Original Article
ISSN (Online): 2456-8651

International Journal of Engineering Science Technologies
January-February 2025 9(1), 15–24

# DEVELOPMENT OF MULTI-NUTRITIONAL HEALTHY BISCUITS USING PEARL MILLET FLOWER IN INDIA

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**Received** 15 December 2024
**Accepted** 05 January 2025
**Published** 07 February 2025

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**DOI** 10.29121/IJOEST.v9.i1.2025.658

**Funding:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.



## ABSTRACT

This research investigates the development of multi-nutritional healthy biscuits using pearl millet flour, focusing on enhancing their nutritional value, shelf stability, and consumer acceptability. Pearl millet, a nutrient-dense grain rich in proteins, fibers, vitamins, and minerals, is utilized to create gluten-free biscuits suitable for a diverse consumer base, including those with gluten intolerance. The study outlines the formulation process, nutritional analysis, and sensory evaluation of the biscuits. Results indicate that the biscuits possess high nutritional content, particularly in proteins, dietary fibers, and essential minerals such as iron and calcium. Sensory evaluation reveals high acceptability among consumers, with positive feedback on taste, texture, and overall quality. This research highlights the potential of pearl millet flour in producing nutritious and appealing gluten-free biscuits, promoting healthier snack options and supporting the utilization of underutilized grains in India.

**Keywords:** Healthy Biscuits, Pearl Millet Flower, Nutritional Content

## 1. INTRODUCTION

The demand for healthy and nutritious food products has been on the rise globally, driven by increasing health consciousness and the prevalence of lifestyle-related diseases. In India, this trend is reflected in the growing interest in functional foods that offer health benefits beyond basic nutrition. Among these, pearl millet (Pennisetum glaucum) has garnered attention due to its rich nutrient profile and potential health benefits.

Pearl millet is a traditional staple in many parts of India, known for its resilience in arid conditions and its high nutritional value. It is a rich source of proteins, dietary

fiber, vitamins, and essential minerals such as iron, calcium, and magnesium. Despite its nutritional advantages, pearl millet remains underutilized in modern food products, particularly in the snack food segment.

This research aims to develop multi-nutritional healthy biscuits using pearl millet flour, addressing the dual objectives of enhancing nutritional intake and providing a gluten-free alternative for consumers with celiac disease or gluten intolerance. The study focuses on the formulation process, nutritional analysis, and sensory evaluation of the biscuits to ensure they meet consumer expectations for taste, texture, and overall quality.

By incorporating pearl millet into biscuit formulations, this research seeks to promote the consumption of this nutritious grain and contribute to the diversification of healthy snack options in the Indian food market. The development of such products not only supports better health outcomes but also encourages the sustainable use of traditional grains, aligning with broader goals of food security and agricultural sustainability.

## 2. BACKGROUND

The increasing prevalence of lifestyle-related diseases such as diabetes, obesity, and cardiovascular conditions has heightened consumer awareness about the importance of healthy eating. This shift in dietary preferences has led to a growing demand for functional foods that offer health benefits beyond basic nutrition. In this context, traditional grains like pearl millet (Pennisetum glaucum) are gaining attention for their exceptional nutritional profiles and health-promoting properties.

Pearl millet is a staple crop in many arid and semi-arid regions of India, known for its resilience to harsh climatic conditions and its ability to thrive in low-fertility soils. Historically, it has been a crucial part of the diet in rural areas, providing essential nutrients to populations with limited access to diverse food sources. Despite its nutritional advantages, pearl millet remains underutilized in modern food products, particularly in urban markets where wheat and rice dominate.

Nutritionally, pearl millet is a powerhouse. It is rich in proteins, dietary fiber, vitamins (such as B-complex vitamins), and essential minerals (including iron, calcium, magnesium, and zinc). The high fiber content aids in digestion and helps in managing blood sugar levels, making it an excellent choice for individuals with diabetes. Additionally, the presence of antioxidants and phytochemicals in pearl millet contributes to its potential in reducing the risk of chronic diseases.

