Development of evaporated milk Shrikhand and vitamin C enrichment by using Malta orange juice

Dravesh Kumar, Rekha Rani, Prachi Wasnik, John David and Sandeep Kumar

Abstract
Shrikhand is one of the most popular fermented milk product known for its taste and therapeutic value. Shrikhand was prepared using evaporated milk and evaporation was done as 1:2.5 folds. Orange is rich source of vitamin C sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium. Initial trials were conducted to find the most acceptable levels of Malta orange juice (15%, 20%, and 25%) and the best level was selected on the basis of sensory evaluation. The optimized product contained 20% Malta orange juice, and it was highly acceptable without adversely affecting the sensory attributes of shrikhand. Physicochemical analysis for optimized product contained fat (8.71%), protein (6.18%), total solids (47.35%), ash (0.61%), carbohydrate (31.63%), Ascorbic acid (0.033%), crude fiber (0.89%), titratable acidity (1.06% L.A.). Sensory characteristics (flavour and taste, colour and appearance, consistency, sweetness, overall acceptability) were judged by panel on 9 point hedonic scale. Overall acceptability score for treatments T0, T1, T2 and T3 were 7.4, 8.1, 8.5 and 7.6 respectively. The cost of production of final product for treatments T0, T1, T2 and T3 were 231.2, 238.75, 229.33, 217.44 (Rs/Kg) respectively. Textural properties of treatment T2 evaluated firmness (g), consistency (g sec), cohesiveness (g) and index of viscosity were 407.145, 9869.794, -277.571 and -17.368 respectively. Treatment T2 with 20% Malta orange juice was found to be the best among all. Addition of Malta orange juice in evaporated milk shrikhand increased vitamin C content as well as enriched natural flavour. Chakka prepared using evaporated milk saved drainage time of whey which was 4 hr, as well as have the potential to solve the problem of availability of milk in lean season to industries. Thus, product acceptability judged by sensory evaluation, the best treatment can be rated as T2>T1>T3>T0.

Keywords: Evaporated, juice, Malta, milk, orange, sensory, shrikhand.

1. Introduction
Milk, and milk products like curd, buttermilk lassi and shrikhand is inseparable dish in a regular diet of Indians. Fermented milk products constitute a vital component of the human diet in many regions of the world. One such product is shrikhand which plays a prominent role in people’s diet (Srinivas et al., 2017)[25]. It is used as a delicacy in western part of the country like Maharashtra and Gujarat. The name shrikhand is derived from Sanskrit word “Shikharani” (Shambhar, et al., 2011). It is one of the most popular fermented milk product obtained by lactic acid fermentation through the action of Lactobacillus bulgaricus, Lactococcus lactis and Streptococcus thermophilus. It is known for its taste and therapeutic value along with containing appreciable amount of milk protein and phospholipids (Mehta, 2013)[26]. Recently there has been an increasing trend to fortify shrikhand with different types of ingredients like herbs, fruits, minerals etc. According to FSSAI (2017)[37], shrikhand-means the product obtained from chakka or skimmed milk chakka to which milk fat is added. It may contain fruits, nuts, sugar, cardamom, saffron and other spices. It shall not contain any added colouring and artificial flavouring substances.

Fruits are considered good source of mineral and vitamins. Oranges are one of the fruits globally known for their nutritional and medicinal properties. The fruit is fleshy, indesicent, berry ranging from 4 cm to 12 cm and belongs to Rutaceae family (FAO, 2006)[15]. Common Malta fruits are orange-yellow, surface smooth; shape medium to large in size; spherical; thickness of the rind medium, segments 10, well-defined; pulp orange, abundant juice, good flavour. Blood Red Malta fruits skin is yellow with scarlet blush. Rind is relatively thin, tight and glossy. Pulp corn coloured and red streaked, early ripening; pulp sweet, abundant juice, red coloured, pleasant flavor (Milind and Dev, 2012)[23]. It is grown almost all over the world as a source of food because of its high nutritional values (especially vitamin C), sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium (Angew, 2007)[9].
Nutrient composition of sweet orange includes sugar 9.35 g, dietary fiber 2.4 g, fat 0.12 g, protein 0.94 g, water 86.75 g, vitamin A equiv. 11 µg (1%), vitamin C 53.2 mg (64%), iron 0.1 mg (1%) and energy 197 kJ (47 kcal) (Parle and Chaturvedi, 2012) [30]. It possesses anti-bacterial, anti-fungal, anti-diabetic, cardio-protective, anti-cancer, anti-arthritic, anti-inflammatory, anti-oxidant properties, that’s why have a centre of attraction for various scientists (Milind and Dev, 2012) [27]. The main flavonoids found in citrus species are hesperdine, narinurin, naringin and eriocitrin. Vitamin C is the primary water soluble antioxidant, which prevents free radicals generation in the body and damage to tissue in the aqueous environment both inside and outside the cells (Etebu et al., 2014) [14].

