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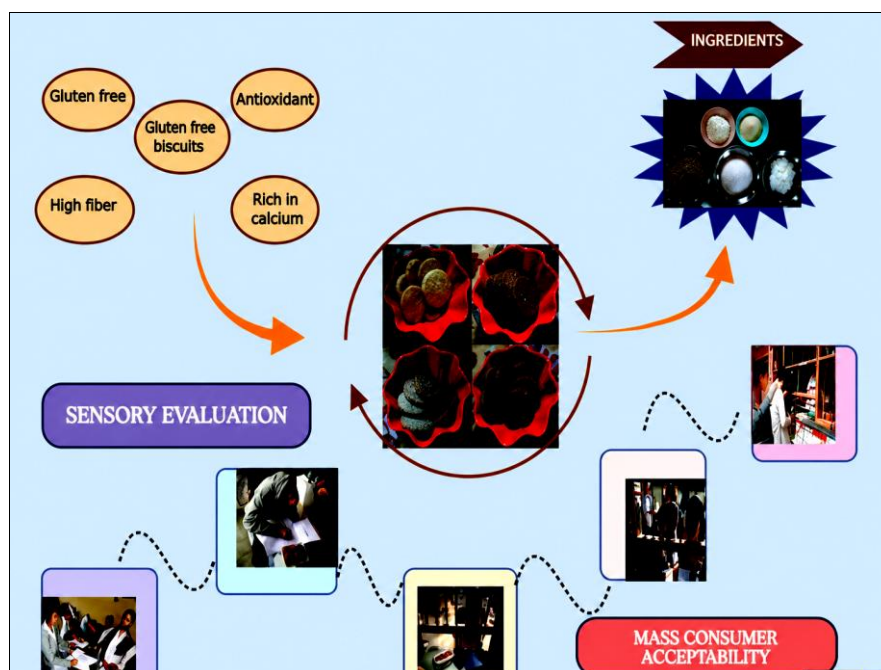
Studying the sensory evaluation and mass consumer acceptability of developed gluten free biscuits using millets

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Abstract

The increasing prevalence of celiac disease and gluten intolerance has heightened the demand for gluten-free products. The present study was carried out to develop gluten free biscuits using millets (barnyard millet, finger millet, buckwheat and pearl millet). This study investigates the sensory evaluation and mass consumer acceptability of gluten-free biscuits developed using various millets. Millets, known for their nutritional benefits and gluten-free properties, are explored as alternative ingredients in biscuit production. Sensory evaluation was conducted through a structured panel involving trained judges who assessed texture, flavor, appearance, and overall acceptability. Additionally, a consumer survey was carried out to gauge mass acceptability. The findings indicate that millet-based gluten-free biscuits were generally well-received, with certain millet varieties showing higher acceptance due to their favorable sensory attributes. The study contributes valuable insights into the potential of millets as a viable ingredient for gluten-free biscuit production and highlights consumer preferences in this niche market.



Keywords: Gluten free, antioxidant, mass consumer acceptability, sensory evaluation

1. Introduction

With the rising awareness of celiac disease and gluten intolerance, there is an increasing demand for gluten-free products (Singh *et al.*, 2019) ^[27]. Gluten-free diets necessitate the use of alternative grains and flours that do not contain gluten, a protein found in wheat, barley, and rye (Miller *et al.*, 2019) ^[16].

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Among the various alternatives, millets have garnered attention due to their nutritional benefits and their suitability for gluten-free formulations (Gull *et al.*, 2020)^[11]. Millets are small-seeded grasses that are rich in fiber, vitamins, and minerals, making them a promising ingredient in gluten-free products (Patel *et al.*, 2017)^[18].

This study aims to evaluate the sensory properties and consumer acceptability of gluten-free biscuits made from different types of millets. Sensory evaluation is critical for understanding how product attributes such as taste, texture, and appearance affect consumer preferences (Stone & Sidel, 1993)^[30]. Additionally, assessing mass consumer acceptability provides insights into market viability and consumer preferences (Lawless & Heymann, (2010)^[15].