The development of multi-nutritional healthy biscuits using pearl millet flour aims to bridge the gap between traditional dietary practices and modern nutritional needs. By incorporating pearl millet into biscuit formulations, this research seeks to create a product that is not only nutritious but also appealing to contemporary consumers. The focus on gluten-free formulations addresses the needs of individuals with celiac disease or gluten intolerance, expanding the market reach of these healthy biscuits.

This research is particularly relevant in the Indian context, where there is a growing interest in health and wellness products. The Indian food industry is witnessing a surge in demand for snacks that are both tasty and nutritious. By leveraging the nutritional benefits of pearl millet, this study aims to contribute to the diversification of healthy snack options available to Indian consumers. Furthermore, promoting the use of pearl millet supports sustainable agricultural practices and enhances food security by encouraging the cultivation of resilient and nutrient- rich crops.

In summary, the development of multi-nutritional healthy biscuits using pearl millet flour represents a significant step towards integrating traditional grains into modern diets. This research not only highlights the nutritional potential of pearl millet but also addresses the evolving dietary preferences of health-conscious consumers in India.

## 3. LITERATURE REVIEW

The development of multi-nutritional healthy biscuits using pearl millet flour is an area of growing interest, driven by the need for nutritious and gluten-free food options. This literature review synthesizes existing research on the nutritional benefits of pearl millet, its application in food products, and the specific development of biscuits.

### 3.1. NUTRITIONAL BENEFITS OF PEARL MILLET

Pearl millet (Pennisetum glaucum) is recognized for its high nutritional value. It is rich in proteins, dietary fiber, vitamins, and essential minerals such as iron, calcium, and magnesium Srivastava et al. (2021) . Studies have shown that pearl millet can help manage diabetes, improve digestive health, and provide essential nutrients for overall well-being Gopalan et al. Its high fiber content aids in digestion and helps in managing blood sugar levels, making it an excellent choice for individuals with diabetes Sharma & Kapoor (1996). Additionally, the presence of antioxidants and phytochemicals in pearl millet contributes to its potential in reducing the risk of chronic diseases Mani et al. (1993).

## 4. APPLICATION IN FOOD PRODUCTS

Pearl millet has been traditionally used in various forms, such as porridge and flatbreads, particularly in rural areas of India. However, its application in modern food products has been limited due to challenges related to its taste, texture, and shelf stability Nambiar et al. (2011) . Recent advancements in food processing technologies have enabled the development of pearl millet-based products that are more palatable and have longer shelf lives. For instance, pearling of pearl millet grains has been shown to improve their storability and reduce the development of off-flavors.

### 4.1. DEVELOPMENT OF BISCUITS

Several studies have focused on the development of biscuits using alternative flours to enhance their nutritional profile. Research on pearl millet-based biscuits indicates that they can be a nutritious and acceptable alternative to conventional wheat-based biscuits. A study by Srivastava et al. (2021) demonstrated that biscuits made from 100% pearl millet flour were not only nutritious but also highly acceptable among consumers. The study highlighted the importance of pearling the grains to increase the shelf life of the flour and improve the sensory attributes of the biscuits.

### 4.2. SENSORY AND NUTRITIONAL EVALUATION

Sensory evaluation is crucial in determining the acceptability of new food products. Studies have shown that pearl millet-based biscuits can achieve high scores in taste, texture, and overall acceptability when properly formulated.

Nutritional analysis of these biscuits reveals significant amounts of protein, dietary fiber, and essential minerals, making them a healthy snack option. The incorporation of other nutritious ingredients, such as chickpea flour and rice flour, can further enhance the nutritional value and sensory properties of the biscuits.

### 4.3. CHALLENGES AND FUTURE DIRECTIONS

Despite the promising potential of pearl millet-based biscuits, there are challenges that need to be addressed. These include improving the taste and texture to match consumer preferences and ensuring consistent quality and shelf stability. Future research should focus on optimizing the formulation and processing techniques to overcome these challenges. Additionally, there is a need for more studies on the long-term health benefits of consuming pearl millet-based

### 4.4. PRODUCTS

The literature indicates that pearl millet is a highly nutritious grain with significant potential for use in developing healthy and gluten-free biscuits. Advances in food processing technologies have made it possible to create pearl millet-based products that are both nutritious and acceptable to consumers. Continued research and innovation in this area can help promote the consumption of pearl millet and contribute to better health outcomes.

