Development of Khoa Powder Based Gulabjamun Mix

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Gulabjamun is a popular khoa based sweet in India among all the traditional delicacies. Though it is made from khoa, gulabjamun mix became popular among consumers mainly because of convenience in the preparation procedure. Gulabjamun mix contains skimmed milk powder (SMP), butterfat, maida, suji and baking powder and no khoa component is present. Hence, there is a difference in the quality of gulabjamun made from the ready mix and that made from khoa. The product made from ready mixes lacks typical gulabjamun flavour and texture of the product. In the present study, for improving the flavour and granular texture of the gulabjamun, khoa powder has been used as base material in place of SMP in the gulabjamun mix. The effect of maida and baking powder levels in khoa powder based gulabjamun mix (KP-GMP) on the sensory and textural characteristics of the gulabjamun was studied. Different ratios of khoa powder and maida were tried: 80:20, 70:30 and 60:40. Out of these, use of 30 parts of maida gave best body and texture, flavour and highest overall acceptability of gulabjamun. Further, incorporation of baking powder at 0.5 parts level gave the best quality of gulabjamun with soft and uniform granular texture. The average composition of KP-GMP was: moisture 9.43 per cent, fat 18.94 per cent, protein 14.03 per cent, ash 3.97 per cent and total carbohydrates 53.63 per cent. The shelf life of the KP-GMP was found to be more than 60 days at 300C when packed in LDPE or Metalized pouch.

Keywords: Khoa, gulabjamun, khoa powder, gulabjamun mix, baking powder, textural characteristics, sensory attributes

INTRODUCTION

Gulabjamun, a popular khoa based sweetmeat of India, is prepared from khoa, admixed with wheat flour (maida) and baking powder. Because of low shelf life and non-availability of khoa throughout the year, attempts were made to find out its substitute in the preparation of gulabjamun and as such ready mixes were developed (Rajorhia, 1989; Rajorhia and Pal, 1989). The gulabjamun made from the commercial mixes is smooth and soft which finds some acceptance with consumers. But, the product lacks typical gulabjamun flavour and texture of the khoa based product. Attempts were made to enhance the quality of gulabjamun made from the mixes by ingredients like WPC (Vani and Jayaprakasha, 2004). However, all these mixes lacked khoa component in the ready mix. Therefore, there is a further scope of improvement in the flavour and texture of the gulabjamun by incorporating khoa powder in the commercial mix. There were no such studies in this direction earlier. However, Thompkinson and De (1981) reported the use of khoa powder for the preparation of gulabjamun and even reported the effect of stored khoa powder. However, no reports exist on the preparation of ready mix using khoa powder as such. If SMP in the ready mix is completely replaced with khoa powder, then the final product is expected to retain the typical khoa flavour. Further, because of granularity of the khoa powder, it is also expected to improve the granular nature of gulabjamun. In this project, a gulabjamun mix (GMP) formulated by completely replacing SMP with tray dried khoa powder is being reported. Since khoa powder is more granular, it is expected to improve the texture of gulabjaumn, however, it may result in problems such as low cohesiveness. This has to be overcome by adding maida or other binders. Thus consumers can be provided with better quality gulabjamun.
MATERIALS AND METHODS

Preparation of khoa powder
Cow milk obtained from the Experimental Dairy, National Dairy Research Institute was used for preparation of khoa. Milk was standardized to 4.0% fat and 8.5% solids-not-fat (SNF). The standardized milk was converted to khoa by heat desiccation method in an open steam jacketed kettle (steam pressure: 2 kgcm-2). Khoa was taken in a tray and manually broken into small particles and spread in the tray up to 1 cm bed thickness. The tray was loaded into vacuum tray drier (Alpha Scientific Co., Bangalore) and the heater and vacuum pump started. A vacuum level of 0.65 bar was maintained. After about two hours of drying at about 50 oC, the vacuum pump was stopped, the door of the drier was opened and the partially dried khoa particles were manually mixed in the tray itself and spread again. Drying was carried out further for 4-6 hrs under the specified vacuum. After drying was completed, the tray was taken out of the drier and allowed for cooling to ambient temperature. The dried khoa particles were ground in a mixer to a fine power. The khoa powder thus obtained was stored in a desiccator till further use.

Formulation of khoa powder based gulabjamun mix (KP-GMP)
KP-GMP was prepared by dry blending of khoa powder, maida (procured from local market) and baking powder (REX Brand) in different proportions. Khoa powder: Maida - 80:20, 70:30 and 60:40 parts; Baking powder-0, 0.5 and 1 part.

Gulabjamun was prepared from the above mixes and the effect on the sensory and textural quality of the product was studied.

Preparation of gulabjamun
A known quantity (100 g) of KP-GMP was taken in a mixing bowl, desired quantity of water (50-55 ml) was added in lots and kneaded into a smooth dough. The bowl was then covered with wet muslin cloth and allowed for about 5 min for hydration purpose. Ten grams of dough was accurately weighed and then rolled into smooth, crack free balls. Six such balls were placed in one litre hot refined oil (Brand - Fortune) taken in a SS shallow bottom karahi and fried at 135-140°C till brown colour was attained. The fried balls were transferred to sugar syrup (50% concentration) and soaked for 4-6 hrs at 50°C (Fig.1).

For preparation of control sample, gulabjamun dough was prepared from (80 g) khoa, (20 g) maida and (1 g) baking powder and rest of procedure was same as described above.

Packaging of KP-GMP
LDPE and metalized pouches of 100 μM and 130 μM thickness, respectively were filled with 125 g KP-GMP each and heat sealed with the minimum air space.

Storage of KP-GMP
The packaged KP-GMP samples were stored at 30°C in thermostatically controlled incubator. At regular intervals of 15 days, the mix sample was drawn and used for gulabjamun preparation. The gulabjamun was evaluated for textural and sensory attributes. The mix was evaluated for change in moisture, FFA, TBA and reflectance values, which referred to changes in colour, lipolysis and oxidation, respectively.

Chemical analysis
Fat, total protein and ash contents in KP-GMP were determined according to AOAC (2005). Moisture content in KP-GMP was determined as per BIS (1981) and total carbohydrates was obtained by difference. The method of Deeth et al. (1975) was used for the estimation of free fatty acids. Thiobarbituric acid (TBA) value was measured by the method suggested by Sidwell et al. (1955). Reflectance was determined using reflectancemeter (Elico Brand - Hyderabad) by the method described by Shaunak (2008).

![Flow Diagram of Gulabjamun Prepared from KP-GMP](image-url)
Sensory evaluation and textural characteristics

Gulabjamun were subjected to sensory evaluation by an expert panel of 8 judges using 9-point hedonic scale wherein a score of 1 represented 'dislike extremely' and score of 9 represented 'like extremely' (Amerine et al. 1965). The sessions were conducted in Sensory Evaluation Room under fluorescent lights. The panelists were asked to score the following parameters: color and appearance, flavor, body and texture and overall acceptability. Textural characteristics of gulabjamun were measured using Texture Analyzer (TA-XT plus, Stable Micro Systems, England) by Texture Profile Analysis technique (Fig.2) (Bourne, 2002).

Statistical analysis

The sensory evaluation data was subjected to one way analysis of variance as described by Snedecor and Cochran (1994) employing MS Excel package. Where F-test was significant, further analysis was proceeded with computation of critical difference to know the significant difference between any pair of treatments (Sundarraj et al., 1972).

RESULTS AND DISCUSSION

The ingredients used in KP-GMP were khoa powder, maida and baking powder. The proportion of these ingredients was optimized.

Optimisation of maida level

Maida is having a property of good water binding because of starchy nature (Manay and Shadaksharaswamy, 2008) and its use in the gulabjamun mix provides the product with firmness. Since tray dried khoa powder particles are less cohesive, binder like maida is required to impart cohesiveness to the mix. The maida level was optimized by evaluation of its effect on the sensory and textural characteristics of gulabjamun.

It was observed that a minimum of 20 parts of maida has to be used along with 80 parts of khoa powder. Below 20 parts, gulabjamun cannot be prepared as it led to breakage of balls during frying. At 20 parts maida level, the gulabjamun was hard and brittle indicating that the level

![Fig 2: Typical texture profile curve (F- Hardness; A2/A1 - Cohesiveness; C-D/E-F - Springiness; Hardness x Cohesiveness = Gumminess; Gumminess x Springiness = Chewiness)](image)
was not enough for binding. At 30 parts level, the body and texture (B&T) score was 7.46 against 7.71 for control indicating good acceptability (Table 1). When the maida level increased to 40 parts, the score decreased significantly to 7.27. The product displayed sogginess. The effect of maida was significant (P<0.05) at 20 and 40 parts in comparison with control sample. There was no influence of maida on colour and appearance (C&A) and flavour of gulabjamun. The effect on B&T decided the overall acceptance of gulabjamun. The textural values indicated that maida imparted firmness and springiness to gulabjamun and thereby chewiness (Table 2). However, there was slight decrease in cohesiveness by maida, may be because of granular nature of the mix. Khoa powder with 70 parts and maida 30 parts were found to be optimum.

