Iron, Phosphorus, Vitamin A of about 16.9 mg, 592 mg and 925.9 µg respectively.

Qualitative analysis

Qualitative analysis was performed for Flavonoid, Polyphenol and Phytosterols in the selected variation of the product. Analysis was done by using four different solutions namely, Distilled water, acetone, ethanol and chloroform. Results of qualitative analysis is displayed in (Table 4).

Table 3 Qualitative analysis of flavonoid, polyphenol and phytosterols

Solutions	Flavonoid		Polyphenol		Phytosterols	
	Observation	Inference	Observation	Inference	Observation	Inference
Distilled water	Formation of Yellow colour in the sample solution while addition of 10 N NaOH	Presence	Formation of Blue or green colour in the sample solution while addition of 10% Ferric chloride.	Presence	Formation of Red coloured ring on layer of H ₂ SO ₄ is observed	
Acetone	No changes	-	Formation of Blue or green colour in the sample solution while addition of 10% Ferric chloride.	Presence	Formation of Red coloured ring on layer of H ₂ SO ₄ is observed	Presence
Ethanol	Formation of Yellow colour in the sample solution while addition of 10 N NaOH	Presence	No changes	-	No changes	-
Chloroform	No changes	-	No changes	-	Formation of Red coloured ring on layer of H ₂ SO ₄ is observed	Presence

Microbial Load

Microbial Load of Bacteria was noted to analyze the keeping quality of the control and the selected variation of all the three products incorporated with Jackfruit seeds. The bacterial count (10⁻⁶ cfu/g) of selected variation of Jackfruit seed incorporated Paniyaram, Adai and Ladoo were 32, 40 and 16 respectively.

CONCLUSION

Now, in recent years, the researchers are focusing on waste utilization and developing the product that will be economical, easily affordable and ready -to- cook at home. As Jackfruit seeds have many health benefits and has excellent concentration of iron, which helps in preventing anaemia and other blood related disorders, more research is being carried out with Jackfruit seeds. It can also help in boosting immunity. It has higher antioxidant capacity and it can make skin glow and promotes better hair growth. It can lower the risk of heart diseases, prevents constipation and promotes weight loss. It is the best therapeutic aid, essential to develop a novel drug from the bio active components of the plant. It is suggested that

research should focus on the therapeutic potential of *Artocarpus heterophyllus* with the aim of producing it as a new therapeutic agent. Researchers should focus on economical products from locally available underutilized products for treating the degenerative diseases.

Recommendations

- India ranks 6th in patients with Diabetes. India is a developing country with maximum number of population under the category of low and middle economy. There is an urgent need to provide locally available, easy to process and low cost supplement to replace costly medicines.
- To increase marketing of *Artocarpus heterophyllus* products.
- Supplementation of value-added products for medical nutrition therapy.
- Nutritional awareness of the underutilized locally available products should be given to the public.
- “Know around you to treat your Illness” is a programme similar to that of “One Station One Products”. It can help people to know more about locally available food source and their benefits

LITERATURE CITED

1. Butool Shadab and Butool Masrath (2015). Nutritional Quality on Value addition of Jackfruit Seed Flour. *International Journal of Science and Research*, 4: 2406 – 2411. <https://www.ijsr.net/archive/v4i4/12041501.pdf>
2. Dwitriyanti D., Arcinthy R., Rachmania & Jihadudin Pahlevi., (2019). In Vivo Activities and In Silico Study of Jackfruit seeds (*Artocarpus heterophyllus*) on the Reduction of Blood sugar Levels of Gestational Diabetes Rate Induced by Streptozotocin. *Open Access Macedonian Journal of Medical Sciences*, 7(22). 3819 – 3826.
3. Guariguata L, Whiting D, Weil C, Unwin N. (2011). The International Diabetes Federation Diabetes atlas methodology for estimating Global and National prevalence of Diabetes in adults. *Diabetes Res Clin Pract*, 94(3), 322 – 332. <https://pubmed.ncbi.nlm.nih.gov/22100977/>
4. Haque Amdadul., Akter F. (2019). Jackfruit waste: A Promising source of Food and Feed. *Annals of Bangladesh Agriculture*, 23(1), 91-102. <https://www.researchgate.net/publication/337473709>
5. Haque Amdadul., Akter F. (2019). Jackfruit waste: A Promising source of Food and Feed. *Annals of Bangladesh Agriculture*, 23(1), 91-102. <https://www.researchgate.net/publication/337473709>
6. Mandave Prajakta et al. (2018). Jackfruit Seed flour: Processing technologies and application. *International Journal for Agricultural Engineering*, 11, 149-154. http://www.researchjournal.co.in/upload/assignments/11_149-154.pdf

Diet Diversity, Macronutrient Consumption and Self-Perceived Diet Adherence in Type-2 Diabetics

Sharmila JB^{*1}, Thahira Banu A² and Janeline Lunghar³

¹ Department of Home Science, Sri Meenakshi Govt. Arts College for Women, Madurai - 625 002, Tamil Nadu, India

²⁻³ Department of Home Science, Gandhigram Rural Institute, Dindigul - 624 302, Tamil Nadu, India

Correspondence to: Sharmila JB, Department of Home Science, Sri Meenakshi Govt. Arts College for Women, Madurai - 625 002, Tamil Nadu, India, Tel: +91 9566790040; E-mail: jbs2k2@gmail.com

Abstract

The evaluation of diet adherence in type-2 diabetics necessitates diet quality assessment tools. Studies related to Self-Perceived Diet Adherence (SPDA) and diet diversity among diabetics are rare. The study aimed at understanding the relationship between diet diversity, macronutrient consumption and SPDA in type-2 diabetics. The cross-sectional study was conducted at a tertiary hospital in a southern district of Tamil Nadu, India. A total of 166 type-2 adult (age >18 years) diabetic patients (92 female, 74 male) were enrolled for the study. Baseline characteristics, macronutrient consumption, diet diversity of the subjects were elicited through a pre-tested questionnaire. The SPDA questionnaire was developed and validated. The data were presented as descriptive statistics and compared using unpaired 't' test ($p < 0.05$). The mean Diet Diversity Score (DDS) of the participants is 5.9 ± 2.1 out of a maximum score of 12. The mean macronutrient consumption deviated from the ICMR guideline, with carbohydrate intake as high as 65.6 per cent. The overall SPDA scores were moderate (24.6 in male and 29.8 in female) with women having significantly better scores ($p < 0.001$).

Key words: Diet diversity, Macronutrient consumption, Self-Perceived Diet Adherence, Type-2 diabetes

Diabetes mellitus is a chronic metabolic disorder known to have a profound impact on life expectancy. Metabolic Syndrome (MS), a clustering of cardiovascular risk factors, including obesity, hypertension, dyslipidemia and hyperglycemia, is prevalent in most of the T2D patients and the co-existence of the two conditions increases the consequences of co-morbidities. Adherence to diet, medication and physical activity are the essential self-management behaviour recommended in diabetic care. Though diet counselling forms an essential component of routine diabetic care, diet adherence is regarded as an arduous task and the approach to evaluate diet behaviour of T2D patients based on simple, inexpensive and practical measures is limited. Further, a myriad of factors act as barriers to diet adherence in diabetic patients' in spite of adequate nutrition knowledge.

Dietary Adherence in Type-2 Diabetes

To optimize the management of diabetes, adherence to medication, diet and physical activity, enabled through lifestyle modification are advised. To ensure adequate adherence, the challenges faced by the individual in adhering to treatment plan have to be identified and alleviated. Non-adherence to diet and physical activity regimens in Type-2 Diabetes is common as reported by several studies reviewed by Mumu, Saleh, Ara, Afnan, & Ali (2014) and is attributed to many influencing factors such as age, duration of disease, socio-economic factors,

health beliefs and behaviours, and lack of adequate contact between the patient and healthcare providers. Several factors have been reported to be associated with non-adherence to diet in Type-2 Diabetes, namely, levels of education, socio-economic status, urban/rural area of living, occupation, material status, age, religious and cultural practices. In the STARCH study, (Joshi et al. 2014) reported that adherence to a prescribed diabetic diet plan was recorded as a "Yes" or "No" outcome, which could provide more useful information about the quality and quantity of carbohydrate consumed by the Type-2 Diabetics at various meals during a typical day.

Assessment of Dietary Adherence

Diet counseling targets behaviour modification and therefore, should be individualized and based/built on the individual's former diet. The quality of diet can be assessed using food recall or food records and food frequency questionnaires. However, these are cumbersome and time-consuming to be effectively used in clinical set up. Specific tools to measure dietary adherence and the barriers to dietary adherence need to be developed to facilitate easy validation and interpretation of diet quality and dietary adherence of Type-2 Diabetics (Hemiö et al., 2014). Many such short and specific diet quality questionnaires have been developed, however they are restricted to few nutrients such as intake of fat, intake of fruits & vegetables, etc. as pointed out by Hemiö et al. (2014).

They further validated a 16-point short, food intake questionnaire to estimate daily food and nutrient intake, based on the recommended daily food record as the reference method. This study on a Finnish population concluded that the food intake questionnaire could be useful as a tool to estimate nutrient intakes at group level and thereby facilitate monitoring of dietary adherence. Diet quality questionnaires assigning scores for each food group frequency and the total score depicting overall diet quality have been validated by Svilaas et al., (2002) and, Schröder, Vila, Marrugat and Covas (2008).

Asaad *et al.*, in 2015 developed and validated the Perceived Dietary Adherence Questionnaire (PDAQ) with a purpose to measure diabetic individuals' perceptions of their dietary adherence. A dietary assessment tool for Type-2 Diabetics should be simple to administer, easy to score, as well as reflect current recommendations for a diabetic diet.

Non-adherence to dietary recommendations is defined by Lim, Park, Choi, Huh and Kim (2009) as self-reported adherence of less than three days a week. On the contrary, WHO (2003) indicated that no single measurement strategy has been deemed optimal. A multi-method approach that combines feasible self-reporting and reasonable objective measures can set the record in measurement of adherence behaviour. Gómez-Donoso et al., (2018) created the Dietary Obesity-Prevention Score weighted the consumption of vegetables, fruits, legumes, yogurt, nuts, fish, and a ratio of vegetable to animal protein, whereas the consumption of red meat, processed meat, saturated animal fat, refined grains, ultra-processed food, sugary beverages, beer and spirits were inversely weighted. Energy-adjusted tertiles of each item were used to build the DOS, ranging from 14 (lowest adherence) to 42 points (highest adherence). It was reported that a higher adherence to a food-based score was significantly associated with lower risk of overweight/obesity and lower average annual weight gain.

Objective of the study

The study aimed to understand the relationship between the diet diversity, macronutrient consumption and Self-Perceived Diet Adherence (SPDA) of type-2 diabetic patients with Metabolic Syndrome (MS).

MATERIALS AND METHODS

The cross-sectional study was conducted at the outpatient department of a tertiary hospital in Madurai, a southern district of Tamil Nadu, India. A total of 166 type-2 adult (age >18 years) diabetic patients with MS (92 female, 74 male) were enrolled for the study after obtaining their informed consent and approval from the Institutional Ethical Committee.

T2D subjects were selected for the study based on the following criteria:

Inclusion criteria: Patients registered in the diabetic clinic and diagnosed with type-2 diabetes for at least one year, aged above 18 years, able to read the questionnaire in vernacular or English.

Exclusion criteria: Type-1 diabetic patients, Type-2 diabetic patients aged less than 18 years, having severe comorbidities, identified with cognitive impairment or psychiatric disorders, pregnant and lactating diabetics were excluded.

Baseline characteristics, anthropometric measurements, clinical and biochemical profile, diet diversity of the study volunteers were elicited through a pre-tested

questionnaire. Self-Perceived Diet Adherence (SPDA) was measured using a developed and validated questionnaire. All continuous data were presented as descriptive statistics and gender comparisons made using unpaired 't' test. The statistical significance was assumed at a p-value of <0.05. Pearson's correlation coefficient, independent t-test and Chi-square test were used to analyse the data.

Assessment of baseline characteristics: Anthropometric measurements which included height were measured using the stadiometer Model 220 (SECA, Germany) scale to the nearest 0.1 cm, whilst the body weight was measured using the Tanita UM-052 (Japan) scale to the nearest 0.1kg. Body mass index (weight/height²) was calculated based on a formula recommended by the World Health Organisation (2004). Waist circumference was measured using a non-elastic tape and Blood Pressure was measured using a sphygmomanometer. Measurements were taken twice and the average of the two readings was used in the data analysis. Dietary intake was assessed using 24-h diet recall. Nutrient intake was analysed using the DIETCAL software (Kaur, 2014) while the macronutrient intake was calculated based on individualised requirements according to RDA (ICMR, 2011) and Diet guidelines for Diabetics (API-JAPI, 2007).

Assessment of Diet Diversity Score

Diet Diversity Score is the number of different food groups consumed over a given period. To better reflect a quality diet, the number of different food groups consumed on household or individual level is calculated, rather than the number of different foods consumed. An average of four different food groups implies that their diets offer some diversity in both macro- and micro nutrients. This is a more meaningful indicator than knowing that individuals consume four different foods, which might all be cereals. The following set of 12 food groups is used to calculate the Diet Diversity: Cereals; Roots & Tubers; Pulses / legumes/ nuts; Vegetables; Fruits; Meat, poultry; Fish & seafood; Milk / Dairy products; Eggs; Sugars/sugar products, honey; Oil / fats; Condiments.

Development and Validation of the SPDA Scale

Adherence to diet is recommended as a non-pharmacological, behavioural and lifestyle modification and is projected as a self-care measure in diabetes management. However, a specific measure of diet adherence to facilitate assessment of diabetes self-management is limited. The investigator developed the Self-Perceived Dietary adherence (SPDA) scale based on the existing tools developed in the studies conducted in Canada and Ethiopia (Asaad et al., 2015); (Worku, Abebe, & Wassie, 2015).

Self-Perceived Dietary Adherence (SPDA) is the degree to which an individual perceives that he/she follows or adheres to the dietary recommendations made by qualified healthcare professionals.

Self-Perceived Dietary Adherence Scale scale is a simple and easy measure of adherence to dietary recommendations by an individual with Type-2 Diabetes Mellitus.

The SPDA measure was developed as a rating scale with an aim to provide a quick and easy tool to evaluate the level of dietary adherence as perceived by the Type-2 Diabetics and the associated barriers to their dietary adherence. An introductory question was added to ensure that the subjects had been given a personalized diabetic diet plan by the attending dietitian at the hospital. The subsequent questions were directed to identify the

subject's dietary adherence based on everyday choice of inclusion of food groups, carbohydrate spacing and the use of food exchange list in daily meal plan. The subjects had to rate each question according to their perception of dietary adherence on the given five point Likert scale. The options given were "Always", "Frequently", "Often", "Sometimes" and "Never" and a score was assigned to each option to quantify the measure.

The final version of the developed SPDA scale consisted of ten questions pertaining to the self-perception of Dietary Adherence by the individual Type-2 Diabetics. Each option was assigned to a score from one to five, which added up to a maximum score of ten to fifty for ten questions and a total score range of 10 to 50. The level of SPDA of each subject was classified based on the mean SPDA scores as 'poor' (<15), 'average' (≥ 15 to ≤ 30) and 'good' (>30). The SPDA scale was

thus developed to measure the level of dietary adherence of the Type-2 Diabetics. The SPDA measure was tested for reliability using Cronbach's Alpha. The overall value was 0.785, which well exceeds the minimum value of 0.70 (Bland and Altman, 1997). Thus, it can be concluded that the measure had an acceptable level of reliability. The data were coded and analyzed using SPSS software version 22.

RESULTS AND DISCUSSION

The profile of the selected T2D in terms of age groups, gender, number of family members, family income, educational status, lifestyle and dietary habits, anthropometry, biochemical profile, and DDS, macronutrient consumption and SPDA scores are presented in the following tables.

Table 1 Anthropometric and Biochemical components in the selected T2D patients

Parameters	Female (n=92)		Male (n=74)	P value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
Age (yrs)	50.78 \pm 11.66	53.77 \pm 11.39		0.099*
BMI (kg/m ²)	28.73 \pm 4.54	27.16 \pm 4.002		0.021*
Waist Circumference (cm)	96.75 \pm 9.84	81.34 \pm 9.81		P<0.001***
Blood Pressure Systolic (mmHg)	144.34 \pm 19.18	140.27 \pm 14.14		0.130
Blood Pressure Diastolic (mmHg)	87.80 \pm 11.30	87.00 \pm 10.84		0.643
Fasting Plasma Glucose (mg/dl)	188.90 \pm 61.50	198.22 \pm 66.52		0.352
LDL Cholesterol (mg/dl)	132.04 \pm 38.43	119.29 \pm 42.02		0.043
HDL Cholesterol (mg/dl)	38.68 \pm 5.03	33.51 \pm 2.95		P<0.001***
Triglycerides (mg/dl)	255.88 \pm 98.48	265.97 \pm 121.93		0.556

*p<0.05 - Significant , **p<0.01 and ***p<0.001 highly significant

The mean age of the subjects had a marginally significant (p=0.099) difference between genders, with a lower mean among women. Lower mean age of women indicates the incidence of diabetes at an earlier age in women. Similarly, a mildly significant difference (p=0.021) in BMI was noted between the male and female subjects. There was a highly significant difference (P<0.001) in the mean waist circumference and HDL cholesterol level between groups. The mean value for waist circumference of the male subjects was lower than the cut-off for men (>90cm). Women subjects had a higher mean for waist circumference and lower HDL level

when compared to men. This observation may highlight one of the reasons for higher propensity of MS in women. The mean values of parameters such as blood pressure, fasting plasma glucose and triglycerides were above normal levels and comparable between genders. However, the mean values of LDL cholesterol were lower in both genders.

Food frequency

The following table (Table 2) presents the dietary behaviour and food frequency of the Type-2 Diabetics with MS.