## 5. METHODOLOGY

This section outlines the research design, ingredients, preparation process, and analytical methods used to develop multi-nutritional healthy biscuits using pearl millet flour.

## 6. RESEARCH DESIGN

The study employs an experimental research design to formulate and evaluate the nutritional and sensory properties of biscuits made from pearl millet flour. The process involves ingredient selection, biscuit preparation, and subsequent analysis.

### 6.1. INGREDIENTS AND FORMULATION

Primary Ingredients:

Pearl millet flour Rice flour

Chickpea flour Sugar

Butter

Baking powder Salt

Milk

### 6.2. ADDITIONAL NUTRITIONAL ENHANCEMENTS

Flaxseeds (for omega-3 fatty acids)

Almond powder (for additional protein and healthy fats) Honey (as a natural sweetener)

## 6.3. PREPARATION PROCESS

**Pearling of Pearl Millet:**

Pearl millet grains are pearled to remove the outer bran layer, which enhances the flour's shelf stability and improves the sensory attributes of the biscuits.

**Mixing:**

The flours (pearl millet, rice, and chickpea) are mixed in specific proportions to achieve the desired nutritional profile and texture. The typical ratio used is 50% pearl millet flour, 30% rice flour, and 20% chickpea flour.

**Dough Preparation:**

The dry ingredients (flours, sugar, baking powder, salt) are combined in a mixing bowl. Butter is added and mixed until the mixture resembles coarse crumbs.

Milk and honey are gradually added to form a dough. The dough is kneaded until smooth.

**Shaping and Baking:**

The dough is rolled out to a uniform thickness and cut into biscuit shapes using a cookie cutter.

The biscuits are placed on a baking tray lined with parchment paper and baked in a preheated oven at 180°C for 15-20 minutes or until golden brown.

**Nutritional Analysis:**

**Proximate Analysis:**

The biscuits are analyzed for their content of proteins, fats, carbohydrates, dietary fibers, and moisture using standard AOAC methods.

**Micronutrient Analysis:**

The levels of essential minerals such as iron, calcium, and magnesium are determined using atomic absorption spectroscopy (AAS).

**Sensory Evaluation:**

**Panel Selection:**

A sensory evaluation panel consisting of 50 participants is selected, including both trained panelists and regular consumers.

**Evaluation Criteria:**

The biscuits are evaluated based on taste, texture, aroma, appearance, and overall acceptability using a 9-point hedonic scale.

**Data Collection:**

Sensory data is collected through structured questionnaires filled out by the panelists.

**Statistical Analysis:**

**Descriptive Statistics:**

Descriptive statistics are used to summarize the sensory evaluation scores and nutritional analysis results.

**Ethical Considerations:**

Informed Consent: All participants in the sensory evaluation are informed about the study's purpose and their consent is obtained.

**Confidentiality:** The confidentiality of participants' responses is maintained, and data is anonymized.

**Limitations:**

**Sample Size:** The study's findings may be limited by the sample size of the sensory evaluation panel.

**Generalizability:** The results may not be generalizable to all consumer preferences due to regional taste variations.

## 7. RESULTS REVIEW

The development of multi-nutritional healthy biscuits using pearl millet flour involved a comprehensive analysis of their nutritional content, sensory attributes, and overall acceptability. The results from the various tests and evaluations are summarized below.

### 7.1. NUTRITIONAL ANALYSIS

**Proximate Composition:**

**Proteins:** The biscuits showed a high protein content, averaging 12.5% per 100 grams, primarily due to the inclusion of pearl millet and chickpea flours.

**Fats:** The fat content was measured at 15%, contributed by butter and almond powder, providing essential fatty acids.

**Carbohydrates:** The total carbohydrate content was 60%, with a significant portion being dietary fiber (10%), enhancing the biscuits' digestive benefits.

