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Development of Healthy Moringa Leaves Snacks

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Abstract: ***The present study was conducted to develop and evaluate nutritious Moringa oleifera leaves snacks using moringa leaf powder, rice flour, wheat flour, and selected spices. The product was prepared by tray drying fresh moringa leaves at 50–55°C, grinding them into powder, and incorporating them into snack formulation. Proximate analysis revealed low moisture content (3.82 g/100 g), indicating better shelf stability. The developed snack showed high protein (18.62 g/100 g) and crude fibre (21.57 g/100 g) content, demonstrating its nutritional and functional benefits. The product also contained 32.88 g/100 g carbohydrates, 10.18 g/100 g fat, and provided 427 kcal/100 g energy value. Ash content (5.46 g/100 g) indicated good mineral presence, while acid-insoluble ash (0.02 g/100 g) confirmed product purity. Microbiological analysis and heavy metal evaluation were found within permissible limits as per FSSAI standards, confirming product safety and hygienic processing conditions. Overall, the developed moringa leaves snacks were found to be nutritionally rich, safe, shelf-stable, and suitable as a functional snack product for health-conscious consumers.***

Keywords: Moringa oleifera leaves, functional snack, proximate analysis, dietary fibre, high-protein snack, nutraceutical food, microbiological safety, shelf-stable product.

I. INTRODUCTION

In recent years, the demand for healthy and functional food products has increased due to growing awareness about nutrition and lifestyle-related diseases. Most commercially available snacks are rich in fat, sugar, and calories but lack essential nutrients. Therefore, the development of nutritious snack products using natural ingredients has become an important area of research in the food industry.

Among various functional foods, Moringa oleifera has gained significant attention because of its excellent nutritional and medicinal properties. Moringa leaves are rich in proteins, vitamins, minerals, antioxidants, dietary fiber, and essential amino acids. They contain high amounts of vitamin A, vitamin C, calcium, iron, and potassium, which help in reducing malnutrition and micronutrient deficiencies. In addition, moringa leaves possess antioxidant, antimicrobial, anti-inflammatory, and therapeutic properties due to the presence of bioactive compounds such as flavonoids, tannins, and saponins.

Fresh moringa leaves are highly perishable; therefore, drying is commonly used to convert them into moringa leaf powder for longer shelf life and easy incorporation into

food products. Moringa powder can be successfully used in snack formulations to improve nutritional quality by increasing protein, fiber, mineral, and antioxidant content.

The preparation of moringa leaves snacks involves the use of ingredients such as wheat flour, rice flour, sesame seeds, turmeric powder, chilli powder, ajwain, coriander powder, and salt, which contribute to texture, flavor, aroma, and overall acceptability of the product. These ingredients also provide additional functional and health benefits.

Therefore, the present study was undertaken to develop and evaluate moringa leaves–based snacks with improved nutritional and sensory qualities. The study aims to assess the nutritional composition, functional properties, and acceptability of the developed snack product as a healthy alternative to conventional snacks..

II. MATERIAL AND METHODOLOGY

A. MATERIALS

The raw materials used for the preparation of moringa leaves snacks included fresh moringa leaves, wheat flour, rice flour, salt, turmeric powder, sesame seeds, ajwain (ova), chilli powder, and coriander powder. All ingredients were procured from the local market and stored under hygienic conditions until use.

1) Moringa Leaves

Fresh Moringa oleifera leaves were used as the primary functional ingredient in the preparation of snacks. Moringa leaves are highly nutritious and rich in proteins, vitamins, minerals, antioxidants, and phytochemicals. The leaves were selected due to their nutritional and therapeutic properties and their potential application in functional food products.

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2) Wheat Flour

Wheat flour was used to improve dough elasticity, binding properties, and structural stability of the snack product. Wheat flour contributes gluten formation, which helps in dough development and texture formation during processing.

3) Rice Flour

Rice flour was incorporated to improve crispness, texture, and overall sensory quality of the snacks. Rice flour also contributes to better mouthfeel and enhances product acceptability.

4) Salt

Salt was added as a flavor enhancer and preservative. Salt improves the taste and contributes to the overall palatability of the product.

5) Turmeric Powder

Turmeric powder was used for its natural coloring property and medicinal benefits. Turmeric contains curcumin, which possesses antioxidant and antimicrobial activities.