Previous research has demonstrated that millet-based products can offer a nutritious alternative to traditional

wheat-based foods (Rao *et al.*, 2015)^[21]. However, consumer acceptance of these products varies, making it essential to explore how different millet varieties impact the sensory characteristics and overall appeal of gluten-free biscuits (Sanjay & Venkatesh, 2021)^[24]. This study addresses this gap by combining sensory analysis with consumer preference data to provide a comprehensive evaluation of millet-based gluten-free biscuits.

2. Materials and Methods

Developed gluten free biscuits using millets were packaged in recyclable plastic boxes and aluminum foil and compared with control (the existing market ones). Attention as an integral component of sustainable and integrated nutrient management

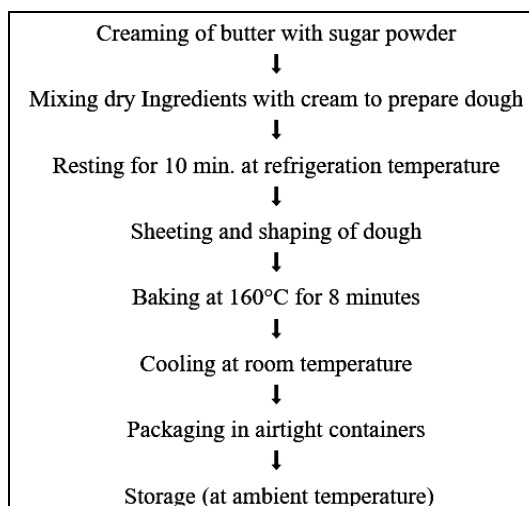


Fig 1: Flow chart for gluten-free biscuits preparation



Fig 2: Control & Gluten free biscuits

2.1 Sensory Characteristics: Developed Gluten free biscuits were evaluated for their sensory characteristics (color & appearance, texture, taste, aroma, and overall acceptability etc.) using 9-point hedonic scale.

2.2 Mass consumer acceptability of gluten free biscuits: Consumer acceptability of gluten free biscuits was checked

by selling acceptable products to the students and staff at the sale counter (Jugaad) of DEI. Feedback forms were filled by consumers (students & staff) at the same time using the product rating scale as presented in given pictures below (Appendix II). Pictures of checking mass consumer acceptability are given in Fig 3.



Fig 3: Pictures of checking mass consumer acceptability at Jugaad

3. Results and Discussion

3.1 Sensory characteristics of gluten free biscuits prepared by using millets

Gluten free biscuits were evaluated for organoleptic characteristics (color & appearance, texture, taste, aroma, and overall acceptability) by 10 semi trained panelists. Mean scores for sensory characteristics of gluten free biscuits are presented in table 1. Mean score for sensory characteristics i.e. color & appearance, texture, taste, aroma and overall acceptability of control biscuits were 6.60, 6.50, 5.80, 6.80, and 6.30 respectively as given in table 1. Mean score for sensory characteristics i.e. color & appearance, texture, taste, aroma and overall acceptability of gluten free biscuits prepared by using barnyard millet, finger millet, buckwheat and pearl millet flour is ranged from 7.00-7.30, 6.30-7.10, 6.30-7.10, 6.10-6.70 respectively. Mean score for color & appearance of gluten free biscuits prepared by using barnyard millet, finger millet, buckwheat and pearl millet flour are ranged from 7.00-7.30. Barnyard biscuits got the highest score (i.e.7.30) whereas buckwheat biscuits got lowest score (i.e. 7.00) for color & appearance. Mean score for texture of gluten free biscuits prepared by using barnyard millet, finger millet, buckwheat and pearl millet flour are ranged from 6.30-7.10. Finger millet biscuits got the highest score (i.e. 7.10) whereas buckwheat biscuits got lowest score (i.e. 6.30). Texture of the barnyard biscuit was liked equally as control (i.e. 6.50).