Table 2 Food Frequency Pattern of the Type-2 Diabetics with MS

Food groups	Frequency	Male (n=74%)	Female (n=92%)	Level of Significance
Cereals	Never	0	0	0.4
	Occasionally	0	0	
	Once a day	4(5.4)	8(8.7)	
	2-3 servings a day	30(40.5)	32(34.8)	
	4-6 servings a day	40(54.1)	52(56.5)	
Roots/Tubers	Never	37(50)	44(47.8)	0.7
	Occasionally	32(43.2)	42(45.7)	
	Once a day	4(5.4)	6(6.5)	
	2-3 servings a day	0	0	
	4-6 servings a day	1(1.4)	0	
Pulse/Seeds	Never	2(2.7)	0	0.5
	Occasionally	18(24.3)	26(28.2)	
	Once a day	30(40.5)	26(28.2)	
	2-3 servings a day	20(27.0)	39(42.3)	
	4-6 servings a day	4(5.4)	1(1.0)	
Greens/Veg	Never	0	0	0.8
	Occasionally	15(20.3)	14 (15.2)	
	Once a day	32(43.2)	44(47.8)	
	2-3 servings a day	23(31.1)	30(32.6)	
	4-6 servings a day	4 (5.4)	4(4.3)	
Fruits	Never	22(29.7)	22(23.9)	0.2
	Occasionally	43(58.1)	50(54.3)	

	Once a day	8(10.8)	12(13)	
	2-3 servings a day	1(1.4)	7(7.6)	
	4-6 servings a day	0	1(1.1)	
Meat	Never	40(54.1)	46(50)	
	Occasionally	32(43.2)	42(45.7)	
	Once a day	1(1.4)	3(3.3)	0.8
	2-3 servings a day	1(1.4)	1(1.1)	
	4-6 servings a day	0	0	
Sea Foods	Never	31(41.9)	44(47.8)	
	Occasionally	40(54.1)	44(47.8)	
	Once a day	1(1.4)	3(3.3)	0.6
	2-3 servings a day	2(2.7)	1(1.1)	
	4-6 servings a day	0	0	
Dairy	Never	0	0	
	Occasionally	2(2.7)	7(7.6)	
	Once a day	40(54.1)	46(50.0)	0.3
	2-3 servings a day	17(23.0)	26(28.3)	
	4-6 servings a day	15(20.3)	13(14.1)	
Egg	Never	25(33.8)	24(26.1)	
	Occasionally	46(62.2)	60(65.2)	
	Once a day	3(4.1)	6(6.5)	0.5
	2-3 servings a day	0	1(1.1)	
	4-6 servings a day	0	1(1.1)	
Jaggery/Sugar	Never	28(37.8)	37(40.2)	
	Occasionally	39(52.7)	53(57.6)	
	Once a day	7(9.5)	1(1.1)	0.0
	2-3 servings a day	0	0	
	4-6 servings a day	0	1(1.1)	
Oil/Ghee	Never	0	1(1.1)	
	Occasionally	8(10.8)	8(8.7)	
	Once a day	23(31.1)	41(44.6)	0.3
	2-3 servings a day	28(37.8)	28(30.4)	
	4-6 servings a day	15(20.3)	14(15.2)	
Spices	Never	0	1(1.1)	
	Occasionally	3(4.1)	11(12.0)	
	Once a day	22(29.7)	32(34.8)	0.2
	2-3 servings a day	35(47.3)	32(34.8)	
	4-6 servings a day	14(18.9)	16(17.4)	
Type and Frequency of snacks consumed				
Sweets / Desserts	Once a day	0	1(1.1)	
	Once in 2 days	0	0	
	Twice a week	0	0	
	Once a week	3(4.1)	1(1.1)	0.5
	Occasionally	10(13.5)	13(14.1)	
	Never	61(82.4)	77(83.7)	
Savouries	Once a day	2(2.7)	1(1.1)	
	Once in 2 days	17(23)	21(22.8)	
	Twice a week	9(12.2)	8(8.7)	
	Once a week	5(6.8)	4(4.3)	0.8
	Occasionally	4(5.4)	5(5.4)	
	Never	37(50)	53(57.6)	
Bakery items	Once a day	15(20.3)	20(21.7)	
	Once in 2 days	12(16.2)	21(22.8)	
	Twice a week	9(12.2)	8(8.6)	
	Once a week	4(5.4)	3(3.2)	0.5
	Occasionally	0	0	
	Never	34(45.9)	40(43.5)	

(*multiple responses) *p<0.05 - Significant, **p<0.01 and ***p<0.001 highly significant.

Almost all the subjects consumed cereals everyday out of which more than fifty per cent (54.1% male, 56.5% female) consumed four to six servings per day. Nearly one third of the subjects (40.5% male, 28.2% female) consumed pulses at least once every day, more than forty per cent consumed roots and tubers occasionally, while almost half the sub-sample never included it in their meal. Greens and vegetables were included

at least once a day by a simple majority (>42%) of the subjects. Fruits were included only occasionally by almost half the number of subjects (58.1% in male and 54.3% in female). Almost half the number of subjects never or occasionally consumed sea foods. Dairy products were consumed once a day (54.1% in male, 50% in female) or 2 to 3 servings a day (23% in male and 28.3% in female subjects). A sizable proportion of

the subjects avoided sugar/jaggery completely in their routine diet. Oils and spices formed part of their daily meal pattern. It may be noticed that nearly one third of the T2D subjects (29.7% male, 23.9% female) never consumed fruits and around 50 per cent of them consumed fruits only occasionally.

Although three-fourths of the subjects were non-vegetarians, nearly half of them completely avoided meat and seafood, while the remaining consumed it occasionally. Similarly, eggs were consumed only occasionally by a majority (62.2% male, 65.2% female) and avoided by one third of the Type-2 Diabetics with MS. Among the subjects, more than

eighty percent never consumed sweets/desserts, half of the subjects avoided savouries and a majority of subjects in both genders avoided bakery items. Bakery items were the most preferred snack in this population of Type-2 Diabetics.

Macronutrient Consumption

Dietary adherence in Type-2 Diabetes is reflected in the total calories and Macronutrient consumption of the Type-2 Diabetics with MS. The mean macronutrient consumption of the Type-2 Diabetics with MS are presented in (Table 3).

Table 3 Mean Macronutrient Consumption of the Type-2 Diabetics with MS

Particulars	*RDA	Male n=74	Mean difference	Female n=92	Mean difference	Total N=166
Calories (kcal/day)	25-30 kcal/IBW* 1200-2000 kcal#	2750.0±327.2	+ 751.3±54.1	2533.2±128.1	+ 521.2±33.9	2660.8 ±245.3
Carbohydrates (g/day)	180-300 g/day#	451.4±39.1	+ 143.7±12.1	416.0±28.1	+ 139.2±18.6	436.8 ±34.6
(% calorie)	55 – 60%*	65.6±3.9	+ 5.6±2.1	65.6±2.9	+ 5.6±2.0	65.6±3.1
Protein (g/day)	45 – 75 g/day#	83.1±9.8	+ 12.8±3.4	65.9±10.2	13.7±2.9	76.0±9.9
(% calorie)	12 – 15%*	12.0±1.9	3.2±0.9	10.4±2.1	4.0±0.1	11.4±1.5
Fat (g/day)	40 – 67 g/day #	67.8±01.9	4.9±2.0	68.8±2.1	6.2±1.3	68.2±2.0
(% calorie)	20 – 30%*	22.1±4.8	5.6±1.1	24.4±5.2	5.8±1.2	23.0±4.9
Dietary Fibre (g/day)	40 gm/day*	13.8±4.1	20±5.3	8.8±3.0	21.3±9.8	11.7±1.5

*ICMR Guidelines for Management of Type-2 Diabetes, 2018; # Calculated value

The mean intake of total calories exceeded the recommended level by 751.3kcal in male and 521.2kcal in female Type-2 Diabetics. Similarly, the calorie percentage from carbohydrate intake of the Type-2 diabetics was greater than the ICMR recommendations (55 to 60%) by 5.6 per cent in both male and female subjects. The difference was much pronounced in male subjects. Mean calorie percentage from protein intake was lesser in female Type-2 Diabetics (10.4%) than in male subjects (12.0%) according to the recommended calorie percentage. Mean calorie percentage from fat intake was within the recommended levels of 25 to 30 percent of total calories. However, the mean intake of macronutrients by the male and female subjects, based on the three-day recall, showed that carbohydrate intake in grams per day was greater (+143.7g in male, +139.2g in female subjects) than the calculated values derived from the guidelines. The intake of protein and fat was within the recommended range in both male and female subjects. The mean total protein and fat intake per day were 57.1g and 37.2 g respectively. The finding that the subjects consumed a greater proportion of calories from carbohydrates is supported by the findings of Joshi et al. (2014) and Mohan et

al., (2009). Both the studies report a higher percentage of carbohydrate intake in a south Indian population of Type-2 Diabetics and the adverse effect of high carbohydrate diet on glycemic control.

Thus, it can be noted that the macronutrient consumption of the subjects with MS deviated from the ICMR guidelines for Type-2 Diabetics by exceeding in total calorie consumption which was supplied by the excess carbohydrate consumption. Carbohydrate intake is directly linked to glycemic status in Type-2 Diabetes and therefore efforts should be taken to restrict the excess intake of carbohydrates and increase the intake of dietary fibre among the subjects.

Diet Diversity Score

The diabetic diet is often considered to be lacking in diversity which leads to dietary non-adherence. Therefore, testing the diet quality in the form of DDS throws light on the choice of food groups included by the subjects in their daily diet. The DDS of the selected Type-2 Diabetics with MS was elicited and presented in (Table 4).

Table 4 Diet Diversity Score of the Type-2 Diabetics with MS

Diet Diversity Score	Maximum score*	Male n=74	Female n=92	Total N=166
Mean Score	12	5.7 ±0.6	6.3 ±1.0	5.9 ±2.1
Classification of DDS Score				
Classification	DDS Range	n(%)	n(%)	n(%)
Poor	≤4	13(17.6)	8 (9.1)	21 (12.6)
Average	>4 to ≤6	58(78.5)	76 (82.8)	134 (80.8)
Good	>6	3 (3.9)	8 (8.6)	11 (6.6)

Source: Compiled from primary data *(FAO, 2010)

The mean DDS was slightly raised in the female (6.3±1.0) Type-2 Diabetics with MS compared to male (5.7 ±0.6) subjects. The scores reflect a moderate diversity in the daily diet of the Type-2 Diabetics with MS. The unsatisfactory macronutrient consumption with high carbohydrate intake is reflected in the low DDS derived from excess cereal consumption as noted from the food frequency data. This

finding may be linked to the various barriers faced by the Type-2 Diabetics. Restricted servings of refined cereals, and increased intake of dietary fibre through increased consumption of three to four servings of fruits and vegetables every day are proven to improve the metabolic state in type-2 diabetes.

SPDA scores

SPDA measure was developed as a qualitative tool to assess the dietary behaviour of the Type-2 Diabetics which was correlated with quantitative dietary assessment, based on

macronutrient analysis of a 24 hour food recall and use of food frequency to derive Diet Diversity Score. Table 5 presents the mean SPDA scores and DDS of the Type-2 Diabetics with MS.

Table 5 Mean scores of SPDA and DDS of the Type-2 Diabetics with MS

S. No.	Details of Dietary Adherence	Max Score	Mean Scores	
			Male (n=74)	Female (n=92)
1	Plan ahead everyday meals	5	2.0	2.7
2	Follow meal time schedule	5	2.1	2.2
3	Use of food measure or portion size	5	1.1	2.0
4	Use of food exchanges to plan diet	5	1.2	2.1
5	Inclusion of low GI foods in daily diet	5	1.5	2
6	Inclusion of whole grains in daily diet	5	3.2	3.1
7	Inclusion of vegetables and greens in daily diet	5	4.1	4.2
8	Inclusion of fruits in daily diet	5	4.0	3.2
9	Limit, avoid/restrict sweets in diet	5	3.2	4.2
10	Feeling hungry or deprived	5	2.0	3.1
	Overall SPDA	50	24.6±2.2	29.8±2.2
	Mean Diet Diversity Score	12	5.7±0.6	6.3±1.0

The mean individual score for each item in the questionnaire is presented in the above table and it is noted that both the male and female Type-2 Diabetics scored well (4.1 and 4.2 respectively) for inclusion of vegetables, followed by intake of fruits (4.0 and 3.2 respectively) and whole grains (3.2 and 3.1). Use of food exchange, food measures and portions, and low GI foods received low scores. Planning the meal ahead and keeping up to the meal schedule also received poor scores. The poor scores indicate non-adherence to planning diet ahead, reluctance to use food measures and food portions to control intake, avoidance of the use of food exchanges to have flexibility and choice in the diabetic diet and the inability to identify low GI foods that have a direct impact on glycemic status.

The overall mean SPDA scores of the male and female Type-2 Diabetics were moderate (24.6 in male and 29.8 in female Type-2 Diabetics with MS) with women scoring slightly better than men which was statistically significant ($p < 0.001$). Bano et al., (2017) reported poor dietary practices and Khattab, Abolfotouh, Khan, Humaid, & Al-Kaldi, (1999) projected 60 per cent dietary compliance among Type-2 Diabetics in

different settings. Similarly, the mean DDS was between five and six, out of a range of 1 to 12. Women scored slightly better DDS than male Type-2 Diabetics with MS.

Table 6 presents the overall SPDA scores and gender comparisons of the independent, demographic determinants among the T2D patients with MS, selected for the second phase of the study. It is observed that the mean SPDA scores were slightly higher among female subjects, especially in the age groups, 61 to 80 years (31.00±2.08) and 21 to 40 years (30.2±3.60) when compared to the middle age group of 41 to 60 years (29.40±2.29) and the differences showed mild statistical significance ($p < 0.05$). Earlier, Worku et al. (2015) stated similar findings of poor diet adherence among 47.50 per cent of T2D patients of 30 to 60 years and 60.30 per cent of those subjects above the age of 60 years. The male T2D patients with MS had comparably lower SPDA scores across age classification, against the female T2D patients with MS. However, a similar trend was noticed among the female subjects of the present study, and the lower SPDA scores among the 41 to 60 age group can be attributed to their preoccupation with their career or household chores.

Table 6 Overall SPDA scores with demographic data of the selected T2D patients with MS

Parameters	Female		P-Value	Male		P-Value
	With Mets (n=92)			With Mets (n=74)		
	n	Mean±SD		n	Mean±SD	
Age						
<20 years	0	0		1	26.00±0	
21-40 years	18	30.20±3.60	0.05	6	24.10±2.50	0.850
41-60 years	60	29.40±2.29		44	24.90±2.30	
61-80 years	14	31.00±2.08		23	25.00±2.02	
Marital status						
Unmarried	0	0		2	24.50±2.10	
Married	89	29.80±2.20		69	24.60±2.26	0.995
Widowed	0	0	0.914	1	25.00±0	
Divorced	2	30.50±3.54		0	0	
Separated	1	30.00±0		2	25.00±1.40	
Family members						
<= 4 members	42	30.12±2.20	0.272	29	24.30±2.26	0.256

>4 members	50	29.60±2.29		45	24.90±2.16	
Family type						
Joint	66	29.80±2.23	0.857	44	24.55±2.24	0.543
Nuclear	26	29.70±2.32		30	24.80±2.17	
Religion						
Hindu	66	29.88±2.20		57	24.60±2.21	
Muslim	13	29.70±2.20		10	25.60±1.70	0.136
Christian	13	29.70±2.50	0.958	7	23.40±2.51	
Others	0	0		0	0	
Education						
Illiterate	0	0		0	0	
Primary	0	0		0	0	
Middle school	9	29.50±3.01		9	25.00±2.29	0.613
Higher secondary	9	29.50±2.40	0.877	6	23.60±1.03	
UG/PG	15	29.60±1.90			11	24.60±2.50
Professional	59	29.90±2.24		48	24.80±2.26	
Occupation						
Unemployed	20	29.30±2.31		1	22.00±0	
Unskilled	2	29.30±2.81		24	24.75±1.92	
Semi-skilled	2	31.00±1.41		3	22.00±1.73	0.136
Skill work	4	30.70±1.71		0	0	
Clerical/farmer/shop owner	14	30.70±1.67	0.402	16	25.00±2.22	
Semi professional	17	29.40±2.60		10	24.30±2.21	
Professional	23	30.40±1.89		20	25.20±2.37	
Monthly Income						
6362-10602	11	30.40±2.11		5	23.60±2.51	
10603-15904	47	29.40±2.19		33	25.30±2.24	0.093
21207-42412	21	30.80±1.89	0.074	22	23.90±1.63	
>=42413	13	29.30±2.67			14	24.90±2.54
Socio economic Status						
Lower	0	0		0	0	
Upper lower	23	29.10±2.44		15	24.50±2.17	0.956
Lower middle	24	30.40±2.17		21	24.50±2.20	
Upper middle	39	30.00±2.17	0.407	32	24.81±2.15	
Upper	6	30.50±2.17		6	24.83±3.12	

Marital status, religion, type of family, number of family members and educational status had no significant statistical association with SPDA, similar to the findings of Worku et al. (2015). The SPDA scores of both male and female T2D patients slightly differed across the types of occupation and socio-economic status, however, the differences were statistically negligible ($p=0.136$ in males and $p=0.402$ in females).

Barriers to Dietary Adherence

Adherence to diet is a huge challenge faced by Type-2 Diabetics which may be attributed to several reasons. The developed SPDA scale elicited the various barriers to dietary adherence as identified by the subjects. Table 7 and Figure 1 depict the findings on the barriers to dietary adherence as experienced by the subjects.

Table 7 Barriers to Dietary Adherence reported by the Type-2 Diabetics with MS

Barriers to diet adherence	Male (n=74%)	Female (n=92%)	Level of significance
Food Expense	17 (22.9)	34 (36.9)	<0.0***
Inadequate portion size	16 (21.6)	6 (6.5)	<0.0***
Inadequate family support	23 (31.1)	19 (20.7)	0.1
Confusion about foods included/avoided	54 (73.0)	24 (26.1)	<0.0***
Difficulty during special occasions	17 (23.0)	24 (26.1)	0.6
Lack of time to plan ahead	36 (48.6)	18 (19.6)	<0.0***
Lack of knowledge about role of diet in diabetes	0	0	1
Feeling hungry/fatigued	10 (13.5)	25 (27.2)	0.0*
Unable to identify low GI foods	4 (5.4)	47 (51.1)	<0.0***
Craving for sweets or refined carbohydrates	23 (31.1)	16 (17.4)	0.0
Difficulty when traveling / eating out	30 (40.5)	18 (19.6)	0.0**
Difficulty in choosing healthy snacks	20 (27.0)	48 (52.1)	<0.0***
Lack of interest/motivation	52 (70.2)	59 (64.1)	<0.0*

* $p<0.05$ - Significant, ** $p<0.01$ and *** $p<0.001$ highly significant (multiple responses)

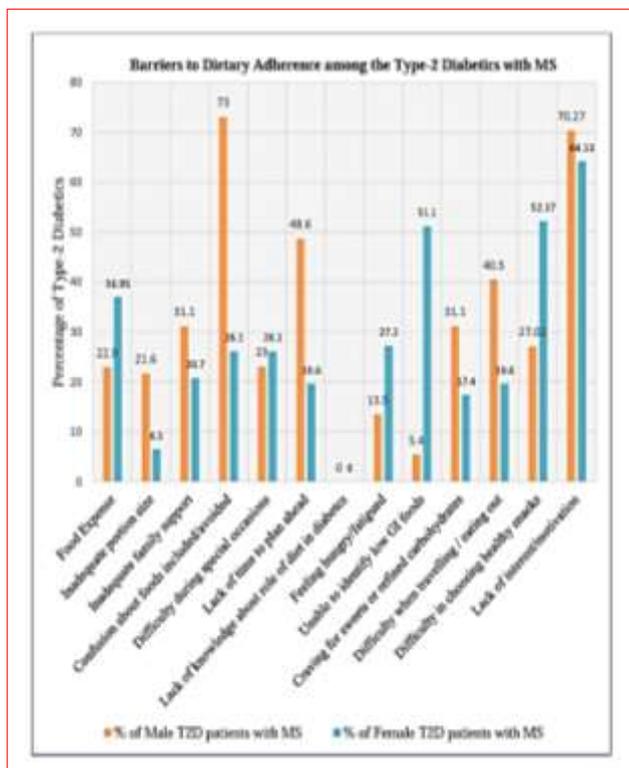


Figure 1 Barriers to Dietary Adherence reported by the Type-2 Diabetics with MS

Among the various barriers mentioned by the subjects, lack of interest or motivation was most often quoted (70.2% in male and 64.8 per cent in female subjects). Seventy-three per cent of the male and 26.1 percent female Type-2 Diabetics with MS, respectively reported confusion about foods to be included/avoided. The other most commonly quoted barriers for diet adherence among the male Type-2 Diabetics were lack of time to plan the diet ahead (48.6%), difficulty when traveling or eating out of home (40.5%), inadequate family support

(31.1%), and inadequate portion size (21.6%), while female subjects quoted difficulty in choosing healthy snacks (52.1%), inability to identify low GI foods (51.1%), food expense (36.9%), difficulty during special occasions (26.10%) and confusion about foods to be included/avoided (26.10%).

Similar barriers were reported by Worku et al., (2015) in a study at Ethiopia among Type-2 Diabetics. They observed that the barriers reported by the Type-2 Diabetics were food likes and dislikes (22.0%), appetite variations (22.0%), forgetting to plan diet ahead (18.0%), practical constraints such as food cost, lack of family support, travel days and eating out (19.0%) and health associations including quality of life (19.0%). The above-mentioned barriers to dietary adherence may have contributed to the unsatisfactory DDS and SPDA of the Type-2 Diabetics with MS.

