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Formulation and Evaluation of Instant Food Products Based on Bamboo Rice and Black Rice Flour

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Abstract

The bamboo rice and black rice were processed to yield flour. The present study aimed to analyze the physicochemical, functional and nutritional properties, and assess the storage stability of formulated instant mixes using bamboo rice and black rice flour. The physicochemical and functional properties such as moisture, ash, bulk density, true density, porosity, water holding capacity and swelling capacity were analyzed. The nutrient content of bamboo rice was found to be 78.9g of carbohydrate, 10.5g of protein, 3.7g of fibre, 63.8mg of calcium, 100mg of phosphorus and 106.6mg of iron whereas in black rice it was found to be 81.2g of carbohydrate, 8.9g of protein, 5.2g of fibre, 48.7mg of calcium, 193.3mg of phosphorus and 86.67mg of iron. It contains phytochemical components such as alkaloids and flavonoids. The bamboo rice and black rice flour added products were formulated and compared with standard instant mix products and subjected to organoleptic evaluation by 25 semi-trained panellists. The overall acceptability showed a maximum score for formulated instant mix products. Compared with the standard, the formulated products were nutritionally high such as carbohydrates, protein, dietary fibre, calcium, iron and phosphorus. Microbial analysis showed that the instant mixes can be stored for 10 days without any preservatives. The study concluded that it can be highly recommended for diabetes patients and children for growth and development.

Keywords: Bamboo Rice, Black Rice, Instant Mix, Storage Stability

1. Introduction

In India, the food habits of people have changed due to Western influence. Most of them preferred to prepare at home or purchase from hotels. There is a variety of instant food products available in the market. Now, instant foods become a part of day-to-day life[1].

The bamboo rice tree is a woody tree with a hollow stem and the leaves are slender, and thin having 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 South Asian countries.

Bamboo rice contains medicinal properties and high nutritive value. Regular consumption of bamboo rice controls back pain and joint pain. And also, it increases the bone strength in the body. During pregnancy time eating bamboo rice helps to improve brain development and cognitive function in infants. The fibre-rich and calorie-dense kernels of bamboo 'rice' are seeds of bamboo flowers collected by tribal people. Locally called Mulayari, it is hard to collect as the flowering pattern of bamboo is highly unpredictable and can vary from 5 years to 50 years. It has a slightly sweet wheat-like taste and can be used as a substitute for both wheat as well as rice. It helps in the detoxification of the body, improving reproductive health and relieving rheumatic pain[2].

Black rice is a native of the common rice species (*Oryza sativa*) and the scientific name of black rice is (*Zizania aqatica*). Other common names for black rice are purple rice, heaven rice, imperial rice, and king's rice. Black rice was initially grown in China before the Chinese dynastic period and was called the 'luck rice' because it was believed to be 'dirty' because of its black colour. It was found that the colour of the grain is determined by the accumulation of coloured pigments. In black rice, there is production of anthocyanin pigment due to the mutation of a gene controlling pro-anthocyanidin biosynthesis. Initially, black rice was reserved only for the kings of China and Indonesia due to its high price and enormous

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medicinal properties to cure various illnesses, but now it is available even for local people[3].

Nowadays, instant food products occupy legitimate shelf space in stores and supermarkets in India. New and high-quality instant food products have changed the lifestyle of people and led to more Indian companies entering the market with varieties of instant food products.

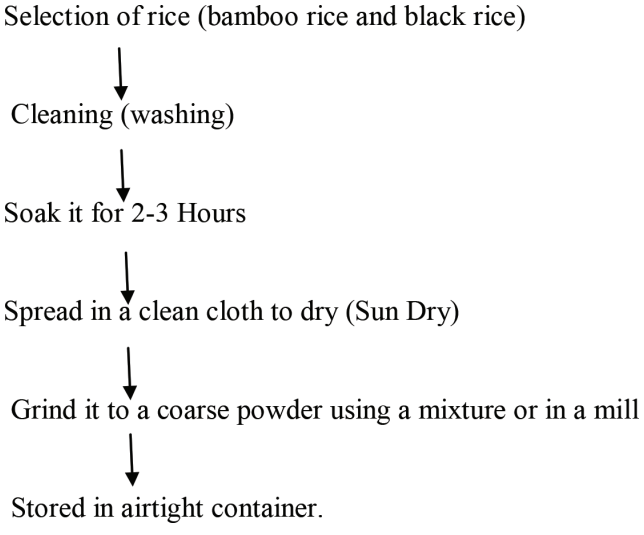
So, keeping all these views in mind, about the role and benefits of bamboo rice and black rice, the present study has been carried out with the following objectives,

