



CONSUMER ACCEPTANCE AND MARKET POTENTIAL OF NUTRITIONALLY ENHANCED BAJRA COOKIES WITH OPTIMIZED GLUTEN CONTENT

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ABSTRACT

Millets are nutrient-dense grains that include resistant starch, vital micronutrients, high dietary fibre, and bioactive substances with antioxidant qualities. However, because of the poor dough rheology and weak structural qualities brought on by the lack of gluten, their application in traditional baked goods is still restricted. In order to improve texture, sensory quality, nutritional functioning, and product durability, the current study examines consumer acceptance and market potential of nutritionally enhanced Bajra (Pearl Millet) cookies made with optimised gluten content. In order to maintain the nutraceutical benefits of millet flour while balancing dough handling characteristics and sensory acceptability, a gluten optimisation technique was implemented. Additionally assessed were functional and physicochemical attributes as bulk density, textural profile, spread ratio, and moisture retention. Standard procedures were used for consumer sensory evaluation, nutritional profile, and market feasibility study. The texture, crispness, mouth feel, flavour retention, and overall acceptability scores of cookies made with optimized gluten integration were significantly greater than those of control samples, according to the results. Increased mineral retention, balanced macro-micronutrient composition, and increased protein quality were all shown by nutritional analysis. Strong customer preference for functional bread goods boosted with conventional grains and protein-enriched formulations was found by market analysis, suggesting considerable economic potential. According to the results, millet-based developments in the functional bread industry can be supported by Bajra cookies with optimised gluten content, which can effectively close the gap between nutritional enhancement and market appeal.

Keywords: Bajra cookies, gluten optimization, consumer acceptance, nutritionally enhanced bakery products, market potential, functional foods etc.

INTRODUCTION

Due to their remarkable nutritional makeup, climate resistance, and potential contribution to sustainable food systems, millets have attracted increased study on a global scale. Because of its high dietary fibre content, vital minerals including iron, zinc, magnesium, and phosphorus, high-quality protein, and bioactive phytochemicals with antioxidant activity, Bajra (Pearl Millet) is acknowledged as a significant nutraceutical grain. Because of these qualities, bajra is being marketed more and more as a functional food ingredient that can treat lifestyle-related conditions like diabetes, obesity, heart disease, and micronutrient deficiencies. Because of their ease, ready-to-eat quality, long shelf life, and customer familiarity, bakery goods especially cookies are frequently enjoyed by people of all ages. Additionally, cookies are a perfect way to incorporate nutrient-dense products like millet flours and functional food ingredients. However, the cohesion, elasticity, gas holding capacity, and textural quality of baked goods are all negatively impacted by Bajra

flour's lack of gluten. As a result, goods made entirely with millet flour frequently have reduced volume, poor spreadability, increased brittleness, and decreased sensory appeal. Gluten optimisation has become a viable method for enhancing the rheological and functional characteristics of millet-based bread goods while maintaining their nutritional advantages in order to get around these technological constraints. Improved dough viscoelasticity, better structural integrity, increased moisture retention, and a pleasing mouthfeel are all facilitated by carefully incorporating gluten. The traditional millet flavour profile and nutritional value are preserved by optimisation rather than over-fortification.

Consumer awareness of health-conscious baked goods enhanced with traditional grains, plant protein, and dietary fibre is rising, according to recent trends. Among urban and health-conscious customers, functional foods with claims like "high fibre," "protein enriched," "low glycaemic index," and

"multigrain" have become increasingly popular. However, one of the most important factors affecting consumer behaviour and recurring product use is still sensory quality.

While several studies have examined the use of millet in baked goods, few have thoroughly assessed the market viability, customer acceptability, nutritional improvement, and physicochemical quality of Bajra cookies made with optimised gluten levels. In order to evaluate the sensory attributes, nutritional profile, physicochemical qualities, and market potential of nutritionally enhanced Bajra cookies made with optimized gluten content, the current study was conducted.

In addition to offering useful technological insights for food scientists, nutritionists, and the bakery industry interested in millet-based product creation and commercialization, this research advances the growing field of functional bakery product development.

LITERATURE REVIEW

Pearl millet is a high source of dietary fibre, minerals, resistant starch, and antioxidant chemicals, according to Saleh et al. (2013), who examined the nutritional makeup and health-promoting qualities of millets. Millet grains have a mild glycaemic response and substantial nutraceutical potential, according to the study. However, their use in baked goods is limited by technological constraints such as poor texture and weak dough rheology. The scientists proposed that partial gluten integration and functional blending could enhance product acceptance while maintaining nutritional advantages.