Relationship between SPDA scores and MS parameters

It may be noted that a larger proportion of male Type-2 Diabetics with MS expressed barriers to Dietary Adherence as compared to the female counterparts. The difference between the percentage of male and female subjects who reported the barriers was statistically significant ($p < 0.001$) as shown in Table 8, which may have a bearing on the lower SPDA scores of the male subjects. It may be derived that the quantitative and qualitative methods of assessing Self-Perceived Diet Adherence provides a better understanding of the dietary behaviour, adherence and diet practices of the Type-2 Diabetics with MS.

Strength of the study

In this study, the SPDA measure was developed as a qualitative tool to assess the dietary behaviour of the T2D patients which was correlated with quantitative dietary assessment, based on macronutrient analysis of a 24 hour food recall and use of food frequency to derive Diet Diversity Score. Assessment of diet adherence is the need of the hour to plan effective diabetes self-management behaviour to attain health outcomes among the T2D patients.

LITERATURE CITED

1. API-JAPI. (2007). API-ICP Guidelines on Diabetes 2007. Journal of Association of Physicians of India, 55. Retrieved from www.japi.org
2. Asaad, G., Sadegian, M., Lau, R., Xu, Y., Soria-Contreras, D. C., Bell, R. C., & Chan, C. B. (2015). The Reliability and Validity of the Perceived Dietary Adherence Questionnaire for People with Type 2 Diabetes. *Nutrients*, 7, 5484–5496.
3. Bano, A., Afzal, M., Sarwar, H., Waqas, A., Kousar, S., & Gulzar, S. (2017). Dietary knowledge, Attitude and Practices of Diabetes Patients at Services Hospital Lahore. *International Journal of Applied Sciences and Biotechnology* (Vol. 5). <https://doi.org/10.3126/ijasbt.v5i2.17625>
4. Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *BMJ*, 314(7080), 572–572. <https://doi.org/10.1136/bmj.314.7080.572>
5. Gómez-Donoso, C., Martínez-González, M. A., Gea, A., Murphy, K. J., Parletta, N., & BesRastrollo, M. (2018). A food-based score and incidence of overweight/obesity: The Dietary Obesity-Prevention Score <https://doi.org/10.1016/j.clnu.2018.11.003> (DOS). *Clinical Nutrition*.
6. Hemiö, K., Pölonen, A., Ahonen, K., Kosola, M., Viitasalo, K., & Lindström, J. (2014). A simple tool for diet evaluation in primary health care: validation of a 16-item food intake questionnaire. *International Journal of Environmental Research and Public Health*, 11(3), 2683–97. <https://doi.org/10.3390/ijerph110302683>
7. ICMR. (2011). DIETARY GUIDELINES FOR INDIANS-A Manual (2nd editio). Hyderabad. Retrieved from <http://ninindia.org/DietaryGuidelinesforNINwebsite.pdf>
8. Joshi, S. R., Bhansali, A., Bajaj, S., Banzal, S.S., Dharmalingam, M., Gupta, S., Joshi, S.S. (2014). Results from a dietary survey in an Indian T2DM population: a STARCH study. *BMJ Open*, 4(10), e005138. <https://doi.org/10.1136/bmjopen-2014-005138>
9. Kaur, G. (2014). DietCal. Retrieved February 27, 2019, from <http://dietcal.in/>
10. Khattab, M. S., Abolfotouh, M. A., Khan, M. Y., Humaid, M. A., & Al-Kaldi, Y. M. (1999). Compliance and control of diabetes in a family practice setting, Saudi Arabia. *Eastern Mediterranean Health Journal*, 5(4), 755–765. Retrieved from

https://www.researchgate.net/publication/11997872_Compliance_and_control_of_diabetes_in_a_family_practice_setting_Saudi_Arabia

11. Lim, H.-M., Park, J.-E., Choi, Y.-J., Huh, K.-B., & Kim, W.-Y. (2009). Individualized diabetes nutrition education improves compliance with diet prescription. *Nutrition Research and Practice*, 3(4), 315–22. <https://doi.org/10.4162/nrp.2009.3.4.315>
12. Mohan, V., Radhika, G., Mohan Sathya, R., Paranjothi Tamil, S., Ganesan, A., & Sudha, V. (2009). Dietary carbohydrates, glycaemic load, food groups and newly detected type 2 diabetes among urban Asian Indian population in Chennai, India (Chennai Urban Rural Epidemiology Study 59). *British Journal of Nutrition*, 102, 1498–1506. <https://doi.org/10.1017/S0007114509990468>
13. Mumu, S. J., Saleh, F., Ara, F., Afnan, F., & Ali, L. (2014). Non-adherence to Life-style Modification and its Factors Among Type 2 Diabetic Patients. *Indian Journal of Public Health*, 58(1). <https://doi.org/10.4103/0019-557X.128165>
14. Schröder, H., Vila, J., Marrugat, J., & Covas, M.-I. (2008). Low Energy Density Diets Are Associated with Favorable Nutrient Intake Profile and Adequacy in Free-Living Elderly Men and Women. *The Journal* <https://doi.org/10.1093/jn/138.8.1476>
15. Svilaas, A., Ström, E. C., Svilaas, T., Borgejordet, A., Thoresen, M., & Ose, L. (2002). Reproducibility and validity of a short food questionnaire for the assessment of dietary habits. *Nutrition, Metabolism, and Cardiovascular Diseases : NMCD*, 12(2), 60–70. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12189905>
16. WHO. (2003). Evidence for action World Health Organization 2003. Retrieved from https://www.who.int/chp/knowledge/publications/adherence_full_report.pdf
17. Worku, A., Abebe, S. M., & Wassie, M. M. (2015). Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia. *SpringerPlus*, 4(15), 1–8. <https://doi.org/10.1186/s40064-015-0785-1>

Assessment of Nutritional and Fitness Status of Adolescent Sports Girls

Rajiga R^{*1}, Manjuladevi M² and Sharmila JB³

^{1,3} Sri Meenakshi Govt Arts College for Women (A), Madurai - 625 002, Tamil Nadu, India

Correspondence to: Rajiga R, Sri Meenakshi Govt Arts College for Women (A), Madurai - 625 002, Tamil Nadu, India, Tel: +91 9791783067; E-mail: rajiga.july.friday@gmail.com

Abstract

Sports nutrition is the application of nutrition knowledge to providing the fuel for physical activity, repair and rebuilding process, optimizing athletic performance and promoting overall health and wellness. Young girls involved in sports have increased nutrient demands for performance before, during and after practices. Energy bars are used as energy sources during athletic events like marathons, triathlon and other outdoor activities. The study presents information on the personal, socio-economic status, lifestyle habits of the selected adolescents, to assess the nutritional status, physical performance and to standardize the developed low-cost energy bar to popularize among the selected adolescent girls. The study population comprises adolescent college going girls, in the age group of 17 to 21 years. The energy bar was developed from indigenous foods such as millets, peanuts, coconut oil and local fruits. The nutrition composition was calculated and method of preparation was standardized. The present study has led to the findings that the adolescent college going sports girls had medium to poor nutritional and fitness status. This may be attributed to the poor food habits of the respondents. The energy bar was well accepted by the sports girls.

Key words: Adolescent sports girls, Sports nutrition, Energy bar

Sports nutrition is a specialization within the field of nutrition that is closely related to the study of the human body and exercise science. It is the application of nutrition knowledge to a practical daily eating plan focused on providing the fuel for physical activity, facilitating the repair and rebuilding process following hard physical work, and optimizing athletic performance in competitive events, while also promoting overall health and wellness (Fink&Mikesky 2015). The foundation of optimizing health, performance and training adaptations through nutrition is a well-balanced, energy sufficient diet that meets energy and nutrient demands. In general fitness and health, nutritional needs can be met by adherence to a well-balanced diet (Richard, 2019). Nutrition plays a central role in adaptation, rehydration, refueling and repair as well as recovery from injury (Bagchi, 2013).

Energy is crucial that athletes meet their energy needs during the hard periods of training in order to achieve improvements in performance and maintain good health. Failure to consume sufficient energy can result in muscle loss, reduced performance, slow recovery, disruption of hormonal functions (Anita Bean, 2013). Nutrition is important for an athlete because it provides energy required to perform the activity. The food they take leaves an impact on strength, training, performance and recovery. Not only the type of food is important for sport nutrition but also the time is equally important for what they eat throughout the day. It also has an impact on their performance level and their body ability to recover after workout (Indoria and Singh, 2016).

Meals eaten before and after exercising have an immediate effect on an athlete's body. They are said to be an important source of nutrition for them. Indeed, the athletes should eat 2 hours before exercising, which should include more carbohydrates and less fats as well as proteins. Proteins are intended to gain muscle mass and should be avoided in excessive quantities before a sportsman's performance. It is the carbohydrates that work as the major source of power for preparing athletes to carry out their sports activity or even exercises. On the other hand, protein is needed for muscle repair that can be taken after the sports activity has been finished (KheloMore, 2019).

Drinking fluid during exercise is necessary to replace fluids lost in sweat. This action will reduce the risk of heat stress, maintain normal muscle function, and prevent performance decreases due to dehydration. As dehydration increases, there is a gradual reduction in physical and mental performance (Sport Dietitian, 2009).

The nutritional requirements of adolescents are influenced primarily but on the set of puberty and the final growth rate is accompanied by increased needs for energy, protein, vitamins and minerals. Adolescent females are at high risk for nutritional inadequacies, nutritional status of adolescent girls remains of concern because of low dietary intake and marginal level of calcium iron and folic acid. Adolescent female athletes in sports emphasize leanness, research indicates that energy and nutrient intake are generally well below the recommended dietary allowances (MC Donald et.al., 2011).

Millet as a source of carbohydrates and B group vitamins improve the functioning of the nervous system, additionally has alkalizing properties, making it easier to maintain the acid balance. It also has iron, but low availability not exceeding 10 percent, has large amounts of the amino acid tryptophan affecting the level of serotonin and thus improves mood (Mizera, 2019). The United Nations General Assembly at its 75th session in March 2021 declared 2023 the International Year of Millets. FAO is the lead agency for celebrating the year in collaboration with relevant stakeholders. Millets can grow on aired lands with minimal inputs and are resilient to climate change. It will be an opportunity to raise awareness of direct policy attention to the nutritional and health benefits of millets and their suitability for cultivation under adverse and changing climatic conditions (FAO, 2022).

Objectives of the study

1. To obtain information on the personal, demographic, socio-economic and lifestyle habits of the selected adolescent sports girls.
2. To assess the nutritional status and physical performance levels of the selected adolescent sports girls.
3. To standardize the developed low cost energy balls to popularize among the selected adolescent sports girls.

MATERIALS AND METHODS

In the initial phase of the research, the research design of the study was planned and is presented as follows.

Selection of the sample

A sample of 40 sports students were selected from Meenakshi College for the purpose of the study. The area selected for the present study was Sri Meenakshi government Arts College for women (autonomous), Madurai district of Tamil Nadu. The selection of this area was based on the convenience sampling technique. The particular college was chosen for the convenience of assessment and monitoring process.

Selection of the respondents

The sample was selected based on purposive sampling in such a way that the sample population were adolescent college students from our institution. The size of the sample selected should neither be excessively large, nor too small; it should be optimum; an optimum size is one, which fulfills the requirement and flexibility. Hence, in a total of adolescent sports 40 girls were selected.

Tools for Data Collection

A well-structured interview schedule was formulated to assess the nutritional status of the selected sports adolescent girls and the schedule was pre-tested.

Assessment of personal and anthropometric measurement

The data was collected on the baseline characteristics, anthropometric measures and dietary behavior of the selected subjects. Such as education, and family income were elicited from the selected subjects.

The dietary behavior of the selected subjects was assessed using the questionnaire and information on the diet pattern (vegetarian / non vegetarian), number of meals per day, frequency and type of snacking, food frequency pattern, diet consumption over 24 hours recall of previous day's menu were obtained.

The searcher measured the anthropometric parameters of each participant of the study which included height, weight and waist circumference (WC), Body weight was measured to the nearest of 0.1kg with the participant wearing light clothing and without footwear using digital OMRON weighing scale, Height was measure nearest to 0.1cm with the participant standing erect, without footwear, using a stadiometer. Body mass index (BMI) was calculated using weight and height measure in metric units (kg/m²) waist circumference was measured to the nearest 0.1cm at the lateral lower ribs and the iliac crest, when the participant stood in abduction after moderate expiration.

Assessment of Physical Performance

(a) Push up test

The push up test is usually used to measure upper body endurance. In this, the client takes the push up position, men on hand and toes and women on hands and knees. The number of pushups they can perform correctly is counted. The test is concluded when the client cannot maintain from or complete another repetition. The scores of the client are interpreted in comparison with published norms in testing manuals (Srilakshmi, 2018).

(b) Vertical jump test

The vertical jump test is used to assess muscle power and is one of the objective measurements used to determine the athlete's progress in a training program. In this test the athlete stands next to a wall and fully extends an arm over the head and reaches the highest position, fingers fully extended and palm facing the wall while standing flat-footed. This spot is marked on the wall. Next the athlete performs a counter movement wherein the athlete bands his /her knees into a squat position and jumps as high as possible touching the wall at the peak height of the jump. The spot is then marked and the difference between the marks is the vertical jump height. Usually 3 jumps are performed with a difference of 15-30 seconds between the jumps. The highest jumps should be recorded. Commercial apparatus are now available to assess vertical jump height. Leg power is determined using the following equation.

$$\text{Leg Power (kgm/s)} = 2.21 \times \text{wt in kg} \times \sqrt{\text{vertical jump (m)}}$$

(c) Sit-up test

The YMCA sit and reach test is easy to perform and requires only a yard meter stick and does not need any special equipment. The protocol for the sit and reach test is as follows:

1. A yard stick is placed on the ground and a piece of tape is placed perpendicular to the yard / meter stick.
2. The subject sits on the floor with legs extended and the heels of the feet placed on the taped line approximately 10-12 inches apart.
3. With hands together and the arms extended the subject then reaches forward as far as possible along the yard stick without bending the knees and holds this position for a few seconds. The legs should remain extended and the knees should not bend.
4. The score is recorded as the distance the subject reaches. Three trials are typically performed with the best score of the three trials representing the subject's level of flexibility.

Table 1 Constituents of the low-cost energy ball

Ingredient	Quantity(g)	Cost (Rs)
Ragi	100	10.00
Groundnuts	50	10.00
Palm jaggery	50	30.00
Total	200	50.00

Development of the energy ball.

The development of ragi energy balls using low-cost foods made by locally available ingredients and to provide high energy value, such that the energy requirements are met out by sports girls. The products were also kept for sale in our college exhibition. It is shown in (Table 1).

RESULTS AND DISCUSSION

The personal details and nutritional status of the respondents are discussed. In (Table 2) personal data of the respondents reveals that 35 respondents (87.5%) were in the age group of 17 -20 years followed by 12.5 per cent in 21 -22 years. 47.5 percent of the respondents were living in rural areas while the rest (52.5%) in urban localities.

Table 2 Personal data of the respondents

S. No	Details	N=40	Percentage
1.	Age		
	17-20	35	87.5
	21-22	5	12.5
2.	Locality		
	Rural	19	47.5
	Urban	21	52.5
3.	Family Types		
	Joint	13	32.5
	Nuclear	27	67.5
4.	Family Income/month (Rs)		
	<30,000	7	17.5
	31,000-75,000	31	77.5
	>75,000	2	5

There were significant associations ($p < 0.05$) between sports club participation and: all demographic characteristics; all measures of family and peer support; and access to sport-related felicities. Highest levels of participation were associated with parents employed, and high levels of parental assistance, engagement and support (Rochelle *et al.* 2013). Out of the total number of 40 subjects, 67.5 percent belonged to nuclear families and 32.5 percent were in joint families. Table 2 reveals that 17.5 percent of the respondents belonged to the monthly family income of < 30,000 per month followed by 77.5 per cent in the lower middle class with 31,000 – 75,000 followed by 5 percent of the respondents belonging to >75,000 per month.

Table 3 BMI of the respondents

BMI	N=40	Percentage
Underweight <18.4	15	37.5
Normal 18.5-22.9	17	42.5
Overweight 23-24.9	7	17.5
Obese >25	1	2.5

The distribution of the selected athletes according to BMI classification recommended for women by ICMR (2008). It is evident from (Table 3) that a majority (42.5 percent) of the selected respondents were in the normal range of body mass index namely 18.4 to 22.9. The study shows that the prevalence of underweight in adolescent girls was 28% by having the body mass index less than 18.5kg/m² and 5.2% were at risk of obesity (Wolde, et.al., 2014). Study Shows that BMI for age out of 200 adolescents 13 percent were wasted followed by being overweight (8.5%). The rest of the adolescents (78.5%) were found to be normal (Varsha Rani, 2017). Among the respondents, 42.5percent were in the normal range and the remaining 17.5 percent of the respondents had a body mass index in the range of 23 – 24.9 percent.

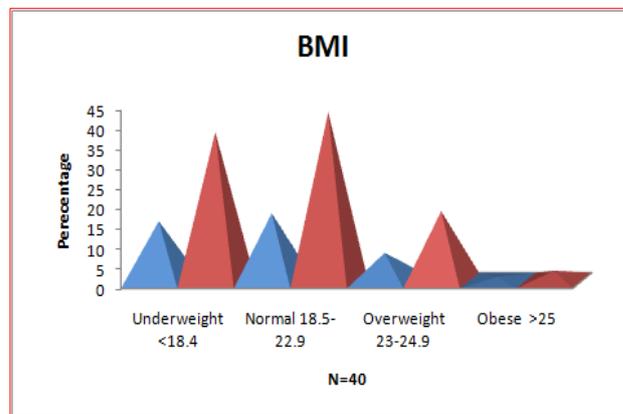


Fig 1 BMI of the respondents sample adolescent girls

Dietary habits of the respondents

Nutrient requirements are increased during sports and athletic performance. Good nutrition is essential as physical activity, athletic performance and recovery from exercise are enhanced by optimal nutrition (Benardot, 2011).

Table 4 Skipping meals of the respondents

Skipping meals	N=40	Percentage
Breakfast	24	60
Lunch	16	40
Dinner	0	0

It is evident from (Table 4) that skipping of meals namely breakfast was rampant among 60 per cent of the athletes. This was followed by 40 percent of the respondents who had the habit of skipping their lunch. The study shows that skipping meals a few times a week was associated with abnormal weight, special attention should be paid to promoting increasing the physical activity of teenagers (Wadolowska *et al.*, 2019). A study by Goyal and Talwar (2020) in Haryana, India, indicated that 94.2 percent of adolescent girls had three meals per day. However, another study by Alavi *et al.* (2013) shows that 48.4 percent of the participants skipped breakfast which is lower than the number of sports girls skipping breakfast in our study group. Breakfast skipping is also frequently associated with productivity and cognitive performance for adolescents (Hoyland *et al.* 2009). None of the respondents preferred consumption of supplements.

Table 5 Consumption of supplements by the respondents

Supplements	N=40	Percentage
Yes	0	0
No	40	100

Table 6 Water consumption (per day) of the respondents

Water consumption (per day)	N=40	Percentage
<1 litre	4	10
1-2 litre	24	60
2-3 litre	12	30

The results revealed that only nine per cent consumed one litre, 14 percent consumed two litres, 52 per cent consumed three litres and 24 per cent had four litres of water daily. During exercise it is necessary to recover the fluid which is lost in sweat, because even a low dehydration of 2% of body weight can significantly affect the athlete. The loss of every 0.5kg of body weight as a result of exercise is a waste of about 500ml of fluids and consumption of the same amount is required for the preservation of hydration, thus fluid intake during exercise

should keep up with fluid loss through sweating (Okanović *et al.* 2014).

