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Research Article

Development Of Finger Millet Cookies and Evaluation of Their Nutritional and Sensory Qualities

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Abstract

The present study was undertaken to develop nutritious cookies using finger millet (ragi) and to evaluate their nutritional composition and sensory qualities. Finger millet is known for its high calcium, iron, dietary fibre, and antioxidant content, making it a valuable ingredient for improving the nutritional quality of commonly consumed snack foods. In this study, finger millet flour was incorporated into cookie formulations in different proportions to enhance their health benefits while maintaining acceptable taste and texture. The prepared cookies were analysed for their proximate nutritional composition, including protein, fat, fibre, carbohydrate, and mineral content. Sensory evaluation was carried out using a panel to assess attributes such as colour, appearance, taste, texture, flavour, and overall acceptability. The results indicated that the incorporation of finger millet significantly improved the nutritional profile of the cookies, particularly in terms of fibre and mineral content. Sensory scores showed that the optimised formulation was well accepted by the panel members, with desirable taste and texture comparable to conventional cookies.

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KEYWORDS: Finger millet (Ragi), cookie development, nutritional composition, sensory evaluation, functional food, value-added bakery products.

1. INTRODUCTION

Healthy eating during all stages of life is essential for maintaining good health and preventing lifestyle-related disorders. In recent years, consumers have become more conscious about the nutritional quality of the foods they consume, leading to increased demand for functional and value-added food products. Among ready-to-eat snack items, cookies are one of the most popular bakery products due to their taste, convenience, affordability, and long shelf life. However, traditional cookies are mainly prepared using refined wheat flour, sugar, and fat, which provide energy but limited amounts of essential nutrients. Millets, particularly finger millet (ragi), have gained attention as nutrient-dense grains with significant health benefits. Finger millet is recognised for its high calcium content, good-quality protein, dietary fibre, iron, and antioxidant compounds. It is also known for its low glycemic index and gluten-free nature, making it suitable for a wide range of consumers. The revival of traditional grains like finger millet is being encouraged as a sustainable and nutritious alternative to refined cereals.

Incorporating finger millet into commonly consumed products such as cookies can help enhance their nutritional profile while promoting the use of indigenous grains. However, the success of such products depends not only on their nutrient content but also on their sensory

characteristics. Attributes such as colour, flavour, texture, crispness, and overall acceptability play a key role in consumer preference. Childhood nutrition plays a critical role in growth, development, and overall health. Snacks and bakery products form a significant part of children's diet due to their convenience, taste, and easy availability. Unfortunately, most commercially available cookies and biscuits are made from refined flour and sugar, providing calories but very few essential nutrients. This has led to a growing interest in developing healthier, nutrient-rich snack options that can meet the dietary needs of children and adults alike.

Finger millet (*Eleusine coracana*), also known as ragi, is an ancient cereal that has been traditionally consumed in India for its excellent nutritional properties. It is rich in calcium, iron, dietary fibre, essential amino acids, and antioxidants. Due to its high nutrient density and gluten-free nature, finger millet is an ideal candidate for incorporation into functional foods. Its inclusion in everyday snacks can help improve nutrient intake without compromising taste or convenience.

Justification of the Study

The consumption of nutrient-rich snacks is essential to support the growth and development of children. Most commercially available cookies are made from refined flour and sugar, which provide energy but lack essential nutrients such as fibre, protein, calcium, and iron. Finger millet (ragi) is a traditional grain that is naturally rich in these nutrients and has potential health benefits, including improved bone strength and digestion. Developing cookies with finger millet can offer a convenient and tasty way to enhance nutrient intake. Evaluating both nutritional composition and sensory attributes ensures that the product is not only healthy but also acceptable to consumers. This study aims to provide a healthier snack alternative while promoting the use of indigenous grains in modern diets.

