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Formulation and Evaluation of Selected Recipes from Red Rice Flakes Incorporated *Senna auriculata* (L.) Roxb Mix

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Abstract

Convenience foods require little to no preparation or cooking before consumption, they are ideal for people who are constantly on the go. Food is considered "ready-to-cook" when it has been brought to the point of consumption by enabling direct cooking to produce the desired serving form. In India's Ayurvedic and Siddha medical systems, senna auriculata is a traditional medicinal herb used to cure a variety of ailments. It has been used to cure skin conditions, rheumatism, asthma, diabetes, dysentery, and metabolic issues. It includes a variety of photochemicals. Diabetics can benefit from red rice flakes that are strong in fibre. The unprocessed husk has antioxidants that increase metabolism and guard against colon cancer. Magnesium is another ingredient that helps to build bones, fight asthma, and lower the risk of obesity. Therefore, the study's goal was to create, combine, and standardize recipes through the use of trial and error. Examinations were done on the self-life, microbiological, functional, and physical aspects. By integrating mix into particular recipes, a 9-point hedonic scale was used to conduct the sensory evaluation. Moisture (10%±1.03), protein (2.8gm±0.09), fat (2.5gm±1.03), ash (5.45%±0.15), crude fiber (8.8%±0.09), carbohydrates (54.05gm±0.01), and energy (350.7kcal±0.1) were the results of the mix's proximate composition study. In addition to having a high nutritional composition and being enhanced with antioxidants, the study found that adding red rice flakes and senna auriculata also prevented microbial development for 30 days and helped all recipe treatments achieve the highest acceptance score of 7.5 to 8.5. Thus, it could be a unique antioxidant combination for people of all age group.

***Key words*:** Convenience foods, Red rice flakes, *Senna auriculata,* Sensory attributes, Value added mix

Convenience foods are ones that require little to no processing or preparation beforehand, making them ideal for people who are constantly on the go. "Ready-to-cook" describes food that has been prepared for consumption by letting it cook directly, giving it the right consistency and serving shape. (Mishra, Raj, Suvadharshini, 2021). Ready-to-cook food has already been processed and prepared with minimal effort, making it convenient [8]. Prepared meals that are both convenient and not so convenient. Non-convenience foods include prepared meals, homemade fresh foods, homemade preserves, and ingredient foods. Another type of food that requires less skill and preparation time is convenience food. It consists of premade and prepared convenience meal items served by peers who do not prepare their own meals at home [12]. *Cassia auriculata* is a widespread plant that grows in India and other regions of Asia. Senna auriculata is a legumeinous tree in the Caesalpinioideae subfamily. Mature tea tree, avaram or ranawara (Tamil: ஆவாரை āvārai), or avaram senna in English are some of the colloquial names for it. It is the official flower of Telangana. It can be found in the dry parts of India and Sri Lanka. It is common in the arid zone and near the coast of Sri Lanka. The Avaram senna is a smooth, cinnamon-colored shrub with tightly spaced pubescent branchlets. It grows in dense branches [16].

Auriculata Cassia Linn. Tanner's Cassia is a common name for this wild, perennial shrub. It can withstand a broad range of temperatures and climates ecologically. This plant and its parts are traditionally used in Aryurveda, Naturopathy, and Herbal treatment to treat a wide range of human ailments, including liver toxicity, fungal and microbial infections, inflammation, pyrexia, constipation, conjunctivitis, skin conditions, rheumatism, etc. The presence of derivatives of hydroxyanthraquinone accounts for *C. auriculata's* therapeutic qualities. The primary ingredient in Kalp Herbal Tea, which is frequently used to treat diabetes, is this plant. [4]. Avartaki, scientifically known as Senna auriculata (L.) Roxb., Cassia auriculata L., Family: Fabaceae, is a widely used traditional medicinal plant that is used to treat a variety of ailments in India's Ayurvedic and Siddha medical systems. Nearly every component of the plant, including the flowers, leaves, seeds, bark, and roots, has been shown to have medicinal uses. In the past, it has been used to treat skin conditions, rheumatism, asthma, diabetes, dysentery, and metabolic issues. The plant Senna auriculata (L.) Roxb. is rich in phytochemicals, which include: ±-tocopherol-β-D-mannosidase, epicatechin, ferulic acid, quercetin-3-O-rutinoside, quercetin, sugar, saponins, phenols, terpenoids, flavonoids, tannins, steroids, palmitic acid, linoleic acid, benzoic acid, 2-hydroxyl methyl ester, 1-methyl

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butyl ester, resorcinol, α-tocopherol-β-D-mannosidase, linoleic acid, terpenoids, flavonoids, tannins, steroids, and palmitic acid [21].