Hydration plays an important role in the performance, injury prevention recovery for athletes engaged in competitive sports. Results demonstrated that 97.3% (n=287) of the respondents knew that dehydration would decrease physical performance (Judge *et al.* 2021). Table 6 shows the hour of practice hours per day of the respondents. Most of them (97.5 percent) come under > 2 hours of routine practice per day and the remaining had 1 to 2 hours / day of practice hours.

Table 7 Practice hours per day of the respondents

Practice hours / day	N=40	Percentage
< 1 hours	0	0
1 to 2 hours	1	2.5
> 2hours	39	97.5

Physical Fitness of the respondents

Physical activity is any bodily movement produced by skeletal muscles that result in energy expenditure. Exercise that is planned, structured, repetitive and purposeful with the aim to improve or maintain one or more components of physical fitness, including muscular endurance, strength and power, body composition, flexibility and balance (Regina *et al.* 2019).

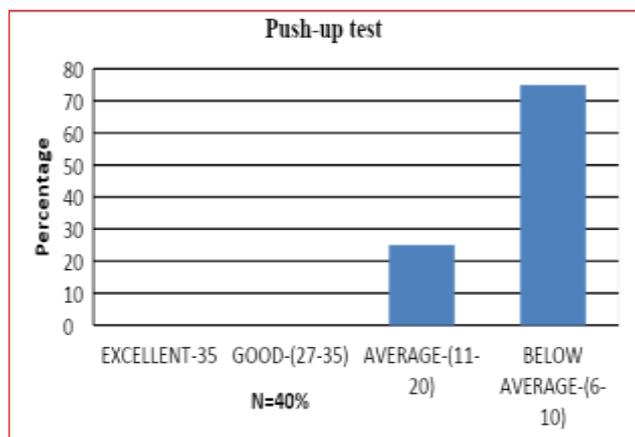


Fig 2 Push-up test of the sample adolescent sports girls

Table 8 Push-up test of the respondents

Push-up test	N=40	Percentage
Excellent (>35)	0	0
Good (27-35)	0	0
Average (11-20)	10	25

Tests for muscular endurance by floor push – up revealed in (Table 8) indicate that 25 percent of the subjects had average results. The high capacity of the respondents to repeat contractions and show evidence of having fast twitch muscle fibers, Rest of the (75 percent) were not able to show good results thus came under below average category. The results of study indicate that participating in sports training has a positive effect on knowledge of physical activity and sports. Training according to the capabilities of adolescents showed the significant level of low physical activity is also caused by a lack of financial resources or friends (Oja and Piksoot, 2022).

Table 9 Vertical jump test

Vertical jump test (cm)	N=40	Percentage
Above average (41-50)	10	25
Normal average (31-40)	30	75
Below average (21-30)	0	0
Poor (11-20)	0	0

Table 9 shows results of the vertical jump test that is categorized into four sections. Based on this category, 75 percent of the respondents scored in the normal or average range and the rest (25 percent) of them were in the above average level.

In (Table 10), none of the respondents showed the normal range of sit-up performance. Performances that were below average and poor levels were shown by the few of the respondents (7.5 and 2.5 per cent) respectively. A majority of (90 per cent) of the respondents had very poor sit - up performance.

Table 10 Sit-up test of the respondents

Sit-up test (count)	N=40	Percentage
Normal (29-32)	0	0
Below average (25-28)	3	7.5
Poor (18-24)	1	2.5
Very poor (>18)	36	90

Sensory Evaluation

Ragi is nutritionally almost better than wheat or rice. Proteins are prolamins and gluten ins and have all essential amino acids rich in minerals especially calcium, fibre and contain B vitamins but are poor in B₂. Flour from puffed ragi has good flavor and can be used in snacks and supplementary foods (Srilakshmi, 2015).

Peanuts are one of the richest dietary sources of biotin, magnesium, niacin, copper, oleic acid, and multiple antioxidants, such as resveratrol (Atli Arnarson, 2019). By using these ingredients, ragi nutriball was developed with locally available ingredients.

In a study by Priya and Kowsalya (2015), pearl millet, finger millet, and sorghum convenience food mixes were formulated by incorporating green gram, roasted Bengal gram and groundnut. Nutritional and shelf-life evaluation was carried out. From the mixes, three breakfast and three snacks were prepared and sensory evaluation was done. The mean energy content of the mixes were in the range of 388.09 kcal - 372.35 kcal, pearl millet based mix contains iron content 7.78 mg and zinc content of 3.01 mg and calcium content of ragi based mix was 284.78 mg. The importance of formulating convenience mixes by incorporating malted millets with pulses and nuts which would result in micronutrient-rich mixes which will serve as a sustainable solution to solve the problem of hidden hunger.

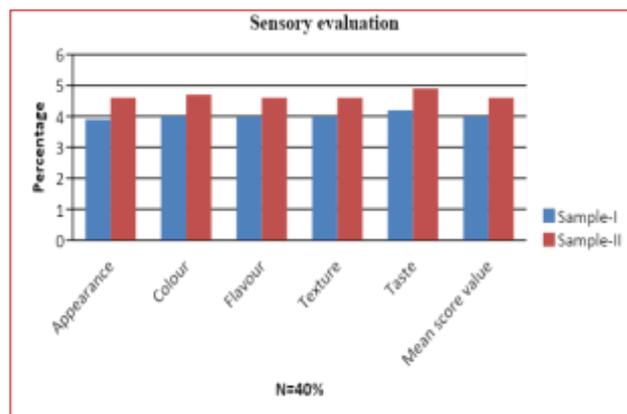


Fig 3 Sensory evaluation of the prepared sample energy ball

A ready to eat nutrient bar was developed using locally available ingredients such as bajra flakes, dates, dates syrup, grated coconut, pumpkin flesh, gum, almonds and flax seeds.

Two variations were developed S1 with bajra flakes and S2 with jowar flakes and accepted by the panel members but the mean score was highest for S1 (8.16, 7, 8.14, 7.82, 8.36, 8.4) when compared to S2 (8.02, 8.02, 8.12, 7.64, 8.2, 8.3) using 9 point hedonic scale (Bhargavi *et al.* 2022).

From (Table 11), sensory evaluation of the low-cost energy balls indicates that there is a variation between sample I and II. In sample I, the raw ragi flour was used to prepare the energy ball. The mean score for appearance was 3.9, the score for colour, flavour and texture was 4 each and the taste score

was 4.2. The product made in sample II, through a variation in ragi flour roasted indicates the sample energy ball can be successful. Results depict that mean value of flavour and texture are 4.6, 4.7 for colour and the final taste score was 4.9. The sample-II products are accepted by the respondents which had the best mean score of 4.6.

Nutritive value of the energy ball depicts that the presence of macro nutrients is Energy 124 kcal, Carbohydrate 13g, protein 2.15 and fat gives 2.125 g. These are the values calculated for one energy ball (20g).

Table 11 Sensory evaluation of the energy ball

Ratio	Appearance	Colour	Flavour	Texture	Taste	Mean score value
Sample-I	3.9	4	4	4	4.2	4
Sample-II	4.6	4.7	4.6	4.6	4.9	4.6

Table 12 Nutritive value of the energy ball

Ingredients	Carbohydrate (g)	Protein (g)	Fat (g)	Calcium (mg)	Energy (kcal)
Ragi (10g)	7.2	0.73	0.13	34.4	32.8
Ground nut (5g)	1.33	1.31	1.99	3.85	28.5
Palm sugar (5g)	4.23	0.11	0.005	62.6	62.35
Total (20g)	12.76	2.15	2.125	100.85	123.65

Thus, the above study shows that adolescent sports girls in colleges have a poor nutritional status, moderate food patterns and low physical performance. If the low-cost energy dense food products such as the developed millet based energy balls is popularized, energy needs of the sports girls can be met.

CONCLUSION

The study was conducted in a Government Arts College in Madurai district of Tamil Nadu. A total of 40 adolescent sports girls were selected. A well-structured interview schedule was formulated to assess the nutritional status of the selected sports adolescent girls and the schedule was pre-tested. The data was collected on the baseline characteristics, anthropometric measures and dietary behavior were done, physical fitness such as, push up test, vertical jump test, sit up test were assessed, developed and popularized the millet-based energy ball among the adolescent girls. The collected data was consolidated, tabulated, analyzed and interpreted by using Excel database, and using Microsoft word.

The findings of the study

- The number of college students who participated in the study were 40.
- Majority (87.5%) were in the age group of 17 -20 years
- Majority of the respondents belonged to the nuclear family.
- 45 per cent of the respondents were in the normal reference height and the remaining 40 per cent came under >150 cm.
- Majority of the respondents have snacking habit
- 60 percent of the respondents were taken electrolytes and glucose water was consumed during the break in the middle of the game. 20 percent of the subject's preferred consuming bananas.
- 36 percent of the athletes drank 3-2 liters of water. Only 10 per cent drank 1 liter of water per day.
- Among the selected respondents 60 percent of them drank 2 to 1 liter whereas 36 percent of the athletes drank 2-3 litres of water. Only 10 per cent drank less than 1 litre of water per day.
- Most of them (97.5 percent) come under > 2 hours of routine practice per day and the remaining had 1 to 2 hours / day of practice hours.

- Tests for muscular endurance by floor push – up test indicate that 25 percent of the subjects had average results. The high capacity of the respondents to repeat contractions and show evidence of having fast twitch muscle fibers, Rest of the (75 percent) were not able to show good results thus came under below average category.
- Vertical jump test results that are categorized into four sections. 75 percent of the respondents scored in the normal average range and the rest of the 25 percent of them were taken above average level.
- Sit-up performance below average and poor levels of performance shown by the respondents of 7.5 and 2.5 per cent respectively. A Majority of (90 per cent) of the respondents shows very poor sit - up performance.
- The table of food frequency patterns reveals that out of 40 respondent's states that 77.5 percent were consumed in the formation of cereal food thrice in a day The food frequency of pulses indicates that 52.5 percent of the respondents were taken once in a day Out of 40 respondents 50 percent consumed vegetable patterns frequently 25 percent of the respondents at once a day. The largest fruit choices taken at occasionally were as 50 percent of the respondents, 12.5 percent taken both of once a day Egg and animal foods are largely consumed by frequently 55 percent of the respondents Intake of dairy products 37.5 percent if the respondents once a day, 25 percent at twice a day Fats and oil consumption taken of the respondents comes under the category of 55 percent thrice a day and the remaining 45 percent were as twice a day.
- Sensory evaluations indicate there is a variation between sample I and II. In sample I, the raw ragi flour which was used to prepare the energy ball. Sample II, though a single variation in ragi flour would be roasted and added. So the sensor's taste results indicate the sample II energy ball can be successfully accepted by the respondents which was the best mean score of 4.6.

The conclusion is that the majority of the adolescent girls belonged to the nuclear type of family. BMI percentiles scores show that most of them are underweight. The mean foods intake patterns of the adolescent girls were lower than the Recommended Food Allowances. The fitness status shows that

the majority of the girls have poor fitness levels. The millet-based energy balls were developed and popularized among the

adolescent's girls that insist them to utilize the low-cost millets and foods, to overcome malnutrition.

LITERATURE CITED

1. Alavi, M., Eftekhari, M. B., Noot, R., Rafinejad, J., &Chinekesh, A. (2013). *Global Journal of Health Science* 5(5).
2. Anita bean, The Complete Guide to Sports, seventh edition, 2013, Bloom berry ISBN-10: 140817457X, ISBN-13: 978-1408174579
3. AtliArnarson, P. (2019, May 7). Agriculture Education News | Agriculture Jobs | Agriculture Education Abroad | Ag Food News | Crop Cultivation | Agriculture Crop Information |Agri Farming <https://www.indiaagronet.com/indiaagronet/crop%20info/groundnut.htm>
4. Bagchi, D., Nair, S., & Sen, C. K. (2013). Preface. *Nutrition and Enhanced Sports Performance*, xv-xvi. <https://doi.org/10.1016/b978-0-12-396454-0.00061-8>
5. Benardot, D. (2011). *Advanced sports nutrition*. Human Kinetics Publishers.
6. Best Sports Flooring Products and Services in India|Multi Sport Activities flooring|Indoor and outdoor Sports Flooring|GoSportz. <https://www.gosportz.in/importance-of-nutritinon-for-sports-people.php>
7. Bhargavi M, Veena BM, Sushma BV (2022). Macromolecules and Sensory quality studies on millet-based formulation in context to elite athletic performance. *International Journal for Research Trends and Innovation*, 8(8). Retrieved from <https://ijrti.org/viewpaperforall.php?paper=IJRTi2206056>
8. Eime, R. M., Harvey, J. T., Craike, M. J., Symons, C. M., & Payne, W. R. (2013). Family support and ease of access link socio-economic status and sports club membership in adolescent girls: A mediation study. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1), 50. <https://doi.org/10.1186/1479-5868-10-50>
9. Fink, H. H., &Mikesky, A. E. (2013). *Practical applications in sports nutrition*. Jones & Bartlett Publishers.
10. Food and Agriculture Organization of The United Nations – Sustainable Development Goal 2022
11. Goyal, P., &Talwar, I. (2020). Assessment of Nutritional status and its correlates among adolescent girls of Haryana, India. *Annals of pediatrics and Child health*, 8(10).
12. Hoyland, A., Dye, L., & Lawton, C. L. (2009). A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutrition Research Reviews*, 22(2), 220-243. <https://doi.org/10.1017/s0954422409990175>
13. Indoria, A., & Singh, N. (2016). Role of nutrition in sports: a review. *Indian J Nutr*, 3(2), 1-6.
14. Judge, L. W., Bellar, D. M., Popp, J. K., Craig, B. W., Schoeff, M. A., Hoover, D. L., Fox, B., Kistler, B. M., & Al-Nawaiseh, A. M. (2021). Hydration to maximize performance and recovery: Knowledge, attitudes, and behaviors among collegiate track and field throwers. *Journal of Human Kinetics*, 79(1), 111-122. <https://doi.org/10.2478/hukin-2021-0065>
15. McDonald, R. E., Avery, D. R., & Dean, J. A. (2011). Preface. McDonald and Avery Dentistry for the Child and Adolescent, ix. <https://doi.org/10.1016/b978-0-323-05724-0.50003-5>
16. Millet - Types of millets, health benefits, Glossary (Kambu, Thinai, Saamai, Varagu, Kuthiraivali, ragi). (2022, November 26). Chitra's Food Book. <https://www.chitrasfoodbook.com/2014/07/milletstypes-of-milletshealth.html?m=1>
17. Mizera, J., &Mizera, K. (2019). *Sports nutrition handbook: Eat smart. Be healthy. Get on top of your game*. VeloPress.
18. Noll, M., Rodrigues, A. P., &Silveira, E. A. (2020). The health-related determinants of eating pattern of high school athletes in Goiás, Brazil. *Archives of Public Health*, 78(1). <https://doi.org/10.1186/s13690-020-0396-3>
19. Oja, L., &Piksööt, J. (2022). Physical activity and sports participation among adolescents: associations with sports-related knowledge and attitudes. *International Journal of Environmental Research and Public Health*, 19(10), 6235.
20. Okanović, Đ., Ilić-Udovičić, D., Džinić, N., &Jokanović, M. (2014). Importance of water in sportsman nutrition. *Quality of Life (Banja Luka) - APEIRON*, 9(1-2). <https://doi.org/10.7251/qol1401068o>
21. Priya, S. S., Kowsalya, S. (2015). Formulation and evaluation and convenience food mixes from malted millets. *Int. Jr. Sci. Research*.
22. Regina Belski, Adrienne Forsyth, EvagelineMantzioris. (2020). Nutrition for sport, exercise and performance. *ISBN -13*, 1-5. <https://doi.org/10.4324/9781003116592>
23. Richard B. Kreider FACSM FISSN FNAK. (2019). *undefined*. Lulu.com.
24. SDA - Sports Dietitians Australia. <https://www.sportsdietitians.com.au/wp-content/uploads/2015/04/Fluids-in-sport.pdf> , Fact Sheet- Fluids in Sports, June 2009
25. Srilakshmi. B Food Science Sixth Multi Colour Edition New Age International Publication ISBN-13:978-81224438093 ISBN-10: 81224438091 Page No-49 and 50 1 January 2015.
26. Srilakshmi. B, Suganthi.V and Kalaivani Ashok. C Exercise Physiology and Fitness and Sports Nutrition, New Age International, ISBN-10: 8122440983 ISBN-13: 978-8122440980Published 1 January 2016.
27. Varsha Rani, N. R. (2017). Dietary diversity in relation to micronutrient adequacy in the diets of adolescents of Fatehabad Haryana, India. *International Journal of Current Microbiology and Applied Sciences*, 6(9), 302-310. <https://doi.org/10.20546/ijcmas.2017.609.038>
28. Wadolowska, L., Hamulka, J., Kowalkowska, J., Ulewicz, N., Gornicka, M., Jeruszka-Bielak, M., Kostecka, M., &Wawrzyniak, A. (2019). Skipping breakfast and a meal at school: Its correlates in adiposity context. Report from the ABC of healthy eating study of Polish teenagers. *Nutrients*, 11(7), 1563. <https://doi.org/10.3390/nu11071563>
29. Why sports nutrition is important for a sportsperson. (2020, March 17). *KheloMore*. <https://blog.khelomore.com/why-sports-nutrition-is-important-for-a-sportsperson/>
30. Wolde, T., Amanu, W., Mekonnin, D., Yitayin, F., Abu, F., Dufera, F.&Ejeta, E. (2014). Nutritional status of adolescent girls living in Southwest of Ethiopia. *Food Science and Quality Management* 34: 58-64.

Molecular Docking Study of Lignans Obtained from Flax Seeds for their Role in the Management of Polycystic Ovarian Syndrome (PCOS)

Jeyamani Divya Christodoss^{*1}, Raamapriya V² and Vasantha Esther Rani³

^{1,2}Loyola College (Autonomous), Chennai - 600 034, Tamil Nadu, India

³Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India

Correspondence to: Jeyamani Divya Christodoss, Loyola College (Autonomous), Chennai - 600 034, Tamil Nadu, India, Tel: +91 9841866964; E-mail: divyajc@loyolacollege.edu

Abstract

Since women's health revolves around her reproductive health, a healthy lifestyle coupled with adequate reproductive health knowledge and awareness are important for the maintenance of satisfying and fruitful life of women's physical, mental, and social well-being globally. Polycystic ovarian syndrome (PCOS) is a heterogeneous metabolic disorder often diagnosed in adolescent and premenopausal women. It is manifested through variable degrees of ovarian and adrenal hyperandrogenism along with chronic anovulation. PCOS is frequently accompanied by symptoms of hirsutism, acne vulgaris and metabolic disorders such as obesity and insulin resistance. Flax seeds are excellent sources of lignans, that break down to form enterolactone and enterodiol by the intestinal microflora and has continued to function as a food despite being used for generations as a form of natural medicine. A Molecular docking study of enterolactone and enterodiol was conducted to evaluate their efficacy in managing polycystic ovarian syndrome (PCOS). The compounds fit the criteria under Lipinski's Rule of Five, and their docking was carried out with LibDock protocol on Discovery studio with select protein targets of PCOS. It was observed that the metabolites enterolactone and enterodiol from flax seeds show potential as a natural alternative therapy in managing PCOS.