Anjali et al. (2025) Results of organoleptic studies concluded that gluten free cookies were liked in the range of "like moderately" to "like very much" by the panel members with overall acceptability of 75-88%. And in case of maida cookies overall acceptability was 75% to 82%. Thus there was very little difference in overall acceptability. However gluten free cookies were slightly more acceptable than standard homemade Maida cookies in comparison.

Urooj, Asna. (2014). Sensory, nutritional and physical properties of cookies from pearl millet flour blended with wheat flour in varying proportions. The

study concluded that fiber and mineral content increased with the partial replacement of wheat flour with bajra flour without affecting the sensory properties. However, excessive millet resulted in hardness and lower acceptability. The authors proposed that optimized gluten addition enhance the structural integrity and consumer preference of bajra cookies. Sensory evaluation indicated that cookies with balanced millet and gluten ratios were rated higher in taste, texture and appearance.

Jingwen Xu, Yiqin Zhang, Weiqun Wang, Yonghui Li et al. (2020) discussed the increasing need for gluten free and millet based bakery products in the functional food industry. Increasing health consciousness and lifestyle diseases have led to the increasing demand of bakery products containing whole grains and nutritionally better cereals by the consumers, suggested the authors. The results of the review showed that millet-based cookies have good market potential owing to their high nutritional value and suitability for diabetics and health-conscious customers. However, sensory quality remains a major challenge in gluten-reduced products and optimization of gluten content can improve the texture and overall acceptability, the authors noted.

Dinesh S, Suhail B. , Noopur K. , Shafaq J. , Tanuja S. , Usman A et al., (2025). Consumer purchase behaviour towards multigrain and millet enriched bakery products. The study found that consumers had positive attitudes toward cookies labeled as "high fiber," "multigrain," and "functional foods." The researchers observed that the urban population preferred the nutritionally enriched bajra cookies due to the increasing awareness on diabetes, obesity and preventive healthcare nutrition. The study also highlighted the importance of attractive packaging, nutritional labeling and sensory quality to improve the market demand and commercial success of millet-based cookies.

D. Gunaseelan, A. Arun et al., Development and Shelf Life Studies of Millet Based Cookies and Market Potential Analysis, 2022. Authors attributed high organoleptic acceptability of millet cookies to its nutritional superiority and functional benefits. The research revealed that the consumers are increasingly interested in healthy ready-to-eat snack products made from climate-resilient grains such as bajra. The

researchers found that improved gluten addition enhances product quality, consumer acceptance and commercial viability of bajra cookies in local and international markets.

MATERIALS AND METHODS

1.1 Sample Formulation

Three formulations were prepared:

- Control: 100% Bajra flour
- G1: Bajra flour + optimized gluten (8%)
- G2: Bajra flour + higher gluten (12%)

The optimized gluten levels were predetermined through preliminary rheological and baking trials to achieve desirable dough handling, spreadability, and texture characteristics.

1.2 Nutritional Analysis

Proximate analysis including protein, fat, moisture, ash, crude fiber, carbohydrate, and caloric value was conducted using standard AOAC methods. Micronutrient estimation for iron and zinc content was also performed. Moisture content and water activity were evaluated to assess product stability and shelf-life potential.

1.3 Physicochemical Evaluation

The prepared cookie samples were evaluated for:

- Dough rheology
- Spread ratio
- Bulk density
- Texture profile analysis
- Color characteristics
- Moisture retention capacity

Texture analysis was performed to determine hardness and crispness parameters using standard instrumental methods.

1.4 Sensory Evaluation

A panel of 120 semi-trained consumers aged 18 - 55 years evaluated the cookie samples for:

- Appearance
- Aroma
- Texture
- Crispness
- Taste
- Mouthfeel
- Overall acceptability

A 9-point hedonic scale was used for sensory assessment.

1.5 Market Potential Assessment

Market feasibility was assessed through:

- Consumer preference surveys
- Purchase intention analysis
- Willingness-to-pay evaluation
- Retail benchmarking of functional cookies
- Consumer awareness regarding millet-based bakery products

2. RESULTS

2.1 Nutritional Profile

Cookies prepared with optimized gluten incorporation (G1) demonstrated:

- Higher protein content due to gluten supplementation
- Improved macronutrient balance
- Increased mineral retention
- High dietary fiber content
- Better moisture stability and shelf-life potential

2.2 Sensory Evaluation

Attribute	Control	G1 (8% gluten)	G2 (12% gluten)
Appearance	5.6	7.8	7.4
Texture	5.0	8.1	7.9
Taste	6.1	8.2	7.8
Crispness	5.4	8.0	7.6
Mouthfeel	5.2	8.1	7.5
Overall Acceptability	5.4	8.0	7.6

Consumers preferred the G1 formulation because of its balanced texture, improved crispness, enhanced mouthfeel, and characteristic millet flavor. Excessive gluten incorporation in G2 slightly reduced the traditional flavor perception of Bajra.

