Open Access

CARAS

© 2023, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

International Conference on "Millets- Ensuring Food Security and Sustainable Farming"
Volume 14; Issue 04 (July-Aug 2023); pp 909–915

Full Length Research Article

Formulation of Beta Carotene and Fibre Rich Nutritious Bar using Sweet Potato (*Ipomoea batatas*) and Millets

Abinaya G. P[1] and Thilakavathy S*[2]

[1-2] Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India

Correspondence to: Thilakavathy S, Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India, Tel: +91 9994327041; E-mail: thilakavathy_fsn@avinuty.ac.in

Abstract

Vitamin A is important for the regulation of various bodily functions and vitamin A deficiency is higher among children with lower socio-economic status. Hence the present study aims to formulatebeta carotene and fiber-rich nutritious bar using sweet potato (*Ipomoea batatas*) and millets. The oriental (yellow-fleshed) and Hannah (white-fleshed) sweet potatoes, popped finger millet, pearl millet and sorghum millet were mainly used in the study. The functional properties, phytochemicalsand nutrients of the oriental and Hannah sweet potato flours were analyzed. Millet bars such as popped finger millet bar, popped pearl millet bar and popped sorghum millet bar were prepared withthe incorporation of Oriental and Hannah sweet potato flour and sensory analysis was done. Based on the nutrient profile of the sweet potato flours, the oriental sweet potato flour incorporated millet bars were subjected to nutrient analysis. The microbial content, texture and shelf life of all the developed products were determined using appropriate methods. The popped bajra millet bar with oriental sweet potato flour had the highest beta-carotene content of 211µg/100g. The popped sorghummillet bar with Oriental and Hannah sweet potato flour had the lowest total plate count and the highestshelf life compared to all products.

***Key words*:** Beta carotene, Fibre, Oriental sweet potato, Hannah sweet potato, Millets

The most crucial factor in protecting human health and overall physical well-being is the nutrient composition of food. Even though the number of micronutrients needed in a balanced diet is very small, they have a significant influence on a person's physical and mental development. Vitamin A is an essential micronutrient required for the proper functioning of many biological processes of the body which includes ensuring proper growth and development, good vision, healthy reproduction, and healthy cell growth. Since the human body cannot naturally produce vitamin A, it must be acquired through diet. According to estimates, children with lower socioeconomic class are much more likely to be vitamin A deficient due to decreased food consumption and depleted vitamin A reserves in the body. Factors that increase the risk are high prevalence of infectious diseases like hookworm infestations, some respiratory diseases, diarrhea and measles (Rajya Lakshmi Devi and Thilakavathy 2021). Foods sources rich in beta–carotene include mangoes, carrots, papaya and sweet potato. Since long back, several international initiatives have been established to treat vitamin A deficiency and prevent night blindness. Among the various strategies, the food-based approach aids in accomplishing and sustaining an adequate intake of foods high in micronutrients. In terms of production and consumption, the sweet Potato (*Ipomoea batatas*) is the second-most significant root and tuber after potato. The Oriental sweet potato has 293.28 mcg/ml of flavonoids. The flesh of hannah sweet potato has the highest phenol concentration of 1285.25mcg/ml. The vitamin A found in sweet potatoes is important for the production of some necessary hormones during pregnancy and lactation. (Rajya Lakshmi Devi Yenmula & Thilakavathy,2018). Significant interest has recently been generated by the use of sweet potato flour as a component in functional foods. The essential nutritional content of sweet potato flour serves as a base for innovative food formulations (Dereje 2020). Phytochemicals and micronutrients present in millets make them one of the most important cereal grains. Some of the important millets include Sorghum, Pearl millet, Finger millet, Kodo millet, Proso millet, Foxtail millet, little millet and Barnyard millet (Bhatt *et al*. 2022). Millets that have been biofortified have an assurance of alleviating the deficiencies of micronutrients in countries that are developing. Since millets are less expensive than other cereals, they may be the best option for fortification. Millets flours may be used in a variety of culinary preparations due to the presence of particular bioactive components and significant nutrients like protein, fibre, and minerals. Millet-based snack bars are small rectangular nutritional food bars that provide a fast, appropriate food source requiring simple preparation with high shelf life and no requirements for storage in refrigerators (Singh *et al*. 2021). Due to the growing consumer demand in consuming nutritious food products and various beneficial

aspects of sweet potato and millets, the oriental and Hannah sweet potato flour was incorporated into the different millet bars. Thus, Pearl millet bar, Finger millet bar and Sorghum millet bar were prepared and to these millet bars oriental and hannah sweet potato flours were incorporated at various levels and their acceptability was tried out.