6) Sesame Seeds

Sesame seeds were incorporated to enhance the nutritional value, flavor, and texture of the snacks. Sesame seeds are rich in healthy fats, proteins, calcium, and antioxidants.

7) Ajwain

Ajwain was added to improve flavor and digestive properties. Ajwain is known for its characteristic aroma and medicinal benefits.

8) Chilli Powder

Chilli powder was used to impart pungency, color, and flavor to the snack product.

9) Coriander Powder

Coriander powder was added as a flavoring agent to improve the sensory characteristics of the developed snacks.

B. METHODOLOGY

Flowchart for Preparation of Moringa Leaves Snacks

Collection of Fresh Moringa Leaves

↓

Cleaning and Sorting

↓

Tray Drying of Leaves

↓

Grinding to Obtain Moringa Powder

↓

Mixing of Ingredients

(Rice Flour + Wheat Flour + Moringa Leaf Powder +
Salt + Chilli Powder + Sesame Seeds + Ajwain +
Coriander Powder)

↓

Dough Preparation

↓

Sheeting and Cutting (Circular Shape)

↓

Air Drying of Snacks

↓

Cooling

↓

Packaging

↓

Storage

C. Preparation of Moringa Leaves Snacks

1) Collection of Raw Materials

Fresh moringa leaves along with rice flour, wheat flour, sesame seeds, salt, chilli powder, ajwain, coriander powder, and other required ingredients were collected from the local market.

2) Cleaning and Sorting

The collected moringa leaves were thoroughly cleaned to remove dust, dirt, damaged leaves, and foreign materials. Sorting was carried out to ensure good-quality leaves for processing.

3) Drying of Moringa Leaves

The cleaned moringa leaves were spread uniformly on stainless steel trays and dried in a tray dryer at a temperature of 50–55°C until crisp texture was obtained and moisture content was significantly reduced.

4) Grinding

The dried moringa leaves were finely ground using a grinder to obtain moringa leaf powder. The powder was stored in airtight containers until further use.

5) Mixing of Ingredients

The moringa leaf powder was mixed with rice flour, wheat flour, salt, chilli powder, sesame seeds, ajwain, and coriander powder in suitable proportions to obtain a homogeneous dry mixture.

6) Dough Preparation

Water was added gradually to the dry mixture and kneaded properly to obtain a smooth, uniform, and non-sticky dough suitable for sheeting and cutting operations.

7) Sheeting and Cutting

The prepared dough was rolled into thin sheets using a rolling pin or dough sheeter. Circular-shaped snacks were prepared using cutters or moulds of uniform size.

8) Air Drying

The prepared snack pieces were dried in an air dryer or dehydrator until a firm texture and low moisture condition were achieved.

9) Cooling

After drying, the snacks were cooled to room temperature to avoid moisture condensation inside the packaging material.

10) Packaging and Storage

The cooled moringa snacks were packed in airtight food-grade packaging materials and stored in a cool and dry place for further analysis and shelf-life studies.

III. RESULT AND DISCUSSION

A. Determination of Moisture Content

PROCEDURE:

The moisture content of the moringa leaves snack sample was determined using the hot air oven method (AOAC 925.10). Approximately 5 g of powdered sample was weighed into a clean, dry, and pre-weighed moisture dish. The sample was dried in a hot air oven at 105°C for 4–5 hours until a constant weight was obtained. The dish was removed carefully, cooled in a desiccator, and weighed again. Drying and weighing were repeated until the difference between two consecutive weights did not exceed 0.001 g.

FORMULA:`

$$\text{Moisture Content}(\%)=\left(\frac{w2-w3}{w2-w1}\right)\times 100$$

Where:

W_1 = Weight of empty dish (g)

W_2 = Weight of dish + sample before drying (g)

W_3 = Weight of dish + sample after drying (g)

B. Determination of Ash Content

PROCEDURE:

The ash content of the moringa leaves snack sample was determined according to AOAC 942.05 method. About 5 g of powdered sample was taken in a previously dried and weighed silica crucible.

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Approximately 5–10 ml ethanol was added for proper charring of the sample. The crucible was then placed in a muffle furnace and ignited at 550°C for 4 hours until light grey or white ash was obtained. The crucible was removed carefully and *cooled in a desiccator before weighing. Ignition was repeated* every 30 minutes until constant weight was achieved.

