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Sensory evaluation of dietetic Gulab Jamun prepared with syrup optimized using sucralose and whey

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Abstract

This study was undertaken to optimize the soaking syrup for dietetic Gulab Jamun by incorporating whey and sucralose, with emphasis on sensory quality. Nine syrup formulations were prepared using whey at 25%, 50%, and 75% levels, combined with sucralose at 200, 300, and 400 ppm. The Gulab Jamun samples were evaluated for flavour, colour and appearance, body and texture, sweetness, and overall acceptability using a nine-point hedonic scale. Statistical analysis was performed through the Kruskal-Wallis test and two-way ANOVA. Among the treatments, the syrup containing 25% whey and 400 ppm sucralose was identified as optimal, as its sweetness and overall acceptability did not differ significantly from the conventional control. These findings highlight the potential of combining whey and sucralose to produce an acceptable dietetic Gulab Jamun, while also supporting the effective utilization of dairy by-products.

Keywords: Dietetic Gulab Jamun, whey, sucralose, syrup optimization, sensory evaluation

Introduction

Gulab Jamun is one of the most cherished traditional Indian dairy sweets, valued for its soft, spongy texture and syrup-soaked sweetness. However, the high sugar content of conventional Gulab Jamun restricts its suitability for consumers seeking reduced-calorie options. To address this, researchers have explored the use of low-calorie sweeteners as a means of developing dietetic versions of traditional sweets. Chetana *et al.* (2004) [1] demonstrated that Gulab Jamun could be successfully optimized using sugar substitutes, showing that sweetener replacement can modify the nutritional profile without compromising product quality.

Sucralose, a high-intensity sweetener with negligible caloric value, has been widely studied for its potential in reducing sugar content in traditional desserts. Previous work has shown that Gulab Jamun prepared with sucralose syrup can achieve satisfactory sensory acceptance. Kumari (2013) [6] reported that replacing sugar with sucralose in the syrup, up to 75%, resulted in acceptable sensory properties, while Anusha (2013) [7] found that Gulab Jamun prepared with sucralose syrup was comparable to the conventional control in overall acceptability.

Whey, a major dairy by-product, also offers significant potential for value addition in traditional dairy foods. Its incorporation not only supports better utilization of dairy resources but also enriches products with soluble milk solids and proteins. Studies have highlighted its suitability in Gulab Jamun preparation and Rameshbhai (2012) [8] reported improved consumer acceptance when whey solids and sweet cream buttermilk were used, and Vani and Jayaprakasha (2004) [5] demonstrated the effectiveness of whey protein concentrate and buttermilk in developing Gulab Jamun mix.

The soaking syrup plays a critical role in determining the sweetness, flavour, and overall sensory quality of Gulab Jamun. Hence, optimizing both sucralose concentration and whey incorporation in the syrup is essential for achieving desirable sensory characteristics in dietetic Gulab Jamun. While earlier studies have examined sweetener replacement or dairy by-product incorporation individually, limited research has focused on their combined use. The present study was therefore undertaken to evaluate different levels of whey and sucralose in the soaking syrup and to identify an optimal formulation based on sensory evaluation.

Raw Materials

Sucralose was obtained from JK Sucralose, GTB Nagar, Delhi, and whey was sourced from the University Dairy Plant, Kerala Veterinary and Animal Sciences University. All other ingredients required for Gulab Jamun preparation were procured from the local market.

Preparation of Gulab Jamun

The Gulab Jamun balls were prepared following the standardized method described by Haritha *et al.* (2023) [12]. The prepared balls were used for subsequent evaluation of the syrup formulations.

Preparation and Optimization of Syrup

Nine syrup formulations were developed by varying the levels of whey (25%, 50%, and 75%) and sucralose (200, 300, and 400 ppm). These formulations were compared with a conventional sugar syrup, which served as the control (T₁). The Gulab Jamun balls were soaked in the respective syrups under standardized conditions before sensory evaluation.

Sensory Evaluation

The soaked Gulab Jamun samples were evaluated by a panel of five trained judges using a nine-point hedonic scale. The attributes assessed included colour and appearance, flavour, body and texture, sweetness, and overall acceptability. The hedonic scale ranged from 1 (disliked extremely) to 9 (liked extremely). The sensory responses were used to compare the nine whey-sucralose syrup treatments with the conventional sugar syrup control and to identify the formulation that provided the most desirable sensory characteristics.

Statistical Analysis

The sensory data were subjected to statistical analysis to determine significant differences among treatments. Two-way analysis of variance (ANOVA) was employed to assess the effects of whey level, sucralose concentration, and their interaction on sensory attributes. In addition, the Kruskal-Wallis test was applied to evaluate differences among treatment groups.

Results and Discussion

Flavour The flavour scores of Gulab Jamun varied significantly across the syrup treatments when compared with the control (Table 2), with t-values ranging from 4.49 to 11.78. Among the treatments, T₈ showed the least difference from the control. This variation can be attributed to the combined influence of whey incorporation and sucralose concentration on flavour perception. Similar

findings were reported by Kushwaha *et al.* (2017) [3], who observed that sweetener combinations affected the sensory profile of sugar-free Gulab Jamun, and by Yargatti and Muley (2022) [9], who noted differences in flavour attributes when sucrose was replaced in traditional Indian sweets.

Colour and Appearance Significant differences in colour and appearance were recorded among the syrup treatments. Treatments T₂-T₇ showed differences at the 5% level, while T₈-T₁₀ differed at the 1% level. T₈, however, recorded a relatively lower t-value (3.90), indicating closer similarity to the control. These differences may be linked to variations in syrup composition and its interaction with the product surface during soaking. Renuka *et al.* (2010) [4] reported that replacing sucrose with fructooligosaccharides did not negatively affect colour, while Kushwaha *et al.* (2017) [3] emphasized the importance of colour in sweetener optimization.

Body and Texture Body and texture scores also differed significantly among treatments at the 5% level, with T₈ showing a lower t-value (5.01). The differences may be due to the way syrup composition influences absorption and mouthfeel. Renuka *et al.* (2010) [4] noted changes in texture following sucrose replacement, while Kushwaha *et al.* (2017) [3] highlighted the role of sweetener combinations in determining textural properties.

Sweetness Sweetness scores varied significantly across most treatments, except for T₈. The formulation containing 25% whey and 400 ppm sucralose did not differ significantly ($p \geq 0.05$) from the control, indicating comparable sweetness. The high sweetening intensity of sucralose at this concentration likely contributed to this result, while the moderate whey level provided balance without adverse effects. Kushwaha *et al.* (2017) [3] similarly identified optimized sweetener combinations that achieved high sensory acceptance in sugar-free Gulab Jamun.

Overall Acceptability and Optimization of Syrup Overall acceptability differed significantly among most treatments at the 5% level, but T₈ did not show a significant difference ($p \geq 0.05$) compared with the control. The favourable response for T₈ may be attributed to the balanced contribution of whey and sucralose, which together maintained desirable sensory characteristics. Comparable findings have been reported by Renuka *et al.* (2010) [4] and Kushwaha *et al.* (2017) [3], who demonstrated that appropriate sucrose replacement can yield acceptable Gulab Jamun. Based on the combined sensory evaluation, T₈ (25% whey + 400 ppm sucralose) was identified as the optimized syrup formulation.

Table 1: Different combinations of sugar syrup

Treatment	Whey (%)	Sucralose (in ppm)
T ₂	25	200
T ₃	50	200
T ₄	75	200
T ₅	25	300
T ₆	50	300
T ₇	75	300
T ₈	25	400
T ₉	50	400
T ₁₀	75	400

Table 2: t-values of varying levels of sucralose and whey on the sensory characteristics of *Gulab Jamun*

Attributes	Flavour	Colour and appearance	Body and Texture	Sweetness	Overall Acceptability
T ₂	10.73*	6.53*	6.52*	10.66*	8.76*
T ₃	11.78*	6.53*	6.52*	10.23*	8.11*
T ₄	9.45*	6.53*	6.52*	10.66*	8.11*
T ₅	8.32*	6.26*	6.52*	5.97*	8.32*
T ₆	10.29*	6.26*	6.52*	5.97*	10.29*
T ₇	8.57*	6.26*	5.10*	6.40*	8.57*
T ₈	4.49**	3.90**	5.01*	2.68 ^{ns}	3.58 ^{ns}
T ₉	4.91*	3.90**	5.72*	4.26**	4.82*
T ₁₀	7.56*	3.90**	6.53*	3.54**	7.56*

Figures are the Mean±Standard error of six replications, *-significant at five percent level ($p < 0.05$), ** -significant at one percent level ($p < 0.01$), ^{ns}-non significant ($p \geq 0.05$)

Conclusion

Among the evaluated syrup treatments, T₈ (25% whey + 400 ppm sucralose) was selected as the optimum formulation. This treatment showed no significant difference ($p \geq 0.05$) in overall acceptability compared with the control, confirming that whey and sucralose at these levels can effectively maintain the sensory quality of Gulab Jamun while reducing dependence on sucrose.

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Conflict of Interest

The authors declare no conflict of interest.

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