MATERIALS AND METHODS

Selection and collection of Oriental and Hannah variety of sweet potatoes

The Oriental sweet potato with pink colour peel with a yellow flesh and the Hannah sweet potato with brown colour with white flesh were selected for the development of sweet potato millet bars. The deeper the color of the sweet potato, the richer the beta-carotene content present in it. Small to medium-sized firm sweet potatoes with smooth skin and no bruises or cracks were chosen. The Oriental and Hannah variety of sweet potatoes were collected from the local area of Saibaba Colony, Coimbatore.

Processing of Oriental and Hannah varieties of sweet potato

Both varieties of sweet potato were washed well in running tap water to remove the dirt and sand particles. The clean tubers were peeled manually using vegetable peeler and sliced into 2mm thickness using a slicer. the peeled and sliced sweet potatoes were pre-treated with 100ml water with 0.1% citric acid for 10 minutes to arrest the enzymatic browning and the slices were steam blanched for 3 minutes as steam blanching of sweet potato helps in higher retention of color and nutrients (Marangoni Junior *et al*. 2019).

The sliced sweet potatoes are spread uniformly in a tray and were dried at 45°C for 6 hours in a cabinet drier. After the complete drying of the sweet potato slices, it was powdered with the help of a pulverizer. The powdered flour was sieved to remove any coarse particles to obtain a fine powder of the flour. The powdered flour was stored in airtight containers.

Determination of functional properties, analysis of phytochemicals and nutrients of the oriental and hannah variety of sweet potato flour

Determination of functional properties of Oriental and Hannah varieties of sweet potato flour

Water absorption capacity, Oil absorption capacity and Swelling power

The water absorption capacity of the Oriental and Hannah sweet potato flours were analyzed based on the protocol given by Sosulski *et al*. (1976). The oil absorption capacity of the Oriental and Hannah sweet potato flours was determined according to protocols given by Robertson *et al*. (2000). The swelling power of Oriental and Hannah sweet potato flours was determined based on protocols given by Leach *et al*. (1959).

Analysis of Phytochemical compounds present in Oriental and Hannah varieties of sweet potato flour

The ethanolic extracts were prepared as per the procedure described by Salawu *et al*. (2015). The alkaloids, flavonoids, saponins, tannins, terpenoids and anthraquinones were analyzed using the protocols given by Shaikh and Patil (2020).

Analyzing the nutrients present in Oriental and Hannah varieties of sweet potato flour

The different nutrients namely Energy, carbohydrate, protein, fat, fibre, calcium, iron, beta carotene and vitamin C of the selected Oriental and Hannah varieties of sweet potato flour were analyzed in the laboratory using AOAC (1990) official method of analysis.

Formulation and standardization of millet bars incorporating Oriental and Hannah sweet potato flour.

Selection of ingredients for the development of Oriental and Hannah variety sweet potato flour incorporated millet bars

Good quality of pearl millet, finger millet, sorghum, roasted groundnut, white sesame seeds, jaggery and dark chocolate was collected from the local stores of Townhall, Coimbatore.

Popping of the millets [Pearl millet, Finger millet and Sorghum]

The (Figure 1) represents the flowchart for the preparation of popped pearl millet, finger millet and sorghum millet flour:

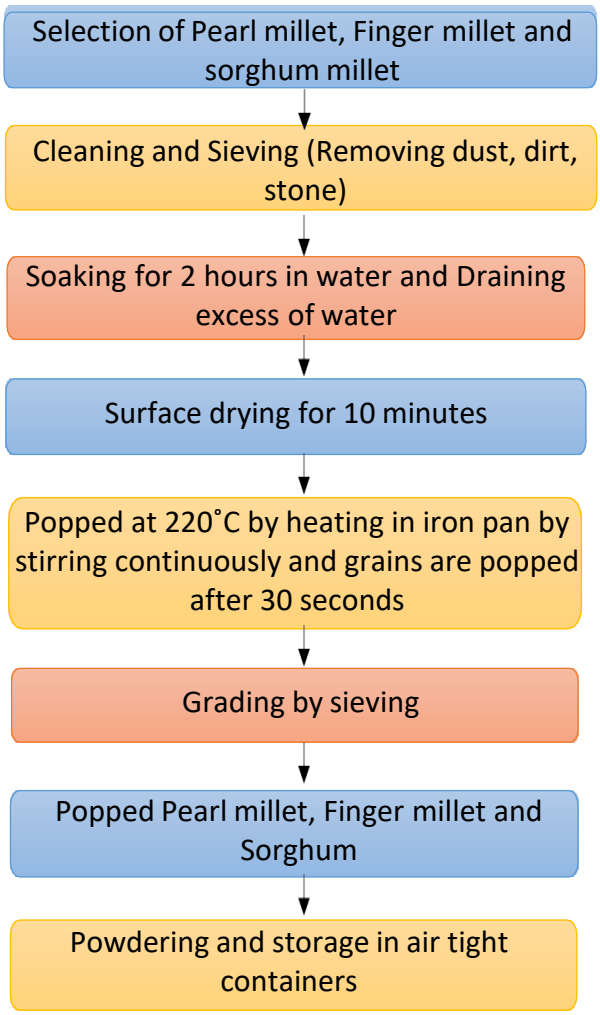

Fig 1 Flowchart for the preparation of popped pearl millet, finger millet and sorghum millet flour

The popping yield was determined as per the method given by Malleshi and Desikchar (1981). White sesame seeds were dry roasted and the dark chocolate was double-boiled and melted to get the chocolate sauce.

Popped finger millet, pearl millet and sorghum millet bars incorporating oriental and hannah sweet potato flour

Table 1 represents the composition of the popped sweet potato millet bars.

Table 1 Composition of popped finger millet, pearl millet and sorghum millet bars incorporated with Oriental and Hannah sweet potato flour

Ingredients	Standard	Variation I	Variation II	Variation III
Popped finger millet bars incorporated with Oriental and Hannah sweet potato flour				
Sweet potato flour (Both Oriental and Hannah variety)	-	40	50	60
Jaggery (g)	100	100	100	100
Popped finger millet flour (g)	90	50	40	30
Peanuts(g)	5	5	5	5
Sesame seeds(g)	2	2	2	2
Dark chocolate (g)	3	3	3	3
Popped pearl millet bars incorporated with Oriental and Hannah sweet potato flour				
Sweet potato flour (Both Oriental and Hannah variety) (g)	-	40	50	60
Jaggery (g)	100	100	100	100
Popped pearl millet flour (g)	90	50	40	30
Peanuts (g)	5	5	5	5
Sesame seeds (g)	2	2	2	2
Dark chocolate (g)	3	3	3	3
Popped sorghum millet bars incorporated with Oriental and Hannah sweet potato flour				
Sweet potato flour (Both Oriental and Hannah variety)	-	40	50	60
Jaggery (g)	100	100	100	100
Popped sorghum millet flour (g)	90	50	40	30
Peanuts (g)	5	5	5	5
Sesame seeds (g)	2	2	2	2
Dark chocolate (g)	3	3	3	3

For the preparation of popped millet sweet potato bar, all the pre-processed ingredients (sweet potato flour, respective millet flour, roasted sesame seeds and coarsely powdered roasted groundnuts) were mixed well and kept aside. In a thick-bottomed vessel, jaggery and water are added in a ratio of 2:1 and once the jaggery melts, the jaggery syrup is strained to remove the unwanted substances and it is again allowed to boil until it reaches the hard ball stage. Once the hard ball stage is reached, the vessel is taken off from the flame and all the pre-processed ingredients are added to the jaggery syrup and mixed well. On a flat surface, ghee is applied on butter paper and the mixture is poured and rolled evenly and cut into rectangular bars using a stainless-steel knife. After the bars are cooled, it is dipped inside the double-boiled dark chocolate sauce.