Key words: Phytoestrogens, PCOS, Mammalian Lignans, Enterolactone, Enterodiol, Flaxseed

Around 6-21% of women of reproductive age worldwide are affected by Polycystic Ovarian Syndrome (PCOS), an endocrine disorder associated with hyperandrogenism and chronic anovulation [2]. PCOS impairs physical and emotional wellness in patients, especially in adolescent girls [10]. Patients with PCOS have a high risk of developing type 2 diabetes mellitus, cardiovascular disease, hypertension, dyslipidaemia and endometrial cancer [2]. While the exact cause of PCOS is unknown, it appears to have a heterogenous aetiology of inheritable and environmental factors like genetics, obesity, birth weight, hyperinsulinemia and insulin resistance [24]. Increased insulin levels elevate the production of testosterone by ovaries, resulting in hyperandrogenism showing symptoms of hirsutism, acne and alopecia [11]. The elevated testosterone levels result in the excessive production of Anti Mullerian Hormone (AMH), a local inhibitor of FSH action that has been found elevated in PCOS, and also disrupts the Follicle stimulating hormone's (FSH) action of picking the dominant follicle. During the menstrual cycle of persons with PCOS, luteinizing hormone (LH) levels are high, and (FSH) and progesterone levels are low. Since LH: FSH ratio is altered, a severe menstrual disturbance is noted, as the eggs are rarely or never released from their follicles and develop into ovarian cysts over time [30].

Lifestyle management with regular aerobic exercise and diet modification has been shown to stabilize the hormonal imbalance, improve the blood lipid profile, and decrease abdominal fat and androgen levels in the blood [14,28]. Drugs like Metformin (N, N-dimethyl biguanide) also improve the symptoms of PCOS. Management of PCOS aids in reducing the risk of metabolic diseases later in life. The drug Metformin decreases blood glucose levels by impairing glucose production in the liver and improving insulin sensitivity by activating AMP-activated protein kinase (AMPK). This liver enzyme plays an essential role in insulin signalling and glucose metabolism [4]. Side effects of Metformin include dyspepsia, nausea and diarrhoea. Patients with severely compromised renal function should avoid Metformin due to the risk of developing lactic acidosis. Patients with acute/decompensated heart failure and severe liver disease are advised to avoid Metformin as well [3], [27].

Flax seeds (*Linum usitatissimum* L.), an oil seed with 50% oil and 5% of mucilage, was initially used to produce linen. Flax seeds have proven anti-inflammatory properties and decrease the risk of various cancers and cardiovascular diseases. Flax seed lignans have also been studied for their efficacy in managing PCOS in premenopausal women with good results [16]. Flax is a very important functional food that

gives extra health benefits apart from the traditional nutrients like alpha-linolenic acid (ALA), the essential omega-3 fatty acid, high fibre content and is the best source of lignans secoisolariciresinol diglycoside (SDG) (0.05-0.2% by weight). These lignans are broken down by our intestinal microflora to

form enterolactone and enterodiol [25]. These lignan metabolites are phytoestrogens, compounds that mimic the structure and function of the hormone oestrogen in our body upon entering our bloodstream [29].

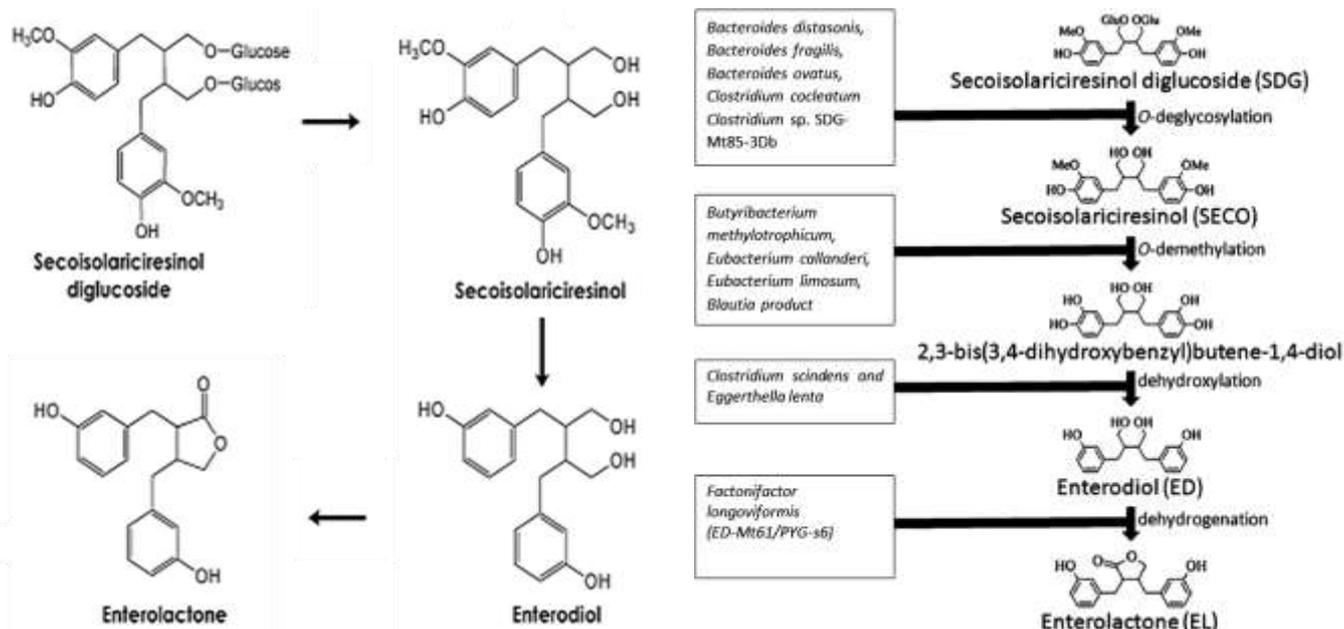


Fig 1 Conversion of mammalian lignan precursor SDG to enterodiol and enterolactone by the gut microflora [22], [7]

Molecular docking forms a part of the drug designing experiments to predict the orientation and binding affinity of the drug with the target protein of a disease [26]. The study aimed to compare the efficiency of lignan phytoestrogens on PCOS against the commonly prescribed medication for PCOS, namely Metformin, by molecular docking. The target proteins selected for this study influence testosterone production, LH: FSH ratio, insulin production and overall metabolism.

Objectives of the current study

To compare the efficacy of the phytoestrogen lignans, Enterolactone and Enterodiol present in flaxseeds with the conventionally prescribed drug for PCOS, namely Metformin by evaluating the binding modes and the intermolecular interactions between the ligands and the following receptors:

a. Receptors of hormones (Activin, Follistatin, Follicle stimulating hormone, Luteinizing hormone, Estrogen and Progesterone) which regulates FSH: LH levels, ovulation processes and fertility functions.

b. Receptors of hormones and enzymes (Androgen receptor, Beta-2 Adrenergic receptor, 5-Alpha-reductases, Sex Hormone Binding Globulins, Steroidogenic Acute Regulatory protein and 17 β -hydroxysteroid dehydrogenase) which influences blood testosterone levels by performing Ligand Fit Module of Discovery Studio 3.5.

c. Receptors of Insulin and Insulin-like Growth Factor which contributes to the insulin resistance conditions found in PCOS and influences androgen levels by performing Ligand Fit Module of Discovery studio 3.5.

MATERIALS AND METHODS

PCOS target proteins identified from literature (Table 1) and their 3D crystalline structures were downloaded from Protein Data Bank in .pdb file format. On the discovery studio software, energy optimization of the proteins was carried out, where water molecules, ligands and unnecessary amino acid

side chains were removed from the protein structure and replaced with hydrogen atoms. Following this, the identification of the docking site was carried out. Structures of ligands of our interest, namely, enterolactone, enterodiol and Metformin, were downloaded from the PubChem database. The ligands were evaluated for drug likeliness following Lipinski's Rule of Five. These ligands were then docked with the protein structures using the Libdock protocol on Discovery studio software, and the docked protein structures were visualized on the Discovery Studio Visualiser.

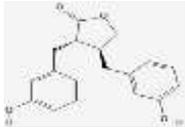
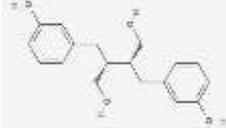
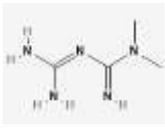
Table 1 List of protein targets of PCOS and their PDB ID

Protein	PDB ID
Androgen receptor	(1GS4)
Insulin-like growth factor I receptor	(1IGR)
Follicle-stimulating hormone receptor	(1XUN)
Luteinizing hormone choriogonadotropin receptor	(1LUT)
Peroxisome proliferator-activated receptor- γ	(1FM6)

RESULTS AND DISCUSSION

Molecular docking predicts the favourable orientation and binding affinity of two molecules, usually between two proteins or a protein and a ligand. In this study, docking is used to understand the possible mechanism of action of Flax seed metabolites on the proteins contributing to PCOS symptoms. The ligands were docked with the prepared proteins by Discovery studio with the LibDock module, whose high thorough-put algorithm docks small molecules into an active receptor site. The relative energy and the docking score (LibDock score) were observed and noted for each protein and ligand combination. If more than one pose was obtained, the discovery studio software arranges the poses and finds the best pose with the lowest relative energy and the highest docking score [26].

Table 2 Drug-likeness properties and structures of enterolactone, enterodiol and Metformin

Parameter	Enterolactone	Enterodiol	Metformin	Reference value
PubChem ID	10685477	115089	4091	
Number of H bond donors	2	4	3	<5
Number of H bond acceptors	4	4	1	<10
Molecular weight	298.338	302.37	129.167	<500
LogP	2.672	2.1	-1.244	<5
Molar refractivity	81.561	84.733	37.223	40-130
Total polar surface area (Angstrom ²)	66.76	80.92	91.49	<140
2D Structure				

The ligands displayed a pattern in the type of interaction with which they bind with the target proteins. Enterolactone and Enterodiol bonded with the target proteins utilizing conventional hydrogen bonding and pi-alkyl interactions. In comparison, Metformin interacted using carbon-hydrogen bonding and conventional hydrogen bonding methods. Hydrogen bonds are stronger intermolecular bonds as compared to other intermolecular interactions [1]. All ligands followed

Lipinski's Rule of Five for drug-likeness. The lignan metabolites exhibited similar properties, but enterolactone had a lower total polar surface area and fewer hydrogen bond donors than enterodiol. Compounds that follow Lipinski's rule of Five have higher water solubility, intestinal permeability and oral bioavailability-hence exhibiting better ADME (Absorption, Distribution, Metabolism, and Excretion) properties [13].

Table 3 Docking results of the lignan metabolites and Metformin with PCOS protein targets

Protein	Enterolactone		Enterodiol		Metformin	
	Relative energy	Libdock Score	Relative energy	Libdock Score	Relative energy	Libdock Score
Androgen receptor (1GS4)	1.285	116.79	-	-	5.157	42.457
IGF I receptor (1IGR)	4.287	97.043	17.984	109.258	5.156	41.646
FSH receptor (1XUN)	6.074	133.398	-	-	-	-
LHCG receptor (1LUT)	7.297	141.782	11.558	87.128	0.000	30.668
PPAR- γ (1FM6)	10.352	127.098	4.26056	130.699	0.213	34.355

Patients with PCOS were tested to have higher LH levels and lower FSH levels. Typically, a 3:1 ratio signifies aberrant gonadotropin secretion. FSH promotes follicle development and holds the developing eggs in the ovaries. If FSH levels are low over a prolonged period of time, the follicle would not mature and produce eggs, resulting in infertility. Small cysts will develop in the ovaries because of the immature follicles [30]. With both the luteinizing hormone receptor and follicle-stimulating hormone receptor proteins, enterolactone displayed a very favourable docking score and low relative energy. Enterodiol and Metformin did not bind with the FSH receptor protein. The androgen receptor helps in the uptake of testosterone. Hyperinsulinemia, one of the most common characteristics of PCOS, results in hyperandrogenism. Symptoms of hirsutism and male pattern hair loss, typically seen in hyperandrogenism, can be prevented by compounds that competitively bind with the androgen receptor and reduce androgen uptake [23]. Enterolactone was the best ligand that bound with the androgen receptor. Enterodiol did not bind with this receptor protein [21].

Insulin-like growth factor-1(IGF-I) regulates the secretion of Sex Hormone Binding Globulin (SHBG) in the liver, which is an essential protein that binds with excessive testosterone in the blood and excretes it. Individuals with PCOS were reported to have lower levels of serum SHBG. Lowering IGF-I levels may lower the levels of LH secretion, thereby increasing SHBG and lowering testosterone levels [8]. IGF-I is also said to stimulate ovarian growth and steroid synthesis [20]. Enterolactone was the best ligand to bind with the IGF-1 receptor protein. [21].

PPAR γ (Peroxisome proliferator-activated receptor gamma) has an influence on insulin resistance pathophysiology

in women with PCOS. It is a ligand-activated nuclear transcription factor that regulates glucose metabolism, lipid metabolism, and ovary steroidogenesis. More recently, a partial agonistic binding to this protein has been shown to influence the insulin pathway positively without extreme side effects such as weight gain, increased adipogenesis and cardiovascular complications. [21,12] Enterodiol has a good binding affinity to this protein.

CONCLUSION

Insulin controls the metabolism of carbohydrates, which is essential for preserving blood glucose levels. Insulin resistance, which is caused by a decreased response to insulin signalling, impaired insulin absorption, and hyperinsulinemia in the blood, is caused by high levels of insulin. One of the typical signs of PCOS is insulin resistance. As insulin is responsible for increasing the concentration of IGF-I and androgens, it has been observed that a rise in insulin level and IGFBP-1 (Insulin-Like Growth Factor Binding Protein) activity can be considered as the key factors contributing to PCOS [31]. Additionally, it has been documented that insulin changes SHBG levels, preventing its synthesis and secretion when insulin levels are high, and that patients with hyperinsulinemia have much lower serum SHBG levels. Additionally, it has been discovered that IGF-1 raises LH production, which causes hyperinsulinemia and decreases SHBG levels. [8]. As a result, decreasing insulin and plasma IGF1 levels might cause a drop in LH secretion, which in turn causes an increase in SHBG and a decrease in testosterone levels. The three insulin receptor proteins and the IGF protein could both bind well to enterolactone. Enterolactone may be able to control insulin

levels and boost the liver's production of SHBG through interacting with these proteins. Polycystic ovarian syndrome is an increasingly prevalent lifestyle disease that affects women through ovulation & hyperandrogenism. A collection of five proteins that play an essential role in the biochemical pathways of the polycystic ovarian syndrome were docked with lignan metabolites of flax seeds, namely, enterolactone and enterodiol.

The docking scores were compared to the drug commonly prescribed for PCOS- Metformin- to determine which is more effective in managing PCOS. Enterolactone docked with all the proteins with high scores, followed by enterodiol. The favourable binding capabilities and drug likeliness of the lignan metabolites show that they are a promising candidate for managing PCOS in a holistic manner.

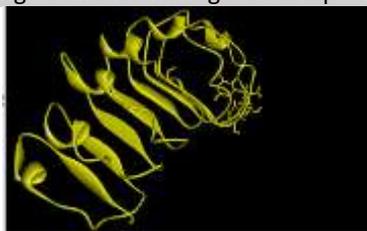
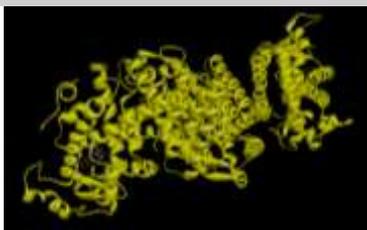
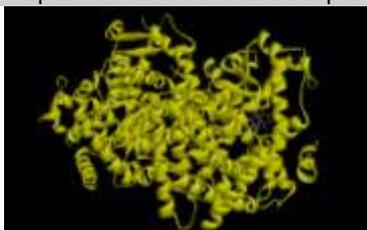
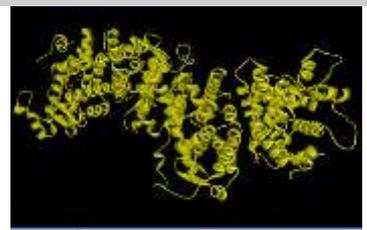
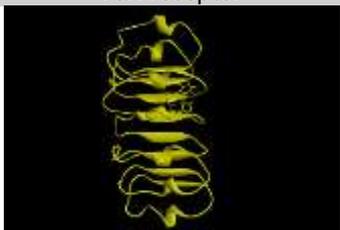
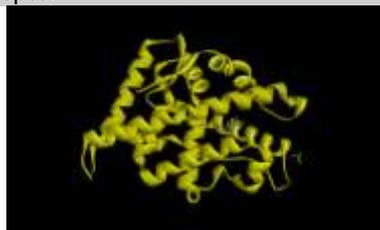
Insulin-like growth factor I receptor		
		
Enterolactone: Conventional, Pi Alkyl	Enterodiol: Pi Alkyl, Carbon, Conventional	Metformin: Conventional
Luteinizing hormone choriogonadotropin receptor		
		
Enterolactone: Conventional, Alkyl, Carbon, Pi Alkyl, Amide	Enterodiol: Pi Alkyl, Pi Cation, Pi Donor, Conventional	Metformin: Conventional, Carbon
Peroxisome proliferator-activated receptor-gamma		
		
Enterolactone: Alkyl, Pi Alkyl, Conventional, Carbon, Pi Donor	Enterodiol: Pi Alkyl, Carbon, Conventional, Pi Donor	Metformin: Conventional, Carbon
FSH receptor	Androgen receptor	
		
Enterolactone: Pi Alkyl, Conventional, Pi Donor	Enterolactone: Conventional, Alkyl, Pi Alkyl, Pi Sulfur	Metformin: Conventional, Carbon

Table 4 Docked structures of proteins and ligands along with their molecular interaction types

LITERATURE CITED

1. Bissantz, C., Kuhn, B., & Stahl, M. 2010. A medicinal chemist's guide to molecular interactions. *Journal of Medicinal Chemistry*, 53(14), 5061–5084. <https://doi.org/10.1021/jm100112j>
2. Che, Y., Yu, J., Li, Y. S., Zhu, Y. C., & Tao, T. 2023. Polycystic ovary syndrome: Challenges and possible solutions. *Journal of Clinical Medicine*, 12(4), 1500. <https://doi.org/10.3390/jcm12041500>
3. Derosa, G., Rivera, R., D'Angelo, A., & Maffioli, P. 2020. Metformin: From immediate release to extended release formula, effectiveness, and safety in patients with chronic kidney disease. *Diabetes*.
4. Dumitrescu, R., Mehedintu, C., Briceag, I., Purcărea, V. L., & Hudita, D. 2015. Metformin-clinical pharmacology in PCOs. *Journal of Medicine and Life*, 8(2), 187–192.
5. Gampe, R. T., Jr., Montana, V. G., Lambert, M. H., Miller, A. B., Bledsoe, R. K., Milburn, M. V., Kliewer, S. A., Willson, T. M., & Xu, H. E. 2000. Asymmetry in the PPARgamma/ RXRalpha crystal structure reveals the molecular basis of heterodimerization among nuclear receptors. *Molecular Cell* 5(3): 545–555. [https://doi.org/10.1016/s1097-2765\(00\)80448-7](https://doi.org/10.1016/s1097-2765(00)80448-7)

