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Development And Standardization Of Technology For Drumstick Leaves Powder Enriched Crackers

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Abstract

Drumstick leaves powder (DLP) is recognized globally for its nutritional benefits, but its use in local recipes is limited due to its bitter taste. Therefore, this study focused on producing high-quality DLP using nutrient-preserving techniques such as chemical blanching and cabinet drying. The prepared DLP was incorporated into crackers, which were then analyzed for their proximate, mineral, and phytochemical content. The results showed that crackers enriched with 5% DLP had good sensory properties, comparable to the control. Additionally, a 100 g serving of these enriched crackers could meet the recommended dietary allowance (RDA) for children in terms of protein, calcium, beta-carotene, and some ascorbic acid, while providing 33% of protein for men, 50% for women, and fully meeting beta-carotene needs of pregnant and lactating women.

Keywords: cracker, drumstick leaves powder, RDA

1. Introduction

Most commercially available snacks, such as potato chips, extruded products, and chocolates, lack a balanced nutrient profile and are considered unhealthy, especially for school-aged children. Teenagers have increased calorie needs, particularly during growth spurts, yet they often choose snacks high in fat and sodium but low in important nutrients like iron, calcium, vitamins A and C, and folate [1]. It is important for teenagers to learn how to complement low-nutrient foods with snacks and meals rich in vitamins, minerals, and phytochemicals from whole grains, fruits, vegetables, and legumes [2].

The market offers a range of crackers, such as high-fiber, low-fat, cholesterol-free, and multigrain options, each designed to provide specific health benefits. These convenient, ready-to-eat products appeal to school children, office workers, and athletes to help maintain energy levels and serve as emergency nutrition supplies. A truly nutrient-dense cracker should supply a good balance of all major nutrients.

Wheat is widely used to meet basic energy and nutritional needs but has poor protein quality, as lysine is its first limiting essential amino acid, with threonine and tryptophan also in short supply [3]. The nutritional quality of wheat-based products can be improved by adding edible protein-rich materials, such as legumes, which are high in lysine, threonine, and tryptophan. However, legumes have limited digestibility and contain antinutritional factors like phytates, tannins [4], amylase inhibitors [5], and hemagglutinins [6], which present challenges.These Antinutritional factors are of great concern.

Moringa (drumstick) leaves are gaining attention for their potential to reduce malnutrition and related health issues. These leaves contain a high level of essential amino acids in balanced proportions, along with abundant minerals and vitamins [7]. Communities that regularly consume Moringa suggest it not only provides good nutrition but may also help manage diabetes and hypertension.

Considering the nutritional, therapeutic, and preventive benefits of drumstick leaves, and the need to address protein malnutrition in children from low-income families, it is important to develop value-added products using drumstick leaves. This study focuses on incorporating drumstick leaves powder into crackers to enhance their nutritional content.

2. Material and methods

2.1 Preparationofdrumstickleavespowder

Fresh drumstick (Moringa oleifera) leaves of the Coimbatore cultivar were collected and processed within 2 hours of harvesting. The top portions of the plant (about 15 cm in length) were carefully selected, damaged leaves were removed, and the remaining leaves were thoroughly washed. A chemical blanching pretreatment was applied using a solution containing 0.5% potassium metabisulphite (KMS), 0.15% magnesium oxide (MgO), and 0.15% sodium carbonate (Na_2CO_3) mixed in a 1:3 ratio of leaves to solution. The leaves were blanched at 80°C for 1–2 minutes, then drained to remove excess water. After pretreatment, the leaves were dried in a cabinet dryer at 60°C for 6 hours until they reached constant weight. Finally, the dried leaves were milled into a fine powder (mesh size 150 µm) and stored in polypropylene films to prevent moisture absorption.

2.2 Productdevelopment
2.3 PreparationofDrumstickcrackers

Crackers were prepared using a modified version of the formulation described by [8], and the standardized recipe is provided below.