Para et al., (2014) [29] evaluated the effect of orange pulp and chiku pulp in combination (1:1) on the quality attributes of shrikhand. The pulp combination was incorporated at 0%, 7%, 14% and 21% level (replacing chakka) into the formulation of shrikhand. Bhoyar et al. (2018) made efforts to incorporate the nutritional value of banana in shrikhand and prepared the value added fermented dairy product. Dhotre and Bhadania (2016) [13] studied thermised shrikhand at 8 ± 2 °C. Kumar et al. (2017) [23] developed shrikhand by partial addition of different level of sapota pulp and cocoa powder and to evaluate its effect on nutritional and microbial quality. Deshmukh et al., (2017) [11] studied that preparation and standardization of probiotic shrikhand by utilizing mango and banana pulp. Chaudhari et al. (2018) [9] prepared the probiotic shrikhand blending with sapota pulp in different concentration by using whole milk. Sameem et al. (2018) [32] conducted experiments to evaluate the shelf life of soy-milk (20%) incorporated mango pulp (25%) based shrikhand. Chorage et al. (2018) [10] prepared shrikhand from buffalo milk by using yoghurt culture. Ginger juice was used as flavouring agent at different levels viz. 5 % (T1), 10 % (T2) 15 % (T3) and 20 % (T4) of the chakka.

No studies have been carried out on incorporation of Malta orange juice in evaporated milk for preparation of Shrikhand. Malta orange juice with evaporated milk shrikhand could be much more beneficial to health than the traditional shrikhand. Hence the present study was carried out to find their effect on physico-chemical, sensory and microbial characteristics of the final product.

2. Materials and Method

The experiments were carried out in the Laboratory of Dairy Technology, Warner College of Dairy Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The control and evaporated milk and Malta orange juice supplemented shrikhand samples were tested and statistically analyzed by Analysis of Variance (ANOVA).

2.1 Procurement of ingredients

Buffalo milk, Malta Orange, Ground sugar, Muslin cloth and Polystyrene Cups were collected from local market. Evaporated milk was prepared in laboratory of Dairy Technology. Starter culture was collected from NCDC-167, NDRI, Karnal. (Lactococcus lactis ssp. lactis, Lactococcus lactis ssp. cremoris, Lactococcus lactis ssp. biovar. diacetylactis in 1:1:1 ratio). Amount of ingredients used for various ingredients are given in Table 1. Preparation of control sample and experimental samples are illustrated in Figure 1.

Table 1: Treatments combination for preparation of evaporated milk shrikhand

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Chakka (g)</th>
<th>Ground Sugar (g)</th>
<th>Malta Orange Juice (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>77</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>T1</td>
<td>69</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>T2</td>
<td>67</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>T3</td>
<td>65</td>
<td>19</td>
<td>16</td>
</tr>
</tbody>
</table>

Fig 1: Flow diagram for preparation of control and experimental shrikhand
2.2 Sensory evaluation of control and experimental shrikhand
Standardization of shrikhand supplemented with evaporated milk and Malta orange juice was done by sensory evaluation using 9 point Hedonic scale.