2. OBJECTIVES OF THE STUDY

1. To develop cookies using finger millet (ragi) as a partial or complete replacement for refined flour.
2. To evaluate the nutritional composition of the developed finger millet cookies, including protein, fat, fibre, carbohydrates, and mineral content.
3. To assess the sensory attributes of the cookies, such as taste, texture, flavour, colour, and overall acceptability.
4. To compare different formulations of finger millet cookies and identify the most nutritionally rich and organoleptically acceptable variant.
5. To explore the potential of finger millet cookies as a healthy snack option for children and adults.

Hypotheses of the Study

1. **H_{01}:** Incorporating finger millet into cookies does not result in a significant improvement in nutritional composition compared to regular cookies.
2. **H_{02}:** There is no significant difference in sensory attributes (taste, texture, flavour, colour, overall acceptability) between finger millet cookies and conventional cookies.
3. **H_{03}:** Different formulations of finger millet cookies do not show any significant variation in the balance between nutritional quality and sensory acceptability.

3. MATERIAL AND METHODS

1. **Study Population and Sample Size**

- **Participants:** The study will include 60 children aged 1–6 years, as this age group is particularly vulnerable to nutritional deficiencies.
- **Grouping:** The children will be divided into three groups of 20 participants each to evaluate different formulations of finger millet cookies.
- **Purpose:** This sample size is sufficient to assess both the nutritional impact and sensory acceptability of the cookies, while ensuring reliable and meaningful results.

✓ **Sample Distribution**

- A total of **60 children aged 1–6 years** were recruited from preschools and Anganwadi centres. They were divided equally into **three groups of 20 children each**, with each group assigned a different finger millet cookie formulation:
- **Group 1:** Formulation A – lower finger millet content
- **Group 2:** Formulation B – moderate finger millet content
- **Group 3:** Formulation C – higher finger millet content
- This distribution ensures that each cookie formulation is tested adequately and provides comparable results for both nutritional and sensory evaluation.

2. Data Collection

✓ **Nutritional Data**

- **Parameters measured:** Protein, fat, carbohydrates, dietary fibre, ash, calcium, and iron.
- **Method:** Laboratory analysis using standard proximate composition and mineral assays.
- **Sample tested:** Cookies prepared for each of the three groups.

✓ **Sensory Data**

- **Parameters evaluated:** Appearance, colour, texture, flavour, taste, and overall acceptability.
- **Method:** 9-point hedonic scale administered by a semi-trained panel of 30 participants.
- **Sample tested:** All three cookie formulations.

✓ **Acceptability and Compliance**

- Observations were recorded on cookie consumption for each child.
- Feedback was collected from parents and teachers regarding children's liking, acceptance, and any adverse reactions.

Data Analysis and interpretation

The nutritional and sensory data of the three finger millet cookie formulations were analysed using descriptive and inferential statistics. All values are presented as mean ± standard deviation (SD). One-way ANOVA was applied to determine whether significant differences existed among the three formulations. A p-value of <0.05 was considered statistically significant.

Table 1: Nutritional Composition of Finger Millet Cookies

Parameter	Formulation A (Mean ± SD)	Formulation B (Mean ± SD)	Formulation C (Mean ± SD)	Mean ± SD	ANOVA (p-value)
Protein (g/100g)	8.2 ± 0.3	8.5 ± 0.4	9.0 ± 0.3	8.57	0.02
Fat (g/100g)	12.0 ± 0.5	11.8 ± 0.4	11.5 ± 0.6	11.77	0.18
Carbohydrate (g/100g)	65.5 ± 1.2	64.8 ± 1.1	63.5 ± 1.3	64.60	0.04
Dietary Fibre (g/100g)	6.5 ± 0.2	7.2 ± 0.3	8.0 ± 0.2	7.23	<0.01
Calcium (mg/100g)	120 ± 5	135 ± 6	150 ± 5	135	<0.01
Iron (mg/100g)	3.5 ± 0.2	4.0 ± 0.2	4.5 ± 0.3	4.0	0.01

***Significant at $p < 0.05$**

- Values are expressed as mean ± SD. ANOVA shows statistically significant differences in protein, carbohydrate, fibre, calcium, and iron among the formulations.