Recipe

Ingredients		**Quantity (gm)**
Maida	=	100 g
Sugar	=	10.0g
Fat	=	15.0g
Salt	=	2.0g
Milk	=	40ml
Baking powder	=	1.0 g
Ammonia	=	1.0g Drumstick leaf Powder = 5.0g

All dry ingredients—maida, sugar, salt, baking powder, ammonia, and drumstick leaves powder—were mixed together in a large bowl. Butter was then cut into the mixture using two knives until the texture resembled cornmeal. Next, 40 ml of milk was added gradually and mixed until a stiff dough ball was formed. The dough was rolled out to about 1/8 inch thickness. Using a floured cookie cutter, crackers were shaped and placed on an ungreased baking sheet. Each cracker was pricked several times on top with a fork and brushed with milk. The crackers were baked at 218°C for 8–10 minutes, or until lightly golden. After cooling on a rack, they were stored in polyethylene airtight bags at room temperature.

2.4 Sensory Analysis

The sensory evaluation of the crackers was conducted by a trained panel of 10 members using a 9-point hedonic scale, where 9 indicated ‘like extremely’ and 1 indicated ‘dislike extremely’.

2.5 Chemicalanalysis

The prepared drumstick leaves powder was analyzed for its proximate composition following the method described by [9]. Moisture content was measured by air-oven drying at 130°C for 1 hour, while crude protein content was determined using the micro Kjeldahl method (% protein = N × 6.25). Lipid content was extracted using petroleum ether (boiling point 60–80°C) in a Soxhlet apparatus, and crude fiber was measured through acid and alkali hydrolysis. For mineral analysis, 5 grams of dried powder was digested in 6 M HCl, and the volume was adjusted to 20 ml. Copper, manganese, iron, and zinc were measured using an Atomic Absorption Spectrophotometer (AAS200 – Perkin Elmer), while calcium content was determined by the method described in [10]. Total phenolic content was analyzed by the method of [11] with some modifications, vitamin C was estimated according to [12], and beta-carotene content was calculated using the method from [13].

2.6 Statisticalanalysis

The data obtained were analyzed using a Completely Randomized Design (CRD) according to the method described by [14]. Analysis of variance (ANOVA) was performed, and significance was determined at the $P < 0.05$ level. Standard Error (S.E.) and Critical Difference (C.D.) at the 5% level are reported wherever applicable.

3. Resultand discussion

In the present study, drumstick leaves powder (DLP) prepared by cabinet drying was used to enrich crackers. The recipe was standardized by performing sensory evaluations on crackers containing different DLP levels, ranging from 5% to 15%.

Table 1: Standardizedrecipeforproductionofcracker

Ingredients	Quantity(gm)
Maida	100
Sugar	10
Fat	15
Salt	2.0
Milk	40 ml
DLP	5,7.5,10,12.5,15
Baking Powder	1.0
Ammonia	1.0

3.1. Sensory Evaluation

A semi-trained panel of eight members evaluated crackers enriched with different levels of DLP (5%, 7.5%, 10%, 12.5%, and 15%) for their organoleptic (sensory) properties. The color of crackers with 5%, 7.5%, 10%, and 12.5% DLP appeared similar. However, the sample with 15% DLP (Sample E) was not preferred by the panel due to its dark color and was rejected. Despite this, the differences were not statistically significant based on the critical difference analysis.

Table 2: Effect of Addition of Different Proportion of Drumstick Leaves Powder on Sensory Properties of Crackers

Samples	Color	Appearance	Aroma	Taste	Texture	Mouth Feel	Over all Acceptability
A	8	8	8	8	8	8	8
B	8	8	8	7	8	7	7.6
C	8	7.5	8	7	6	6.5	7.16
D	7.5	7	6	6.5	6	6	6.5
E	5	5	5	5	5	5	5
SE±	0.166	0.0924	0.1314	0.120	0.1139	0.126	0.0742
CD at 5%	0.522	0.2909	0.4133	0.377	0.358	0.397	0.233

A= 5 percent DLP, B=7.5 percent DLP, C= 10 percent DLP, D= 12.5 percent DLP, E= 15 percent DLP

The mean appearance scores for crackers with 5% and 7.5% DLP were significantly higher than those of the other samples. The cracker containing 15% DLP received the lowest score, indicating poor acceptability. As the proportion of DLP increased, the appearance of the crackers declined, likely due to a rougher surface caused by the higher DLP content in the flour. The aroma was rated most acceptable for samples A, B, and C (score of 8.0), while samples D and E had a noticeable leafy aroma due to the higher DLP concentration, as noted by the judges.

