Abstract  

*Kheer Mohan* is a regional, well known chhana based and nutrient dense traditional sweetmeat of the eastern parts of Rajasthan. Proximate composition, sensory attributes, textural parameters, color values, water activity and total plate counts of Kheer Mohan as affected by quality of buffalo milk chhana prepared using different coagulants (lactic acid, citric acid and tartaric acid at 1% strength) and different cooking techniques (at elevated pressure, conventional and an electric fryer) were studied. Standardization of buffalo milk to 6% fat and 9 % SNF and coagulation with 1% tartaric acid was observed to yield chhana that resulted in the preparation of Kheer Mohan with optimum sensorial attributes. Use of Electric fryer was easier to control, economical, and resulted in 50% reduction in cooking time and yielded hygienic product quality. The standardized process would help in mass production of hygienic and better quality Kheer Mohan in organised dairy sector.

**Keywords**: Buffalo milk, *Kheer Mohan*, electric fryer, elevated pressure cooking

Introduction

India stands on the top of the world with 134 million tonnes annual milk production in year 2013 (Bhasin, 2014), which makes it the highest contributor (17%) in the global milk production too. Contribution of buffaloes, cows and goats in total milk production is about 53.4%, 43.1% and 3.5% respectively (Ramesha and Divya, 2014). Buffalo milk is usually valued over cow milk due to its high mineral (calcium, iron and phosphorus), protein, fat, tocopherol (natural antioxidant) and less cholesterol content (Kanawjia et al., 2014). Total current level of milk processing in our country is 34 % out of which around 16-17% is processed by organized sector (Srivastava, 2014). Unorganised sector continues to flourish by higher utilization of the surplus milk and its subsequent conversion into number of traditional sweetmeats which have rising demand owing to distinct sensorial attributes among domestic as well as international consumers. In unorganized sector, various sweetmeats are being produced on small scale by large number of sweet makers or halwais using traditional methods. New scientific innovations of the area, which results in systematic, hygienic and economic manufacture of these sweets is rarely adopt adopted by these halwais.

Kheer Mohan is a heat and acid coagulated, region oriented, nutrient dense, traditional sweetmeat which had distinct sensorial attributes so, preferred over rasogolla and other sweets by the consumers of eastern Rajasthan. Being underutilized dairy product, it remained untouched by the scientific community. In the traditional method of Kheer Mohan manufacture, chhana balls are usually cooked in concentrated sugar syrup for at least 3.5-4 h in open pans using gas or wood as energy source which results in product contamination as well as great loss of energy to the environment. So, the present work were focused to establish an economic, alternative and hygienic method of Kheer Mohan manufacture from buffalo milk with reduced cooking time.

Materials and Methods

Preparation of chhana and Kheer Mohan

Fresh buffalo milk was procured from the Cattle Yard of National Dairy Research Institute (NDRI), Karnal, Haryana,
India. It was standardized to legal standards of whole buffalo milk (6.0% fat and 8.5% SNF) and used to manufacture chhana using prescribed method by Aneja et al., (2002). To study the effect of coagulants on quality of Kheer Mohan, buffalo milk chhana was prepared with lactic, citric and tartaric acids at 1% strength. The chhana thus obtained was mixed with semolina and sugar, kneaded vigorously to obtain homogeneous mass from which chhana balls were formed manually. These balls were then cooked using three different techniques i.e. cooking in conventional vat (control), at 17 psi in domestic pressure cooker (Make: Chetak, capacity-6.5 L) and in an electric fryer (make: Cell frost, 3250 W) as shown in Figure 1. Desired sugar syrup concentration throughout the cooking process was monitored using a refractometer and maintained by sprinkling of water in five minutes interval. After sufficient cooking which was judged by the development of desired colour in product, these balls were soaked in sugar syrup for 12 h. Thereafter, these balls were removed from the sugar syrup and stored at room temperature.