- To collect and process the bamboo rice and black rice.
- To assess the physicochemical, functional and nutritional properties of bamboo rice and black rice flour.
- To formulate and evaluate the acceptability of bamboo rice flour and black rice flour added to instant food products.
- To analyze the storage stability of bamboo rice flour and black rice flour-added products.

2. Methods and Materials

2.1 Selection and Procurement

The cereals should be of good quality and free from infection. The rice selected should have a high storage capacity. Bamboo rice and black rice without bran were purchased from Iyarkai Angadi at Perundurai by the investigator.



(Source: Nindita *et al.*, 2018)[4]

Flow Chart 1. Processing of bamboo rice and black rice flour.

2.2 Processing of Bamboo Rice and Black Rice

The bamboo rice and black rice were sun-dried after a thorough rinse. The dried rice was ground and sieved. The processing of bamboo rice and black rice powder is shown in Flow Chart I.

2.3 Physico Chemical and Functional Properties of Bamboo Rice and Black Rice Flour

The physical properties and functional properties such as moisture content, ash content, bulk density, true density, porosity, water holding capacity and swelling capacity of bamboo rice and black rice were analyzed.

2.4 Nutrient Analysis of Bamboo Rice and Black Rice Flour

The nutritive value of bamboo rice and black rice was analyzed in terms of macronutrients such as carbohydrates (Anthrone test), proteins (Kjeldahl method), dietary fibre (Prosky method) and micronutrients such as phosphorus (micro method), calcium (EDTA method) and iron (Wong's method) using standard procedures.

2.5 Qualitative Phytochemical Analysis of Bamboo Rice and Black Rice Flour

The presence or absence of phytochemicals such as flavonoids, alkaloids, amino acids and phenolic content were analyzed for bamboo rice and black rice flour using standard procedure.

2.6 Formulation and Preparation of Bamboo Rice and Black Rice Flour Added Instant Food Mixes

The processed bamboo rice and black rice flour were used in the formulation of instant food mixes. The following instant food mixes were prepared.

Murukku mix

Puttu mix
Gulab jamun mix

2.7 Organoleptic Evaluation of Instant Food Products

The products prepared from bamboo rice flour and black rice flour added instant food mixes were compared with the products prepared from commercial standard instant mixes that were purchased from the local market of the Erode district. All the products are organoleptically evaluated by 25 semi-trained panel members in terms of appearance, texture, flavour, taste and overall acceptability. A composite scoring test was used for the evaluation of overall acceptability.

2.8 Assessment of Storage Stability of the Instant Food Mixes

The prepared bamboo rice flour and black rice flour added instant mixes are stored in a High-Density Polyethylene [HDPE] bag for 10 days at room temperature. The microbial loads were assessed on the 1st and 10th day of storage.

2.9 Computation of Nutrient Content of Instant Mix Products

The nutrients such as carbohydrates, protein, fibre, calcium, phosphorus and iron of the prepared bamboo rice flour and black rice flour added instant mix products were calculated using Ntutive software.

2.10 Cost Calculation

Cost is one of the important features to make a product acceptable. The cost of preparing the instant food products based on bamboo rice and black rice was evaluated. The price of purchased ingredients and gas/electricity utilized were included for cost calculation.

2.11 Statistical Analysis

Statistics function in three important ways in the analysis, interpretation and consolidation of obtained data. The data obtained from the organoleptic evaluation and overall acceptability of instant food products based on bamboo rice and black rice were consolidated, tabulated, and statistically analyzed using mean, standard deviation, and t-test and the results were discussed and concluded.

3. Results and Discussion

3.1 Yield of Bamboo Rice and Black Rice Flour After Processing

The total weight of the bamboo rice and black rice before and after processing were found to be reduced to 6.33% and 5.93% respectively.

