ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(12): 433-435
www.agriculturaljournals.com
Received: 04-10-2025
Accepted: 07-11-2025

SD Bhandare
M.Sc. Schlor, Department of AHDS, COA, VNMKV, Parbhani, Maharashtra, India

GK Londhe
Professor and Head, M.Sc. Schlor, Department of AHDS, COA, VNMKV, Parbhani, Maharashtra, India

AA Deshmukh
M.Sc. Schlor, Department of AHDS, COA, VNMKV, Parbhani, Maharashtra, India

HS Nishigandh
M.Sc. Schlor, Department of AHDS, COA, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
SD Bhandare
M.Sc. Schlor, Department of AHDS, COA, VNMKV, Parbhani, Maharashtra, India

Studies on the preparation of Gulabjamun by replacing Maida with barnyard millet (Echinochloa Frumentacea) flour

SD Bhandare, GK Londhe, AA Deshmukh and HS Nishigandh

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i12f.1072

Abstract
Gulabjamun, a widely consumed khoa-based confection, is traditionally prepared from khoa in the northern, western and central regions of the country. The present study aimed to develop a value-added *gulabjamun* through partial replacement of maida with roasted barnyard millet flour without compromising consumer acceptability or product quality. *Gulabjamun* samples were prepared from buffalo milk khoa. The control (T_1) contained 25 parts maida, while in treatments T_2, T_3 and T_4, maida was replaced with roasted barnyard millet flour at 2%, 4% and 6% levels. The prepared samples were assessed for their textural parameters. The textural properties of *gulabjamun* were significantly influenced by the level of roasted barnyard millet flour incorporation Hardness, springiness, gumminess and chewiness showed a progressive increase from control (T_1) to the highest millet level (T_4), indicating a firmer and more compact product structure with higher millet addition. Cohesiveness increased up to T_3 but slightly declined in T_4, suggesting reduced internal bonding at higher substitution levels. Adhesiveness values became less negative with increasing millet content, reflecting lower stickiness of the product. The highest gumminess and chewiness were observed in T_4, while T_2 exhibited textural attributes closer to the control. Overall, incorporation of roasted barnyard millet flour significantly altered the textural profile of *gulabjamun*, with moderate levels (T_2) maintaining desirable texture characteristics.

Keywords: *Gulabjamun*, Barnyard millet, Maida substitution, Nutritional quality, Sensory evaluation

Introduction

India is the world's leading producer of milk, with an annual production of approximately 239 million tonnes and a per capita availability of 459 g per day (PIB, GOI, 2024). Nearly 45.7% of the total milk produced is consumed in liquid form, while a substantial proportion of the remaining milk is utilized in the manufacture of traditional dairy products such as khoa, *gulabjamun*, peda and burfi (Pal *et al*., 2006) [7]. Buffalo milk is particularly preferred for the preparation of khoa-based sweets due to its higher fat and protein content, which contributes to superior texture and flavour (Aggarwal *et al*., 2018) [2]. Among these products, *gulabjamun* is one of the most widely consumed traditional Indian sweets and is conventionally prepared using khoa and refined wheat flour (maida). Although milk is considered a nearly complete food, it is deficient in certain micronutrients, including iron, copper, dietary fibre and some vitamins. Consequently, fortification or substitution with nutrient-dense ingredients can significantly enhance the nutritional quality of traditional dairy products such as *gulabjamun*. Dietary fibre, particularly soluble fibre, plays an important role in promoting digestive health, regulating blood glucose levels, lowering cholesterol and reducing the risk of colon cancer (Ambuja & Rajkumar, 2018) [3]. Incorporation of fibre-rich ingredients in dairy products can also improve functional attributes such as texture, viscosity and shelf stability. Barnyard millet (*Echinochloa frumentaceae*) is an underutilized yet highly nutritious cereal known for its adaptability to diverse biotic and abiotic stresses. It is gluten-free and rich in dietary fibre, protein and essential micronutrients including iron, magnesium, zinc and copper (NIN, ICMR, 2018; Rasane *et al*., 2023) [11]. Consumption of barnyard millet has been associated with health benefits such as improved management of diabetes, cardiovascular diseases, obesity, celiac disease and osteoporosis (Prasad *et al*., 2019) [9].

In contrast, refined wheat flour is nutritionally inferior, as processing removes the bran and germ, resulting in low fibre and micronutrient content and a high glycaemic index. Additionally, the use of chemical bleaching agents in maida raises health concerns related to carcinogenicity, mineral imbalance and gluten intolerance (Ganga *et al*., 2020) [4]. Given these considerations, the present study aimed to develop and evaluate *gulabjamun* by replacing maida with barnyard millet flour in order to enhance its nutritional and health value. The specific objectives of the study was: to evaluate the textural profile of the developed *gulabjamun*.

Material and Methods

The present investigation on the preparation of *gulabjamun* through substitution of maida with barnyard millet flour (BMF) was carried out at the Department of Animal Husbandry and Dairy Science, VNMKV, Parbhani, during the academic year 2024 -2025.