Organoleptic Evaluation of the developed products

The developed products were organoleptically evaluated by 30 semi-trained panel members in the Food Sensory Laboratory at Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. Bar samples were presented on odourless white ceramic plates at ambient temperature. Panelists were instructed to use the drinking water to cleanse their palates before tasting the samples and at any time during the test as needed. The sensory characteristics of the developed products like Appearance, Taste, Colour, Texture, Flavour and Overall acceptability were assessed using the 9- point Hedonic Scale. Using the SPSS software, the data obtained were statistically analyzed 31 by One Way ANOVA, Post hoc and DMRT which is used to determine statistically significant differences between the samples.

Nutrient Analysis of the Oriental sweet potato flour bars incorporated millet bars

Two varieties of sweet potato flours (Oriental and Hannah) were analysed for all the nutrients. After the analysis, the Oriental sweet potato flour that had high beta carotene level and hence the Oriental sweet potato flour incorporated bars were analyzed for the nutrient in the laboratory. The moisture, ash, energy, carbohydrate, protein, fat, fibre, calcium, iron, vitamin C, beta carotene was analyzed in the Oriental sweet potato flour incorporated millet bars following the standard AOAC (1990) procedure.

Analyzing the microbial content, texture characteristics and shelf life of all the prepared sweet potato millet bars.

Microbial Analysis

The microbial load was assessed by the pour plate method as described by Geetha *et al*. (2019).

Texture Analysis

Textural characteristics were determined according to a three-point bending test using a texture profile analyzer (Model: EZ – XS, Shimadzu Corporation, Japan). The hardness and adhesiveness values of the prepared bars were determined. The measurement was done with a test speed of 1mm/sec. The sample was placed centrally under the three-point bending rig probe until the probe came in contact with the sample. The peak force was recorded as the hardness value of the bars.

Shelf-life analysis by accelerated shelf-life study

Oriental and Hannah sweet potato millet bars were packaged in LDPE laminated stand-up paper pouches and was selected for storage studies. In this method, one set of packets was stored in an incubator (45 ºC) and the other set was stored at ambient temperature for 30 days. After every 5 days interval, samples were drawn for moisture analysis. Samples were randomly collected for analysis during the storage period.

RESULTS AND DISCUSSION

Selecting, drying and powdering of the Oriental and Hannah sweet potato flour

Hundred grams of fresh samples of the Oriental and Hannah sweet potatoes were taken and after drying 42g and 40g of Oriental sweet potatoes and Hannah sweet potatoes were

obtained respectively. The sweet potato flour obtained from Oriental and Hannah sweet potatoes were 40g and 38 g respectively. After sieving the weight of the Oriental and Hannah sweet potatoes were 38g and 36g respectively. A supported study by Trang *et al*. (2020) revealed that sweet potatoes contain 62.7% moisture.

Determination of functional properties, analysis of phytochemicals and nutrients of the oriental and hannah variety of sweet potato flour

Determination of functional properties of Oriental and Hannah Sweet potato flour

Functional properties of Oriental & Hannah varieties of sweet potato flour are shown in (Table 2).

Data depicted in (Table 2) revealed that the water absorption capacity of Oriental sweet potato flour and Hannah sweet potato flour is 295g and 250g respectively. The Oil absorption capacity of Oriental and Hannah sweet potato flour was 110±0.10 and 95±0.05 respectively. Findings of a study carried out by Azima *et al*. (2020) reported that the oil absorption capacity of yellow sweet potato and white sweet potato was 1.152g/g and 1.150g/g respectively. The swelling power of Oriental and Hannah sweet potato flour was 3.45g/g and 3.35g/g respectively.

Table 2 Functional properties of Oriental and Hannah varieties of sweet potato flour

Functional properties	Mean ± SD	
	Oriental sweet potato flour	Hannah sweet potato flour
Water absorption capacity (g/100g)	295±0.07	250±0.03
Oil absorption capacity (g/100g)	110±0.10	95±0.05
Swelling power (g/g)	3.45±0.01	3.35±0.03

Analyzing the Phytochemical compounds present in Oriental and Hannah varieties of sweet potato flour

Phytochemicals are compounds that are produced by plants. Some of these phytochemicals are believed to protect cells from damage that could lead to disease (Mahajan *et al*. 2012). Table 3 gives the details on the phytochemical compounds present in oriental and hannah sweet potato flour.