3.2 Physicochemical and Functional Properties of Bamboo Rice and Black Rice Flour

The physicochemical properties such as moisture content, ash content and functional properties such as bulk density, true density, porosity, water holding capacity and swelling capacity of bamboo rice and black rice were determined and the results are given in Table 1.

The result shows that the physicochemical and functional properties such as moisture content of bamboo rice and black rice flour were found to be 7.67% and 9.17%, and the ash content of bamboo rice and black rice was found to be 1% and 1.73% respectively. The bulk density, true density and porosity of bamboo rice were found to be 0.86g, 1.20g and 27.96g and for black rice 0.82g, 1.53g and 48.58g respectively. The water-holding capacity of bamboo rice and black rice were found to be

Table 1. Physicochemical and functional properties of bamboo rice and black rice flour

S. No.	Physicochemical and Functional Properties	Mean ± Standard deviation	
		Bamboo Rice Flour	Black Rice Flour
1.	Moisture (%)	7.67 ± 1.43	9.17 ± 0.24
2.	Ash (%)	1 ± 0	1.73 ± 0.25
3.	Bulk density (g)	0.86 ± 0.07	0.82 ±0.07
4.	True density (g)	1.20 ± 0.07	1.53 ± 0.13
5.	Porosity (g)	27.96 ± 0.09	48.58 ± 0.6
6.	Water holding capacity (g)	4.33± 0.9	4.22 ± 2.44
7.	Swelling capacity (g/ml)	4.06 ± 0.02	4.04 ± 0.02

433.33g and 422g respectively. The swelling capacity of bamboo rice and black rice were found to be 4.06g/ml and 4.04g/ml respectively.

3.3 Nutrient Content of Bamboo Rice and Black Rice Flour

The nutrient content of bamboo rice and black rice flour were analyzed using standard procedures and the results are given in Table 2.

From Table 2, it was noted that after processing the nutrient content of bamboo rice flour was found to be 78.9g of carbohydrate, 10.5g of protein, 3.7g of fibre, 63.8mg of calcium, 100mg of phosphorus and 106.6mg of iron. Whereas the carbohydrate, protein, fibre, calcium, phosphorus and iron content of black rice flour was found to be 81.2g, 8.9g, 5.2g, 48.7mg, 193.3mg and 86.67mg respectively.

3.4 Phytochemical Analysis of Bamboo Rice and Black Rice Flour

The presence or absence of phytochemicals was analyzed in the aqueous extract and ethanol extract of samples using standard procedures.

The phytochemicals such as alkaloids were present in the aqueous extract and absent in the ethanol extract of bamboo rice flour. Flavonoids were present in both aqueous and ethanol extract of bamboo rice flour. The phytochemicals such as alkaloids and flavonoids were present in both aqueous and ethanol extract of black rice flour. The phenols and amino acids were absent in both extracts of bamboo rice and black rice flour.

Table 2. Nutrient content of bamboo rice and black rice flour

S. No.	Nutrients	Nutrient Content (Per100 G) *	
		Bamboo Rice Flour	Black Rice Flour
1	Carbohydrate (g)	78.9	81.2
2	Protein (g)	10.5	8.9
3	Fibre (g)	3.7	5.2
4	Calcium (mg)	63.8	48.7
5	Phosphorus (mg)	100	193.3
6	Iron (mg)	106.6	86.67

* - Mean values of Triplicates

3.5 Organoleptic Evaluation between Standard and Formulated Instant Food Products

The mean score obtained through organoleptic evaluation of standard and formulated instant mix products is discussed below.

3.5.1 Mean Score for Organoleptic Evaluation of Standard and Formulated Murukku

The mean scores for the acceptability of standard murukku and formulated murukku are given in Table 3.

Table 3 shows the results of sensory evaluation using composite scoring of both standard and formulated murukku. The sensory evaluation score used for each criterion is 20. It was observed that the criteria such as appearance, colour, flavour, texture and taste evaluated for the formulated murukku received maximum scores than the standard murukku. The flavour of the formulated murukku received maximum (19.89 ± 0.47) scores than the other criteria of formulated as well as standard murukku.