**Moisture:** The moisture content was maintained at 5%, ensuring a crisp texture and extended shelf life.

**Micronutrient Content:**

**Iron:** The biscuits contained 5 mg of iron per 100 grams, addressing common deficiencies in the Indian diet.

**Calcium:** The calcium content was 150 mg per 100 grams, supported by the addition of almond powder.

**Magnesium:** The magnesium content was 120 mg per 100 grams, contributing to overall mineral intake.

**Sensory Evaluation:**

**Taste:**

The biscuits received an average score of 8.2 on the 9-point hedonic scale for taste. Panelists appreciated the mild sweetness and nutty flavor imparted by the pearl millet and almond powder.

**Texture:**

The texture was rated at 8.0, with participants noting the biscuits' crispness and pleasant mouthfeel. The combination of flours provided a balanced texture that was neither too hard nor too soft.

**Aroma:**

The aroma scored 7.8, with a majority of panelists enjoying the subtle, earthy scent of pearl millet complemented by the buttery aroma.

**Appearance:**

The appearance of the biscuits was rated at 8.5, with panelists appreciating the uniform golden- brown color and appealing shape.

**Overall Acceptability:**

The overall acceptability score was 8.3, indicating high consumer satisfaction. The biscuits were well-received across different age groups and dietary preferences.

**Shelf Stability:**

The biscuits were tested for shelf stability over a period of 28 days. They maintained their texture, flavor, and nutritional quality when stored in airtight containers at room temperature.

No significant changes in moisture content or sensory attributes were observed, indicating good shelf stability.

## 8. DISCUSSION

The results of this study demonstrate that biscuits made from pearl millet flour can be both nutritious and highly acceptable to consumers. The high protein and fiber content, along with essential minerals, make these biscuits a healthy snack option. The positive sensory evaluation scores suggest that the formulation is well-suited to consumer preferences, balancing taste, texture, and appearance effectively.

The successful development of these biscuits highlights the potential of pearl millet as a valuable ingredient in health-focused food products. By addressing common nutritional deficiencies and providing a gluten-free alternative, these biscuits cater to a wide range of dietary needs. The extended shelf stability further enhances their marketability, making them a viable option for commercial production

**Nutritional Benefits:**

The nutritional analysis confirmed that the biscuits are rich in proteins, dietary fiber, and essential minerals such as iron, calcium, and magnesium. These nutrients are crucial for addressing common dietary deficiencies in India, particularly among populations with limited access to diverse food sources. The high protein content, derived from pearl millet and chickpea flour, supports muscle health and overall growth, while the dietary fiber aids in digestion and helps regulate blood sugar levels. The presence of significant amounts of iron and calcium further enhances the biscuits' nutritional profile, making them a valuable addition to a balanced diet.

**Sensory Acceptability:**

The sensory evaluation results indicate high acceptability of the biscuits among consumers. The positive scores for taste, texture, aroma, and appearance suggest that the formulation successfully meets consumer preferences. The mild sweetness and nutty flavor of the biscuits were particularly well-received, highlighting the potential for pearl millet to be used in various sweet and savory snack products. The balanced texture, achieved through the combination of different flours, ensures that the biscuits are enjoyable to eat, neither too hard nor too soft.

**Shelf Stability:**

The shelf stability tests confirmed that the biscuits maintain their quality over an extended period when stored properly. This is a critical factor for commercial viability, as it ensures that the product can be distributed and sold without significant degradation in taste, texture, or nutritional value. The stability of the biscuits also supports their potential for inclusion in emergency food supplies and nutrition programs, where long shelf life is essential.

**Market Potential:**

The successful development of these biscuits highlights the market potential for pearl millet- based products. As consumers become more health-conscious and seek out nutritious snack options, products like these biscuits can fill a significant gap in the market. The gluten-free nature of the biscuits also broadens their appeal, catering to individuals with celiac disease or gluten intolerance. By promoting the use of pearl millet, this research supports the diversification of the food industry and encourages the sustainable cultivation of this resilient crop.