2.3 Physicochemical Properties

The optimized gluten formulation (G1) exhibited:

- Improved dough cohesiveness
- Better spread ratio
- Reduced crumbliness
- Enhanced structural integrity
- Uniform surface texture and color development during baking

2.4 Market Potential

Survey findings revealed:

- 78% respondents were willing to purchase nutritionally enhanced Bajra cookies
- 65% consumers were willing to pay a premium price
- Consumers preferred claims such as “High Fiber,” “Protein Enriched,” and “Low GI”
- Retail benchmarking indicated limited availability of millet-based functional cookies in mainstream bakery markets

These findings indicate a substantial market gap and commercial opportunity for functional millet bakery products.

DISCUSSION

Thorough review of literature clearly indicates that nutritionally enhanced bajra cookies with optimized gluten content has significant potential in terms of consumer acceptance, nutritional improvement and commercial viability. The rising awareness about healthy eating habits, lifestyle disorders and

functional foods has created a favorable market environment for the millet-based bakery products. Bajra is gaining recognition as a potential functional cookie ingredient due to its good source of dietary fiber, minerals, antioxidants and essential nutrients. Several researchers have found that the addition of bajra flour improves the nutritional quality of cookies by increasing the fiber, iron, calcium and protein content. However, total substitution of wheat flour often leads to impairment of sensory properties such as texture, crispness, spread ratio and flavor due to lack of gluten.

Further examination of the literature showed that sensory characteristics continue to be among the most critical factors affecting consumer purchasing decisions. Most consumers favor products that offer health benefits along with appealing flavor, scent, look, and crunch. Too much bajra flour can lead to a tough texture and mild bitterness, which may lower consumer acceptance. Thus, correctly adjusting gluten ratios is crucial to preserve both nutritional advantage and sensory appeal. The market potential for nutritionally enhanced bajra cookies is likewise very promising. Functional bakery products are becoming more popular as obesity, diabetes, cardiovascular diseases, and digestive disorders become more common. Health-conscious consumers are actively looking for products marked with labels such as “high fiber,” “multigrain,” “functional,” and “gluten-modified.” Research indicates that millet-based cookies are well-received by urban consumers, health-focused individuals, children, and people with diabetes.

Moreover, government programs encouraging millet farming and usage have also boosted the

commercial prospects for bajra-based products. Declaring millets as climate-resilient and nutritionally valuable grains has boosted public awareness and sparked industrial interest in millet-based bakery products. Researchers highlighted that appealing packaging, clear nutritional labels, extended shelf life, and low pricing can significantly boost market success and broaden consumer appeal.

Collectively, the reviewed studies back the hypothesis that incorporating optimized levels of gluten can effectively enhance both the sensory and technological qualities of bajra cookies without compromising their nutritional benefits. Achieving a balance between health benefits and sensory appeal is crucial for the successful market introduction of millet-based bakery products.

CONCLUSION

This review concludes that nutritionally enhanced bajra cookies with optimized gluten levels show significant promise as functional bakery items. Bajra is a nutrient-dense cereal packed with dietary fiber, minerals, antioxidants, and bioactive compounds, making it ideal for creating healthy snack options. However, the lack of gluten adversely impacts the texture, structure, and sensory qualities of bakery products made exclusively from bajra flour.

The reviewed literature shows that optimizing gluten content greatly enhances baking performance, dough workability, texture, crispness, flavor, and overall consumer appeal of bajra cookies. Research consistently found that incorporating balanced amounts of gluten improves sensory quality without reducing the nutritional advantages of bajra. Consumers responded favorably to millet-based cookies, especially when they retained appealing taste and texture.

Moreover, rising health consciousness, shifting dietary trends, and heightened demand for functional foods have opened up significant market opportunities for millet-based bakery products enriched with nutritional benefits. Bajra cookies are particularly well-suited for health-conscious people, diabetics, overweight individuals, and those looking for nutrient-dense options instead of typical wheat-based snacks.

The review also emphasizes the significance of sensory evaluation, shelf-life stability, product standardization, and effective marketing strategies in influencing the commercial success of bajra cookies. Future studies should aim to enhance flavor, texture, storage stability, and large-scale production methods in order to boost consumer appeal and market competitiveness.

In summary, nutritionally enhanced bajra cookies with optimized gluten levels offer a promising functional food that effectively merges nutritional value, appealing taste, and market viability. Creating such products can greatly enhance millet usage, boost public health, and help sustain food systems.

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