Table 3 Phytochemical profile of Oriental and Hannah sweet potato flour

Phytochemicals	Oriental sweet potato flour	Hannah sweet potato flour
Alkaloids	++	++
Flavonoids	+++	+++
Saponins	+++	+++
Tannins	++	-
Terpenoids	+++	++
Anthraquinones	-	-
Phenolic compounds	++	++

(+++) –Highly Present, (++) -Moderately Present, (+) -Presence, (-)-Absence

Flavonoid and saponin were highly present; Alkaloid, tannin, terpenoid and phenolic compounds were present moderately whereas anthraquinone was absent in both Oriental and Hannah sweet potato flour.

Analyzing the nutrients present in Oriental and Hannah varieties of sweet potato flour

(Fig 2) represents the comparison of nutrients present in oriental and Hannah sweet potato flour.

From the above results, it was inferred that the nutrients and beta carotene present in the oriental sweet potato flour was higher when compared to hannah sweet potato flour. Therefore, the nutrient content of the Oriental sweet potato flour incorporated millet bars were analyzed in the laboratory.

Formulation and standardization of the millet bars incorporating oriental and Hannah sweet potato flours.

Popping of millets (finger millet, pearl millet and sorghum)

100g of finger millet, pearl millet and sorghum were taken. The popping yield of finger millet, pearl millet and sorghum millet were 80%, 60% and 40% respectively.

Organoleptic Evaluation of the developed products

a. Popped finger millet bar, pearl millet bar and sorghum millet incorporated with Oriental sweet potato flour

With regard to the overall acceptability of sweet potato popped finger millet bar, variation I scored the highest score of 8.9±0.3 followed by standard, variation III and variation II with score of 8.8±0.3, 8.1 ± 0.5 and 7.0±0.4 respectively. With regard to the overall acceptability of sweet potato popped pearl millet bar, variation III scored the highest score of 8.9±0.2 followed by standard, variation I and variation II with score of 8.8±0.3 ,8.1±0.4 and7.0±0.4 respectively. With regard to the overall acceptability of sweet potato sorghum finger millet bar, variation 3 scored the highest score of 8.9±0.4 followed by standard, variation I and variation II with score of 8.8±0.3, 7.9±0.3 and 7.0±0.3 respectively.

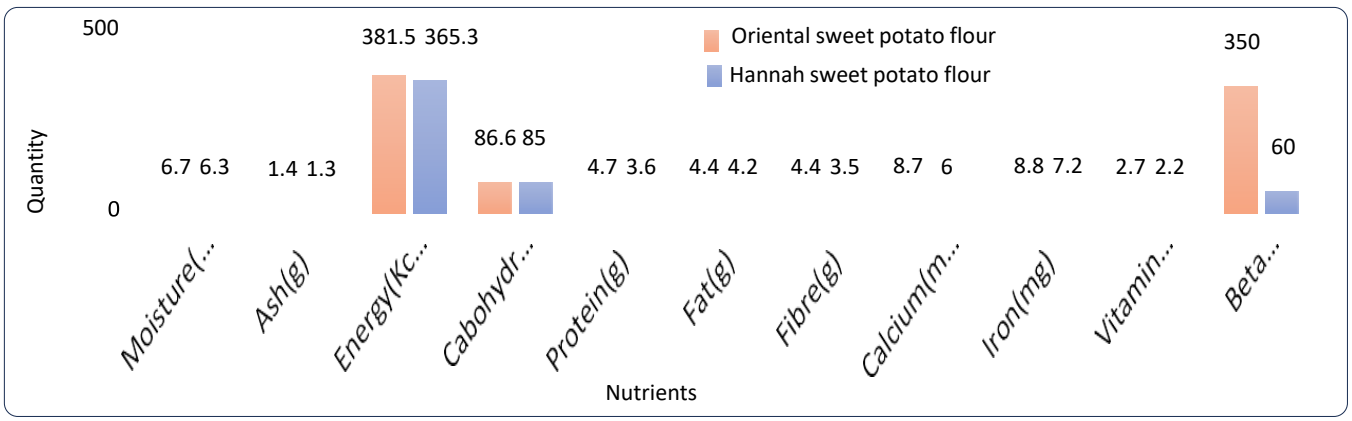

Fig 2 Comparison of nutrients present in oriental and Hannah sweet potato flour

Nutrient Analysis of the Oriental sweet potato flour incorporated bars

Table 4 presents the data on the nutrients present in popped finger millet bar, pearl millet bar and sorghum millet incorporated with oriental sweet potato flour in comparison with standard millet bar.