According to Yang *et al.*,[5] 2-AP, guaiacol, indole and p-xylene largely influenced the difference between the aroma in cooked black and white rice. 2-AP and guaiacol were major contributors to the unique character of black rice. On statistical analysis, the results revealed that there was a 1 per cent level of significant difference found between standard and formulated murukku with all the criteria.

3.5.2 Mean Score for Organoleptic Evaluation of Standard and Formulated Puttu

The mean scores for the acceptability of standard puttu and formulated puttu are given in Table 4.

Table 4 shows the sensory evaluation using composite scoring of both standard and formulated puttu. The

Table 3. The mean score for organoleptic evaluation of standard and formulated murukku

Criteria	Standard murukku Mean ±SD	Formulated Murukku Mean ±SD	't' value
Appearance	18.76 ± 1.19	19.68 ± 0.47	3.61**
Colour	18.26 ± 1.19	19.64 ± 0.56	5.24**
Flavour	18.6 ± 1.41	19.89 ± 0.47	3.1**
Texture	18.2 ± 1.70	19.76 ± 0.59	3.87**
Taste	18.88 ± 1.20	19.8 ± 0.5	4.34**

** - 1 per cent significance

sensory evaluation score used for each criterion for the standard and formulated puttu is 20. It was observed that the criteria such as appearance, colour, flavour, texture and taste evaluated for the formulated puttu received maximum scores than the standard puttu. Among all the criteria the texture of the formulated puttu had received higher scores than the other criteria of formulated as well as standard puttu. On statistical analysis, the results revealed that there was a 1 per cent level of significant difference found between standard and formulated puttu with all the criteria.

3.5.3 Mean Score for Organoleptic Evaluation of Standard and Formulated Gulab Jamun

The mean scores for the acceptability of standard gulab jamun and formulated gulab jamun are given in Table 5.

Table 5 shows the sensory evaluation of standard and formulated gulab jamun. For the sensory evaluation score composite scoring was used and for each criterion, gulab jamun is 20. It was observed that the criteria such as appearance, colour, flavour, texture and taste evaluated for the formulated puttu received maximum scores than the standard gulab jamun. The colour of the formulated gulab jamun received higher ratings (19.16 ± 0.92) than the other criteria of formulated as well as standard. On statistical analysis, the results revealed that there was a 1 per cent level of significant difference found between standard and formulated gulab jamun with all the criteria.

3.6 Comparison of Overall Acceptability of Standard and Formulated Instant Mix Products

The overall acceptability of standard and formulated instant mix products was evaluated and the results are given in Table 6.

Table 4. The mean score for organoleptic evaluation of standard and formulated puttu

Criteria	Standard puttu Mean ±SD	Formulated Puttu Mean ±SD	't' value
Appearance	18.88 ± 1.45	19.26 ± 0.47	3.26**
Colour	18.48 ± 2.32	19.56 ± 0.91	4.50**
Taste	18.16 ± 4.26	19.88 ± 0.33	3.38**
Flavour	18.08 ± 1.52	19.75 ± 0.46	3.7088
Texture	18.08 ± 1.38	19.96 ± 0.2	3.13**

** - 1 per cent significance

From Table 6, it was observed that the sensory evaluation for overall acceptability of the standard and formulated instant mix products. The results showed that the mean score of formulated products received maximum scores than standard products.

In statistical analysis, the t value showed that the overall acceptability of formulated products such as murukku, puttu and gulab jamun exhibit a 1 per cent level of significance.

3.7 Storage Stability of Formulated Instant Mixes

The microbial count of formulated instant mixes was analyzed initially and 10th day of storage after packaging with High-Density Polyethylene (HDPE) cover and the results obtained are given in Table 7.