6. Garrett, T. P., McKern, N. M., Lou, M., Frenkel, M. J., Bentley, J. D., Lovrecz, G. O., Elleman, T. C., Cosgrove, L. J., & Ward, C. W. 1998. Crystal structure of the first three domains of the type-1 insulin-like growth factor receptor. *Nature*, 394(6691), 395–399. <https://doi.org/10.1038/28668>
7. Hålldin, E., Eriksen, A. K., Brunius, C., da Silva, A. B., Bronze, M., Hanhineva, K., Aura, A. M., & Landberg, R. 2019. Factors explaining interpersonal variation in plasma enterolactone concentrations in humans. *Molecular Nutrition and Food Research*, 63(16), e1801159. <https://doi.org/10.1002/mnfr.201801159>
8. Hara, N., Takizawa, I., Isahaya, E., Nishiyama, T., Hoshii, T., Ishizaki, F., & Takahashi, K. 2012. Insulin-like growth factor-1 is associated with regulation of the luteinizing hormone production in men receiving androgen deprivation therapy with gonadotropin-releasing hormone analogues for localized prostate cancer. *Urologic Oncology*, 30(5), 596–601. <https://doi.org/10.1016/j.urolonc.2010.11.001>
9. Jiang, X., Dreano, M., Buckler, D. R., Cheng, S., Ythier, A., Wu, H., Hendrickson, W. A., & el Tayar, N. 1995. Structural predictions for the ligand-binding region of glycoprotein hormone receptors and the nature of hormone-receptor interactions. *Structure*, 3(12), 1341–1353. [https://doi.org/10.1016/s0969-2126\(01\)00272-6](https://doi.org/10.1016/s0969-2126(01)00272-6), PubMed: 8747461
10. Joseph, N., Reddy, A. G., Joy, D., Patel, V., Santhosh, P., Das, S., & Reddy, S. K. 2016. Study on the proportion and determinants of polycystic ovarian syndrome among health sciences students in South India. *Journal of Natural Science, Biology, and Medicine*, 7(2), 166–172. <https://doi.org/10.4103/0976-9668.184704>
11. Karkera, S., Agard, E., & Sankova, L. 2023. The clinical manifestations of polycystic ovary syndrome (PCOS) and the treatment options. *European Journal of Biology and Medical Science Research*, 11(1), 57–91. <https://doi.org/10.37745/ejbmsr.2013/vol11n15791>
12. Lewis, S. N., Bassaganya-Riera, J., & Bevan, D. R. 2010. Virtual screening as a technique for PPAR modulator discovery. *PPAR Research*, 2010, 861238, 1-10. <https://doi.org/10.1155/2010/861238>
13. Lipinski, C. A. 2004. Lead- and drug-like compounds: The rule-of-five revolution. *Drug Discovery Today. Technologies*, 1(4), 337–341. <https://doi.org/10.1016/j.ddtec.2004.11.007>
14. Matias, P. M., Carrondo, M. A., Coelho, R., Thomaz, M., Zhao, X. Y., Wegg, A., Crusius, K., Egner, U., & Donner, P. 2002. Structural basis for the glucocorticoid response in a mutant human androgen receptor (AR) derived from an androgen-independent prostate cancer. *Journal of Medicinal Chemistry*, 45(7), 1439–1446. <https://doi.org/10.2210/pdb1gs4/pdb>
15. Moran, L. J., Hutchison, S. K., Norman, R. J., & Teede, H. J. 2011. Lifestyle changes in women with polycystic ovary syndrome. *Cochrane Database of Systematic Reviews*, 7, CD007506. <https://doi.org/10.1002/14651858.CD007506.pub3>
16. Muir, A. D. (2003). *Flax: The genus Linum*. Taylor & Francis.
17. National Center for Biotechnology Information. 2023. PubChem compound summary for CID 114739, Enterolactone. Retrieved March 1, 2023. <https://pubchem.ncbi.nlm.nih.gov/compound/Enterolactone>
18. National Center for Biotechnology Information. 2023. PubChem compound summary for CID 115089, Enterodiol. Retrieved March 1, 2023. <https://pubchem.ncbi.nlm.nih.gov/compound/Enterodiol>
19. National Center for Biotechnology Information. 2023. PubChem compound summary for CID 4091, Metformin. Retrieved March 1, 2023. <https://pubchem.ncbi.nlm.nih.gov/compound/Metformin>
20. Nobels, F., & Dewailly, D. 1992. Puberty and polycystic ovarian syndrome: The insulin/insulin-like growth factor I hypothesis. *Fertility and Sterility*, 58(4), 655–666. [https://doi.org/10.1016/s0015-0282\(16\)55307-2](https://doi.org/10.1016/s0015-0282(16)55307-2)
21. Panda, P. K., Rane, R., Ravichandran, R., Singh, S., & Panchal, H. 2016. Genetics of PCOS: A systematic bioinformatics approach to unveil the proteins responsible for PCOS. *Genomics Data*, 8, 52–60. <https://doi.org/10.1016/j.gdata.2016.03.008>, PubMed: 27114910, PubMed Central: PMC4832036
22. Patel, D., Vaghasiya, J., Pancholi, S. S., & Paul, A. 2012. Therapeutic potential of secoisolariciresinol diglucoside: A plant lignan. *International Journal of Pharmaceutical Sciences and Drug Research*, 4(1), 15–18.
23. Rodriguez Paris, V., & Bertoldo, M. J. 2019. The mechanism of androgen actions in PCOS etiology. *Medical Sciences*, 7(9), 89. <https://doi.org/10.3390/medsci7090089>
24. Rosenfield, R. L., & Ehrmann, D. A. 2016. The pathogenesis of polycystic ovary syndrome (PCOS): The hypothesis of PCOS as functional ovarian hyperandrogenism revisited. *Endocrine Reviews*, 37(5), 467–520. <https://doi.org/10.1210/er.2015-1104>
25. Setchell, K. D., Brown, N. M., Zimmer-Nechemias, L., Wolfe, B., Jha, P., & Heubi, J. E. 2014. Metabolism of secoisolariciresinol-diglycoside the dietary precursor to the intestinally derived lignan enterolactone in humans. *Food and Function*, 5(3), 491–501. <https://doi.org/10.1039/c3fo60402k>, PubMed: 24429845, PubMed Central: PMC3996458
26. Singh, J., Kumar, M., Mansuri, R., Sahoo, G. C., & Deep, A. 2016. Inhibitor designing, virtual screening, and docking studies for methyltransferase: A potential target against dengue virus. *Journal of Pharmacy and Bioallied Sciences*, 8(3), 188–194. <https://doi.org/10.4103/0975-7406.171682>
27. Subramaniam, K., Joseph, M. P., & Babu, L. A. 2021. A common drug causing a Common Side effect at an uncommon time: Metformin-induced chronic diarrhea and weight loss after years of treatment. *Clinical Diabetes*, 39(2), 237–240. <https://doi.org/10.2337/cd20-0101>
28. Szczuko, M., Kikut, J., Szczuko, U., Szydłowska, I., Nawrocka-Rutkowska, J., Ziętek, M., Verbanac, D., & Saso, L. 2021. Nutrition strategy and lifestyle in polycystic ovary syndrome—Narrative review. *Nutrients*, 13(7), 2452. <https://doi.org/10.3390/nu13072452>
29. Wang, L. Q. 2002. Mammalian phytoestrogens: Enterodiol and enterolactone. *Journal of Chromatography. B, Analytical Technologies in the Biomedical and Life Sciences*, 777(1–2), 289–309. [https://doi.org/10.1016/s1570-0232\(02\)00281-7](https://doi.org/10.1016/s1570-0232(02)00281-7)
30. Yau, T. T., Ng, N. Y., Cheung, L. P., & Ma, R. C. 2017. Polycystic ovary syndrome: A common reproductive syndrome with long-term metabolic consequences. *Hong Kong Medical Journal*, 23(6), 622–634. <https://doi.org/10.12809/hkmj176308>
31. Panda, P. K., Rane, R., Ravichandran, R., Singh, S., & Panchal, H. (2016). Genetics of PCOS: A systematic bioinformatics approach to unveil the proteins responsible for PCOS. *Genomics data*, 8, 52-60.

Comparative Analysis of Blossoms of Rasthali, Malai Valai and Nattu Valai for Product Development

K. Akshaya*¹, K. Sindhuja² and K. Nithya³

^{1,2}The American College, Madurai - 625 002, Tamil Nadu, India

Correspondence to: K. Akshaya, The American College, Madurai - 625 002, Tamil Nadu, India, Tel: +91 8220057650; E-mail: akshayakamu67@gmail.com

Abstract

Banana blossom is an edible flower rich in phenolic acids, tannins, flavonoids and other medicinal properties like antioxidant properties, anti-diabetic, to cure premenstrual syndrome. The objective of the study was comparative analysis of Rasthali, Malai valai and Nattu valai for product development of banana blossoms of three cultivars. The three different blossoms were collected from three cultivars grown in Tamil Nadu. They are powdered and stored in an airtight container for further use. Proximate analysis was performed and thereby products like gummies, cookies and green tea were developed. The result showed that the sample of banana blossom powder in 100 grams of Rasthali, Malai valai and Nattu valai contain high amount of Magnesium (328 to 350 mg), Fiber (34.1 to 36 g) and Iron (30 to 42 mg) were found to be similar in all the cultivars. The conclusion of the study clearly shows adding banana blossoms to the diet in the form of products used to prevent conditions such as Anemia, Hypomagnesemia and Constipation.

Key words: Antioxidant, Comparative Analysis, Diet, Constipation, Hypomagnesemia, Anemia, Banana blossom

Banana Blossoms is otherwise known as Banana Heart. They are large, fleshy, red- or purple-colored flowers that grow at the end of a banana (Elaveniya *et al*, 2014). Banana blossoms are slightly bitter in taste but they are used for cooking purposes because the flowers have huge medicinal properties used to treat illnesses (Marikkar *et al*, 2016). It contains fiber, potassium, iron, magnesium, calcium, copper, protein, phosphorus, vitamin A, C, E etc., Blossoms also have anti-cancer, anti-microbial, anti-diabetic and antioxidant properties. It is consumed by the people due to their tremendous health benefits and also beneficial for Women's health to cure menstrual bleeding (Pushpaveni *et al*, 2019). They are rich in dietary fiber similar to meat. It increases the hemoglobin and reduces blood sugar level. As well as banana blossoms contain

high quality proteins. Nowadays plant proteins have become popular in Food industry. The plant protein, they are not like animal protein because it lacks major amino acids. Vegans must eat a variety of plant proteins to balance their nutritional needs. So, Banana blossom powder is incorporated in commercial items like cookies, gummies, pickles, green tea and pharmaceuticals (Duartea *et al*. 2002).

MATERIALS AND METHODS

Selection of banana blossom

The three varieties (Blossoms of Rasthali, Malai valai and Nattu valai) are collected from three different local cultivars of Tamil Nadu.



Fig 1 Rasthali banana blossom



Fig 2 Malai valai blossoms



Fig 3 Nattu valai blossom

A preparation of rasthali, malai valai and nattu valai blossom powder

Cleaning

The firm and fresh flower was purchased
The banana blossoms were separately peeled
Lift the bracts
Remove the florets



Fig 4 Peeled blossoms



Fig 5 Blossoms immersed in Citric acid



Fig 6 Dried blossoms in tray



Fig 7 Rasthali blossom powder

Drying

After that the water was drained and the banana blossom slices were spread over the trays. Banana blossom slices were dried in a hot air oven at 120°C for 3 hours or until they became dry.

Grinding

Ground in a mixer grinder into a small particle size of 40, packed in a polyethylene bag and then stored at 50°C prior to further analysis.

Storage

Banana blossom powder can be stored for one year under the following conditions: clean, dried powder in an airtight container, protected from light and humidity, and kept below 24°C (75. 2°F). If stored blossom powder is exposed to heat or direct sunlight it will degrade and the nutrient content will be reduced.



Fig 8 Banana blossoms stored in airtight container

Incorporate banana blossom powder in different products

Gummies

It is made from the blossoms of Nattu valai powder, which is rich in iron. It helps to prevent anemia.

Ingredients

Discard both stamen and style.

Reduce browning reaction

The blossoms were cut into a thickness of 5mm, directly into 0.5 % Citric acid solution in order to reduce enzymatic browning. The slices were immersed in the Citric acid solution for 30 minutes.

Agar - 2.5g

Banana blossom powder (Nattu valai) - 1g

Lemon juice - few drops

Sugar - 15g

Water - 100ml

Materials required

Bowl, spoon, weighing machine, measuring jar, teddy bear mold, dropper.

Method

In 100 ml of water, Agar agar and Banana blossom powder (Nattu valai), sugar, and a few drops of lemon juice were added. Mix, heat it well & let it cool. Using a dropper, fill the mold and refrigerate for 30 minutes.



Fig 9 Bear shaped gummy (Nattu valai)

Green tea

In Malai valai blossom powder, it contains high amounts of Magnesium. It helps to prevent Hypomagnesemia.

Ingredients

Green tea - 1g

Banana blossom powder (Malai valai) - 2g

Water - 150ml

Materials required

Bowl, spoon, cotton tea bags.

Method

Malai valai blossom powder is incorporated with green tea in a ratio of 1: 0.5.

The daily intake of this green tea prevents Hypomagnesemia.



Fig 10 Green tea bags (Malai valai)

Cookies

Rasthali banana blossom powder contains high amounts of fiber. It helps to prevent constipation.

Ingredients

Wheat flour - 100g
Jaggery - 50g
Ghee - 25ml
Banana blossom powder (Rasthali) - 3g
Baking powder - a pinch
Baking salt - a pinch
Water/ Milk if needed

Materials required

Weighing machine, measuring jar, spoon, bowl, cookie cutters

Method

100 g of wheat flour, 50g of jaggery, 3 grams of banana blossom powder (Rasthali), 25 ml of ghee and finally a pinch of baking soda & baking salt were added (add Water/Milk in needed amount). Dough for cookies were prepared and cut into desired size. Bake it in the oven at 120° C for 20 mins.

Determination of DPPH radical scavenging activity of banana blossom

The solution of DPPH (2, 2 diphenyl 12 picrylhydrazyl hydrate) in methanol was prepared by dissolving 4mg of DPPH in 100 ml methanol and it was protected from light by covering the test tubes with aluminum foil. Stock solutions of samples were prepared by dissolving 5g of dried extracts in 100ml of methanol. Different volumes (50-200µl) of extracts and 1 ml of DPPH solution were added. The reaction mixture was incubated in dark condition at room temperature for 20 minutes. Then, the absorbance of the mixture was read at 517 nm (Williams *et al.*

1995). The percentage of RSA of the Banana blossom extracts was calculated using the following formula:

$$\% \text{ RSA} = \frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}} \times 100$$

*RSA= Radical Scavenging Activity

*Abs sample= Absorbance of DPPH radical + Extract solution

*Abs control= Absorbance of DPPH radical + methanol



Fig 11 Banana blossom cookies (rasthali)

RESULTS AND DISCUSSION

The present study was carried out to utilize banana blossoms in the form of powder. Incorporate the banana blossom powder to the cookies, green tea and gummies. They were selected based on the nutrient composition, especially fiber rich in Rasthali, magnesium rich in Malai valai and Iron rich in Nattu valai (blossoms) to cure the disease conditions like Constipation, Hypomagnesemia and Anemia.

Proximate analysis of banana blossom powder

Table 1 Parameters (nutrients) calculated for Rasthali blossom powder in 100g

S. No	Parameters	Values / 100g
1	Energy	363 kcal
2	Carbohydrate	64.5 g
3	Protein	17.0 g
4	Fat	4.2 g
5	Dietary fiber	36 g
6	Iron	33 mg
7	Magnesium	328 mg
8	Vitamin C	9.2 mg

Table 2 Parameters (nutrients) calculated for Nattu valai blossom powder in 100g

S. No	Parameters	Values / 100g
1	Energy	369 kcal
2	Carbohydrate	66.4 g
3	Protein	18.2 g
4	Fat	3.4 g
5	Dietary fiber	38.2 g
6	Iron	42 mg
7	Magnesium	337 mg
8	Vitamin C	9.8 mg

Table 3 Parameters (nutrients) calculated for Malai valai blossom powder in 100g

S. No.	Parameters	Values / 100g
1	Energy	361 kcal
2	Carbohydrate	63.2 g
3	Protein	16.6 g
4	Fat	4.7 g
5	Dietary fiber	34.1 g
6	Iron	30 mg
7	Magnesium	350 mg
8	Vitamin C	8.5 mg

Antioxidant activity

Table 4 Antioxidant Activity of Banana Blossom - DPPH Radical Scavenging method

Concentration of solution	Absorbance
Control	0.7214

Concentration of solution (sample)	Result in %
50µl	73.6 %
100µl	90.8%
150µl	93.6%
200µl	93.7%

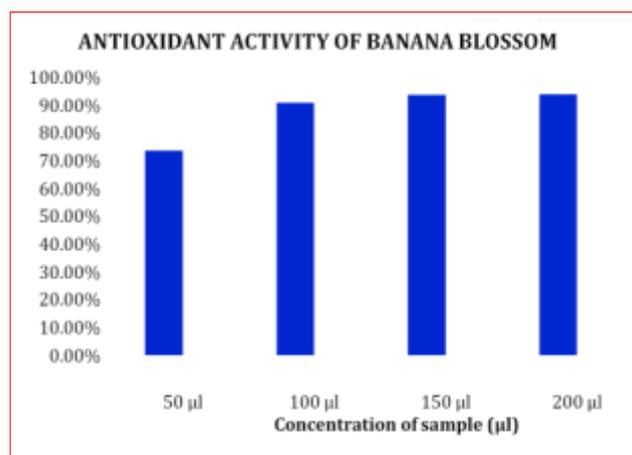


Fig 12 Antioxidant activity of banana blossom (Malai valai)

This research has comprehensively investigated the nutritional composition of banana blossoms (Powder) of three cultivars. The results indicate that banana flowers are a good source of minerals, such as magnesium and Iron in addition to high dietary fiber and flavonoid concentrations. The utilization of banana blossoms could provide additional benefits in reducing the banana blossoms waste, and increasing the use in food science (Sheng *et al.* 2010).

Cookies

Cookies preparation idea was obtained from literature reviews. We tried banana blossom cookies with various concentrations of blossom powder (1%-6%) for 50 grams. Dough was not so good in 1 to 4 percent and 6 percent showed dark color. 5% percent showed good appearance. Crude fiber content in powdered samples is almost similar 16%. But

blossom powder incorporated cookies contain high fiber (20%) when compared with standard and control biscuits. Addition of fiber to biscuits products increases dietary fiber intake and decreases the caloric density of baked goods. This study confirms that the percentage of fiber in biscuits is increased when compared with commercialized biscuits. Constipation is a common condition that can be debilitating and difficult to treat (Lembo A & Camilleri M, 2003). The flower is found to be good in dietary fiber which is an important nutrient as it relieves constipation. Normally, banana blossom powder can be incorporated in various food products to enhance the antioxidant profile and fiber content (Soni D & Saxena G, 2021).

Green tea

The developed products with varied concentrations (1g, 2g, 2.5g, 3g) of banana blossom powder and (0.5g, 1g, 1.5g, 2g) of green tea powder were analyzed for their color, texture, taste, appearance and aroma. As a cofactor in numerous enzymatic reactions, magnesium fulfills various intracellular physiological functions. Thus, imbalance in magnesium status primarily hypomagnesaemia as it is seen more often than hypomagnesaemia might result in unwanted neuromuscular, cardiac or nervous disorders. Measuring total serum magnesium is a feasible and affordable way to monitor changes in magnesium status, although it does not necessarily reflect total body magnesium content (Jahnen-Dechent W & Ketteler M, 2012). Banana Blossoms were used for the incorporation of green tea. At the level of 10%, 20%, 30% add Banana Blossom in green tea. The overall acceptability and rating scale is higher for the 20% level of incorporation of Banana Blossom powder. Nutritional value of Banana Blossoms is found to be high. This is very nutritious and free of cost, so it can be used in different types of food products (Komal D & Kaur P, 2019).