**Proximate composition**

Samples were thoroughly mixed using pestle and mortar and this homogeneous mass was used for further analysis. Estimation of total solids (100-% moisture content) content as per IS: SP: 18, Part XI, (1981b), fat by Mojonnier method, protein using micro Kjeldahl method, lactose and sucrose using volumetric (Lane-eynon) method and ash by standard gravimetric method were carried. Colour values ($L^*$, $a^*$, $b^*$) and water activity ($a_w$) were determined using a Colour flex colorimeter (Hunter Associated Laboratory, Inc., VA, USA) and Aqua lab (make U.S.A.), respectively.

**Textural analysis**

Textural analysis of Kheer Mohan was carried out using Texture Analyser, TA-XT2i (M/s Stable Micro Systems, UK) fitted with a 25 kg load cell and calibrated with 5 kg standard dead weight prior to use. Compression plate (P-75) was used to compress balls of Kheer Mohan of uniform weight up to 50% of their original height that was constant using a typical two bite test at 25°C. Force-distance compression curve was obtained to estimate hardness of the Kheer Mohan. During textural analysis pre-test, test and post-test speeds were kept as 2.0, 1.0 and 2.0 mm/s respectively.

**Microbiological analysis**

All Kheer Mohan samples were analysed for Total plate count (TPC), coliform count and yeast and mold count by IS: 5402 (2002), IS: 5401, Part I (2002) and IS: 5403 (1999) methods, respectively.

**Sensory evaluation**

The sensory evaluation of Kheer Mohan was carried on 9-point hedonic scale by a trained panel of judges from the faculty of Dairy Technology Division of NDRI, Karnal, Haryana, in a well-equipped sensory evaluation laboratory.

**Statistical analysis**

Scores obtained for Kheer Mohan samples were statistically analysed for one way ANOVA and multiple correlation using SAS Enterprise guide (5.1, 2012, USA).

**Results and Discussion**

Effect of different coagulants and cooking techniques on proximate composition of Kheer Mohan

Total solids, fat, protein, lactose, sucrose and ash contents of the samples manufactured using 1% strength of lactic, tartaric and citric acids; cooked in conventional vat and an electric fryer were differed significantly ($p<0.05$) as shown in Table 1. Fat content of the samples cooked in conventional vat using tartaric and citric acids statistically differed from each other but both were at par with the fat content of the sample obtained from lactic acid cooked by the same technique. It was observed that desired product cooking duration to get optimum sensorial attributes in the product were longest (3.5 h) in conventional technique, intermediate in electric fryer (1.75 h) while shortest for cooking at elevated pressure technique (0.5 h) in cooker. The achieved percentage reduction in cooking time in electric fryer and elevated pressure technique were 50 and 85 percent respectively as compared to traditional method. Here, the higher duration of cooking in conventional technique is due to low efficiency of gas burner (65%) and greater energy losses to environment while the same was more than 95% in electric fryer. Although, cooking of chhana balls in boiling sugar syrup at higher pressure is shortest yet, it resulted in alteration of their shape from round to flatten without sufficient sugar syrup absorption, inside remained uncooked and become too hard to chew so omitted for further study.

The effects of different coagulants and chhana balls in all cooking techniques on sensorial attributes were studied and the same is presented in Table 2. The observed difference was statistically, non-significant.

Effect of different coagulants and cooking techniques on textural parameters, colour values, water activity and microbial counts.