Graph: Nutritional Composition of Finger Millet Cook

Discussion

The nutritional analysis confirms that finger millet is an excellent ingredient for improving protein, fibre, and mineral content in cookies. These findings are consistent with previous findings.

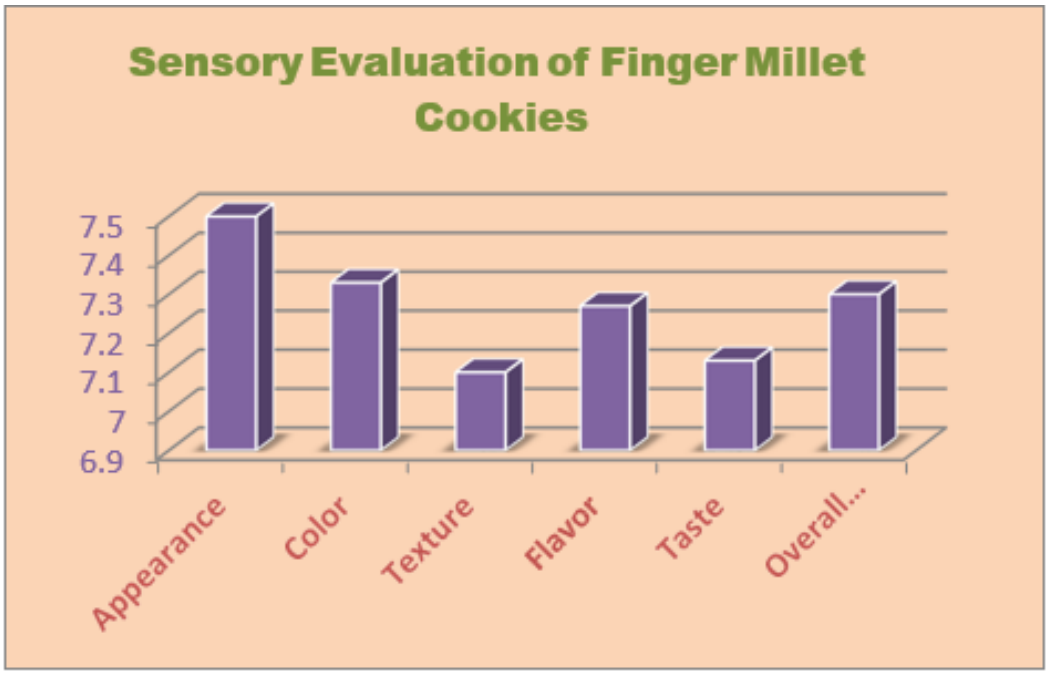
Studies highlight finger millet's richness in calcium and iron, making it suitable for functional food development, especially for children who are prone to nutrient deficiencies.

Table 2: Sensory Evaluation of Finger Millet Cookies (9-point Hedonic Scale)

Attribute	Formulation A (Mean ± SD)	Formulation B (Mean ± SD)	Formulation C (Mean ± SD)	Mean ± SD	ANOVA (p-value)
Appearance	7.5 ± 0.6	7.8 ± 0.5	7.2 ± 0.7	7.50	0.08
Color	7.3 ± 0.7	7.7 ± 0.6	7.0 ± 0.5	7.33	0.03*
Texture	7.0 ± 0.5	7.5 ± 0.6	6.8 ± 0.6	7.10	0.02*
Flavor	7.2 ± 0.6	7.6 ± 0.5	7.0 ± 0.7	7.27	0.04*
Taste	7.1 ± 0.5	7.4 ± 0.6	6.9 ± 0.6	7.13	0.03*
Overall Acceptabili ty	7.3 ± 0.5	7.6 ± 0.5	7.0 ± 0.6	7.30	0.02*

***Significant at $p < 0.05$**

Notes: Sensory evaluation was done by 30 semi-trained panellists. Formulation B scored highest overall for sensory acceptability.