Table 7 revealed the Total bacterial count of the instant murukku mix, instant puttu mix and instant gulab jamun mix and the results show that there were not found any bacteria at the time of initial storage. After 10 days of storage, it was noted that 85×10^1 CFU/g bacterial count in the instant murukku mix, 40×10^1 CFU/g in the instant puttu mix and 75×10^1 CFU/g in the instant gulab jamun mix. The shelf life of minimally processed food has the

Table 5. The mean score for organoleptic evaluation of standard and formulated gulab jamun

Criteria	Standard Gulab Jamun Mean ±SD	Formulated Gulab Jamun Mean ±SD	't' value
Appearance	18.8 ± 1.32	19 ± 1.41	3.50**
Colour	17.8 ± 2.49	19.16 ± 0.92	2.50**
Flavour	18.12 ± 2.65	18.64 ± 2.15	2.60**
Texture	17.88 ± 1.49	19.12 ± 1.07	2.42**
Taste	18.4 ± 2.13	18.76 ± 1.45	3.36**

** - 1 per cent significance

Table 6. Overall acceptability mean score of standard and formulated instant mix products

Products	Overall Acceptability (100)		't' values
	Standard	Formulated	
Murukku	93.2 ± 5.16	98.72 ± 1.72	5.04**
Puttu	91.68 ± 6.75	98.88 ± 1.76	5.25**
Gulab Jamun	91 ± 9.86	98.28 ± 6.59	3.06**

** - 1 per cent significance

Table 7. Storage stability of instant mixes

Samples	Total bacterial count CFU/g	
	1st day	10th day
Instant murukku mix	0	85×10^1
Instant puttu mix	0	40×10^1
Instant gulab jamun mix	0	75×10^1

maximum acceptable contaminant value of $5x10^7$ this was found to be at a safe level[6].

3.8 Nutrient Calculation of Standard and Formulated Instant Mix Products

The nutrient content of the standard and formulated instant mix products were calculated using Ntutive software and the results of the percentage increase in the nutrient content are discussed below.

3.8.1 Murukku

The nutrients such as carbohydrate, protein, fibre, calcium, phosphorus and iron in standard murukku were found to be 52.47g, 14.37g, 1.45g, 106.91g, 34.84g and 4.09g respectively, whereas in formulated murukku it was noted that 56.21g, 32.43g, 3.8g, 154.52mg, 57.95mg and 10.29mg respectively. When compared with standard and formulated murukku the nutrients mentioned above were increased by 6.6%, 55.6%, 61%, 30.81%, 39.87% and 60.25%.

3.8.2 Puttu

The carbohydrate content of the standard and formulated puttu was found to be 18.4g and 45.32g. The protein content of the standard and formulated puttu was 2.42g and 7.95g respectively. The fibre content of the standard and formulated was found to be 1.86g and 3.02g respectively. The minerals such as calcium, phosphorus and iron were found to be 3.92g, 33.49g and 0.41g in formulated puttu it was found to be 22.33g, 99.36g and 3.86g respectively. The nutrient contents such as carbohydrates, protein, fibre, calcium, phosphorus and iron were increased in the formulated puttu when compared with the standard.

3.8.3 Gulab Jamun

From the results, it was noted that 100g of standard gulab jamun contains 27.49g of carbohydrate, 4.91g of protein, 1.23g of fat, 166.89mg of calcium, 134.76mg of phosphorus and 0.31mg of iron. Whereas 100g of bamboo rice flour and black rice flour added to gulab jamun contains 32.97g of carbohydrate, 9.06g of protein, 2.98g of fibre, 175.05mg of calcium, 162.43mg of phosphorus and 2.15mg of iron. It was also evident from the above table that there is an increment in nutrient contents such as carbohydrates, protein, fibre, calcium, phosphorus and iron in the formulated gulab jamun when compared with the standard.

3.9 Cost Calculation of Bamboo Rice and Black Rice-Based Instant Products

Compared with standard instant mixes, formulated instant mixes cost was highest due to the cost of bamboo rice and black rice whereas commercial brands, they are using parboiled rice or polished rice.

4. Conclusion

Hence, from the present study, it was concluded that the products prepared from the formulated instant mixes such as murukku, puttu and gulab jamun were highly accepted by the panel members. The storage stability of formulated instant mixes shows limited bacterial count and therefore, it can be stored for more than 10 days without any food additives or preservatives. The study concluded that both bamboo rice flour and black rice flour have high fibre content, hence bamboo rice flour and black rice flour can be suggested for diabetes patients. It also determined that both rice flours are rich in minerals such as calcium, iron and phosphorus. Thus, it can be highly recommended for children for their growth and development.

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