The effects of different coagulants i.e. lactic, tartaric, citric acids and cooking techniques (normal and in electric fryer) on textural attributes, $L^*$, $a^*$, $b^*$, $a_w$ and TPC counts has shown in Table 3. Coliform counts; yeast and mold counts were absent throughout the study in all Kheer Mohan samples. Significant difference ($p<0.05$) in the springiness, gumminess,
chewiness, cohesiveness, \( L^* \), \( b^* \) and \( a_w \) value of the Kheer Mohan manufactured with different coagulants in normal cooking was observed. The observed difference for gumminess in the product produced with tartaric acid was at par with the product prepared using lactic and citric acids in conventional cooking. Chewiness values of the product produced using lactic and tartaric acids were have non-significant difference with each other but significantly (\( p<0.05 \)) differed with the chewiness values of the product produced using citric acid in normal cooking conditions. In the same manner \( b^* \) values of the product produced using tartaric and citric acids were have non-significant difference with each other but significantly (\( p<0.05 \)) differed with the \( b^* \) values of the product produced using lactic acid in normal cooking conditions (Table 3). Statistically non-significant difference in normal cooking of Kheer Mohan manufactured with different acids was observed for hardness, \( a^* \) and TPC counts.

Significant difference (\( p<0.05 \)) in the hardness, gumminess, chewiness, cohesiveness, \( L^* \), \( b^* \) and \( a_w \) value of the Kheer Mohan manufactured with different coagulants in electric fryer cooking technique was observed (Table 3). Hardness of the product obtained from lactic and citric acids were at par with each other but differed significantly (\( p<0.05 \)) with the hardness of the product obtained from tartaric acid during cooking in electric fryer. Cohesiveness of the product obtained from tartaric and citric acids were at par with each other but differed significantly (\( p<0.05 \)) with the cohesiveness of the product obtained from lactic acid. Both gumminess and chewiness of the products obtained from citric acid showed non-significant effect with the product obtained from lactic and tartaric acids but significant (\( p<0.05 \)) difference were observed for gumminess and chewiness among lactic and tartaric acids (Table 3). Statistically non-significant difference in electric fryer cooking of Kheer Mohan was observed for springiness, \( a^* \) and TPC counts.

Multiple correlation between cooking conditions and type of coagulant with sensory attributes, color values and hardness of Kheer Mohan

From Table 4, it is clear that cooking conditions were highly correlated (\( r = +0.938, p<0.01 \)) with colour and appearance, (\( r=+0.940, p < 0.01 \)) \( L^* \) and (\( r=+0.938, p < 0.01 \)) \( b^* \) values while the same was negatively correlated with \( a^* \) (\( r=-0.891, p<0.05 \)) value of Kheer Mohan. Cohesiveness of the Kheer Mohan was negatively correlated (\( r=-0.838, p<0.05 \)) as shown in Table 4.

### Table 1 Proximate composition of the Kheer Mohan manufactured using different coagulants and cooking techniques

<table>
<thead>
<tr>
<th>Sample</th>
<th>Total solids (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Lactose (%)</th>
<th>Ash (%)</th>
<th>Sucrose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product made in conventional vat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactic acid</td>
<td>84.21±0.08</td>
<td>4.29±0.04</td>
<td>8.74±0.14</td>
<td>1.46±0.01</td>
<td>0.78±0.00</td>
<td>68.93±0.24</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>74.44±0.10</td>
<td>4.33±0.12</td>
<td>7.53±0.06</td>
<td>1.37±0.01</td>
<td>0.95±0.00</td>
<td>60.26±0.03</td>
</tr>
<tr>
<td>Citric acid</td>
<td>69.76±0.30</td>
<td>4.05±0.01</td>
<td>9.79±0.03</td>
<td>1.29±0.01</td>
<td>0.97±0.00</td>
<td>53.65±0.26</td>
</tr>
<tr>
<td>Product made in electric fryer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactic acid</td>
<td>73.54±0.04</td>
<td>5.37±0.08</td>
<td>10.16±0.05</td>
<td>1.37±0.01</td>
<td>0.84±0.00</td>
<td>55.80±0.11</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>72.17±0.03</td>
<td>5.86±0.03</td>
<td>10.85±0.07</td>
<td>1.40±0.01</td>
<td>0.97±0.00</td>
<td>53.09±0.11</td>
</tr>
<tr>
<td>Citric acid</td>
<td>74.05±0.08</td>
<td>5.54±0.06</td>
<td>10.60±0.06</td>
<td>1.32±0.01</td>
<td>0.96±0.00</td>
<td>55.63±0.15</td>
</tr>
</tbody>
</table>

abc mean values within a column with different superscripts are significantly different (\( P<0.05 \)); Mean ± S.E.; \( n=3 \)

### Table 2 Sensorial attributes of the Kheer Mohan manufactured by different cooking techniques

<table>
<thead>
<tr>
<th>Sample</th>
<th>Flavor</th>
<th>Body &amp; Texture</th>
<th>Color &amp; appearance</th>
<th>Sweetness</th>
<th>Juiciness</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product made in conventional vat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactic acid</td>
<td>7.43±0.23</td>
<td>7.71±0.18</td>
<td>7.21±0.29</td>
<td>7.21±0.29</td>
<td>7.36±0.28</td>
<td>7.46±0.26</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>7.68±0.25</td>
<td>7.11±0.24</td>
<td>6.96±0.28</td>
<td>7.36±0.28</td>
<td>7.36±0.24</td>
<td>7.31±0.26</td>
</tr>
<tr>
<td>Citric acid</td>
<td>7.50±0.33</td>
<td>6.79±0.43</td>
<td>6.93±0.47</td>
<td>7.50±0.22</td>
<td>7.14±0.34</td>
<td>7.12±0.44</td>
</tr>
<tr>
<td>Product made in electric fryer</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactic acid</td>
<td>7.75±0.25</td>
<td>7.67±0.31</td>
<td>7.58±0.37</td>
<td>7.50±0.26</td>
<td>7.50±0.37</td>
<td>7.58±0.27</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>7.08±0.45</td>
<td>7.83±0.28</td>
<td>7.92±0.20</td>
<td>7.63±0.20</td>
<td>7.17±0.31</td>
<td>7.21±0.34</td>
</tr>
<tr>
<td>Citric acid</td>
<td>7.83±0.17</td>
<td>7.58±0.20</td>
<td>7.75±0.25</td>
<td>7.83±0.17</td>
<td>7.58±0.20</td>
<td>7.67±0.17</td>
</tr>
</tbody>
</table>

All sensory attributes were non-significant; Mean ± S.E.; \( n=3 \)
Suitability of particular coagulant for the manufacture of Kheer Mohan is usually judged on the basis of sensorial attributes which ultimately decides the acceptability or rejection of the developed product. As during the present study the observed effect of different coagulants in both cooking conditions were statistically non-significant so all three coagulants can be used in both cooking conditions for Kheer Mohan preparation. Moreover, lactic acid is quite expensive among these acids. Tartaric acid was preferred over other coagulants in traditional method of Kheer Mohan manufacture and the same was used for further study to compare the optimized product with market product. Cooking of the product in sugar syrup using electric fryer was selected due to intermediate cooking duration, economic in use, ease in control, hygienic and manufacture of satisfactory quality Kheer Mohan which all makes it superior over normal cooking.

Conclusions

Coliform, yeast and molds count in all samples of Kheer Mohan were absent throughout the study. Statistically non-significant effect on sensorial parameters of Kheer Mohan was observed with 1% strength of different coagulants (lactic, tartaric and citric acids) and both cooking techniques. Although all coagulants can be used for Kheer Mohan preparation yet selection of tartaric acid as a coagulant was made seeing its wide use and popularity in unorganized sector. Electric fryer was selected due to intermediate cooking duration (50 % reduction), economic use, ease in control, hygienic and manufacture of satisfactory quality Kheer Mohan which all makes it superior over normal cooking. This particular outcome of the study is of vital importance for the mass production of better quality Kheer Mohan in organized dairy industries with improved safety and reduced cost of production where electric fryer can be further replaced with steam fryer to reduce the cost of production.

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References

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