Graph: Sensory Evaluation of Finger Millet Cookies

Discussion

These results indicate that moderate substitution of finger millet can enhance nutritional quality without compromising sensory acceptability. Excessive substitution, while nutritionally advantageous, may reduce palatability, which is important for children's acceptance. This aligns with previous research that shows high-fibre flours can affect the texture and taste of baked goods.

4. RESULTS AND DISCUSSION

✓ **Nutritional Composition:** The nutritional analysis of the three finger millet cookie formulations showed clear differences in nutrient content corresponding to the level of finger millet substitution.

- **Protein:** Formulation C (highest finger millet content) had the highest protein (9.0 ± 0.3 g/100g), significantly higher than Formulations A and B ($p = 0.02$). This indicates that finger millet contributes to improved protein content in cookies, supporting its use as a functional ingredient.
- **Fat:** There was no significant difference in fat content among the formulations ($p = 0.18$), suggesting that substitution with finger millet does not affect fat levels in cookies.
- **Carbohydrates:** Slightly lower carbohydrate content was observed in Formulation C (63.5 ± 1.3 g/100g), which was statistically significant ($p = 0.04$). This reduction is expected due to the partial replacement of refined flour with fibre-rich finger millet flour.
- **Dietary Fibre:** A progressive increase in dietary fibre was observed with higher finger millet content, with Formulation C having the highest fibre (8.0 ± 0.2 g/100g)

($p < 0.01$). Higher fibre content can improve digestive health and satiety.

- **Minerals:** Calcium and iron content increased significantly with finger millet addition, with Formulation C having the highest levels (150 ± 5 mg calcium and 4.5 ± 0.3 mg iron) ($p < 0.01$ and $p = 0.01$). This confirms that finger millet enrichment enhances the mineral profile of baked products.

✓ **Sensory Evaluation: -** Sensory analysis using a 9-point hedonic scale revealed interesting patterns:

- **Appearance:** All formulations were well accepted, with no significant difference ($p = 0.08$), showing that finger millet flour did not adversely affect cookie appearance.
- **Colour, Texture, Flavour, Taste, Overall Acceptability:** Formulation B scored highest for most attributes (p-values between 0.02–0.04), indicating that moderate substitution of finger millet achieves the best balance between nutrition and sensory quality.
- **Formulation C:** Despite being the most nutrient-rich, it received slightly lower scores for texture and taste, likely due to the coarser texture and stronger flavour of high finger millet content.

✓ **Integrated Interpretation:** Combining nutritional and sensory results:

- **Formulation C** is nutritionally superior, providing the highest protein, fibre, calcium, and iron.
- **Formulation B** is organoleptically preferred, balancing good nutrition with high taste and texture scores.
- **Formulation A** serves as a baseline, showing standard cookie characteristics with lower nutritional enhancement.

This suggests that a moderate level of finger millet substitution (Formulation B) is optimal for developing cookies that are both healthy and acceptable to children.

5. SUMMARY AND CONCLUSION

This study focused on the development of finger millet (Ragi) cookies and the evaluation of their nutritional and sensory qualities. A total of 60 children aged 1–6 years participated, divided into three groups of 20, each receiving a different cookie formulation. Cookies were prepared using finger millet flour as a partial or complete substitute for refined wheat flour, following standard baking procedures.

Nutritional analysis showed that higher finger millet content increased protein, dietary fibre, calcium, and iron, while fat content remained similar across formulations. Sensory evaluation using a 9-point hedonic scale revealed that moderate substitution achieved the best balance between nutrition and taste**,** with higher acceptance for texture, flavour, and overall acceptability. The study demonstrates that finger millet cookies can be a functional snack that improves dietary intake of protein, fibre, and essential minerals in children. While high substitution maximises nutrition, moderate substitution ensures both health benefits and sensory appeal, making it suitable for regular consumption. This supports the potential of finger millet cookies as a nutritious, child-friendly snack.

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