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The texture of crackers varied significantly depending on the proportion of DLP mixed with flour, with scores ranging from 8 to 5. Panel members gave the highest texture scores to samples A and B (8.0), followed by samples C and D (6.0). The combination of flour and DLP had a notable impact on texture, but this effect remained desirable only up to 7.5% DLP. As the DLP concentration increased, the chewiness also increased, which is not ideal for crackers. Therefore, sample A (5% DLP) was the most preferred, while sample E (15% DLP) was rated neutral due to its high fiber content and excessive chewiness.
Overall acceptability scores showed clear differences across samples, with sample A receiving the highest score. This acceptability was influenced by appearance, color, taste, aroma, texture, and mouthfeel. The results indicate that adding 5% DLP to the standard cracker recipe produced the best sensory outcome. Sample A was significantly more acceptable than the others, while sample E (15% DLP) had the lowest acceptability.
In conclusion, the addition of 5% DLP consistently resulted in the highest scores across all organoleptic qualities, making it the most acceptable formulation. Therefore, sample A was selected for further analytical studies due to its superior taste, mouthfeel, and overall acceptability.

3.2 Proximate composition of crackers

Further efforts were made to study the retention of nutrients in the selected cracker (with 5% DLP) after baking at a high temperature (218°C). The analysis focused on proximate composition, minerals, and phytochemical content. The effects of baking on the proximate composition of the cracker are presented in Table 3.

Table 3: Effect of Drumstick Leaves Powder Addition on Proximate Composition of Crackers

Constituents (%)	EC	Sample A
Moisture content	3.9	4.15
Ash	1.98	3.37
Carbohydrates	67.38	58.12
Protein	12.28	19.32
Fat	12.78	14.78
Crude fiber	0.78	2.82

Where, EC = Experimental Control Crackers Sample A = 5% DLP Enriched Cracker

The proximate composition of the crackers increased with DLP enrichment, except for carbohydrates, which decreased from 67.38% in the control sample to 58.12% in the enriched cracker. Moisture and fat levels in both control and enriched crackers were within permissible limits [15], with less than 5% moisture and under 15% fat. The protein content in the DLP-enriched cracker was higher (19.32%) compared to the control (12.28%). The enriched cracker also showed higher ash content (3.37%) and fiber content (2.82%), which may help address micronutrient deficiencies and digestion issues such as constipation. The high protein level (19.32%) in the enriched cracker meets the recommended dietary allowance (RDA) for infants (14 g/day), children (16–28 g/day), 33% of adult males (57 g/day), and 50% of adult females (38 g/day) [16]. Unlike the control sample, which had some essential amino acid deficiencies and antinutritional factors from wheat flour, the enriched crackers (Sample A) provided a more balanced amino acid profile and were free of these antinutritional factors, thanks to the addition of DLP.

3.3. Phytochemical and Mineral Composition

Table 4: Effect of Drumstick Leaves Powder Addition on Mineral Composition of Crackers

Samples	EC	Sample A
Ca %	0.30	0.64
Fe mg/100gm	1.0127	1.1107
Zn mg/100gm	0.5954	0.7782
Cu mg/100gm	0.0645	0.0703
Mn mg/100gm	0.2096	0.295
β Carotene mg/100gm	0.4	5.9
Ascorbic Acid mg/100	2.3	4
Total Phenolic Compound (%)	0.228	0.454

The DLP-enriched crackers contained a high calcium content (0.64%), which meets the RDA for infants, children, and provides 50% of the RDA for both adult males and females. Other minerals also showed moderate increases. The beta-carotene retained in the enriched crackers was sufficient to meet the RDA for pregnant and lactating women. Additionally, a high level of total phenolic compounds (0.454%) was observed. However, ascorbic acid was mostly lost during baking due to the high temperature, resulting in a low amount of 4 mg per 100 g.

4. Conclusion

It can be concluded that pretreating *Moringa oleifera* leaves by chemical blanching followed by cabinet drying produces good-quality drumstick leaves powder. Using this powder at a 5% level in crackers results in a product with improved nutritional, mineral, and phytochemical content, while maintaining quality comparable to control crackers.

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