In gulabjamun ready mixes, maida content varies from 25-35 per cent. Ghosh et al. (1984) used 25 per cent of maida in SMP based gulabjamun mix (GMP), whereas they used 35% maida in WMP based mix (Ghosh et al., 1986). Rangi et al. (1985) recommended 20 per cent maida for preparation of gulabjamun from khoa. Thompkinson and De (1981) used 10 % maida on khoa basis in preparation of gulabjamun from khoa powder.

### Optimisation of baking powder level

According to Prevention of Food Adulteration Act 2008 (PFA, 2008) baking powder contains sodium bicarbonate, and acid-reacting material, starches or other neutral material. It is commonly used in bakery products and has the function of providing texture to the products. In gulabjamun, it is used to obtain expansion and thereby structure to gulabjamun. Addition of soda is recommended in fresh khoa for gulabjamun preparation (De, 1981). However, excess of it breaks the balls during frying. Three levels of baking powder were tried in order to optimize its level. Without any soda use, it resulted in hard product hence lower B&T acceptance was recorded (score 7.23 against 7.71 for control). At 0.5 parts, it improved the B&T score to 7.7 which was not significantly different from that of control (Table 3). Baking soda level had no influence on either appearance or flavour of gulabjamun. The overall acceptance score of 0.5 parts soda - product was 7.74 which was at par with that of control (7.81) (P>0.05). The effect of baking powder level of the mix on hardness, cohesiveness, springiness and chewiness of gulabjamun is given in Table-4. The hardness and chewiness decreased as baking powder level increased. Baking soda on heating liberates carbon dioxide which diffuses through the dough during frying and results in desirable open texture (Manay and Shadaksharaswamy, 2008), however excess of it may lead to puffy texture and breakage during frying process. Higher amount of baking powder imparted soapy taste and extra porosity with big air cells in the gulabjamun balls. In the present investigation, use of more than 1 part baking soda led to breakage of balls during frying. Hence, the baking powder level

### Table 1: Effect of maida level in KP-GMP on sensory acceptance score of gulabjamun

<table>
<thead>
<tr>
<th>Sample</th>
<th>C &amp; A</th>
<th>B &amp; T</th>
<th>Fl</th>
<th>OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (prepared from khoa)</td>
<td>7.74 ± 0.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.71 ± 0.27&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.69 ± 0.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.81 ± 0.22&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>40 Parts</td>
<td>7.60 ± 0.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.27 ± 0.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.15 ± 0.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.36 ± 0.35&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>30 Parts</td>
<td>7.63 ± 0.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.46 ± 0.39&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.36 ± 0.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.46 ± 0.37&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>20 Parts</td>
<td>7.53 ± 0.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.02 ± 0.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.41 ± 0.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.26 ± 0.36&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>CD</td>
<td>-</td>
<td>0.42</td>
<td>-</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Note: C&A - Colour and appearance; B&T - Body and texture; Fl-Flavour; CD - Critical difference; Values with different superscripts in a column are significantly different (P<0.05)

### Table 2: Effect of maida level in KP-GMP on textural characteristics* of gulabjamun

<table>
<thead>
<tr>
<th>Maida level</th>
<th>Hardness, (Newtons)</th>
<th>Cohesiveness</th>
<th>Springiness</th>
<th>Chewiness, (Newtons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 Parts</td>
<td>4.90</td>
<td>0.25</td>
<td>0.47</td>
<td>0.58</td>
</tr>
<tr>
<td>30 Parts</td>
<td>3.33</td>
<td>0.28</td>
<td>0.38</td>
<td>0.35</td>
</tr>
<tr>
<td>20 Parts</td>
<td>2.65</td>
<td>0.30</td>
<td>0.35</td>
<td>0.27</td>
</tr>
</tbody>
</table>

* Average of five trials
was optimized as 0.5 parts on the basis of 70 parts of khoa powder.

**Final formulation of KP-GMP**

The optimized gulabjamun mix powder was as follows: khoa powder (tray dried) 70 parts, maida 30 parts and baking powder 0.5 parts. These ingredients are mixed thoroughly to form KP-GMP.

**Chemical composition of KP-GMP**

The average gross chemical composition of the KP-GMP was: moisture 9.43, fat 18.94, protein 14.03, ash 3.97 and total carbohydrates (by difference) 53.63%.

**Packaging and storage study of KP-GMP**

Since lactose in khoa powder is hygroscopic, the mix has to be packaged in appropriate packaging materials preferably in high moisture barrier pouches. However, it depends on duration of storage, temperature and cost of the packaging material. The KP-GMP was packaged in a high moisture barrier and a low moisture barrier packaging material and studied for shelf life.

**Changes in sensory quality of KP-GMP during storage**

There were no significant changes in the visual appearance of the KP-GMP, however, colour of the mix became slightly brown during storage. However, there was no staling defect. Similar observations were made by Rajorhia and Pal (1989) in GMP packed in laminates and stored at 30°C. They reported cake formation during storage, but in KP-GMP no such lump formation was observed, possibly because of granular nature of the mix. Patel and De (1977) stated that khoa powder could be stored for about 90 days at ambient temperature. Since khoa powder forms bulk of the KP-GMP, the shelf life could be expected as more than 2 months. According to Rajorhia (1989), the shelf life of GMP was 5-6 months at 30°C.

Regarding the quality of gulabjamun, there was a gradual decrease in the colour and appearance, body and texture, flavour and overall acceptability scores of the product prepared from stored KP-GMP (Fig. 3 and 4). At 30°C, the shelf-life of KP-GMP packed in LDPE and metalized pouch, as determined by sensory evaluation of gulabjamun, was found to be more than 60 days. The overall acceptability of gulabjamun from initial score of 7.75 ± 0.27 decreased to 7.28 ± 0.39 for samples packed in LDPE pouch and 7.37 ± 0.15 for samples packed in metalized pouch. Colour and appearance, body and texture and flavour scores also followed the same trends. Rajorhia and Pal (1989) reported that gulabjamun was of acceptable quality till more than two months of GMP storage, but after three months storage developed stale flavour.

**Changes in textural characteristics of gulabjamun**

In food products, storage related changes in texture are common, especially when many constituents are involved. These changes occur possibly as a result of chemical reactions taking place during storage or changes in the

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**Table 3: Effect of baking powder level in KP-GMP on sensory acceptance score of gulabjamun**

<table>
<thead>
<tr>
<th>Sample</th>
<th>C &amp; A</th>
<th>B &amp; T</th>
<th>Fl</th>
<th>OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (prepared from khoa)</td>
<td>7.74 ± 0.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.71 ± 0.27&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.69 ± 0.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.81 ± 0.22&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>0 Parts</td>
<td>7.66 ± 0.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.23 ± 0.46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.36 ± 0.26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.34 ± 0.39&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>0.5 Parts</td>
<td>7.71 ± 0.36&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.70 ± 0.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.64 ± 0.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.74 ± 0.37&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>1 Parts</td>
<td>7.42 ± 0.37&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.36 ± 0.50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.49 ± 0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.46 ± 0.30&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>CD</td>
<td>-</td>
<td>0.4014</td>
<td>-</td>
<td>0.3366</td>
</tr>
</tbody>
</table>

Note: C&A - Colour and appearance; B&T - Body and texture; Fl - Flavour; CD - Critical difference; Values with different superscripts in a column are significantly different (P<0.05)

**Table 4: Effect of baking powder level in KP-GMP on textural characteristics* of gulabjamun**

<table>
<thead>
<tr>
<th>Baking powder level</th>
<th>Hardness, (Newtons)</th>
<th>Cohesiveness</th>
<th>Springiness</th>
<th>Chewiness (Newtons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Parts</td>
<td>4.81</td>
<td>0.46</td>
<td>0.71</td>
<td>1.57</td>
</tr>
<tr>
<td>0.5 Parts</td>
<td>3.24</td>
<td>0.58</td>
<td>0.75</td>
<td>1.37</td>
</tr>
<tr>
<td>1 Parts</td>
<td>2.75</td>
<td>0.41</td>
<td>0.62</td>
<td>0.69</td>
</tr>
</tbody>
</table>

* Average of five trials