Gummies

The varied concentration of banana blossom powder is (0.5 g, 1 g, 1.5 g and 2 g). The preferred concentration is 0.5 g. Individuals highly vulnerable to iron deficiency have high iron needs, as during growth or pregnancy; high noon iron loss, as during marked hemorrhage or excessive and/or frequent menstrual losses; or diets with low iron content or bioavailability (Monsen E. R, 1988). The banana blossom is rich in iron. It helps fight anemia and menstrual problems in women (Kumar *et al.*, 2012). The present study was undertaken to develop and evaluate gummies prepared by banana blossoms for anemic children. Banana blossoms are the rich source of iron and it raises the hemoglobin in the body as it is rich in fiber and iron which assists in RBC (red blood cell) production. gummies make it beneficial for individuals to increase hemoglobin level (Mishra *et al.*, 2017).

CONCLUSION

The study clearly showed that three varieties of banana blossoms are rich in fiber, iron and magnesium. Banana blossom, besides being nutritionally rich, has good functional properties and hence can be incorporated in various dishes prepared both at home and commercially for better health of an individual.

LITERATURE CITED

- Brand-Williams, W., Cuvelier, M. E., & Berset, C. L. W. T. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT-Food science and Technology*, 28(1), 25-30.
- Duarte, A. C. P., Coelho, M. A. Z., Leite, S. G. F. (2002). Identification of Peroxidase and Tyrosinase in Green Coconut Water

Identificación De Peroxidasa Y Tirosinasa En Jugo De Coco Verde Identificación De Peroxidasa E Tirosinasa En Xugo De Coco Verde. *CYTA-Journal of Food*, 3(5), 266-270.

3. Elevenia, E., & Jayamuthunagai, J. (2014). Functional, physicochemical and antioxidant properties of dehydrated banana blossom powder and its incorporation in biscuits. *International Journal of ChemTech Research*, 6(9), 4446-4454.
4. Jahnen-Dechent, W., & Ketteler, M. (2012). Magnesium basics. *Clinical kidney journal*, 5(Suppl_1), i3-i14.
5. Komal, D., & Kaur, P. (2019). Development of value added product and evaluation of banana blossom incorporated nut chocolate. *Development*, 3(5), 1930-1931.
6. Kumar, K. S., Bhowmik, D., Duraivel, S., & Umadevi, M. (2012). Traditional and medicinal uses of bananas. *Journal of Pharmacognosy and Phytochemistry*, 1(3), 51-63.
7. Lembo, A., & Camilleri, M. (2003). Chronic constipation. *New England Journal of Medicine*, 349(14), 1360-1368
8. Marikkar, J. M. N., Tan, S. J., Salleh, A., Azrina, A., & Shukri, M. A. M. (2016). Evaluation of banana (*Musa sp.*) flowers of selected varieties for their antioxidative and anti-hyperglycemic potentials. *International Food Research Journal*, 23(5).
9. Mishra, P., Tewari, M., & Tiwari, D. K. (2017). Development and evaluation of cookies prepared by banana flower, lotus stem and finger millet for anemic adolescent girls. *Annals of Horticulture*, 10(2), 235-239.
10. Monsen, E. R. (1988). Iron nutrition and absorption: dietary factors which impact iron bioavailability. *Journal of the American Dietetic Association*, 88(7), 786-790.
11. Pushpaveni, C., Visagaperumal D., & C. Vineeth. 2019. A Review on Banana Blossom: The Heart of Banana. *World Journal Pharmacognosy Research*. 8(11): 440-450.
12. Sheng, Z. W., Ma, W. H., Jin, Z. Q., Bi, Y., Sun, Z. G., Dou, H. T., ... & Han, L. N. (2010). Investigation of dietary fiber, protein, vitamin E and other nutritional compounds of banana flowers of two cultivars grown in China. *African Journal of Biotechnology*, 9(25), 3888-3895.
13. Soni, D., & Saxena, G. (2021). Analysis of Physico-chemical and Functional Properties of Banana Flower. *Research Journal of Agricultural Sciences, An International Journal*, Res. Jr. of Agril. Sci. (2021) 12(6): 2020–2023.

Quality Evaluation of Bakery Products Enriched with Sweet Potato Flour and Sapota Concentrate

M. Ishwaryalakshmi*¹ and C. Hele⁵

^{1,2}Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India

Correspondence to: M. Ishwaryalakshmi, Fatima college (Autonomous), Madurai - 625 018, Tamil Nadu, India

Abstract

The relationship between diet and health is important hence, there is a growing interest in improving the nutritional profile of most food products, especially those with high sugar and fat contents. Bakery products are consumed by all sectors of the society regardless of age and income level. In bakery products, traditional ingredients such as refined flour and sugar may be successfully replaced by other, healthier substances, without nutritional quality loss. Therefore, the present study was undertaken to develop bakery products such as muffins and brownie by replacing refined flour and sugar with sweet potato flour and sapota concentrate respectively. Sweet potato flour and sapota concentrate were incorporated at various levels into the formulation of muffins and brownie. Proximate composition, sensory attributes and microbial analysis of sweet potato and sapota concentrate enriched muffins and brownie was evaluated using standard procedures. Results demonstrated that the total replacement of refined flour and sugar with sweet potato flour and sapota concentrate increases the nutrients such as carbohydrate, protein, beta carotene, iron, calcium and phosphorus. The sensory characteristics like colour, appearance, taste, texture, flavour and overall acceptability of both muffins and brownie were highly accepted. The microbial analysis of the muffins and brownie revealed that they were acceptable for 10 days from the date of preparation when stored in PET (polyethylene terephthalate) container. Therefore, the formulated muffins and brownie serve as economic substitutes for refined flour and sugar, respectively, and provide a healthier product for health-conscious individuals.

Key words: Sweet potato, Sapota, Muffins, Brownie, Carbohydrate, Protein, Beta Carotene, Iron, Calcium, Phosphorus

The term “baked goods” encompasses multiple food products made from flour (typically wheat flour). The term baked goods also include cakes and cookies, which are rich in fats and sugars but represent an excellent choice for indulgent consumption. Many research groups have focused on the enrichment of baked goods with other plant-based ingredients of high nutritional value. The nutritional improvement of baked goods derived from the use of the aforementioned nutrient-dense ingredients almost always worsens their physical quality. This may result in a critical loss of consumers’ acceptance and, therefore, the unfeasible translation of nutrient-dense ingredient incorporation to the commercial reality (Martinez *et al.* 2019).

White wheat flour is the major raw material for bakery products, substituting it with other flours have been reported to promote the glycemic status, and thus reduce postprandial blood glucose responses (Lanzerstorfer *et al.* 2018). The application of composite flours in the development of food products such as baked foods have been reported by many researchers (Ayele *et al.* 2017). The development of nutritious, healthy bakery products is important as the product forms a major part of the human daily diet. In recent times, there has been an adding interest in sweet potato due to its health benefits.

Sweet potato flour can serve as a source of energy and nutrients (carbohydrates, β -carotene, minerals such as Ca, K, Fe, P, and Z), can add natural sweetness, color, flavor and dietary fiber to food products. Gehan I. Abd El-Wahab (2016) showed that sweet potato flour can easily be promoted as a substitute for wheat flour in sweet baked products and can also be used for its high carotenoid content.

The reduction of sugar in sweet bakery products is challenging, since sugar fulfils more functions than only sweetness and flavour. However, two main strategies to reduce sugar with a promising result have been introduced: Firstly, the replacement of sugar by a sweet bulking agent, such as polyols, and secondly, sugar substitution by a combination of non-sweet bulking agents and high-intensive sweeteners (Clemens *et al.* 2016). Fruits contain sweetness-enhancing volatiles. They function by enhancing perceived sweetness via neural mechanisms.

Sapota (*Manilkara zapota* L.) is a tropical fruit also known as chikku, sapota pearl, or sapodilla that comes under the family Sapotaceae. India is the largest patron of sapota in the world, though sapota is considered to be a minor crop in the country. In India, sapota is extensively cultivated in Tamil

Nadu, Karnataka, Gujarat, Andhra Pradesh, West Bengal, and Maharashtra (Shipra Chaudhary *et al.*, 2020). The fully ripe fruits have an excellent sweet taste and a pleasant aroma. It is an excellent source of vitamins A, C, niacin, folate, and pantothenic acid. It contains essential chemical compounds like sugar, protein, ascorbic acid, phenolics, carotenoids, glycosides, saponins, and minerals like iron, copper, zinc, calcium, and potassium. The tannin content in sapota gives a strong antioxidant, anti-inflammatory, antiviral, antibacterial, and antiparasitic effect. The surplus nutrients in sapota promote the overall health and well-being of humans. The current research therefore focuses on developing nutritious and healthy bakery products using sweet potato flour and replacing refined sugar with an alternative natural sweetener viz., sapota concentrate. The present study “Quality evaluation of bakery products enriched with Sweet Potato Flour and Sapota Concentrate” was carried out to evaluate the nutritional properties and sensory characteristics of bakery products such as muffins and brownie by replacing refined flour and sugar with sweet potato flour and sapota concentrate respectively.

MATERIALS AND METHODS

Procurement of raw materials

Sweet potato and sapota were purchased from local market in Madurai. Other ingredients used for the preparation of bakery products such as wheat flour, sugar, butter, egg and cocoa powder were purchased from a departmental store in Madurai.

Preparation of sweet potato flour and sapota concentrate

The preparation of sweet potato flour and sapota concentrate were shown in Figure I and II respectively.

Formulation of bakery products

Different bakery products such as muffins and brownie were formulated with different proportions of sweet potato flour and sapota concentrate. The following table elucidated the proportions of different variations of bakery products.

Table 1 Proportion of sweet potato flour and sapota concentrate

Variations	Sweet potato flour	Sapota concentrate
I	100%	100%
II	50%	50%
III	100%	-
IV	-	100%

Development of muffins

The composite flour and a small amount of salt were sieved together. Muffins were prepared using sugar batter method. Butter and alternative sweetener were mixed and whipped for 5 to 10 minutes until it will become a creamy texture. Eggs were beaten for 10 minutes to become a foamy texture. Finally, the sieved composite flour was slowly added to the whipped egg mixture and baked in a preheated (170°C) oven for 20 to 25 minutes. After the baking process, the muffins were cooled and stored at room temperature.



Figure 1
Preparation of sweet potato flour

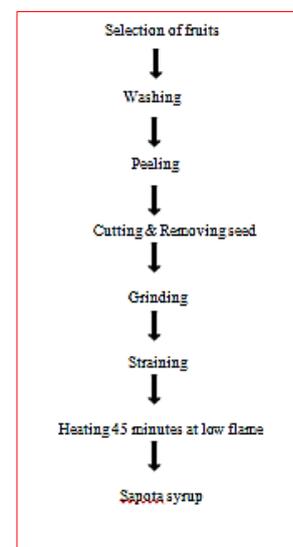


Figure 2
Preparation of sapota concentrate

Table 2 Composition of ingredients used in the preparation of Muffins

Ingredients	Control	Variation-1 Total replacement of refined flour and sugar	Variation-2 Partial replacement of refined flour and sugar	Variation- 3 total replacement of sugar only	Variation-4 Total replacement of flour only
Refined flour	50	-	25	50	-
Sweet potato Flour	-	50	25	-	50
Sugar	30	-	15	-	-
Sapota Concentrate	-	30	15	30	30
Egg	10	10	10	15	15
Butter	10	10	10	10	5

Table 3 Composition of different variations of brownie

Ingredients	Control	Variation-1 Total replacement of refined flour and sugar	Variation-2 Partial replacement of refined flour and sugar	Variation- 3 total replacement of sugar only	Variation-4 Total replacement of flour only
Refined flour	40	-	20	-	40
Sweet potato flour	-	40	20	40	-
Sugar	30	-	15	30	-
Sapota Concentrate	-	30	15	-	30
Egg	15	15	15	15	15
Butter	5	5	5	5	5
Cocoa powder	10	10	10	10	10

Development of brownie

The Sweet potato flour and a small amount of salt, cocoa powder was sieved together. Butter and sapota concentrate were mixed and whipped for 5 to 10 minutes until it will become a creamy texture. eggs were beaten for 10 minutes to become a foamy texture. Finally, the sieved composite flour was slowly added to the whipped egg mixture and baked in a preheated (180°C) oven for 30 minutes. After the baking process, the brownie was cooled and stored at room temperature.



Plate I Formulated muffins

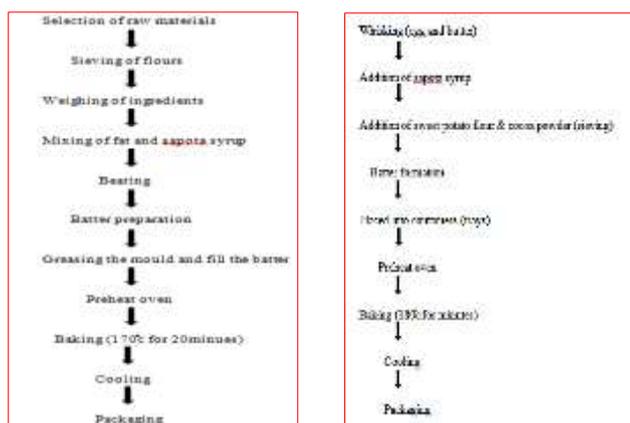


Figure 3 Development of muffins

Figure 4

Table 4 Proximate composition of control, muffin and brownie enriched with sweet potato flour and sapota concentrate (MESPFSC)

Nutrients	Muffin		Brownie	
	Control	MESPFSC	Control	BESPFSC
Moisture (%)	29.77	34.4	38.89	34.2
Ash (g)	2.82	6.2	4.3	7.6
Energy (Kcal)	529	626	379	476
Carbohydrate (g)	33.0	55.9	50	55.3
Protein (g)	6.8	9.1	2.76	3.9
Fat (g)	5.4	4.8	5.6	5
Beta carotene (mcg)	-	1593	-	1752
Iron (mg)	0.68	1.6	1.29	3.6
Calcium (mg)	17.1	18	33	47
Phosphorus (mg)	63	140	87.6	120

The moisture content of the muffins and brownie enriched with sweet potato flour and sapota concentrate were found to be 34.4 and 34.2% respectively. The proximate nutrient content of the muffins enriched with sweet potato flour and sapota concentrate was estimated and it was found to have

Sensory evaluation of the formulated bakery products

Sensory evaluation was carried out on the muffins and brownie formulations by a panel of 20 semi trained members with the help of a sensory score card. The score card was developed to test the organoleptic attributes of the muffins with a grading scale representing degree of liking from dislike to excellent, with a range of 1 being the minimum score and 9 being the highest one (Prakash, 2013). Data was analyzed for mean sensory scores of acceptability and using number of responses for descriptive quality.

Nutritional analysis

The formulated bakery products and their control samples were analyzed for nutritional composition. Moisture was determined using standard oven drying method. Total ash was determined by incineration of sample and measuring the weight of ash. The energy can be determined by oxidizing a known weight of food in a Bomb Calorimeter and the heat produced. Carbohydrate was estimated by Anthrone method. Determination of protein was carried out by Kjeldahl method. Fat content was determined by Soxhlet method. Ash solution was prepared and used to estimate the iron, calcium, and phosphorus contents. Iron was estimated by Wong's method, using spectrophotometry. Calcium was estimated by precipitation, followed by titration with standard potassium permanganate. Phosphorus and beta carotene estimation were also carried out spectrophotometrically by reading intensity of the blue colour developed.

Storage study

For storage studies, muffins and brownie and brownie and brownie were stored at room temperature in a PET (polyethylene terephthalate) container for seven days.

Statistical analysis

All the values were carried out in triplicates. All the data are expressed as mean.

RESULTS AND DISCUSSION

Proximate composition of the bakery products

The proximate composition of muffins and brownie enriched with sweet potato flour and sapota concentrate were presented in (Table 4).

55.9 g of carbohydrate, 9.1g of protein and 4.8 g of fat respectively. The proximate nutrient content of the brownie enriched with sweet potato flour and sapota concentrate was estimated and it was found to have 55.3 g of carbohydrate, 3.9 g of protein and 5 g of fat respectively. The beta carotene

content of the muffins and brownie were estimated to be 1593mcg and 1752mcg respectively. The iron content of the muffins and brownie were 1.6 and 3.6mg respectively. The calcium content of the muffins and brownie were 18 and 47mg respectively. The phosphorus content of the muffins and brownie were 140 and 120mg respectively. Thus, utilization of sweet potato flour and sapota concentrate into product development (muffins and brownie) as functional ingredient offers a unique opportunity to develop bakery products having enhanced nutrients.

Sensory characteristics of bakery products

The sensory characteristics of the bakery products enriched with sweet potato flour and sapota concentrate were presented in the (Figure 1, Figure 2). The effects of addition of sweet potato flour and sapota concentrate on the sensory quality of muffins and brownie were evaluated and judged as good for all formulations.



Plate II Formulated Brownie

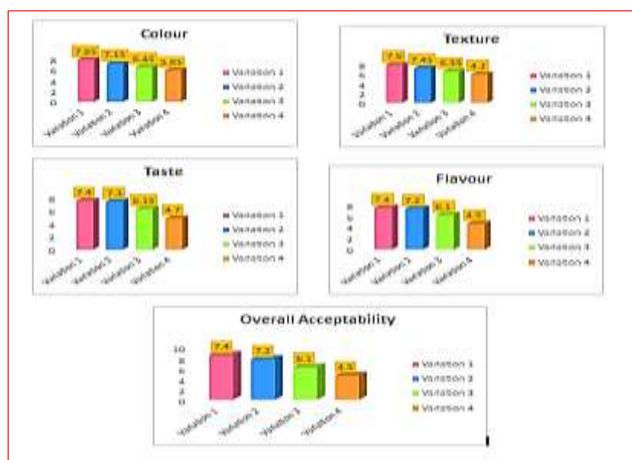


Figure 5 Sensory characteristics of Muffins Enriched with Sweet Potato Flour and Sapota Concentrate (MESPFC)

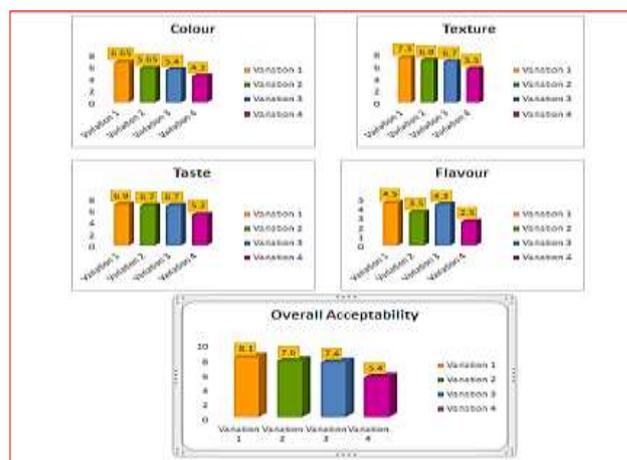


Figure 6 Sensory characteristics of Brownie Enriched with Sweet Potato Flour and Sapota Concentrate (BESPFSC)

CONCLUSION

The demand for gluten free product is increasing, sweet potato can replace refined flour, consumption of the sweet potato has been confederated with good health and boosted mortal nutrition. Sweet potato has antidiabetic agents, anti-cancer properties. In recent years, consumers have shown considerable interest for natural sweeteners as part of growing trend for healthful products. Sapota are found to have polyphenols, carotenoids, sterols, saponins, terpenes and vitamins. Sapota also has antioxidants that overcomes the oxidative stress, antimicrobial property, anti-inflammatory property, analgesic property, antitumor, antidiabetic,

anticholesterolemic, antidiarrheal property. Processing and value addition of bakery products with highly nutritious, underutilized tubers and fruits may help to improve the nutritional and economic status of the population. The current research therefore focuses on developing nutritious and healthy bakery products using sweet potato flour and replacing refined sugar with an alternative natural sweetener viz., sapota concentrate. The results indicated that the addition of sweet potato flour and sapota concentrate increases the nutritional profile of muffins and brownie. The incorporation also increases the overall acceptability of products in terms of colour, taste, texture and flavour. Therefore, the formulated muffins and brownie serve as economic substitutes for refined flour and sugar, respectively, and provide a healthier product.