SSM-Sweet potato flour incorporated popped sorghum millet bar

Based on the results obtained, the highest amount of beta carotene and fibre was present in sweet potato flour incorporated popped pearl millet and the lowest amount of beta carotene and fibre was present in sweet potato flour incorporated popped finger millet bar.

Microbial analysis, Color analysis, Texture characteristics and shelf-life testing of the Oriental and Hannah sweet potato millet bars.

Table 4 Nutrients present in popped finger millet, pearl millet and sorghum millet incorporated with Oriental sweet potato flour

Nutrients	SFM (M ± S. D)	SPM (M ± S. D)	SSM (M ± S. D)
Moisture (%)	7.5±0.12	6.3±0.10	6.82±0.10
Ash(g)	3.7±0.05	3.7±0.10	3.4±0.022
Energy (Kcal)	348.8±1.60	367.1±1.040	385.5±0.115
Carbohydrate (g)	74.2±0.42	74.6±0.152	85.2±0.120
Protein (g)	5.4±0.20	5.7±0.152	4.2±0.248
Fat (g)	3.1±0.20	4.7±0.20	3.4±0.267
Fibre (g)	3.6±0.26	5.6±0.624	2.7±0.092
Calcium (mg)	151.1±0.45	68.2±0.70	65.4±0.350
Iron (mg)	3.4±0.26	8.9±0.251	4.4±0.494
Vitamin C (mg)	4.0±0.041	4.2±0.266	4.2±0.228
Beta carotene (µg)	140.5±0.32	210.6±0.458	190.7±0.416

SFM- Sweet potato flour incorporated popped finger millet bar SPM- Sweet potato flour incorporated popped pearl millet bar

Analysis of the microbial content of the Oriental and Hannah sweet potato millet bars

Table 5 represents the total plate count of Oriental and Hannah sweet potato millet bars:

On the 30th day, the maximum total plate count was observed in SFM with a value of 16.3 x10^{5}cfu/g followed by SPM and SSM with values of 15.3 x10^{5}cfu/g and 13.3 x10^{5}cfu/g respectively on the 30th day. Low microbial growth was observed after 30 days of storage.

Table 5 Total Plate Count of Oriental and Hannah sweet potato millet bars

S. No.	Sample	Microbial count (Total plate count)		
		Day 0	Day 15	Day 30
	Millet bars incorporated with Oriental sweet potato flour			
1.	Sweet potato popped finger millet bar	0	8.2x10^{5}cfu/g	16.3 x10^{5}cfu/g
2.	Sweet potato popped pearl millet bar	0	7.1x10^{5}cfu/g	15.3 x10^{5}cfu/g
3.	Sweet potato popped sorghum millet bar	0	5.1x10^{5}cfu/g	13.3 x10^{5}cfu/g
	Millet bars incorporated with Hannah sweet potato flour			
4.	Sweet potato popped finger millet bar	0	8.2x10^{5}cfu/g	16.3 x10^{5}cfu/g
5.	Sweet potato popped pearl millet bar	0	7.1x10^{5}cfu/g	15.3 x10^{5}cfu/g
6.	Sweet potato popped sorghum millet bar	0	5.1x10^{5}cfu/g	13.3 x10^{5}cfu/g

Analysis of the texture characteristics of the prepared Oriental and Hannah sweet potato millet bars.

Table 6 depicts the texture analysis of the Oriental and Hannah sweet potato flour millet bars.

In comparison between the Oriental and Hannah sweet potato flour incorporated millet bars, the hardness and adhesiveness values of Oriental sweet flour incorporated millet bars were higher. Among the Oriental sweet potato flour incorporated millet bars, the hardness values and adhesiveness values were observed to be high in SPM and the adhesiveness values were observed to be high in SFM. Among the Hannah sweet potato flour incorporated millet bars, the hardness Values were observed to be higher in SSM and the adhesiveness values were observed to be higher in SPM.

