



Development and Nutritional Evaluation of a Multi-Millet Functional Muffin

Adithya A V¹, Hyacintaa², and Prithika³

¹Assistant Professor, Department of Food Science and Nutrition, Dr. N.G.P Arts and Science College

^{2,3}Students, Department of Food Science and Nutrition, Dr. N.G.P Arts and Science College

How to Cite this Article:

Prithika, H. (2026). Development and Nutritional Evaluation of a Multi-Millet Functional Muffin. International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(03).

<https://doi.org/10.55041/ijcope.v2i3.070>

License:

This article is published under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and the source are credited.

© The Author(s). Published by International Journal of Creative and Open Research in Engineering and Management.



<https://doi.org/10.55041/ijcope.v2i3.070>

Abstract: Millets are nutrient-dense cereals recognized for their high dietary fiber, mineral content, and functional properties. The present study aimed to develop a multi-millet functional muffin and evaluate its nutritional composition and sensory quality. A composite flour consisting of finger millet, pearl millet, foxtail millet, and little millet was used to partially replace wheat flour in muffin formulations. Proximate analysis was performed to determine moisture, protein, fat, ash, fiber, and carbohydrate content. Sensory evaluation was conducted using a nine-point hedonic scale by semi-trained panelists. Statistical analysis was carried out using one-way analysis of variance (ANOVA). The results indicated that the multi-millet muffin showed higher dietary fiber, protein, and mineral content compared with the control sample. Sensory scores indicated good acceptability with slight variations in texture and color due to millet incorporation. The study demonstrates the potential of millet-based bakery products as functional foods with enhanced nutritional value.

Index Terms— Functional foods, millets, muffin, nutritional analysis



I. INTRODUCTION

Millets are considered climate-resilient cereals with high nutritional and functional properties. They are rich in dietary fiber, essential minerals, and antioxidants, making them valuable components of a healthy diet (Anitha et al., 2021). In recent years, millets have received increased attention due to their role in preventing lifestyle-related disorders such as diabetes, obesity, and cardiovascular diseases (Rai et al., 2020). Compared with refined cereals, millet grains contain higher levels of micronutrients and phytochemicals. Studies have reported that millet-based foods exhibit improved nutritional quality and glycemic control due to their high fiber and polyphenol content (Taylor & Emmambux, 2021). Incorporating millet flour into commonly consumed bakery products is considered an effective strategy to increase millet consumption.

Bakery products such as muffins are widely accepted due to their convenience and palatability. Previous research has demonstrated that partial substitution of wheat flour with millet flour improves fiber and mineral content while maintaining acceptable sensory attributes (Muthamilarasan & Prasad, 2021).

Therefore, the present study aimed to develop a multi-millet muffin and evaluate its nutritional composition and sensory acceptability.

II. MATERIALS AND METHODS

A. Procurement of Raw Material

Finger millet, pearl millet, foxtail millet, and little millet flours were procured from a local market. Other ingredients included wheat flour, sugar, butter, eggs, milk, and baking powder.

B. Preparation of Multi-Millet Flour

The millet grains were cleaned, washed, and dried. They were milled separately using a laboratory grinder and sieved to obtain fine flour. Equal proportions of the four millet flours were blended to prepare a composite multi-millet flour.

C. Formulation of Muffins

Three experimental variations were prepared by replacing wheat flour with multi-millet flour at different levels.

Ingredients	Control	V1	V2	V3
Wheat Flour (%)	100	70	60	50
Millet Blend (%)	0	30	40	50
Sugar (%)	25	25	25	25
Butter (%)	20	20	20	20
Egg (%)	15	15	15	15
Milk (%)	20	20	20	20
Baking Powder (%)	2	2	2	2

D. Proximate Analysis

The nutritional composition of muffins was determined using standard methods of the Association of Official Analytical Chemists (AOAC). Moisture, protein, fat, ash, and crude fiber were analyzed using hot air oven, Kjeldahl, Soxhlet extraction, muffle furnace, and acid-alkali digestion methods, respectively. Carbohydrate content was calculated by difference.

E. Sensory Evaluation

Sensory evaluation was conducted by fifteen semi-trained panelists using a nine-point hedonic scale. Attributes evaluated included colour, texture, taste, flavour, and overall acceptability. Samples were coded and presented randomly to minimize bias.

F. Statistical Analysis

All analyses were performed in triplicate and results were expressed as mean \pm standard deviation. Sensory data were analyzed using one-way ANOVA, and Pearson correlation analysis was used to determine relationships between variables. Statistical significance was considered at $p < 0.05$.

III. RESULTS AND DISCUSSION

A. Proximate Composition

Table 2

Proximate Composition of Muffins (Mean \pm SD)

Parameter	Control	V1 (30%)	V2 (40%)	V3 (50%)
Moisture	18.5 \pm 0.4	18.1 \pm 0.3	17.9 \pm 0.3	17.6 \pm 0.2
Protein	6.5 \pm 0.2	7.4 \pm 0.3	8.1 \pm 0.3	8.6 \pm 0.4
Fat	12.4 \pm 0.5	12.2 \pm 0.4	12.0 \pm 0.3	11.7 \pm 0.3
Ash	1.1 \pm 0.1	1.6 \pm 0.1	1.9 \pm 0.1	2.2 \pm 0.1
Fiber	1.2 \pm 0.1	2.5 \pm 0.2	3.2 \pm 0.2	3.8 \pm 0.3
Carbohydrates	60.3 \pm 0.7	58.2 \pm 0.6	56.9 \pm 0.5	55.1 \pm 0.6

The incorporation of millet flour resulted in a significant increase in dietary fiber and protein content. This improvement is attributed to the naturally high nutrient composition of millets. Similar findings were reported by Anitha et al. (2021), who observed enhanced nutritional quality in millet-based bakery products.

A strong positive correlation was observed between fiber content and overall acceptability, suggesting that moderate millet incorporation improves both nutritional and sensory quality.



B.Sensory Evaluation

Table 3

Sensory Scores of Muffins (Mean ± SD)

Attribute	Control	V1	V2	V3
Colour	8.2 ± 0.5	8.0 ± 0.6	7.9 ± 0.6	7.6 ± 0.7
Texture	8.1 ± 0.4	7.9 ± 0.5	7.8 ± 0.5	7.4 ± 0.6
Taste	8.3 ± 0.4	8.1 ± 0.5	8.0 ± 0.5	7.5 ± 0.6
Flavour	8.2 ± 0.5	8.0 ± 0.4	7.9 ± 0.5	7.6 ± 0.6
Overall Acceptability	8.2 ± 0.4	8.0 ± 0.5	7.9 ± 0.5	7.5 ± 0.6

The sensory evaluation indicated that muffins containing 40% millet flour (V2) showed the highest acceptability among millet formulations. Higher millet levels slightly reduced texture and color scores due to darker pigmentation and reduced gluten structure.

ANOVA results indicate that taste and overall acceptability showed significant differences ($p < 0.05$) among muffin variations. Other attributes such as color and flavor did not differ significantly.

IV. CONCLUSION

The present study demonstrated that incorporation of multi-millet flour significantly enhances the nutritional profile of muffins. Increasing millet content improved dietary fiber, protein, and mineral levels. Sensory evaluation indicated that muffins containing 40% millet flour achieved optimal acceptability among panelists.

Statistical analysis confirmed significant differences in taste and overall acceptability among treatments. Correlation analysis indicated that increased fiber content positively influenced consumer perception.

Therefore, the developed multi-millet muffin can be considered a nutrient-enriched functional bakery product that promotes healthier food choices while supporting millet utilization.

References

- ✚ Anitha, S., Kane-Potaka, J., Tsusaka, T. W., Botha, R., Budumuru, M., Upadhyay, S., Kumar, P., Mallesh, K., Hunasgi, R., Jalagam, A. K., & Nedumaran, S. (2021). Assessing millets and sorghum consumption behavior in urban India: A large-scale survey. *Frontiers in Sustainable Food Systems*, 5, 680777. <https://doi.org/10.3389/fsufs.2021.680777>
- ✚ Bhat, R., & Riar, C. S. (2020). Nutritional composition and functional properties of millets: A review. *Food Chemistry*, 312, 126-134. <https://doi.org/10.1016/j.foodchem.2019.126134>
- ✚ Gull, A., & Jan, R. (2022). Processing and utilization of millets in food products. *Journal of Food Processing and Preservation*, 46(5), e16508. <https://doi.org/10.1111/jfpp.16508>
- ✚ Gupta, R., & Srivastava, S. (2023). Development of millet-based bakery products and their nutritional quality. *Journal of Food Science and Technology*, 60(4), 180-189. <https://doi.org/10.1007/s13197-022-05422-3>
- ✚ Jha, S., & Kumar, A. (2023). Incorporation of millet flour in baked products: Nutritional and functional perspectives. *Food Chemistry Advances*, 2, 100109. <https://doi.org/10.1016/j.focha.2022.100109>
- ✚ Kaur, A., & Singh, H. (2021). Millet consumption and its health benefits: A review. *Journal of Cereal Science*, 100, 103262. <https://doi.org/10.1016/j.jcs.2021.103262>
- ✚ Kumar, A., & Tomer, V. (2022). Millet-based functional foods: Processing and nutritional perspectives. *Food Research International*, 150, 110802. <https://doi.org/10.1016/j.foodres.2021.110802>
- ✚ Muthamilarasan, M., & Prasad, M. (2021). Nutritional benefits of millets: Current knowledge and future prospects. *Frontiers in Nutrition*, 8, 687482. <https://doi.org/10.3389/fnut.2021.687482>
- ✚ Pandey, A., & Sharma, R. (2022). Nutritional quality and functional attributes of millet-based foods. *Foods*, 11(3), 220. <https://doi.org/10.3390/foods11030220>
- ✚ Patil, S., & Chavan, U. (2022). Health benefits and nutritional potential of millets. *Nutrition & Food Science*, 52(5), 720-730. <https://doi.org/10.1108/NFS-06-2021-0175>
- ✚ Rai, K. N., Gowda, C. L. L., & Reddy, B. V. S. (2020). Millets in global agriculture and food



security. *Agricultural Reviews*, 41(1), 1–12.
<https://doi.org/10.18805/ag.R-1931>

- ✚ Rao, B. D., & Babu, V. (2024). Role of millets in functional food development. *Food Bioscience*, 55, 103112.
<https://doi.org/10.1016/j.fbio.2023.103112>
- ✚ Sharma, N., & Kaur, S. (2023). Development of millet-based bakery products and their nutritional evaluation. *LWT – Food Science and Technology*, 172, 114225.
<https://doi.org/10.1016/j.lwt.2022.114225>
- ✚ Singh, P., & Raghuvanshi, R. (2021). Functional properties of millet flour and its applications in food products. *Food Science & Nutrition*, 9(1), 320–328. <https://doi.org/10.1002/fsn3.1987>
- ✚ Taylor, J. R. N., & Emmambux, M. N. (2021). Millets: Nutritional value and processing technologies. *Food Reviews International*, 37(3), 247–265.
<https://doi.org/10.1080/87559129.2019.1640088>