These changes in texture might be due to the higher fiber

content of buckwheat flour as given here. (Onipe *et al.* 2021) ^[29]. Mean score for taste of gluten free biscuits prepared by using barnyard millet, finger millet, buckwheat and pearl millet flour are ranged from 6.30-6.75. Finger millet biscuits got the highest score followed by pearl millet biscuit, barnyard biscuit and buckwheat biscuit respectively. Mean score for aroma of gluten free biscuits prepared by using barnyard millet, finger millet, buckwheat and pearl millet flour ranged from 6.10-6.70. Mean score for aroma of control is significantly higher than the prepared gluten free biscuits this might be due to the presence of added flavors and additives in it.

Mean score for overall acceptability of gluten free biscuits prepared by using barnyard millet, finger millet, buckwheat and pearl millet flour ranged from 6.40-7.70. Mean score for over acceptability of prepared gluten free biscuits are significantly higher than control and pearl millet biscuit got highest score (i.e.7.70) followed by finger millet biscuit, buckwheat biscuit, and barnyard biscuit. It is observed that gluten free biscuits prepared using barnyard millet flour has highest score for color & appearance and aroma (i.e. 7.30 and 6.70) whereas gluten free biscuits prepared using finger millet flour has highest mean score for taste and texture (i.e. 7.10 and 7.40). Gluten free biscuits prepared using pearl millet flour and finger millet flour have the highest mean score for overall acceptability (i.e. 7.50 and 7.70) as compared to that of control. This means the samples were liked moderately and liked very much by the consumers.

Table 1: Mean score for sensory characteristics of gluten free biscuits

Sample	Color & Appearance	Texture	Taste	Aroma	Overall Acceptability
Control	6.60 ± 0.84	6.50 ± 0.80	5.80 ± 1.25	6.80 ± 0.92	6.30 ± 0.82
Sample 1	7.30 ± 0.48	6.50 ± 1.50	6.70 ± 1.42	6.70 ± 1.16	6.40 ± 1.78
Sample 2	7.10 ± 1.52	7.10 ± 1.14	7.40 ± 1.36	6.70 ± 1.16	7.50 ± 0.97
Sample 3	7.00 ± 1.15	6.30 ± 1.40	6.30 ± 2.15	6.10 ± 1.79	6.40 ± 2.12
Sample 4	7.25 ± 1.10	7.00 ± 1.08	6.75 ± 1.51	6.50 ± 1.27	7.70 ± 1.42
CD at 5%	NS	NS	NS	NS	NS

Control: Britannia nutri-choice high fiber finger millet biscuit

- **Sample 1:** Barnyard biscuit
- **Sample 2:** Finger millet biscuit
- **Sample 3:** Buckwheat biscuit
- **Sample 4:** Pearl millet biscuit

3.2 Mass consumer acceptability of gluten free biscuits

Consumer acceptability of Gluten free biscuits was checked by selling acceptable products to the students and staff at the sale counter (Jugaad) of DEI. Feedback forms were filled by 50 persons (students & staff) at the same time using the product rating scale as the data presented in Table no 2.

It was observed that 64% of consumers rated pearl millet biscuit as excellent, 32% of consumers rated finger millet

biscuit as excellent. However only 6% of consumers rated control (Britannia nutri-choice high fiber finger millet biscuit) as excellent (Table 2).

