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Development and Quality Analysis of Ragi-Based Nutrient-enriched Rusk

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Abstract: The present study was carried out to develop a ragi-based nutrient-enriched rusk. The micronutrient-fortified rusk was developed by using ragi flour, soy flour, dried beetroot, and *Moringa oleifera* leaves powder with milk, yeast, oil, salt, and sugar. Using a five-point rating hedonic scale, the formulated ragi-based Nutrient-enriched rusk was subjected to organoleptic evaluation for its quality attributes like flavour, appearance, taste, texture, and overall acceptability. From the sensory evaluation, the variation found to be with high scores was subjected to physiochemical, nutrient, and microbial analysis.

Keywords: Ragi, rusk, nutrient, moringa oleifera

INTRODUCTION

Finger millet used to be processed in India using techniques like grinding, malting, and fermentation to create beverages, porridges, roti (unleavened flat bread), idli (Indian fermented steamed cake), and dosa (Indian fermented pancake). Consuming whole grains and cereal fiber appears to be adversely associated with BMI, waist circumference, total cholesterol, metabolic syndrome, cardiovascular disease mortality, insulin resistance, and type 2 diabetes incidence, according to research [(1,2)].

The popular polished white rice is not as nutritious as whole-grain cereals like brown rice and millet. Additionally, research has connected the risk of type 2 diabetes to higher amounts of refined grains like white rice and the dietary glycemic load, which measures the quantity and quality of carbohydrates [(3,4)].

A calorie-restricted diet, with a moderate reduction in carbohydrates, was also discovered to be beneficial in lowering insulin resistance and other metabolic disorders in overweight South Asian Indians. Practical strategies have been provided to alleviate the impact of chronic disease by incorporating whole, ancient grains such as sorghum and millets like finger millet into contemporary Asian Indian diets. The various nutritional and health advantages of finger millet have been discussed, particularly regarding its potential in chronic disease prevention [(5,6,7,)].

Asian nations represent the third largest producers of millet, with 80% of its cultivation occurring in India. The highest millet yields are provided by states such as Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, and Haryana. According to the World Health Organization (WHO) fact sheet for 2022, lifestyle-related or noncommunicable diseases (NCDs) are the leading cause of mortality, accounting for 74% of all deaths worldwide. Among this, 77% of deaths were reported in low and middle-income countries. Furthermore, it contributes to elevating blood antioxidant levels and lowering blood sugar levels, as well as maintaining reduced inflammation [(8-12)].

Beetroot is among the most abundant sources of folate. It includes vitamins A, B1, B2, B6, and C. Additionally, it provides a significant amount of calcium, magnesium, copper, phosphorus, sodium, and iron. Findings from multiple studies have shown that betalains found in beetroots exhibit strong antiradical and antioxidant properties. Beetroots have historically been utilized for medicinal reasons, mainly for liver disorders as they assist in enhancing the liver's detoxification processes. The pigment responsible for the beetroot's deep, purple-crimson hue is betacyanin; a potent compound believed to inhibit the growth of certain cancer types [(13-16)].

The study focuses on the preparation of ragi based nutrient-enriched rusk (ragi flour, soy flour, dried beetroot, and *Moringa oleifera* leaves powder with milk, yeast, oil, salt, and sugar). The objectives of the study include:

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- To develop the ragi based nutrient-enriched rusk
- To evaluate the physicochemical and sensory characteristics of the developed products.
- To assess consumer acceptability of the developed products.

METHODOLOGY

The methodology about the study entitled **"Development and Quality Analysis of Ragi Based Nutrient-enriched rusk"** has been discussed in brief below.

2.1 Selection and procurement of ingredients

2.1.1 Selection, development and standardization of nutrient rusk

In the present study, the nutrient-enriched rusk was developed by using ragi flour, soy flour, dried beetroot, and *Moringa oleifera* leaves powder with milk, yeast, oil, salt, and sugar. The above ingredients were quality-checked and purchased from the wholesale market. The moringa leaves were washed and cleaned; beetroots were washed and grated with skin. The ragi flour, moringa leaves, and grated beetroot were sundried to remove the moisture content and ground into powder for the preparation of dough to develop the rusk. The rusk was made by using standard procedure. The product was prepared under three variations (V1, V2, and V3).

Table 1
Standardization of nutrient rusk

Ingredients	**Variations**		
	V1	**V2**	**V3**
Ragi flour	90	90	90
Soy flour	10	10	10
Beetroot powder	50	40	30
Drumstick leaves powder	50	60	70
Total	**200**	**200**	**200**

2.2 Sensory evaluation and nutritive analysis of the developed product

Using a five-point rating hedonic scale, the formulated ragi based nutrient rusk was subjected to organoleptic evaluation for its quality attributes like flavour, appearance, taste, texture, and overall acceptability by 30 semi-trained panel members at Naresh Residency, Avinashi Road, Coimbatore. From the sensory evaluation, the variation found to be with high scores was subjected to physiochemical, nutrient, and microbial analysis. The nutrient analysis for the rusk was done as outsourcing at Alpha labs, Coimbatore.

2.3 Nutrient analysis of the developed product

The fortified rusk was developed and underwent nutrient analysis which includes energy, protein, fat, fibre, calcium, iron and physiochemical properties by using the standard test protocols of AOAC method was followed. The fortified rusk was found to be rich in iron, calcium and a very good source of protein and fibre. Hence 100g of rusk provides 48.2% of iron and 43.3% of calcium as recommended per day for moderate women in RDA 2020 and 2010. This is due to the presents of the leaves of *Moringa oleifera* are rich in minerals like calcium, potassium, zinc, magnesium, iron, and copper. Vitamins like beta-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also present in *Moringa oleifera*. And beetroots are excellent source of folic acid, fibre, manganese, and potassium.

2.4 Statistical analysis

Results of the study were expressed in percentage, mean with standard deviation. The statistical software SPSS version 20 was used for data analysis.

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RESULTS AND DISCUSSION

The results about the study on "**DEVELOPMENT AND QUALITY ANALYSIS OF RAGI BASED NUTRIENT-ENRICHED RUSK"** were discussed under the following headings.

3.1 Sensory evaluation of the developed nutrient-enriched rusk

Sensory evaluation is a scientific discipline that analyses and measures human responses to the composition of food and drink, e.g., appearance, touch, odour, texture, temperature, and taste. The results of the organoleptic evaluation for the three developed rusk variations are depicted in the below table.

Table 2
Organoleptic evaluation of the developed nutrient-enriched rusk

Parameters	**Variations**		
	V1	**VII**	**VIII**
Appearance	4.4±0.62*	4.7±0.43*	4.2±0.76*
Colour	4.3±0.47*	4.7±0.43*	3.8±0.61*
Texture	4.3±0.47*	4.7±0.45*	3.4±0.56*
Taste	4.2±0.40*	4.2±0.52*	3.3±0.61*
Flavour	4.3±0.53*	4.6±0.80*	3.8±0.64*
Overall acceptability	4.4±0.62*	4.8±0.35*	4.31±0.66*

* Significantly different ($p<0.05$) from each other

The above table indicates the average sensory scoring with standard deviation of different attributes and overall acceptability of three variations for the developed rusk. It was evident that variation II scores high in all the parameters like appearance (4.7±0.43), colour (4.7±0.43), texture (4.7±0.45), taste (4.2±0.52), flavour (4.6±0.80) and overall acceptability (4.8±0.35) compared with variation I and III.

3.2 Physio chemical properties and nutritive analysis of the nutrient-enriched rusk

3.2.1 Moisture and ash content of nutrient-enriched rusk

The Manufacturing of Rusk involves the preparation of partially baked bread, slicing, and again roasting in the oven to remove the moisture. Good Roasted rusk has no moisture and be crisp and dry. The high-scored variation II was analysed for moisture and ash.

Table 3.
Moisture and ash content of nutrient-enriched rusk

Parameters	**Test result (g/100gm)**
Moisture	4.37
Total ash	3.09

The moisture and ash value of variation II is 4.37g and 3.09g respectively. These were acceptable values for the developed rusk and the developed product was found to be with good physicochemical properties and shelf life. Another study also reported that the rusks prepared by the modified process had 2.5% moisture, 12.1% fat, 9.4% total protein, 1.9% ash and 74.1% total carbohydrate (Mallik and Kulkarni, 2010).

3.2.2 Nutrient analysis of the developed rusk

Analysis of nutrient content is an important aspect in formulating and developing new products and evaluating new processes for making food products and identifying the sources of problems with unacceptable problems. Adequate analytical methods for nutrients in foods, food ingredients, and food products are the basic first step in determining the nutritional adequacy of a food supply. Whatever the ultimate use of nutrition data, i.e., consumer education via the food label, or databases for nutrient and deficiency disease studies, the assay used to provide the data must determine the analyses of interest adequately.

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Table 4.
Nutrient analysis of the nutrient-enriched rusk

Nutrients	**Test result for 100gm**	
	Test Sample (Developed rusk)	**Control sample (Commercial rusk)**
Energy (Kcals)	397.41	325
Carbohydrate (g)	67.56	48.45
Total Protein (g)	16.49	6.8
Fat (g)	6.09	8.2
Fibre (g)	9.12	2.06
Iron (mg)	14.00	2.12
Calcium (mg)	434.69	34.16

The highly scored variation of ragi-based nutrient-enriched rusk underwent nutrient analysis which includes energy, carbohydrate, protein, fat, fibre, calcium and iron by using standard test protocols of the AOAC method. The fortified rusk was found to be rich in calcium and iron because beetroots are an excellent source of folic acid and a very good source of fibre, manganese, and potassium. The leaves of *Moringa oleifera* are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper. Vitamins like beta-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E are also present in *Moringa oleifera*. From the above table, it was clear that the nutrient composition of the developed rusk was high compared with the commercially available rusk. The nutrient analysis revealed that the developed rusk comprises energy 397.41kcals, carbohydrates 67.56g, Protein 16.49g, fat 6.09g, fibre 9.12 g, Iron 14mg, and calcium 434.69mg which was found to be enhanced when compared to commercially available rusk made by refined flour.

3.2.3 Microbial growth of developed enriched rusk

The shelf life is primarily affected by factors such as light and heat exposure, gas transmission, humidity levels, mechanical stress, and the risk of microbial contamination. Microbiological analysis is important to determine the safety and quality of food. The total plate count was carried for the developed rusk. The developed rusk samples were stored in air-tight containers. The total plate count of the sample was estimated on the first day and finally after three months. The stability of the product was assessed using microbial analysis. The total plate count was analysed initially and after 90 days (storage period at room temperature). The samples were stored in an airtight container. Without any added preservatives, no bacterial growth was found in the analysis after 90 days. Hence the product was safe for consumption. So, from the above result, we can conclude that the newly developed rusk is safe for consumption if it is stored properly.

3.2.4 Labelling and Packaging of Nutrient-enriched Rusk

Today, it is required that they fulfil not only distinctive and promotion functions, but they should be carriers of commercial, educational, and warning information. Hence, the Nutrient-enriched rusk was labelled with information on nutrient content, cost of the product, manufactured and expiry date. Although the individual components of laminates are manufactured and expiry date. Although the individual components of laminates and metalized films are technically recyclable, the difficulty in sorting and separating the material precludes economically feasible recycling. The developed nutrient-enriched rusk was packed in aluminium foil packaging, and they were sealed.

CONCLUSION

In conclusion, the development of the ragi-based nutrient-enriched rusk has proven to be a promising approach to creating a nutritionally enhanced snack. The sensory evaluation results had indicated high acceptability across all key attributes. Further, the physicochemical, nutritional, and microbial analyses confirmed that the product met quality standards, providing a healthy, safe, and functional food option. This fortified rusk could serve as an effective solution for addressing micronutrient deficiencies while offering consumers a desirable, convenient food product.

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