Red rice's have been found to have a high mineral content. Not only is red rice nutritious and medicinal, but it has many other special features. Red rice growers may cultivate rice in a variety of agroclimatic conditions, even unfavorable ones, using both rainfed and irrigated methods [13]. The raw red rice flake has 86.22g of carbohydrates. A 100 grams of flakes contains a lot of minerals, such as potassium (110 mg), iron (5.5 mg), protein (6.69 g), salt (763 mg), and vitamins A and C. Diabetics can substitute red rice flakes for wheat since they are devoid of gluten and cholesterol. The unpolished husk of red rice flakes has an antioxidant that protects against colon cancer and increases metabolism. Magnesium and other nutrients found in red rice help to build stronger bones, manage asthma, and reduce the risk of obesity [28].

Need and significance

- In this modern days, homemade recipes is replaced by commercially prepared instant mix the consumers by way of little or no need of major processing before cooking
- Instant mixes can become an alternative food for breakfast because of their high energy and nutrient content, ease of preparation, and minimum serving time
- Rapid urbanization, the industrialization phenomenon of "working women" in recent years, and consequent changes in the eating habits of consumers have led to the development of instant mixes and Ready to cook foods (RTC).

In this regard the study was carried out with the following objectives.

Objective of the study

- To process, incorporate and formulate the red rice flacks and *senna auriculata* mix.
- To determine the physical and proximate composition of the mix.
- To analyses the microbial quality, functional characteristics and shelf life of the formulated red rice flacks and *senna auriculata* mix.
- To evaluate sensory properties of the selected recipes from the senna auriculata mix.

METERIALS AND METHODS

All of the ingredients for red rice flakes mix including senna auriculata are obtained from a local market in Chennai.

Fig 1 *Senna auriculata*

Fig 2 Red rice flakes

Methodology

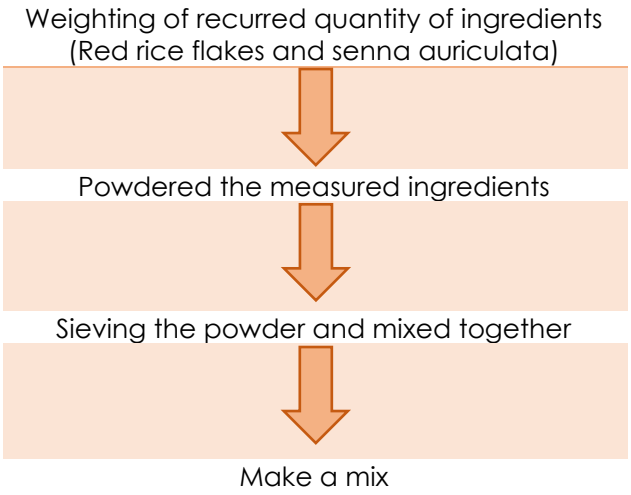
The preparing and purchasing ingredients such as red rice flakes and senna auriculata. Sun dried senna auriculata was taken in a certain amount for powdered and sieving. The red rice flakes were also powdered and sieving.

Ethical consideration

This study entitled "Formulation and evaluation of the selected recipes from the red rice flakes incorporated *Senna auriculata* (L.) Roxb MIX" has been approved by the Independent Human Committee (IHEC) with the protocol on – SDNBVC/HSC/IHEC/2023/13 conducted on November, 20th, 2023, by the deportment of Home Science Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Chromepet, Chennai-44.

The raw materials which are senna *auriculata* was certified by SIDDHA CENTRAL RESEARCH INSTITUTE. The code was given which is S05012402A on January 8th 2023

Preparation of red rice flakes mix



Formulation and standardization of red rice flakes incorporated senna auriculata mix

Treatment 2 has been determined to exhibit the most desirable variation among the five treatments that were administered.

Assessment of physical parameters of value-added mix colour difference of value-added mix

The L* (lightness), a* (redness or greenness) and b* (yellowness or blueness) color values of samples were measured using a Lovibond colorimeter (Model RT-200). The color value of the string hopper prepared solely from rice flakes was used as standard. The color difference of the sample from the standard was calculated using the following[31] formula:

$$(\Delta E) = \sqrt{\begin{matrix}(L * standard - L * sample)^2 + \\ (a * standard - a * sample)^2 + \\ (b * standard - b * sample)^2\end{matrix}}$$

Water absorption capacity for value added mix

Water absorption capacity determined using the method by [22]. First, the sample (2 g) was diluted in 20 ml. of distilled water in 50 ml. centrifuge tubes then mixed for 10 mins and centrifuged at 3000 rpm for 20 mins. After that, the supernatant is placed in an aluminum dish then dried the supernatant in an oven 105ºC for 24 hours, then the weight of the gel and dried supernatant is recorded determined by the following formula:

$$\text{Water absorption capacity} = \frac{density\ of\ volume\ absorbed}{weight\ of\ sample}$$

Rehydration ratio for value added mix

Rehydration ratio the rehydration ratio of rice samples was performed using the method of Cao et al. (2016). Rice flakes (5.08.0-g) were submerged in distilled water at 100°C,

remaining under these conditions for a period of 10 min. At the end of the procedure, rehydration ratio (RR) was calculated in accordance with equation: RR Wr/Wd Where RR is the rehydration ratio (g/g); Wr is the weight of rehydrated grains (g); and Wd is the weight of dry grains (g).