LITERATURE CITED

1. Ayele HH, Bultosa G, Abera T, Astatkie T. 2017. Nutritional and sensory quality of wheat bread supplemented with cassava and soybean flours. *Cogent Food Agric.* 3:1331892.
2. Clemens, R. A., Jones, J. M., Kern, M., Lee, S. Y., Mayhew, E. J., Slavin, J. L., and Zivanovic, S. 2016. Functionality of Sugars in Foods and Health. *Comprehensive Reviews in Food Science and Food Safety*, 15(3): 433–470.
3. Gehan I. Abd El-Wahab, (2016). Utilization of Sweet Potato Flour as Natural Antioxidant to Keeping Quality of Butter Cake during Storage, *Middle East Jr. Appl. Sci.*, 6(4): 1066-1075.
4. Lanzerstorfer P, Rechenmacher E, Lugmayr O, Stadlbauer V, Höglinger O, Vollmar A. 2018. Effects of various commercial whole-grain breads on postprandial blood glucose response and glycemic index in healthy subjects. *Austin Jr. Clin. Med.* 5: 1031.
5. Martinez, M. M., Gomez, M. 2019. Current trends in the realm of baking: When indulgent consumers demand healthy sustainable foods. *Foods* 8(10): 8–10.
6. Shipra Chaudhary and Rajeev Kumar. 2020. Sapota fruit attributed health benefits and its food applications: A review. *Int. Jr. Curr. Res. Aca. Rev.* 8(5): 124-128.

Alginate Extraction from Brown Seaweed (*Sargassum wightii*)

Josephine Jesintha J^{*1} and Karthiga K²

^{1,2}Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India

Correspondence to: Josephine Jesintha J, Fatima College (Autonomous), Madurai - 625 018, Tamil Nadu, India, Tel: +91 9994782780; E-mail: jjesintha16@gmail.com

Abstract

Seaweeds are 'macro algae' which means 'large algae'. They are a group of autotrophic, plant like organisms containing chlorophyll. Rameshwaram, Pamban, Keelakarai and Mandapam areas of South Tamil Nadu coast has rich marine algae vegetation. Edible seaweeds maybe considered as easy sources of nutrients such as minerals and trace elements, vitamins and polyphenols due to their availability. Seaweeds are used as human food, animal fodder, chicken (birds) and aqua (fishes) feed, manure and liquid seaweed fertilizer for crops, besides their use as phytochemicals (agar, agarose, alginate and carrageenan). They also serve as medicines and antioxidants. The present study is undertaken to compare the extraction of alginate by two methods. Sea weed species, *Sargassum wightii* (Brown) were collected from the coast of Gulf of Mannar and used to extract the alginate by using hot and cold method. Alginate from the brown seaweed by using hot method yields 17.2%, cold method yields 39.15% of alginate. And phytochemical analysis was done in the extracted alginate. The phytochemical results indicated the absence of alkaloids, phlobatannins, flavonoids, steroids, terpenoids, cardiac glycosides and phenols. Only carbohydrate as well as sugar derivative of saponins and tannins were found to be present in the alginate.

Key words: Alginate, Extraction, Purity, Phytochemicals

Seaweeds are marine macro algae growing abundantly in the shallow waters of sea, estuaries and backwaters up to a depth of 118 m where 0.1 percent photosynthetic light is available. They are primitive plants that maybe very tiny or large, growing up to 30 m long. Seaweeds are found attached to rocks in the intertidal zone or washed up on the beach and floating on the ocean's surface. Depending upon the photosynthetic pigments present in seaweeds, they are classified into four major divisions such as Chlorophyta (green algae), Phaeophyta (brown algae), Rhodophyta (red algae) and Cyanophyta (blue green algae) [1]. More than 20,000 seaweeds are distributed throughout the world, of which only 221 species (1.1 percent) are commercially utilized. This includes 145 species for food and 110 species for phycocolloid production [2]. The recorded 842 seaweed species from Indian waters comprises of 68 families and 271 genera, which includes 217 Chlorophyta, 191 Phaeophyta and 434 Rhodophyta species [3].

Tamil Nadu was recorded with 104 species of seaweeds comprised of 37 Chlorophyta, 21 Phaeophyta and 44 Rhodophyta [4]. Over the past 50 years, the utilization of algae has increased considerably, with the consequent increase in applied research in various related fields [5]. Seaweeds have been documented to contain many phytochemicals such as antioxidants and microbicidal molecules such as polyphenols, protein, amino acids, sulphated polysaccharides, derived carotenoids such as violaxanthin and fucoxanthin, carrageenans and alginates [6]. Fucan, fucoidan, galactan sulphate,

xylomannan sulphate, and porphyran are some bioactive polysaccharides from seaweed [7].

The nutritional value of seaweeds is really profound and they are used as human food in different countries. Presently, there are 42 countries in the world that exploits seaweeds commercially. Among them, China holds first rank followed by North Korea, Japan, Philippines, Chile, Norway, Indonesia, USA and India. These top ten countries contribute up to 95% of the world's commercial seaweed utilization [8].

Nowadays, Marine plant resources are attracting more and more attention as a raw material for the production of phytochemicals such as Alginic acid, agar-agar, carrageenan, iodine and the like, which are widely used in several industries involved in the manufacture of certain food materials, fertilizers and pharmaceuticals. Brown algae are a promising object in the food industry and prophylactic and clinical medicine. The word alginate is a generic term, meaning the various derivatives of alginic acid that either occur naturally in certain brown seaweeds (alginophytes), are produced from the natural derivatives.

Alginate is a linear glycuronan of (1,4)-linked α -L-guluronate (G) and β -D-mannuronate (M) residues arranged in a non-regular block wise pattern along the chain. The actual chemical structure of the alginate varies between genera, and a similar variability is found in the properties of the alginate that is extracted from the seaweed. The molecular weight of alginate ranges generally between 500 and 1,000 kDa. Its solubility is

influenced by factors such as pH, concentration, ions in solution and the presence of divalent ions. The properties of the alginate vary between species, so the choice of which seaweeds to harvest is based on both the availability of particular species and the properties of the alginate that they contain. The main commercial sources are species of *Ascophyllum*, *Durvillaea*, *Ecklonia*, *Laminaria*, *Lessonia*, *Macrocystis*, *Sargassum* and *Turbinaria* [9]. Alginates are widely used in the pharmaceutical, cosmetic, food and biotechnology industries to produce products such as paper coatings, adhesives, dyes, gels and explosives. The quality of alginate is determined by how well it performs in thickening aqueous solutions and forming gels [10].

Alginic acid is present in brown seaweeds mainly in the form of calcium salt of alginic acid, although other salts such as sodium might be present. The purpose of the extraction step is to convert the alginate to the soluble form of sodium alginate and remove it from the algae [11].

In comparison to the fiber content of the foods derived from terrestrial plants, seaweed has similar or even higher levels of dietary fiber. The average total dietary fiber content in seaweed can be varied from 36% to 60% based on its dry matter. Nearly, 55–70% of its total dietary fiber is represented by the soluble fiber fraction which mainly comprises agar, alginates, and carrageenan at varying amounts depending on the type of seaweed and the growing conditions. Some studies tell that including the alginate in the diet 1-3 % can reduce hypertension. In addition, it can also lower the blood glucose level. And alginate shows anti-cancer activities and pre-biotic properties that promote health, strong free radical scavenging activity, and reno protective effect [12].

Soluble fiber in seaweed can bind with water 20 times of their own volume exhibiting strong hydro colloidal properties of its network structure. Therefore, seaweed added to the diet can enhance water binding to the food pellet in the gut and facilitate stool bulking, and decrease transit time in the colon, that act as positive factors to prevent colon cancer. The viscous indigestible masses of fiber in the gut trap toxins and other cancerous material in the digested food, and those are then expelled through the feces. Thereby, they help to protect the surface membrane of the digestive tract against potential carcinogens. Studies carried out using the laboratory animal models revealed that some seaweed fibers are effective in controlling chemically induced gut cancer. Different diets consisting 0.05–0.2% seaweed powders of *Eiseniabicyclis*, *Laminaria angustata* and *P. tenera* were tested in intestinal tumor induced rats with potent intestinal carcinogen, 1,2-dimethylhydrazine, and after 20 days, the tumor incidence was clearly reduced at varying degrees [13].

The aim of this study is to compare the extraction of alginate from *Sargassum wightii* and *Gracilaria corticata* and its impact on obese rats, an easily available seaweeds in Mandapam (9°16'32.56"N and 79°07'25.03" E), Keelakarai coastal region, Ramanathapuram district.

MATERIALS AND METHODS

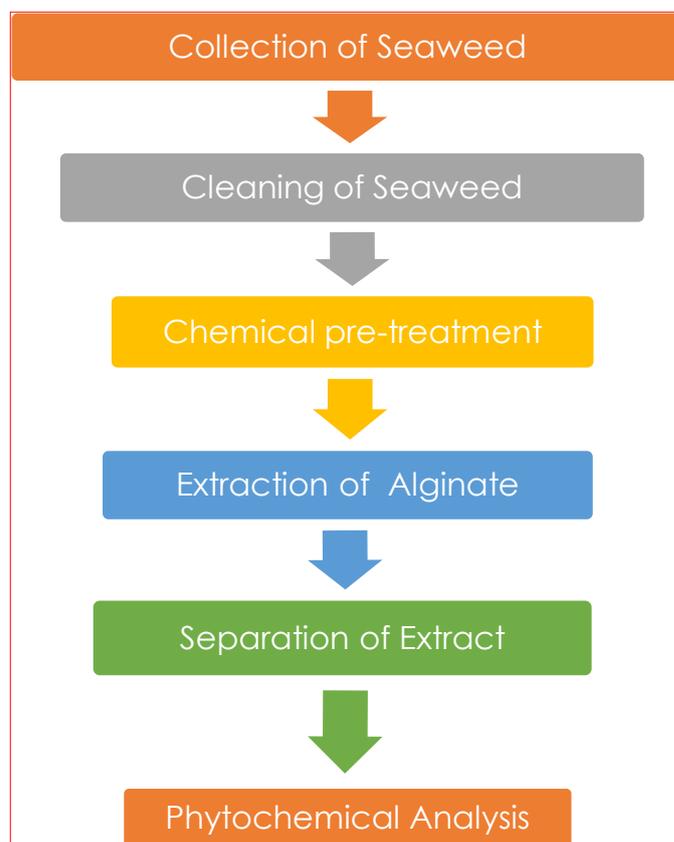
Seaweed collection and processing

The seaweed *Sargassum wightii* was purchased in Mandapam (9°16'32.56"N and 79°07'25.03" E), Keelakarai coastal region, Ramanathapuram district. The seaweeds was washed with clean seawater first. They were then washed with clean freshwater and allowed to drain. The sea weeds were then dried in a cabinet dryer at 60°C for 3 hours. The dried seaweeds were stored in polyethylene bag for further usage.



Figure 1 *Sargassum wightii*

The design adopted for “Alginate Extraction from Brown seaweed (*Sargassum wightii*)” is shown in (Figure 2).



Cleaning of seaweed

Seaweed was washed with deionised water and air dried in the shade at room temperature. dried samples were individually cut into small pieces (2-3cm) homogenized and stored.

Extraction of alginate

Alginate is used as stabilizing and emulsifying agent, gelling agent, in film forming (binding and glazing agent), in medicinal applications, in textile products, in bio – engineering as well as in food, dairy, paper and rubber products (Bixler and Porse 2011, Mc Hugh 2003). Alginate constitutes a production system of bioactive compounds such as polysaccharides, proteins, minerals, lipids including polyunsaturated fatty acids,

pigments, vitamins, antioxidants, etc., which are known to have antibacterial, antifungal, antiviral, antioxidative, anti-inflammatory and antitumor properties (Mc Hugh 2003).

Procedure for extraction of alginate

The sodium alginate was extracted from seaweed by the modified method of Torres et al. (2007). Alginate was extracted by two methods. In the cold method, two sets of 20 g of air-dried seaweed samples were soaked in 300 mL of 1% CaCl₂ solution at room temperature (27°C) overnight (around 18 h). Then, the seaweed was washed with distilled water (3×300 mL), stored in 5% HCl solution for 1 h and washed again with distilled water (3×300 mL). After that, the samples were stored in 300 mL of 3% Na₂CO₃ solution for 1 h and 250 mL of water was added into it before it was left to stand overnight. The viscous mixture was separated from its residue by centrifuging at 14,000×g. Sodium alginate extracted was precipitated from the solution by adding an ethanol/water mixture (1:1, v/v). The precipitate was filtered, washed with ethanol again and dried in air, followed by drying in a vacuum oven. In the hot method, samples were treated similarly as the cold method, except that the storing time was 3 h at 50°C.

$$\text{Yield of alginate (\%)} = \frac{\text{weight of the alginate}}{\text{weight of dry seaweed}} \times 100$$



Determination of purity of alginate (Phytochemical analysis)

To determine the purity of sodium alginate, tests for alkaloids, carbohydrates, flavonoids, steroids, phlobatannins, glycosides, terpins, saponins, tannins and phenols were carried out using standard methodologies (Harborne, 1973; Trease and Evans, 1989; Sofowora, 1993).

Alkaloids

0.5g of sodium alginate was dissolved in 10ml of diluted HCl (0.1N) and filtered. The filtrate was used to test the presence of alkaloids. Dragendroff's reagent was added to the filtrate, formation of red colored precipitate indicated the presence of alkaloids.

Saponins

0.5 g of sodium alginate was dissolved in 5 ml of distilled water in a test tube. The solution was shaken vigorously and observed for a stable persistent froth. The frothing was mixed with 3 drops of olive oil and shaken vigorously. An appearance of creamy mass of small bubbles indicated the presence of saponins.

Tannins

0.5 g of sodium alginate was boiled with 10 ml of distilled water in a test tube and then filtered. A few drops of 0.1% ferric chloride was added and observed for brownish green or a blue-black coloration indicated the presence of tannins.

Phlobatannins

0.5 g of sodium alginate was dissolved in 5ml of distilled water and filtered. The filtrate was boiled with 2% HCl solution. Red precipitate indicated the presence of phlobatannins.

Flavonoids

0.5 g of sodium alginate was dissolved in diluted NaOH and then HCl was added. A yellow solution that turns colorless indicated the presence of flavonoids.

Steroids

2ml of acetic anhydride was added to 0.5 g of sodium alginate with 2 ml of H₂SO₄. The colour changed from violet to blue or green in samples indicated the presence of steroids.

Terpenoids (Salkowski method)

0.5 g of sodium alginate was added to 2 ml of chloroform. Then 3ml of concentrated H₂SO₄ was carefully added to form a layer. A reddish-brown coloration of the interface indicated the presence of terpenoids.

Phenolics

100mg of sodium alginate was boiled with 1ml of distilled water and filtered. Then 2ml of filtrate was taken and 2ml of 1% ferric chloride solution was added in a test tube. Formation of bluish black color indicated the presence of Phenolic nucleus.

Carbohydrates (Molisch's test)

500mg of sodium alginate was dissolved in 5ml of distilled water and filtered. The filtrate was used to test the presence of carbohydrates. To 1ml of filtrate, 2 drops of Molisch's reagent was added in a test tube and 2ml of Conc. H₂SO₄ was added carefully along the side of the test tube. Formation of violet ring at the junction indicated the presence of carbohydrates

RESULTS AND DISCUSSION

Extraction of alginate from brown (*Sargassum wightii*) by hot and cold methods

Alginate was extracted by hot and cold methods in brown seaweed and determined the extraction yield of alginate.

Table 1 Comparison of Alginates from Brown seaweed and red seaweed

S. No.	Samples	Method I (Cold method)	Method I (Hot method)
1.	Brown seaweed (<i>Sargassum wightii</i>)	17.2%	39.15%

The result shows that extraction of alginate in brown seaweed by cold method is 17.2% and by hot method is 39.15%. When comparing both methods brown seaweed by extracting using hot method gives 39.15%, provides high extraction yield.

Phytochemical analysis of extracted alginate

The phytochemical results indicated the absence of alkaloids, phlobatannins, flavonoids, steroids, terpenoids, cardiac glycosides and phenols. Only carbohydrate as well as sugar derivative of saponins and tannins were found to be present in the sodium alginate, which confirmed the better purity of the extracted alginate.

CONCLUSION

In the present study alginate was extracted by hot and cold methods in brown (*Sargassum wightii*). Results shows brown seaweed contain high alginate and hot method provides high extraction yield. The phytochemical analysis was carried out in the present study to determine the purity of the extracted alginate. The result indicated that the extracted alginate of *Sargassum wightii* is pure form and it has no trace of alkaloids, phlobatannins, flavonoids, steroids, terpenoids, cardiac glycosides, phenols, but the only element carbohydrate and its derivative saponins and tannins were present, which confirmed its better purity.

LITERATURE CITED

1. Chapman, V. J., & Chapman, D. J. 1980. Sea vegetables (algae as food for man). In *Seaweeds and their Uses*, (pp. 62-97). Springer, Dordrecht.
2. Chennubhotla, V. S., Rao, M. U., and Rao, K. S. 2013. Commercial importance of marine macro algae. *Seaweed Research and Utilization*, 35(1/2), 118-128.
3. Reddy, C. R. K., Rao, P. V. S., Ganesan, M., Eswaran, K., Zaidi, S. H., & Mantri, V. A. 2006. The seaweed resources of India. *World Seaweed Resources*, Eti Information Services Ltd., Wokingham, Berkshire, UK, pp.25.
4. Sahoo, D. (2010). Common Seaweeds of India. IK International Pvt Ltd., pp.2-7
5. Tiwari, B. K., & Troy, D. J. (2015). Seaweed sustainability-food and non-food applications. In *Seaweed Sustainability* (pp. 1-6). Academic Press.
6. Hernandez-Carmona G, McHugh DJ, Arvizu-Higuera DL, Rodriguez-Montesinos YE. 1999. Pilot plant scale extraction of alginates from *Macrocystis pyrifera*. 1: Effect of pre-extraction treatments on yield and quality of alginate. *J Appl Phycol* 10:507-513
7. McHugh, D. J. 2003. A Guide to the Seaweed Industry. FAO fisheries technical paper.
8. Zhang, J. 2007. Antidiabetic properties of polysaccharide- and polyphenolicenriched fractions from the brown seaweed *Ascophyllum nodosum*. *Can. Jr. Physiol. Pharmacol.* 85(11), 1116-23.
9. West, J., Calumpang, H. P., & Martin, G. 2016. Seaweeds. The First Global Integrated Marine Assessment World Ocean Assessment I
10. Dagar, J.C., Sharma, P.C., Sharma D.K and Singh A.K. 2016. Innovative Saline Agriculture, Springer Publications, India, Pp-104.
11. Jimenez-Escrig, A., & Sanchez-Muniz, F.J. 2000. Dietary fibre from edible seaweeds: chemical structure, physicochemical properties and effects on cholesterol metabolism. *Nutrition Research* 20(4): 585-598.
12. Hurd, C.L., Harrison, P.J., Bischof, K and Lobban, C.S. 2014. *Seaweed Ecology and Physiology*, Second Edition, Cambridge University Press, UK, pp 5.
13. Sumayya, S. S., Bosco, L., Manoj, G.S., & Murugan, K. 2015. Prospects of seaweeds as sources of bioactive phytochemicals: a search along coastal belts of Kerala. *World Journal of Pharmaceutical Research* 5(3): 982-990.