FORMULA:

$$\text{Ash Content (\%)} = \frac{(W3 - W1)}{(W2 - W1)} \times 100$$

Where:

W_1 = Weight of empty crucible (g)
W_2 = Weight of crucible + sample before ignition (g)
W_3 = Weight of crucible + ash after ignition (g)

C. Determination of Protein Content

PROCEDURE:

The crude protein content of the moringa leaves snack sample was determined by the Kjeldahl method (AOAC 2001.11). Approximately 1 g of sample was digested with catalyst mixture and concentrated sulfuric acid until a clear solution was obtained. The digested sample was distilled with sodium hydroxide, and liberated ammonia was collected in boric acid solution. The distillate was titrated against 0.1 N hydrochloric acid. The protein content was calculated from the nitrogen value obtained.

FORMULA:

$$\text{Crude Protein (\%)} = \frac{A - B) \times N \times 14.01 \times 6.25}{W}$$

Where:

A = Volume of HCl used for sample titration (ml)
B = Volume of HCl used for blank titration (ml)
N = Normality of HCl
W = Weight of sample (g)
6.25 = Protein conversion factor

D. Determination of Fat Content

PROCEDURE:

The crude fat content was determined using the Soxhlet extraction method (AOAC 920.39). Approximately 2–5 g of dried sample was extracted continuously with petroleum ether for 6–8 hours. After extraction, the solvent was evaporated and the flask was dried, cooled, and weighed. The increase in weight of the flask represented the crude fat content.

FORMULA:

$$\text{Crude Fat (\%)} = \frac{(W2 - W1)}{W} \times 100$$

Where:

W_1 = Weight of empty extraction flask (g)
W_2 = Weight of flask + extracted fat (g)
W = Weight of sample (g)

E. Determination of Crude Fiber Content

PROCEDURE:

The crude fiber content was determined using acid and alkali digestion method (AOAC 962.09). About 2 g of defatted sample was boiled with dilute sulfuric acid followed by dilute sodium hydroxide solution. The residue obtained was dried, weighed, and then incinerated in a muffle furnace at 550°C. The loss in weight after ignition represented crude fiber content.

FORMULA:

$$\text{Crude Fibre (\%)} = \frac{(W1 - W2)}{W} \times 100$$

Where:

W_1 = Weight of dried residue before ashing (g)
W_2 = Weight of ash after ignition (g)
W = Weight of sample (g)

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F. Determination of Carbohydrate Content

PROCEDURE:

The total carbohydrate content of the moringa leaves snack sample was determined by the difference method. The values obtained from moisture, ash, crude fat, crude fiber, and crude protein analyses were subtracted from 100 to obtain carbohydrate content.

FORMULA:

Total Carbohydrate (%)=100-(Moisture +Ash+Crude Protein+Crude Fat +Crude Fibre)

G. PHYSIOLOGICAL ANALYSIS

Physical measurement:-In this taste, various physical parameters Dlike weight, length, and the moringa snacks width are calculated.

• Shape:

The shape of the bites was identified by a sensory test by the visual method. Various shapes can be made by using cutters.

• Average weight:

Moringa snacks were selected randomly from the prepared batch and their weight was measured. The average weight was calculated by using the formula; Avg

Weight = Total weight of moringa snacks

No. of moringa snacks

• Length:

Moringa leaves were selected randomly and the horizontal length of moringa snacks from the top was calculated by using a digital Vernier caliper scale.

• Width:

By using a digital Vernier caliper scale, the average thickness (vertical height) of selected moringa snacks was calculated.

H. MICROPBIAL ANAYSIS

Microbial analysis of the developed Moringa oleifera leaves snacks was carried out in the laboratory using standard microbiological methods. The results indicated that the product was free from harmful microbial contamination and safe for consumption. The low microbial count confirmed good hygienic processing, proper packaging, and suitable storage conditions.