The dried sample of known weight was fully immersed in water exactly for a minute. After draining water gently, the weight of the rehydrated wet sample was measured. The rehydration ratio can be expressed by the following formula [25].

$$Rehydration\ Ratio = \frac{weight\ of\ rehydrated\ sample}{weight\ of\ dried\ sample}$$

Proximate analysis of the prepared mix

Energy

The energy value of the samples was determined by multiplying the protein content by four, carbohydrate content by four and fat content by nine according to standard James formula (James, 1995).

Energy Value = (protein × 4) + (Total carbohydrate × 4) + (fat × 9)

Moisture

Moisture determination by hot air oven

Moisture content of sample was determined by the gravimetric method. The sample were ground using a laboratory mill (Fred Stein Laboratories and 5 g of sample was used to determine moisture content. Sample were weighed into moisture can and then the sample were heated in a forced air oven at 130 °C for 2 h Wet basis moisture content (w.b. %) was measured using the following equation.

$$\text{Moisture content wb\%} = \frac{weight\ of\ moisture\ (g)}{weight\ of\ sample\ (g)} \times 100$$

Crude fibre

2 g of the ground sample is digested in 50 ml of H_2SO_4 (1.25%). The solution is boiled for 30 min. after which it is filtered and washed with hot water. The filtrate is also digested in 50 ml of NaOH (1.25%). The solution was heated for 30 min., filtered and washed with hot water and oven dried. Finally, the oven-dried residue is ignited in a furnace at 550 ℃. The fiber content is measured by the weight of the left after ignition and was expressed in term of the weight of the sample before ignition (AOAC, 1990).

Ash content

Ash was determined by heating the sample in a furnace for ~12 h at 550°C (AOAC, 1990). 1 g of the oven-dried sample in powder form is placed in crucible of known weight. This is ignited in a muffle furnace for 5 hours at 550 °C. The crucible is cooled and weighed and the ash content was expressed in terms of the oven-dried weight of the sample (AOAC, 1990).

Fat content

The lipid content was determined by extracting the fat from 5 g of the sample using petroleum ether in a Soxhlet apparatus. Total lipid content was determined using Soxhlet equipment with an ether-ethyl solvent (Radin, 1981). The weight of the lipid obtained after evaporating off the petroleum ether from the extract gives the weight of the crude fat in the sample. It was dried in an oven at 80°C-100°C and cooled until a constant weight was achieved. The fat content of the samples was expressed as g/100 g of the sample. (AOAC, 1990).

Carbohydrate content

Carbohydrates comprise the majority 50-70 percent of the dry matter in legumes, rendering them one of the most important components. Legumes, in particular, include carbohydrates in the form of two primary compounds: starch and dietary fiber (Jayapriya & Parameshwari, 2020. Energy contents were estimated using adiabatic bomb-calorimetry in which gross energy was determined by measuring heat of combustion. Large number of analytical techniques have been developed to measure the total concentration and type of carbohydrates present in foods (see Food Analysis by Nielssen or Food Analysis by Pomeranz and Meloan for more details). The carbohydrate content of a food can be determined by calculating the percent remaining after all the other components have been measured: %carbohydrates = 100 - %moisture - %protein - %lipid - %mineral. Nevertheless, this method can lead to erroneous results due to experimental errors in any of the other methods, and so it is usually better to directly measure the carbohydrate content for accurate measurements [11].

Protein content

Protein content was determined using Kjeldahl method and calculated by multiplying the amount of nitrogen by 6.25 10ml of sample was weighed in kjeldahl flask, half a tablet of catalyst mixture (10 partsK,SO, to one part of $CuSO_4$) and 25 mi of concentrated H_2SO_4 were added. The ash content of the flask was digested under boiling at maximum heat for 2-3 hours till clear, and then the flask was distilled using NaOH 40% the ammonia was received in 100ml conical flask containing 10ml of 0.1NHCI and crude protein percentage was calculated as follows (AOAC, 2005).

$$\text{Protein percentage \%} = \frac{N \times.\ 10ml \times 14 \times 100 \times 6.2}{1000}$$

N= Normality of HCI for sample titration.

T=Titration figure. 10ml weight of sample.

1000: Number of milligrams in one gram.

14: Equivalent weight of nitrogen. 6.25: Protein conversion factor

Functional properties of the prepared mix

DPPH radical scavenging activity

The scavenging effect of extract were determined by the method of[20]. Briefly, 2.0 ml of 0.16mM DPPH solution (in methanol) was added to the test tube containing 2.0 ml aliquot of sample. The mixture was vortexed for 1 min and kept at room temperature for 30 min in the dark. The absorbance of all the sample solutions was measured at 517 nm. The scavenging effect (%) was calculated by using the formulae given by [23].

Scavenging effect (%) = | (Abs Control-Abs sample)/Abs control] × 100

Microbial analysis for the prepared mix

Microbial analysis is important to find out the shelf life of developed red rice flacks and senna auriculata mix and there by the safety of the product. (total mold count and total yeast count) [19].