Table 6 Texture Profile Analysis of the Oriental and Hannah sweet potato millet bars

Products	Test mode	Speed	Test type	Shape	Hardness Average	Adhesiveness Average
			Millet bars incorporated with Oriental sweet potato flour			
SFM	Texture	1mm/sec	3 Point bend	Plate	1.266	0.043
SPM	Texture	1mm/sec	3 Point bend	Plate	7.441	0.012
SSM	Texture	1mm/sec	3 Point bend	Plate	4.253	0.013
			Millet bars incorporated with Hannah sweet potato flour			
Products	Test mode	Speed	Test type	Shape	Hardness average	Adhesiveness average
SFM	Texture	1mm/sec	3 Point bend	Plate	1.226	0.011
SPM	Texture	1mm/sec	3 Point bend	Plate	1.710	0.034
SSM	Texture	1mm/sec	3 Point bend	Plate	5.952	0.018

Shelf - life testing of the developed food products

The shelf life of the product was determined by Q10 values.

The data depicted in (Table 7) revealed the variations in moisture content during a storage period of 30 days. It can be concluded that in the oriental sweet potato flour incorporated

millet bars which were packed in LDPE laminated stand-up paper pouches the SFM has a shelf life of 1.10 months, the SPM has a shelf life of 2.57 months and SSM has a shelf life of 2.94 months.

Table 7 Variations in moisture content of Oriental sweet potato flour incorporated millet bars during a storage period of 30 days

Product	Parameter	Temp in °C	Number of days of storage				Rate of reaction	Q1 0	Predicted shelf life (in months)
			0 day	5th day	15th day	30th day			
Oriental sweet potato flour incorporated millet bars									
SFM	Moisture (%)	T_1: 45°C	5.92	6.20	6.55	6.89	0.11	0.3	1.10
		T_2: Ambient temperature	5.92	6.10	6.35	6.70	0.33		
SPM	Moisture (%)	T_1: 45°C	7.35	7.55	7.75	8.05	0.03	0.7	2.57
		T_2: Ambient temperature	7.35	7.40	7.64	7.90	0.04		
SSM	Moisture (%)	T_1: 45°C	6.76	6.98	7.20	7.50	0.04	0.8	2.94
		T_2: Ambient temperature	6.76	6.86	7.10	7.35	0.05		

Table 8 Variations in moisture content of Hannah sweet potato flour incorporated millet bars during a storage period of 30 days

Samples	Parameter	Temp in °C	Number of days of storage				Rate of reaction	Q10	Predicted shelf life (in months)
			0 day	5th day	15th day	30th day			
Hannah sweet potato flour incorporated millet bars									
SFM	Moisture (%)	T_1	5.80	5.95	6.18	6.30	0.10	0.6	2.20
		T_2	5.80	5.89	6.00	6.12	0.16		
SPM	Moisture (%)	T_1	7.29	7.45	7.78	7.99	0.03	0.7	2.57
		T_2	7.29	7.32	7.51	7.82	0.04		
SSM	Moisture (%)	T_1	6.72	6.96	7.19	7.35	0.04	0.8	2.94
		T_2	6.72	6.85	7.05	7.15	0.05		

T1 – 45°C, T2 – ambient temperature

It can be concluded that the in the Hannah sweet potato flour incorporated millet bars which was packed in LDPE (low density polyethylene) laminated stand-up paper pouches, the SFM has a shelf life of 2.20 months, the SPM has a shelf life of 2.57 months and SSM has the highest predicted shelf life of 2.94 months.

CONCLUSION

The results from the study revealed that the oriental sweet potato flour had the highest amount of beta- carotene but both the oriental and hannah sweet potato flour were rich in phytochemicals. All the developed sweet potato millet bars had good overall acceptability. The popped sorghum millet bars incorporated with oriental sweet potato had the highest amount of beta-carotene. The pre-treatment method used for the preparation of sweet potato flour significantly increased the beta-carotene content and the overall acceptability of the products. Popping of finger millet, pearl millet and sorghum millet significantly increased the organoleptic characteristics and nutrient content of millets. All the prepared products had a low microbial growth after 30 days of storage which indicated that all the developed products had a good shelf life. From the present study, it can be concluded that Oriental and Hannah sweet potato flour can be incorporated to enhance the beta-carotene content in the millet bars.