2.3 Chemical analysis of control and experimental shrikhand
Total solids of Shrikhand supplemented with evaporated milk and Malta orange juice was determined gravimetrically as per the procedure for milk laid down in IS 2802,1964. The fat percentage was determined as per AOAC Method 934.01. Determination of protein was done as per the procedure method IS: 1479, Part-II, 1961. Estimation of carbohydrate was done as per the Difference method. Total carbohydrate was determined by using formula Carbohydrate (%) = [Total solids % - (% Fat + % Ash + % Protein + % Crude Fiber)]. Total ash was determined according to A.O.A.C. (1975) [4]. Determination of acidity content was done as per the procedure laid down in IS: 1479-Part-I-1960. Determination of crude fiber contents was done as per AOAC (1995) [5]. Moisture Analysis was done as per IS: (SP: 18, 1981) [21]. Vitamin C content was obtained as per AOAC (2016) [3] method using titration with DCPIP (dichlorophenol-indophenol). The pH of Shrikhand samples was determined by potentiometric method using a digital pH meter.

2.4 Textural properties of control and experimental shrikhand
The textural properties were evaluated using the TA.HD. Plus Texture analyzer of Stable Micro System equipped with 50 kg load cell with Pre-test Speed (1mm/sec), Test speed (1 mm/sec), Post-test speed (5 mm/sec), Target mode (Distance), Distance (5 mm), Count (2 Count). The analyzer is linked to a computer that recorded the data via a software programme for Firmness/Hardness, Cohesiveness, Consistency and Index of Viscosity (Figure 2-5).

2.5 Microbiological Analysis of control and experimental shrikhand
Lactic Acid Bacteria, Coliform count, Yeast and mould count was carried out as per the procedure given by (APHA) standard method for the examination of Dairy products (1992) [6].

2.6 Statistical Analysis
Data was analyzed using Analysis of Variance (ANOVA) and Critical difference (C.D) in WASP software.

2.7 Cost analysis
Cost of production was calculated by considering cost of all raw materials (food cost), cost of process like heating (15% of food cost), labour cost (20% of food cost), overhead cost (20% of food cost) like packaging, space, equipment etc., profits (15% of food cost).

3. Results and Discussion
The present study was carried out on “Development of shrikhand using evaporated milk and vitamin C enrichment by using Malta orange juice”. The data collected on different aspects were tabulated and analyzed statistically using the method of analysis of variance and critical difference. The significant and non-significant differences observed have been analyzed critically within and between the treatment combinations of chemical, microbiological and Sensory characteristics of shrikhand.

3.1 Effect of evaporated milk chakka on drainage time
Chakka was prepared using evaporated and drainage time was studied and given in Table 2. From Table 2, it was found that draining was completed in 4 h when chakka prepared using evaporated milk and yield was also 28%. Whereas, in traditional process when the shrikhand was prepared using milk, the drainage time is generally 6-8 h and yield was also in between 21-25%. Rani et al. (2012) prepared chakka using cow milk and given heat treatment (pasteurization) and found drainage time 8 h and yield was 21%.

3.2 Sensory attributes of control and experimental shrikhand
The best optimized level of Malta orange juice was judged by sensory parameters and are depicted in Table 3.

3.2.1 Effect on color and appearance of control and experimental shrikhand
The sensory score for colour and appearance of the samples from T0 to T3 were found in the range of 7.6 to 8.30, which increased substantially throughout the sample T1 to T3. Highest mean was recorded in treatment of T3 (8.3±0.44). The difference between the mean value of T0-T1 (0.10), T0-T2 (0.60), T1-T2 (0.50), T1-T3 (0.70), T2-T3 (0.20) was less than the C.D. value (0.72). Therefore, the difference was non-significant but higher for T0-T3 (0.80) hence was significant (Table 3).

3.2.2 Effect on consistency of control and experimental shrikhand
The panelist scores for consistency for all the samples of shrikhand from T0 to T3 were found in the range of 7.6 to 8.5. The highest mean score recorded in the sample of T0 (8.5±0.70) followed by T1 (7.9±0.54), T2 (7.8±0.57), T3 (7.6±0.54). The non-significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T0-T1 (0.60), T0-T2 (0.70), T1-T2 (0.10), T1-T3 (0.30), T2-T3 (0.20) was less than the C.D value (0.78). Therefore, the difference was non-significant. Whereas it was greater in case of T0-T3 (0.90). