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DEVELOPMENT, SENSORY EVALUATION AND MINERAL ANALYSIS OF TRADITIONAL SAVOURY SNACKS FORTIFIED WITH MORINGA OLEIFERA LEAF POWDER

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ABSTRACT

The present study was conducted to develop and evaluate traditional products fortified with Moringa oleifera Leaf powder to improve their nutritional quality. Two traditional products, besan chilla and moong dal chilla, were developed and standardized by incorporating moringa leaf powder at 5% (Variation I) and 10% (Variation II) levels. Nutritive value and cost analysis revealed that moringa fortification enhanced the nutritional profile of the products with only a marginal increase in production cost. Sensory evaluation was carried out using a 5-point hedonic scale. The basic besan chilla recorded the highest overall acceptability score (4.90), followed by the 5% (4.75) and 9% (4.65) moringa variations. Similarly, the basic moong dal chilla obtained the highest overall acceptability (4.75), followed by the 5% (4.65) and 9% (4.35) variations. While the basic formulations were the most acceptable overall, variation 1 (5% moringa Fortification) was the most acceptable among the fortified Variations for both products. One-way ANOVA showed significant differences among the formulations ($F = 3.45$ for besan chilla and $F = 7.60$ for moong dal chilla; $p < 0.05$), confirming that the level of moringa incorporation significantly influenced sensory acceptability. Nutrient analysis reported that calcium increased from 39 mg to 80 mg and iron from 3.1 mg to 3.5 mg in besan chilla, while in moong dal chilla calcium increased from 32 mg to 79 mg and iron from 1.8 mg to 2.7 mg after moringa fortification. Thus, fortification with 5% Moringa oleifera leaf powder improved the nutritional quality of traditional products with only a marginal increase in cost. However, higher levels of fortification reduced sensory acceptability, making 5% the optimum level for developing nutritionally enriched traditional foods.

KEY WORDS: Moringa oleifera leaf powder, besan chilla, moong dal chilla, nutrient analysis

INTRODUCTION:

India continues to face the challenge of malnutrition in different forms, including micronutrient deficiencies along with the increasing consumption of processed and nutrient-poor snack foods. This has created a need for healthier alternatives that can improve nutrient intake without changing familiar eating habits. Traditional foods can be enriched with locally available ingredients to improve their nutritional quality. [1]

Recently Moringa oleifera, which is rich in iron and calcium has gained popularity as a sustainable resource. This plant has been a staple in Indian households for centuries. Its drought resistance requires minimal agricultural care enabling global cultivation. [2]

Moringa oleifera is a rapidly developing tropical crop, little known in developed countries but widely cultivated in Africa, Central and South America, Sri Lanka, India, Mexico, Malaysia, Indonesia and the Philippines since ancient times. This crop has great industrial potential and is also well adapted to climate change because it needs little water and has few agricultural requirements. In addition, each one of its parts has significant nutritional properties, in particular their content in proteins, fiber, antioxidants and minerals. Thus, the leaves are used as nutritional supplements, the seeds for water purification, the oil as a biofuel, the trunk as a gum producer, the flowers as a source of honey, and every part of the plant can also be used for therapeutic purposes. Remarkably, the oil produced from the seeds has a similar level of C18:1 to olive oil. Moreover, in the developing countries, sources of vitamin A, such as drumstick leaves, are invaluable in the struggle to overcome the problem of vitamin A deficiency. The food industry might offer traditional products fortified with sustainable sources, such as the different parts of moringa, promoting the consumption of this Plant. [3]

Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one

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of the important minerals for human growth. While 8 ounces of milk can provide 300–400 mg, moringa leaves can provide 1000 mg and moringa powder can provide more than 4000 mg. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2 mg of iron while moringa leaf powder has 28 mg of iron. It has been reported that moringa contains more iron than spinach. A good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for the synthesis of DNA and RNA. M. Oleifera leaves show around 25.5–31.03 mg of zinc/kg, which is the daily requirement of zinc in the diet.[4]

To enhance its consumption and fully realize its economic and nutritional potential, there is a need to develop palatable and appealing Moringa fortified products. Establishing small-scale processing units in rural areas can improve nutritional intake while simultaneously creating employment, increasing rural incomes, and promoting sustainable livelihoods. Thus, development of Moringa Fortified foods serves as a dual solution for improving community health and strengthening rural empowerment. (A.beaulah, 2025).[5]

Many studies have reported the use of moringa leaf powder in bakery products, beverages and snack foods to improve their nutritional value. Although higher levels of fortification increase nutrient content, they may also affect the colour, flavour and overall acceptability of the product. Therefore, selecting an appropriate level of incorporation is important. [1]

Besan and moong dal are commonly used pulse-based ingredients and are naturally rich in protein and other essential nutrients. Since chillas are widely consumed and accepted by people of all age groups, they can serve as suitable products for moringa fortification. Keeping this in view, the present study was undertaken to develop moringa-fortified besan and moong dal chillas and evaluate their nutritional composition, sensory acceptability, cost and mineral content.

MATERIALS AND METHODS

STUDY DESIGN:

An experimental food product development study involving formulation, standardization, and evaluation of food products.

PRODUCT DEVELOPMENT: The present study involves the development of value-added besan and moong dal chillas fortified with different levels of Moringa oleifera leaf powder.

PROCUREMENT OF THE INGREDIENTS:

Ingredients were procured from the local market and online grocery applications. These ingredients include Moringa powder and other ingredients such as chickpea flour, green gram dal, onion, tomato, coriander leaves, green chillies, oil and other spices required for the formulation of food products.

STANDARDIZATION:

In the present study, besan and moong dal chillas were standardized over the course of two trials. The recipe was then standardized. All the recipes were standardized to one serving of the product.

FORMULATION OF THE PRODUCTS:

Besan chilla and Moong dal chilla are a common Indian savoury food that are consumed either as breakfast or a snack, traditionally prepared using chickpea flour and green gram dal. The basic formulation of both products is constant and the two variations are prepared by fortifying the basic formulations with moringa oleifera leaf powder at 5% and 10% levels.

NUTRITIVE VALUE CALCULATION AND COST ANALYSIS:

The nutritive value of the control (basic) and variations were calculated. The nutrients calculated were energy, protein, carbohydrates, fats, calcium and iron. These were calculated using ifct (Indian food composition tables, 2017). The cost of ingredients of control (basic) and the variations was assessed.

SENSORY EVALUATION:

Sensory evaluation of food was performed by 20 semi-trained panelists using 5-point hedonic rating scale. The sensory evaluation was carried out within the food and nutrition department of Veeranari Chakali Ilamma women's University, located in koti, Hyderabad.

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STATISTICAL ANALYSIS OF DATA:

The data collected from sensory scores was compiled and classified. ANOVA (one way classification) was used to discover the significant differences between the mean scores of the basic and the two variations.

MINERL ANALYSIS

The nutrient estimation of calcium along with iron of the control (basic) and the most accepted variation of moringa powder Fortified besan and moong dal chillas was done using standard (AOAC) methods.

RESULTS AND DISCUSSION

NUTRITIVE VALUE OF THE DEVELOPED PRODUCTS:

The nutritive value of the developed products showed that the addition of Moringa oleifera leaf powder improved their nutritional composition. Both besan chilla and moong dal chilla showed higher calcium and iron content after fortification. As the level of moringa increased, the nutrient content also increased, indicating that moringa leaf powder is an effective natural source of these minerals. (Table 1).

COST ANALYSIS:

The cost of the fortified products was slightly higher than that of the basic formulations because of the addition of moringa leaf powder. However, the increase in cost was minimal, suggesting that the fortified products can be prepared at an affordable price without greatly increasing production cost. (Table 2).

SENSORY EVALUATION OF BESAN CHILLA

The sensory evaluation scores showed that the basic besan chilla received the highest overall acceptability score. Among the fortified samples, the 5% moringa variation was preferred over the 10% variation. The lower scores for the 10% formulation may be due to the darker green colour and stronger flavour of moringa. Statistical analysis (one way ANOVA) indicated a significant difference among the formulations ($p < 0.05$). (Table 3).

SENSORY EVALUATION OF MOONG DAL CHILLA

A similar pattern was observed for moong dal chilla. The control sample received the highest sensory scores, while the 5% fortified variation was more acceptable than the 10% variation. Although fortification improved the nutritional quality, increasing the amount of moringa affected the colour and taste of the product, leading to slightly lower acceptability scores. Statistical analysis (one way ANOVA) indicated a significant difference among the formulations ($p < 0.05$). (Table 4).

MINERAL ANALYSIS

Laboratory analysis demonstrated a considerable increase in calcium and iron content following moringa fortification. The analysed mineral values confirmed the calculated nutritive values, indicating that fortification with Moringa oleifera leaf powder effectively enhanced the mineral composition of both products. (Table 5 & 6).

CONCLUSION

The study concluded that fortification of traditional besan and moong dal chillas with Moringa oleifera leaf powder improved their nutritional quality, particularly by increasing calcium and iron content. Among the fortified formulations, Variation I (5% moringa leaf powder) was found to be the most suitable, offering enhanced nutritional value with acceptable sensory quality, while higher levels of fortification resulted in lower sensory acceptability. Therefore, 5% moringa leaf powder can be recommended for the development of nutritious, cost-effective value-added traditional savoury products.

TABLES

TABLE 1: Nutritive value calculation of Besan chilla and Moong dal chilla

Nutrients	Besan chilla			Moong dal chilla		
	Basic	Variation 1	Variation 2	Basic	Variation 1	Variation 2
Energy (kcal)	126.53	134.39	139.63	106.61	115.4	121.26
Carbohydrates (gm)	18.71	20.39	21.5	17.14	18.7	19.87

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Proteins (gm)	7.42	7.74	7.98	7.82	8.18	8.42
Fats (gm)	2.14	2.21	2.16	0.51	0.53	0.56
Calcium (mg)	38	110.24	158.4	30.14	109.6	157.84
Iron (mg)	2.29	5.69	7.97	1.75	5.41	7.73

TABLE 2: Cost calculation of Besan chilla and Moong dal chilla

Cost analysis	**Besan chilla**			**Moong dal chilla**		
	Basic	**Variation 1**	**Variation 2**	**Basic**	**Variation 1**	**Variation 2**
Ingredients	5/-	11/-	15/-	6/-	13/-	17/-
Labour	5/-	5/-	5/-	5/-	5/-	5/-
Total	**10/-**	**16/-**	**20/-**	**11/-**	**18/-**	**22/-**

TABLE 3: Mean sensory attribute scores of moringa powder Fortified besan chilla (basic and variations)

S.No	**Sensory attributes**	**Mean values of basic**	**Mean values of variation 1**	**Mean values of variation 2**	**F calculated**	**Results**
1.	Appearance	4.9	4.9	4.85	**3.45**	**Significant**
2.	Colour	4.95	4.7	4.75		
3.	Taste	4.95	4.5	4.5		
4.	Texture	4.75	4.8	4.55		
5.	Aroma	5	4.85	4.75		
6.	Overall acceptability	4.9	4.75	4.65		

TABLE 4: Mean sensory attribute scores of moringa powder Fortified Moong dal chilla (basic and variations)

S.No	**Sensory attributes**	**Mean values of basic**	**Mean values of variation 1**	**Mean values of variation 2**	**F calculated**	**Results**
1.	Appearance	5	4.6	4.5	**7.60**	**Significant**
2.	Colour	4.75	4.65	4.65		
3.	Taste	4.9	4.45	4.25		
4.	Texture	4.95	4.55	4.45		
5.	Aroma	4.85	4.85	4.5		

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6.	Overall acceptability	4.75	4.65	4.35		

TABLE 5: Mineral analysis of besan chilla (Basic and variation 1)

Minerals	**Basic**	**Variation 1**	**Increment**
Calcium	39mg	80mg	41mg
Iron	3.1mg	3.5mg	0.4mg

TABLE 6: Mineral analysis of moong dal chilla (basic and variation 1)

Minerals	**Basic**	**Variation 1**	**Increment**
Calcium	32mg	79mg	47mg
Iron	1.8mg	2.7mg	0.9mg

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