LITERATURE CITED

1. Bhatt D., Fairos M., & Mazumdar A. (2022). Millets: nutritional composition, production and significance: a review. *The Pharma Innovation Journal* 11(7): 1577-1582 . E-ISSN Number: 2277 - 7695
2. Dereje B., Girma A., Mamo D., & Chalchisa T. (2020). Functional properties of sweet potato flour and its role in product development: a review. *International Journal of Food Properties*, *23*(1), 1639-1662. https://doi.org/10.1080/10942912.2020.1818776
3. Geetha K., Yankanchi G. M., & Hiremath N. (2019). Microbial Quality and Storage Stability of Millet Based High Fiber Food Mix. International Journal of Current Microbiology and Applied Sciences. 8(7): 53-57 https://doi.org/10.20546/ijcmas.2019.807.007
4. Leach H. W., McCowen L. D. and Schoch T. J. (1959). Swelling power and solubility of granular starches. *Cereal Chemistry* .36, 534-544.
5. Mahajan M. S., Gulecha V. S., Khandare, R. A., Upaganlawar A. B., Gangurde H. H., and Upasani C. D. (2012). Anti-edematogenic and analgesic activities of Ficusbenghalensis. *International Journal of Nutrition, Pharmacology, Neurological Diseases*, 2(2), 100-104. DOI : 10.4103/2231-0738.95936
6. Malleshi N. G., Desikachar H. S. R., & Tharanathan R. N. (1986). Physico-chemical properties of native and malted finger millet, pearl millet and foxtail millet starches. *Starch- Stärke*, *38*(6), 202-205. https://doi.org/10.1002/star.19860380608
7. Marangoni Júnior L., Ito, D., Ribeiro S. M. L., Silva M. G. da, Aguirre J. M. de, & Alves R.M. V. (2019). Retention of β-carotene in biofortified sweet potato chips after processing. *Acta Scientiarum Technology*, *42*, 1-9. https://doi.org/10.4025/actascitechnol.v42i1.43103
8. Official Methods of Analysis of AOAC INTERNATIONAL. 1990. AOAC International, Gaithersburg, MD, USA,. Vol 1, Fifteenth edition
9. RajyalakshmiDevi,Y. and Thilakavathy,S.(2018).Sweet potato-Wholesome nutrition in a SPUD. International Journal of Applied Home Science.5(1),261-266. ISSN : 2394-1413

10. RajyalakshmiDevi,Y. and Thilakavathy,S.(2021). Prevalence of vitamin a deficiency in fisherfolk children (6-8 years) of east godavari district and effect of supplementation of orange fleshed sweet potato. The Journal of research. ANGRAU.49(1).53-62 ISSN 0970-0226
11. Robertson S. N., Monredon D., Dysseler P., Guillon F., Amado R. and Thibault J. F. (2000). Hydratation properties of dietary fibre and resistnce starch: *A europen collaborative study*. (33), 72- 79. https://doi.org/10.1006/fstl.1999.0595
12. Salawu S. O., Udi, E., Akindahunsi A. A., Boligon A. A., & Athayde M. L. (2015). Antioxidant potential, phenolic profile and nutrient composition of flesh and peels from Nigerian white and purple skinned sweet potato (Ipomea batatas L.). *Asian Journal of Plant Science and Research*. *5*(5), 14-23. ISSN : 2249-7412
13. Shaikh, J. R., & Patil M. (2020). Qualitative tests for preliminary phytochemical screening: An overview. *International Journal of Chemical Studies*, *8*(2), 603-608. DOI: https://doi.org/10.22271/chemi.2020.v8.i2i.8834
14. Singh R., Singh K., & Nain M. S. (2021). Nutritional evaluation and storage stability of popped pearl millet bar. *Current Science* , *120*(8).1374-1381 doi: 10.18520/cs/v120/i8/1374-1381.
15. Sosulski F.W, Garatt M.O, Slinkard A.E (1976). Functional properties of ten legume flours. *International Journal of Food Science and Technology*. 9:66-69.
16. Trang B. M., Lan S. Y., Park, J. H., Jang H. W., Kim K. M., Cho Y. S., Hwang Y., Kim HY. 2020. The effects of pretreatment methods on quality characteristic of hot air-dried sweet potato slices. *Food Engineering Progress* 24(3): 164-170.