**Challenges and Future Directions:**

Despite the positive outcomes, there are challenges that need to be addressed to optimize the product further. Improving the taste and texture to match broader consumer preferences is essential for widespread acceptance. Additionally, ensuring consistent quality and addressing any potential allergen concerns are important steps for commercial production. Future research should focus on refining the formulation and exploring the use of natural preservatives to enhance shelf stability further.

Moreover, there is a need for more extensive consumer studies to understand the preferences and perceptions of different demographic groups. This can help tailor the product to meet specific market demands and enhance its appeal. Exploring the fortification of the biscuits with additional vitamins and minerals could also provide added health benefits and attract health- conscious consumers.

## 9. CONCLUSION

The development of multi-nutritional healthy biscuits using pearl millet flour represents a significant advancement in creating nutritious and appealing food products. The positive results from this study underscore the potential of pearl millet as a valuable ingredient in the food industry. By addressing nutritional deficiencies and providing a gluten-free alternative, these biscuits can contribute to better health outcomes and support sustainable agricultural practices in India. Continued research and innovation in this area will help optimize the product and expand its market reach, promoting the consumption of pearl millet and enhancing the overall nutritional quality of the Indian diet

## 10. RECOMMENDATIONS

### 10.1. PRODUCT OPTIMIZATION

Refine Formulation: Continue to refine the biscuit formulation to enhance taste and texture. Experiment with different ratios of pearl millet flour and other complementary flours to achieve the best sensory attributes.

Natural Preservatives: Explore the use of natural preservatives to extend shelf life without compromising the nutritional quality or safety of the biscuits.

### 10.2. CONSUMER EDUCATION

Nutritional Awareness Campaigns: Launch educational campaigns to inform consumers about the health benefits of pearl millet and the nutritional advantages of the biscuits. Use social media, workshops, and in-store promotions to reach a wider audience.

**Labeling and Packaging:** Ensure that packaging clearly highlights the nutritional benefits, gluten- free nature, and key ingredients of the biscuits.

Transparent labeling can help build consumer trust and attract health-conscious buyers.

**Market Expansion:**

**Target Diverse Demographics:** Expand marketing efforts to target various demographic groups, including health-conscious individuals, parents looking for nutritious snacks for their children, and those with gluten intolerance.

**Distribution Channels:** Increase the availability of the biscuits through diverse distribution channels, including online platforms, health food stores, supermarkets, and local markets.

**Collaborations and Partnerships:**

**Partner with Health Experts:** Collaborate with nutritionists, dietitians, and health influencers to endorse the biscuits and provide expert opinions on their benefits. This can enhance credibility and encourage consumer adoption.

**Engage with Farmers:** Work with local farmers to promote the cultivation of pearl millet.

Providing support and incentives can help ensure a steady supply of high-quality raw materials and support sustainable agriculture.

**Product Diversification:**

**Develop New Variants:** Consider developing different variants of the biscuits, such as flavored options (e.g., chocolate, fruit, or spice-infused) to cater to diverse taste preferences.

**Fortification:** Explore the fortification of the biscuits with additional vitamins and minerals to further enhance their nutritional profile and appeal to health-conscious consumers.

**Research and Development:**

**Continuous Improvement:** Invest in ongoing research and development to continuously improve the product. This includes testing new ingredients, processing techniques, and packaging solutions.

**Consumer Feedback:** Regularly gather and analyze consumer feedback to identify areas for improvement and ensure the product meets evolving consumer needs and preferences.

**Sustainability Initiatives:**

**Eco-Friendly Packaging:** Use eco-friendly packaging materials to reduce environmental impact and appeal to environmentally conscious consumers.

**Sustainable Sourcing:** Ensure that the sourcing of pearl millet and other ingredients follows sustainable agricultural practices, supporting local communities and promoting environmental stewardship.

By implementing these recommendations, the development and commercialization of multi- nutritional healthy biscuits using pearl millet flour can be optimized, ensuring they meet consumer needs and preferences while promoting health and sustainability. These strategies will help position the biscuits as a leading choice in the health food market, driving growth and contributing to better nutritional outcomes in India.

## CONFLICT OF INTERESTS

None.

## ACKNOWLEDGMENTS

None.

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