Procurement of essential ingredients

Ingredients such as buffalo milk was procured from the buffalo unit, Department of Animal Husbandry and Dairy Science, VNMKV, Parbhani while, barnyard millet, sugar, oil, maida, baking powder and vegetable refined oil were purchased from the local market of Parbhani.

Preparation of *Gulabjamun*

Gulabjamun was prepared from the of fresh buffalo milk, which was filtered and clarified before subjecting it to continuous heating in an open pan with constant stirring and scrapping until pat formation. At this stage, roasted barnyard millet flour was incorporated at 2%, 4% and 6% followed by *khoa* preparation. In control treatment maida was added at 15, 10 and 5 parts and baking soda used as a leavening agent was added at 1% rate, to make a smooth dough which was shaped into balls of approximately 12 g each. These balls were fried in vegetable oil at 110 °C, held for 5 minutes after frying and subsequently dipped in hot sugar syrup maintained at 65 °C. Finally, the fried *gulabjamun* balls were allowed to soak in the sugar syrup overnight to ensure proper absorption and flavor development.

Textural analysis

Texture profile of *gulabjamun* was determined by using Texture Analyser (TA-XT2i; M/s Stable micro systems; Software: Texture Expert Exceed, Version: 2.55), fitted with a 25 kg load cell and calibrated with 5 kg standard dead weight prior to use (Kumar *et al.*, 2006). *gulabjamun* was compressed twice in a reciprocating motion to obtain a two-bite texture profile curve using a double compression test. The various test parameters, used throughout the study, for whole, uncut *gulabjamun* sample were P-75 compression probe, 1 mm/s probe pre-test speed, 0.5 mm/s test speed. 10 mm/s post-test speed, 7.5 mm distance (compression) and 25 ± 1 °C maintained sample temperature. The obtained texture profile curve (TPA) was used to determine the hardness, springiness, cohesiveness, gumminess, chewiness and resilience of the tested market *gulabjamun* samples.

Statistical analysis

Completely randomized design (CRD) was used for data collected. The entire data of the experiment has been properly tabulated, analysed and interpreted as describe by Panse and Sukhatme (1967).

Result and Discussion

Texture analysis

Table 1: Textnral properties of *gulabjamun* as influenced by different level of roasted barnyard millet flour

Sample No.	Hardness (N)	Cohesiveness	Adhesiveness	Springiness (mn)	Gumminess (N)	Chewiness
	H	A2/A1	A3	D1	H×A2/A1	H×(A2/A1) × D1
T_1	2.655^d	0.733^a	-11.282^a	0.370^d	1.957^d	0.9186
T_2	3.316^c	0.742^b	-10.286^b	0.463^c	2.460^c	0.9214
T_3	3.576^b	0.775^c	-5.806^c	0.518^b	2.789^b	1.4466
T_4	3.729^a	0.706^d	-2.253^d	0.672^a	5.717^a	3.8751
S.E. ±	0.0066	0.00168	0.00216	0.00198	0.00263	0.000104
C.D at 5%	0.0204	0.00520	0.00933	0.0085	0.00812	0.000321

Hardness

The hardness values of *gulabjamun* developed using roasted barnyard millet flour (Table 1) varied significantly among treatments. The lowest hardness was recorded in T_1 (2.655 N), indicating a softer texture, while the highest hardness was observed in T_4 (3.729 N), reflecting a firmer product. Treatments T_2 (3.316 N) and T_3 (3.576 N) showed intermediate hardness values, with T_3 being slightly higher than T_2. The increasing trend in hardness from T_1 to T_4 suggests that the level of roasted barnyard millet flour incorporation influenced the firmness of *gulabjamun*, making T_4 the most compact and resistant to deformation compared to other treatments. The average hardness of the experimental *gulabjamun* was found to be between 2.655 and 3.729 N. Furthermore, it was observed that the hardness of the experimental *gulabjamun* increased significantly with a higher rate of addition of roasted barnyard millet flour.

Cohesiveness

The cohesiveness (A2/A1) values of roasted barnyard millet incorporated *gulabjamun* varied significantly among treatments, ranging from 0.706 to 0.775. The control sample (T_1) recorded a cohesiveness value of 0.733, while T_2 and T_3 showed higher values of 0.742 and 0.775, respectively, indicating improved structural integrity with the addition of roasted barnyard millet flour. However, T_4 exhibited the lowest cohesiveness (0.706), suggesting that higher levels of barnyard millet (6%) might have weakened the internal bonding within the product matrix. The statistical analysis revealed a standard error of mean (SE.m) of 0.00168 and a critical difference (CD) at 5% level of 0.00520, confirming that the observed variations among treatments were significant. These results highlight that moderate incorporation of roasted barnyard millet enhances cohesiveness, while excessive levels may adversely affect the textural balance of *gulabjamun*.

Adhesiveness

Adhesiveness, which is the measure of sensory stickiness represented by the negative peak following the initial force peak, varied significantly among the treatments of *gulabjamun* prepared with roasted barnyard millet flour. As shown in Table 1, the adhesiveness values ranged from -11.282 in T_1 to -2.533 in Table 1. The highest adhesiveness (-11.282) was observed in treatment T_1 (control), indicating greater stickiness, whereas the lowest value (-2.533) was recorded in T_4, showing a reduction in stickiness with higher levels of barnyard millet flour incorporation.

Springiness

Springiness, which reflects the ability of *gulabjamun* to return to its original shape after the deforming force is removed, exhibited noticeable variation among the treatments Table 1. The springiness values ranged from 0.370 in T_1 to 0.672 in T_4. The lowest springiness was observed in the control sample (T_1), suggesting a comparatively lower elastic recovery, while the highest springiness was recorded in T_4, indicating improved resilience with the addition of roasted barnyard millet flour. Treatments T_2 (0.453) and T_3 (0.518) showed intermediate values, demonstrating a gradual increase in springiness with increasing levels of barnyard millet flour. This trend suggests that incorporation of barnyard millet flour enhances the structural strength and elasticity of *gulabjamun*, thereby improving its overall textural quality.

Gumminess

Gumminess, which indicates the energy required to disintegrate *gulabjamun* into a state ready for swallowing, showed a clear increasing trend with higher levels of roasted barnyard millet flour (Table 1). The lowest gumminess was noted in T_1 (1.957 N), while it gradually increased through T_2 (2.460 N) and T_3 (2.789 N), reaching the highest value in T_4 (5.177 N). This rise in gumminess suggests that barnyard millet incorporation contributed to a firmer and denser texture, making the product require more energy to break down during mastication.

Chewiness

Chewiness of *gulabjamun* samples prepared with roasted barnyard millet flour, as shown in Table 4.27, exhibited a clear increasing trend with higher incorporation levels. Among the treatments, T_1 recorded the lowest chewiness value (0.9186), followed by T_2 (0.9214), while T_3 (1.4466) and particularly T_4 (3.8751) showed substantially higher chewiness values. This indicates that chewiness improved significantly with increasing hardness, cohesiveness and springiness of the samples. The rise in chewiness in T_3 and T_4 treatments may be attributed to greater structural rigidity and stronger binding of the milk proteins and starch matrix formed by barnyard millet flour, which required more energy during mastication. The statistical analysis confirmed significant differences at the 5% level, suggesting that roasted barnyard millet flour had a pronounced effect on chewiness of the developed *gulabjamun*.

Conclusion

Partial replacement of maida with roasted barnyard millet flour significantly affected the texture of *gulabjamun*. Increasing millet levels (2-6%) led to higher hardness, springiness, gumminess and chewiness, producing a firmer and denser product. Cohesiveness improved up to 4% substitution but declined at 6%, indicating adverse effects at higher levels. Adhesiveness decreased with millet addition, reducing stickiness. Overall, a 2% substitution level maintained texture comparable to the control while improving nutritional quality, making it the most suitable level for incorporation.

References

1. Adhikari AK. Microstructure and texture of khoa and gulabjamun made from cow's milk: heat-induced changes during processing and frying. Journal of the Science of Food and Agriculture. 1993;61:7-15.
2. Aggarwal D, Raju PN, Alam T, Sabikhi L, Arora B. Advances in processing of heat-desiccated traditional dairy foods of the Indian sub-continent and their marketing potential. Food and Nutrition Journal. 2018;3:172. doi:10.29011/2575-7091.100072.
3. Ambuja SR, Rajakumar SN. Review on dietary fiber incorporated dairy foods: a healthy trend. International Journal of Engineering Research and Applications. 2018;8:34-40.
4. Ganga S, Mathiyoli PM, Naachimuthu KP. Dark side of the white flour—maida. Indian Journal of Health and Wellbeing. 2020;11(1-3):100-105.
5. Gulhati HB, Rathi SD, Syed HM, Bache CS. Studies on qualities of gulabjamun. Indian Food Packer. 1992;46(6):43.
6. National Institute of Nutrition (NIN), Indian Council of Medical Research (ICMR). Nutritive value of Indian foods. Hyderabad: NIN; 2018. https://www.nin.res.in/NICE.html
7. Pal D, Sabikhi L, Singh AK, Sharma K. Textbook of developments in traditional dairy products. Karnal: Centre of Advanced Studies, National Dairy Research Institute; 2006.
8. Patel HA, Salunke P, Thakar PN. Chemical, microbiological, rheological and sensory characteristics of peda made by traditional and mechanized methods. Journal of Food Science and Technology. 2006;43(2):196-199.
9. Prasad ME, Joshi I, Kumar N, Gautam P, Chhabra J. Proximate composition of minor millets from cold semi-arid regions. International Journal of Innovative Technology and Exploring Engineering. 2019;8(12S3):86-93.
10. Press Information Bureau, Government of India. Release of basic animal husbandry statistics 2024 on the occasion of National Milk Day 2024. New Delhi: PIB; 2024. https://pib.gov.in
11. Rasane P, Bhatt D, Singh J, Kaur S, Fairos M, Kaur J, Sharma N. Nutritional advantages of barnyard millet and opportunities for its processing as value-added foods. Journal of Food Science and Technology. 2023;60(11):2748-2760.
12. Yawale PA, Rao JK. Development of khoa powder-based gulabjamun mix. Indian Journal of Dairy Science. 2012;65(5):361-367.