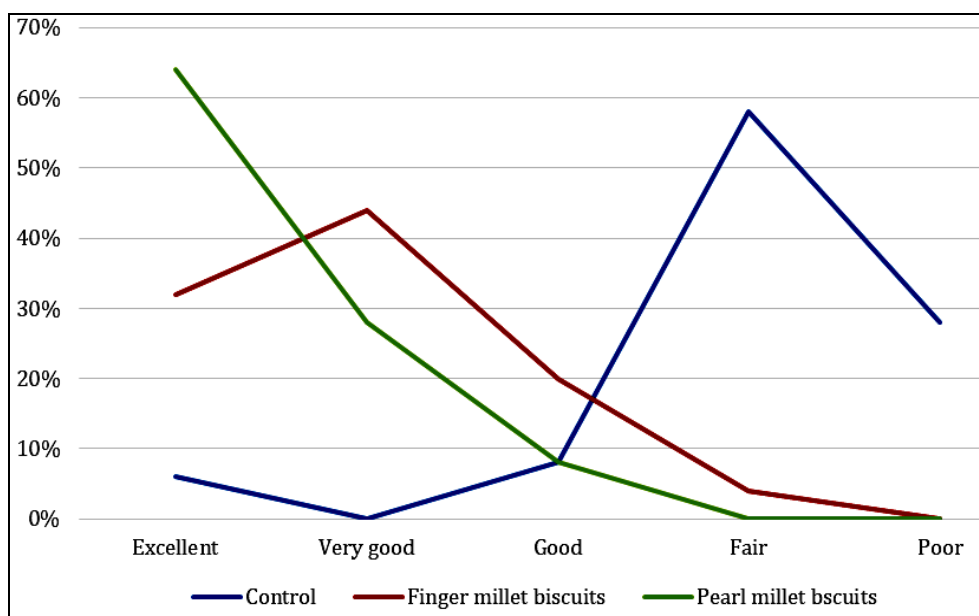
44% of consumers rated finger millet biscuits as very good and 28% of consumers rated finger millet biscuits as very good, whereas, no one marked control (Britannia nutri-choice high fiber finger millet biscuits) as very good.

Almost half percent of consumers (58%) rated control biscuits as fair and 28% of consumers rated control as poor.

Hence, it was observed from results of table 2 that gluten free biscuits prepared using millets are more acceptable to the consumers as compared to the control (Britannia nutri-choice high fiber finger millet biscuit). Only 4% of consumers rated finger millet biscuit as fair and no one marked gluten free biscuits as poor.

Table 2: Mass consumer acceptability of gluten free biscuits

Product Ratings	Control	Finger millet biscuit	Pearl millet biscuit
Excellent	6%	32%	64%
Very Good	0%	44%	28%
Good	8%	20%	8%
Fair	58%	4%	0%
Poor	28%	0%	0%

**Fig 4:** Sensory Evaluation of Control, Finger Millet Biscuits, and Pearl Millet Biscuits

4. Conclusion

In conclusion, this study on the development and evaluation of gluten-free biscuits using various millets demonstrates promising results in terms of both sensory acceptability and nutritional benefits. The standardized procedure for preparing gluten-free biscuits yielded products with varying physical and sensory attributes. Notably, biscuits made from pearl millet and finger millet achieved the highest scores for

overall acceptability, surpassing the control (Britannia nutri-choice high fiber finger millet biscuits) in consumer preference.

Sensory evaluations revealed that gluten-free biscuits, particularly those made from pearl millet and finger millet, were rated more favorably in terms of taste, texture, and overall acceptability compared to the control. This was further supported by consumer feedback, where a significant

majority preferred the taste and quality of the gluten-free options. Additionally, the nutritional analysis highlighted that gluten-free biscuits have a higher protein and fiber content, while their fat content is lower compared to the control, making them a healthier alternative.

The cost analysis indicated that gluten-free biscuits are more economically viable, with lower production costs than the commercially available control product. This aspect, combined with their enhanced nutritional profile and consumer preference, underscores the potential of millet-based gluten-free biscuits as a beneficial and affordable snack option.

Overall, the findings suggest that gluten-free biscuits made from millets not only meet consumer expectations but also offer health benefits and cost advantages, making them a viable and preferable choice in the snack market. Further research and development could focus on optimizing recipes and expanding the range of millet varieties to enhance these benefits even further.

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