Total bacterial count

One gram or one ml of sample was transferred aseptically to 9ml of 0.9% sterile saline solution in a test tube, from this Iml of aliquot was serially dilute up to 10' test tube The total viable count of the sample was calculated by inoculating 0.1ml of from 10 dilutions on plate count agar plate and incubated at 37-C for 24 hrs. After 24 hours bacterial colonies were counted and expressed in CFU/g [14].

Total mold count

The mold count of the value added senna auriculata mix was determined by using the streak plate technique was used for isolation. One gram or one ml of sample was transferred aseptically to 9ml of 0.9% sterile saline solution in a test tube,

from this Iml of aliquot was serially dilute up to 10' test tube. The total viable count of the sample was calculated by inoculating 0.1ml of from 10 dilutions on Rose Bengal agar plate and incubated at 37-C for 72 hrs. After 72hrs fungal colonies were counted and expressed in CFU/g [17].

Total yeast count

The yeast count of the value-added red rice flacks and senna auriculata mix was determined by using the streak plate technique was used for isolation. One gram or one ml of sample was transferred aseptically to 9ml of 0.9% sterile saline solution in a test tube, from this Iml of aliquot was serially dilute up to 10' test tube. The total viable count of the sample was calculated by inoculating 0.1ml of from 10 dilutions on Rose Bengal agar plate and incubated at 37-C for 72 hrs. After 72hrs fungal colonies were counted and expressed in CFU/g [22].

Self-life analysis for the prepared mix

Shelf life of the product was analyzed by performing calculating of presence of CFU bacterial and fungal strains by spread plate technique on different day interval. Storage studies were carried out for the prepared sample and quality parameters were evaluated during storage. The quality parameters of the sample produced were taken after preparation and the measurement was considered as the quality parameter on the 0th day. Later, the sample was filled in glass containers respectively Containers were sealed tightly. The samples in a glass container were stored at refrigerated temperature. The quality parameters data were taken at regular intervals of 0, 1 day, 15th day and 30th day.

Statistical analysis of the prepared mix

Statistical inference (student t-test) and descriptive statistics (mean and standard deviation) are used to interpret the data from the red rice flakes mix. The acquired facts are further expressed diagrammatically or visually. Every analysis and test was run three times, and the results were displayed as mean ± standard deviation, ANOVA, t-test. The mean ± standard deviation was determined. A paired t-test and ANOVA was conducted using SPSS software [12].

Table 1 Different properties of mix

Treatment	Red rice flacks	*Senna auriculata*	Total
Control	100	-	100
T1	70	30	100
T2	**75**	**25**	**100**
T3	80	20	100
T4	85	15	100
T5	90	10	100

Table 2 Proximate analysis of the prepared mix

Parameters	Methods
Energy (kcal)	Energy AOAC 2007 (Frary et al., 2005; Gopalan et al., 2000)
Protein (%)	Kjeldahl method, AOAC 2000
Fat (%)	Gravimetric method, AOAC 2000
Carbohydrate (%)	Differential method (AOAC 2000)
Dietary Fiber (%)	Enzymatic gravimetric method (AOAC 2007)
Moisture (%)	Gravimetric method (AOAC 2000)
Ash (%)	AOAC method 2000
DPPH-Antioxidant analysis	DPPH free-scavenging Assay method
Microbial	Pour plate method
Yeast and mold count	Pour plate method

Table 3 Microbial analysis of storage study

Microbial analysis	Method
Total bacterial count	(Dipak Sharma *et al*. 2017)
Yeast and mold counts	(Dipak Sharma *et al*. 2017)

Sensory examination of the selected recipes from the mix

Twenty-one untrained panelists from the Department of Food Science, Nutrition, and Dietetics at Shrimathi Devkunvar Nanalal Bhatt Vaishnav College in Chennai performed a sensory evaluation of the selected recipes from the mix. The panelists explained on the product and the criteria for grading. Twenty-five panelists were given sensory sheets to evaluate the sample, and ratings were scored based on the type of response. The pickle's sensory attributes like taste, flavour, appearance and colour, texture, and overall acceptability will be assessed for acceptability through a 9-point hedonic scale sensory scale ranging from 1- dislike extremely to 9 – like extremely [26].

9-point hedonic scale for the selected recipes

Remark	Score
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Cost calculation of value-added red rice flaks and senna auriculata mix

The cost for each product is calculated separately. The food costs, labour cost, overhead cost and hidden costs are included under this heading. Per kilogram of value-added mix was estimated through the following formula:

$$\text{Cost of production} = \frac{\text{Cost A} + \text{Cost B}}{\text{Q}}$$

Where; Cost A- Cost of raw materials,
Cost B- Cost of processing and
Q- Quantity of value – added mix per kg [18].

RESULTS AND DISCUSSION

Physical properties of formulated mix

Colour difference

All values are mean of triplicate determination + Standard Deviation (S.D) shown in (Table 4).