IV. OBSERVATION

DIFFERENT FORMULATIONS MoringaLEAVES SNACKS

Sr.no	Raw material	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1	Rice Flour	25.0	30.0	35.0	40.0	40.0
2	Wheat Flour	45.0	40.0	35.0	30.0	30.0
3	Moringa leaf flour	10.0	10.0	10.0	10.0	10.0
4	Sesame Seeds	5.0	5.0	5.0	5.0	5.0
5	Salt	1.5	1.5	1.5	1.5	1.5
6	Chilli Powder	1.0	1.0	1.0	1.0	1.0
7	Ajwain	1.0	1.0	1.0	1.0	1.0
8	Coriander Powder	1.5	1.5	1.5	1.5	1.5
9	Turmeric Powder	0.5	0.5	0.5	0.5	0.5
10	Water	9.5	9.5	9.5	9.5	9.5

*Water quantity was adjusted as required during dough preparation.

Observation: Increase in rice flour improved the crispiness and crunchiness of the developed moringa leaves snacks.

RESULT OF PROIXIMATE ANAKYSIS

FACTORS PARAMETERS	RESULT
Moisture Content	3.82
pH	6.06
Protein	18.62
Carbohydrate	32.88
Ash	5.46

PHYSIOLOGICAL ANALYSIS

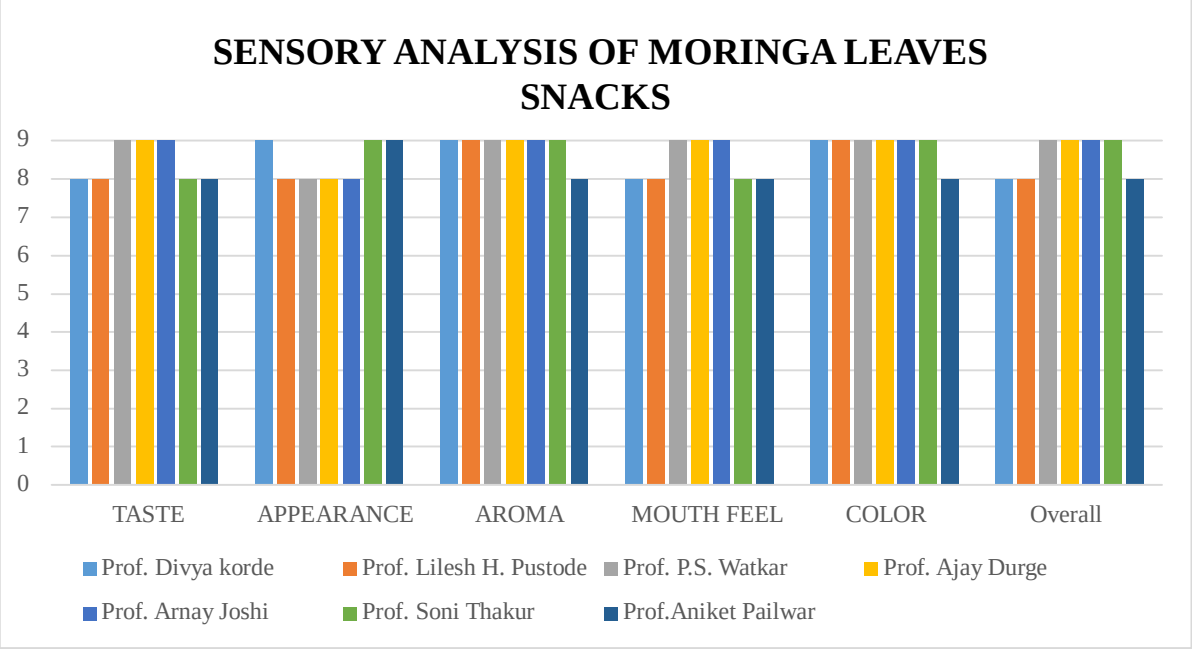
PARAMETERS	RESULT
Shape	Round
Average Weight	2.0g
Length	45.41mm
Width	2.35mm

MICROBIAL ANALYSIS

PARAMETERS	RESULT
Total Plate count	75 cfu/g
Coliform Count	<10cfu/g
Yeast and Mould	<10cfu/g
E Coli	Absent Per gm
Salmonella	Absent Per 25 g

SENSORY GRAPH

- **Fourth Trial Sensory Chart**



FINAL PRODUCT

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V. CONCLUSION

The present study demonstrated that Moringa oleifera leaves can be successfully utilized in the development of nutritious and functional snack products. Incorporation of moringa leaf powder improved the nutritional quality of the snacks by increasing protein, dietary fiber, mineral, and antioxidant content.

The developed snacks showed low moisture content (3.82 g/100 g), high protein (18.62 g/100 g), high crude fiber (21.57 g/100 g), and moderate fat content (10.18 g/100 g), indicating good nutritional value and shelf stability. The product also exhibited desirable functional properties such as improved texture, binding, and structural stability.

Overall, moringa leaves snacks were found to be nutritionally rich, technologically feasible, and consumer acceptable. Therefore, the developed product has strong potential as a healthy alternative to conventional snack foods and may contribute to improved nutrition and functional food development.

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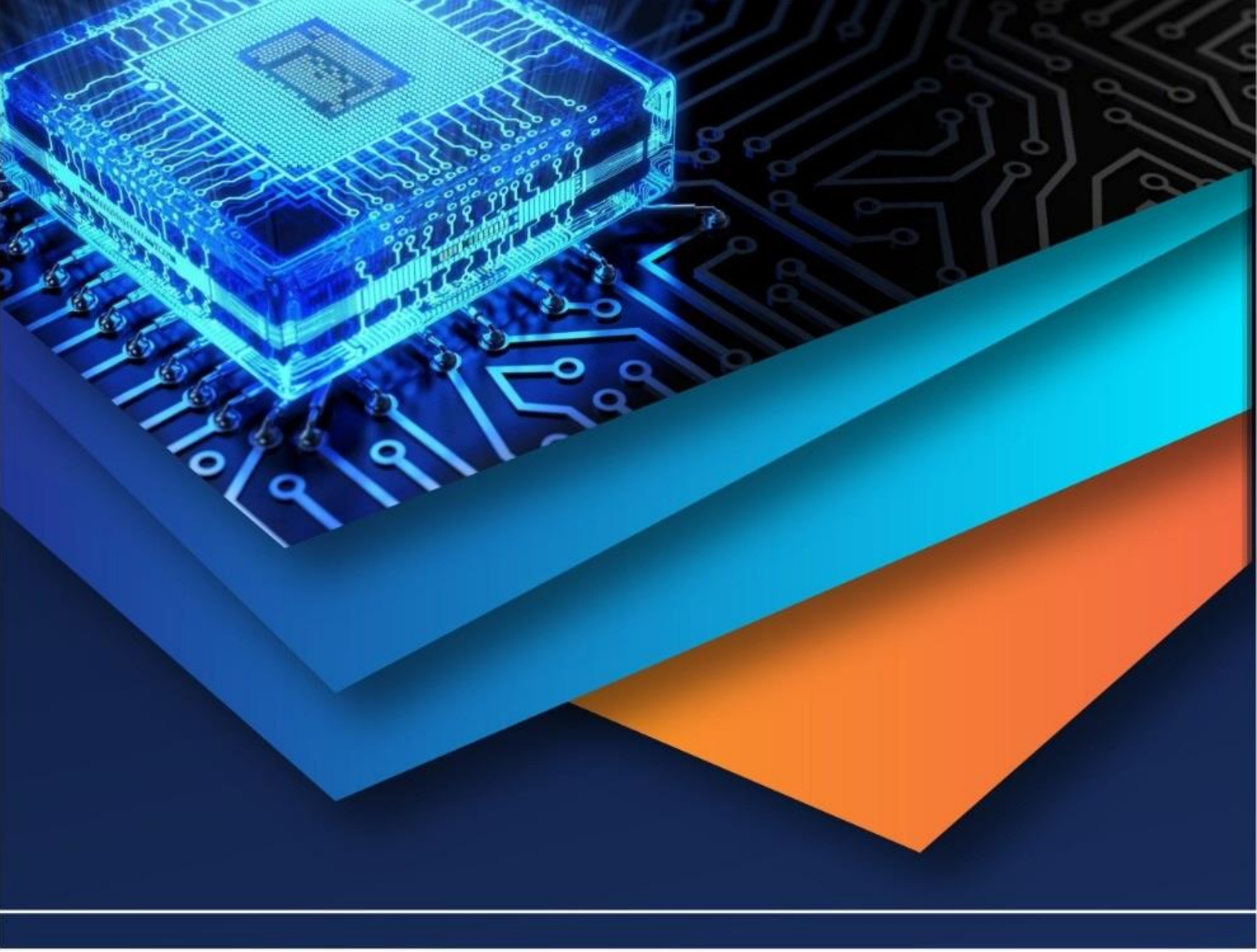
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