Table 4 Colour deference of the prepared mix

S. No.	Analysis	Control	Sample	P-Value
1	L*	44.0±0.1	63.57±0.03	0.00 S**
2	a*	8.2±0.3	4.08±0.18	0.001 S^{**}
3	b*	16.5±0.3	18.9±0.11	0.00 S^{**}
4	dE*	-	63.57±0.03	-

NS-Non-Significant, S* - Significant at 5% level, S** - Significant at 1% level

Color has a vital influence in determining a product's consumer acceptability[8]. Hunter Lab and CIELAB L*a*b* are two popular color spaces for analyzing colorimeter data, where L* stands for lightness or darkness, a* for redness or greenness, and b* for yellowness or blueness [29].

The value of L* in the formulated mix was found to be 63.57. The obtained value in this study was higher when compared with the control sample 44.0±0.1 which could be attributed to the inclusion of senna auriculata powder which is dark yellow in color. The L* of the selected samples was found to be statistically significant (p<0.0l) the lower luminosity (L*) was obtained in the control sample as the predominant ingredient used was brown in color (red rice flakes).

The value of a* in the formulated mix was found to be 4.08. The obtained value in this study was lower when compared with the control sample 8.2±0.3. The a* of the selected samples was found to be statistically significant (p<0.05). The presence of red color in the formulated mix was due to the amounts of red rice flakes in the formulation as well as the presence of other ingredients.

The value of b* in the formulated mix was found to be 18.9. The obtained value in this study was high when compared with the control sample 16.5±0.3. The bo of the selected samples was found to be statistically significant (p <0.05). The color of the ingredients might also have an impact on the finished product. Furthermore, the color of the components, particularly the mix used, might have an impact. As a result, color is extremely significant for this sort of product and is a key factor influencing consumer sensory satisfaction [29].

Table 5 Proximate composition of the prepared mix

Proximate composition	Control	Rice flakes mix (RFM)/100gm
Moisture	10.20% ±0.34^{c}	10±1.03^{c}
Protein	2.5%±0.17^{f}	2.8±0.09^{f}
Fat	3.44%±0.24^{e}	2.5±1.03^{f}
Ash	3.73%±0.17^{e}	5.45±0.15^{e}
Crude fiber	5.47%±0.24^{d}	8.8±0.09^{d}
Carbohydrate	82.28%0.14^{b}	54.05%±0.01^{b}
Energy (kcal/100g)	387.09± 0.5^{a}	350.7 ±0.1^{a}

Water absorption capacity

The water absorption capacity of the value-added mix was found to be 1.912±0.09. The obtained result was more or less similar when compare with the control sample which may attribute to an effective balanced meal.

Rehydration ratio

The rehydration ratio of the value-added Mix was found to be 1.23. The obtained result was more or less similar when compare with the control sample which may attribute to an effective balanced meal

Proximate composition of the prepared mix

The nutritional composition such as energy, moisture, protein, fat, ash, crude fiber and carbohydrate. The test was used to significant the values (P≤0.05) between the control and sample.

Energy

The energy content of the product is determined by the composition of the elements that provide energy, such as proteins, fats, and carbs [6]. For a sedentary worker, the average daily allowance for humans is 1900 kcal. The 350.7 kcal per 100g of red rice flakes mix was sufficient for one meal. The significant difference for the energy was (P≤0.05) between the control and the sample.

Protein

Peptide bonds hold amino acids (AA) together to produce proteins. It is the most fundamental tissue component in both humans and animals (Wu, 2016). Research indicates that eating protein-rich foods can help with weight loss, increase fullness, and lower the risk of cardiovascular disease [3]. In the product, the protein value was higher than the control group because the sample was incorporated with Senna auriculat, which increased the protein level in the sample. The product, the protein value was higher than the control group because the sample was incorporated with Senna auriculat, which increased the protein level in the sample. Significant deference was found (P≤0.05) between the control and the prepared sample.

Fat

In comparison to the other value-added goods, the red rice flakes mix had a reduced fat content. Hence it was suitable for consumption by all age groups. The significant difference between the control and sample was (P≤0.05).

Ash

According to Ismail (2017), the substance is ash. The most common technique for figuring out the ash content is to burn a sample of soil and measure the amount of residue that remains unburned. In contrast to the other value-added products, the ash value was high. This refers to the red rice flakes mix contain high mineral content. There was a significant difference was (P≤0.05) between the control and sample.

Crude fiber

Any non-digestible carbohydrate and lignin that is not broken down in the upper gastrointestinal tract are included in the broad category of substances known as crude fiber (CF) [31]. Fiber reduces energy density because it increases meal weight more than calorie amount does. The consumption of crude fiber is associated with a decrease in food intake because it makes foods bulkier, which prolongs stomach emptying and nutrient absorption and lowers the diet's energy capacity. Therefore, studies suggest that fiber helps with weight control [1]. Compared to the other value-added goods, the red rice flakes mix had a higher level of crude fibre. Due to the higher crude fibre content in the red rice flakes. There was a significance deference (P≤0.05) between the control and sample.

Carbohydrate

Legumes are mostly composed of carbohydrates, which make up between 50 and 70 percent of their dry mass. In

particular, legumes contain two main types of carbohydrates: dietary fiber and starch (Jayapriya and Parameshwari, 2020). It serves as the body's main source of fuel. These polyhydroxy alcohols can be keto or aldehyde and have strong bioactive carbonyl groups. In addition to being essential for energy production, carbohydrates are also important for the structure and operation of the organism [22]. The high amount of carbohydrates in red rice flakes makes them comparable in terms of carbohydrate content to the other value-added products. It was adequate for each meal, and the difference between the control and sample was statistically significant (P≤0.05).

Moisture

A sample's total hydration both bound and free water is its moisture content. The amount of relative humidity in food has a significant impact on how long it can be stored [16]. The red rice flakes mix's moisture content was comparable to that of the other value-added goods. As a result, the red rice flakes mixture had a high level of storage stability. The significant was (P≤0.05) between the control and sample.

Functional properties of the prepared mix

Antioxidant activity

The cooperative (additive and perhaps synergistic / antagonistic) activity of all radicals present in a complex mixture is represented by the total antioxidant capacity (TAC) [27]. An antioxidant is defined as "any chemical that, when present in low quantities compared to those of an organic substrate, considerably slows or inhibits that substrate's oxidation." Antioxidants are primarily utilized to stop damage to biological components resulting from chemical reactions involving free radicals. A great deal of evidence has emerged in recent years suggesting that oxidative stress may be involved in the pathophysiology of various diseases, including metabolic disorders, renal impairment, and cardiovascular diseases, and that free radicals are essential for basic cellular functions [33]. Comparing the antioxidant activity to the control group, it was higher. Due to the fact that senna auriculata has higher levels of antioxidant activity. It raises the sample's antioxidant activity. There was a s significant different seen in antioxidant activity (P≤0.05) between the sample and control shown in (Table 6).

Table 6 DPPH of the prepared mix

Concentrations	Control	Sample	Mean
Scavenging %	70	73	71.500±2.12

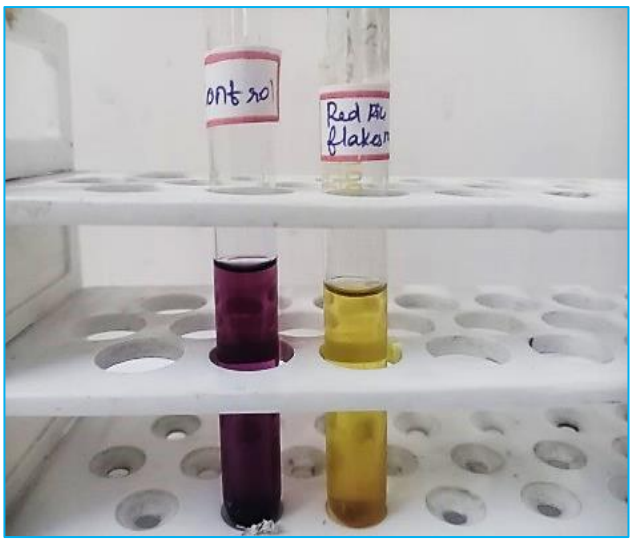
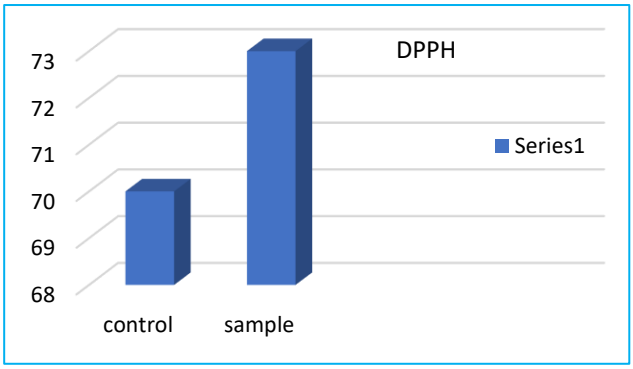


Fig 3



DPPH for the prepared mix

DPPH activity

Microbial characters of the prepared mix

Any sensory modification, such as tactile, visual, olfactory, or flavor alterations, that the client considers unacceptable is referred to as food deterioration (Shukla and Mishra, 2020). Food goods that are made have a microbiome since it affects their safety and quality. The elimination of microbiological pathogens and, to the greatest extent practical, the use of all available methods to prevent their proliferation guarantee the microbial safety of food [27]To evaluate the total bacterial count (TBC), yeast and mold count (YMC), and microbiological quality of the prepared mix.

Total bacterial count (TBC)

The number of bacterial colonies producing units per gram discovered in a food sample is known as the total bacterial count, or TBC. TBC is a metric for handling and food safety [19].

Yeast and mold count (YMC)

Yeasts belong to the same family of organisms as molds and mushrooms: fungi. Unlike some molds and mushrooms, they are typically single organisms that have evolved to exist in specialized, mostly fluid circumstances and do not produce toxic secondary metabolites [19]

Microbial study

The number of bacterial colonies producing units per gram discovered in a food sample is known as the total bacterial count, or TBC. TBC is a metric for handling and food safety [24].

Yeast and mold count

Yeasts belong to the same family of organisms as molds and mushrooms: fungi. Unlike some molds and mushrooms, they are typically single organisms that have evolved to exist in specialized, mostly fluid circumstances and do not produce toxic secondary metabolites [31] shown in (Table 7).

Table 7 Microbial characters of the prepared mix

Analysis	Control	Sample (RFM)
Total bacterial count	No growth	No growth
Yeast / Mold count	No growth	No growth

Storage study of the prepared mix

The presence of CFU bacterial and fungal strains was calculated using the spread plate technique at several day intervals to examine the product's shelf life. An ingredient's shelf-life characteristics are significant because they affect how well it can be used in product creation. The shelf life of a product is a recommendation for how long it may be kept in storage without compromising the quality of a specific quantity

of the product when transported, preserved, and displayed as anticipated [20] shown in (Table 8).

Table 8 Storage study of prepared mix

Intervals	Total bacterial count × 10^4 Cfu/gm	Yeast and mold 10^4 cfu/gm
0^{th} day	Nil	Nil
1^{th} day	Nil	Nil
2^{nd} day	Nil	Nil
15^{th} day	Nil	Nil
30^{th} day	Nil	Nil

The shelf life of the formulated red rice flakes mix (RFS) was analyzed storage stability. It was periodically evaluated for a period of 30 days at (0, 2, 15, and 30 day) at room temperature (30 °C) for its presence of bacteria and yeast or mold count. On the 0th day of storage, there was no presence of bacteria and yeast or mold count in the developed product. Likewise, on the day of the 2nd day, there was no presence of bacterial and yeast or mold count. On the 15 days of storage also it showed presence of bacteria and yeast or mold count and on the final day of storage (30^{th} day) also it showed no presence of bacteria and yeast or mold count. Hence, the product shows greater storage stability for a period of 30 days.

Selected recipes from the prepared mix

Fig 5 Uppma

Fig 6 Salted Puttu

Fig 7 Cutlet

Fig 8 Payasam

Fig 9 Idiyappam

Fig 10 Laddu

Fig 11 Kolukattai

Fig 12 Sweet Puttu

Fig 13 Adai

Fig 14 Paniyaram

Sensory evaluation of the selected recipes from mix of samples C, T1, T2, T3, T4, and T5 was carried out based on appearance, color, flavor, texture, taste, and overall acceptability with the help of sensory evaluation on the hedonic scale by semi-trained panelists. T2 (25% of senna auriculata) was chosen as having the highest overall acceptability of recipes. Sensory for selected recipes obtained are listed in (Table 8). A triplicate set of results were obtained, and the results are displayed as significant in post hoc Duncan test shown in (Table 9).

Table 9 Sensory evaluation of the prepared selected recipes

Prepared recipes	Colour	Taste	Appearance	Flavour	Texture	Overall acceptability
Sweet Puttu	9.55 ± 0.57^{a}	9.35 ± 0.74^{a}	8.98 ± 0.87^{b}	9.76 ± 0.76^{a}	9.54 ± 0.97^{a}	9.86 ± 0.87^{a}
Panniyaram	9.35 ± 0.23^{a}	8.45 ± 0.68^{b}	8.88 ± 0.97^{b}	8.54 ± 0.43^{b}	8.53 ± 0.56^{b}	8.64 ± 0.45^{b}
Kolukattai	8.12 ± 0.44^{b}	8.4 ± 0.94^{b}	9.45 ± 0.45^{a}	8.95 ± 0.51^{b}	9.54 ± 0.76^{a}	8.43 ± 0.14^{b}
Payasam	8.67 ± 1.12^{b}	8.35 ± 0.58^{b}	8.73 ± 0.72^{b}	8.49 ± 0.06^{b}	7.32 ± 0.34^{c}	8.23 ± 0.38^{b}
Idiyappam	8.65 ± 0.78^{b}	9.5 ± 1.00^{a}	8.92 ± 063^{b}	9.52 ± 0.75^{a}	8.92 ± 0.76^{b}	8.76 ± 0.20^{b}
Salted Puttu	9.54 ± 0.67^{a}	8.55 ± 0.51^{b}	9.81 ± 0.88^{a}	9.86 ± 0.43^{a}	9.54 ± 0.67^{a}	9.56 ± 0.84^{a}
Laddu	9.67 ± 0.56^{a}	8.53 ± 0.76^{b}	8.71 ± 0.91^{b}	8.54 ± 0.75^{b}	9.76 ± 0.82^{a}	9.52 ± 0.74^{a}
Cutlet	7.52 ± 0.34^{c}	9.98 ± 0.96^{a}	9.43 ± 0.83^{a}	8.72 ± 0.78^{b}	9.72 ± 0.82^{a}	9.54 ± 0.84^{a}
Adai	8.43 ± 0.54^{b}	8.6 ± 0.65^{b}	8.23 ± 0.51^{b}	8.23 ± 0.83^{b}	8.60 ± 0.68^{b}	8.41 ± 0.82^{b}
Upma	9.56 ± 0.73^{a}	7.32 ± 0.74^{c}	8.85 ± 0.32^{b}	8.54 ± 0.66^{b}	8.96 ± 0.56^{b}	8.49 ± 0.84^{b}

A. *Colour*

The primary sensory characteristic of food is color. You can utilize the product's color to identify particular defects and imperfections.The sensory rating table mentioned above is subjected to the post hoc Duncan test. The significant difference of the colour ($P\leq0.05$) among all of the sensory formulations.

B. *Flavor*

Taste is the perception of ingredients by taste receptors on the tongue, in other parts of the mouth, or in the gullet after they have been absorbed in saliva, oil, vor water. The aforementioned sensory rating table is put through the post hoc Duncan test. There is a notable variation in taste ($P\leq0.05$) between each sensory formulation.

C. *Texture*

A variety of senses are used to perceive texture, including touch, mouth feel, sight, and hearing. It is among the most significant qualities of food. It also covers the food's form, consistency, thickness, fragility, chewiness, and particle size. Using the previously mentioned sensory rating (Table 9), the post hoc Duncan test is employed. There is a substantial variation in texture ($P\leq0.05$) between each of the sensory formulations.

D. *Appearance*

The first characteristic of food that the human senses notice is its look, which is important in identifying and choosing food. Food's visual experience is influenced by color, shape, size, gloss, dullness, and transparency, among other factors. The previously mentioned sensory rating table is subjected to the post hoc Duncan test. A significant difference ($P \leq 0.05$) may be seen in the look of each sensory formulation.

E. *Taste*

Taste is the perception of ingredients by taste receptors on the tongue, in other parts of the mouth, or in the gullet after they have been absorbed in saliva, oil, or water. The aforementioned sensory rating table is put through the post hoc Duncan test. There is a notable variation in taste ($P \leq 0.05$) between each sensory formulation.

F. *Overall acceptability*

Evaluating the sample's overall acceptability offers important information about its thorough assessment, which includes a range of characteristics that add to the sample's overall desirability and appeal. The post hoc Duncan test is used using the sensory rating table given earlier. Significant differences exist in overall acceptability ($P \leq 0.05$) among all of the sensory formulations.

Cost estimation of value-added mix

The cost calculation includes the cost of ingredients used in the formulation development of red rice flaked incorporated senna auriculata mix. Processing costs of the formulated mix include electricity charges, milling charges, labor charges, and miscellaneous costs respectively. The approximate cost obtained for the formulation and development of red rice flakes-based mix was 47.7 rupees and the quantity of mix obtained was about 100 g respectively [28] shown in (Table 10).

The study focuses on the formulation and evaluation of selected recipes using red rice flakes and *Senna auriculata* (L.) Roxb MIX. The mix, which contains nutrients and antioxidants, is used in various Indian cuisine recipes. The study aims to analyze the physiochemical, functional characteristics, and storage stability of the prepared mix without preservatives and additives. The dried senna auriculata is grinded with red rice flakes. The study aimed to process and formulate a mix of red rice flacks and senna auriculata, determine its physical and proximate composition, analyze its microbial quality, functional characteristics, and shelf life, and evaluate its sensory properties. The mix's color was dark yellow, with increased lightness and yellowness. Microbial analysis revealed no bacterial contamination or mold growth, indicating meticulous production processes and safe consumption. The formulated pickle mix underwent a comprehensive analysis of key nutrients, including energy, protein, fat, ash, moisture, crude fiber, and carbohydrate levels. The mix's antioxidant activity was 73%, 3% higher than the control. The microbial growth was absent, indicating proper storage and preparation. The cost analysis showed a production cost of 47.7/-, compared to the market price of Rs. 50/-. This evaluation ensured the mix's competitiveness while maintaining profitability and consumer affordability. The cost-effectiveness of the formulation ensured the product's competitiveness in the market.

Table 10 cost estimation of value-added mix

S. No.	Ingredients	Quantity	Rate	Cost (Rs) Approx.
1	Red rice flakes	75g	156/kg	11.7
2	Senna auriculata	25g	80/100g	20
3	Electricity cost	6/unit	6	6
4	Labour cost		10	10
	Total			
	Quantity of mix product		100g	47.7

CONCLUSION

According to the results of the current study, a blend made using regional ingredients can enhance the nutritional value of spreads without the need for artificial additions. The panelists approved of the mixture made with red rice flake and senna auriculata, and their microbiological quality was within safer bounds. The resulting mixture was low in fat and an excellent source of nutrients including protein, carbs, and crude fiber. Therefore, both young children and the elderly can ingest it. The findings show that the mixture contains antioxidants, doesn't taste good, and may be kept at room temperature. As a result, the mixture created by combining senna auriculata with red rice flakes is rich in vital nutrients, offers a variety of health advantages, and is suitable for consumption by adults, kids, and senior citizens. They are a healthier option because they are low in fat and high in nutrients. Compared to commercial mix, it is more affordable. As a result, compared to the commercially available mix, the produced red rice flake and senna auriculata blend is far more nutrient dense. As a result, consumers may choose from a variety of uses.

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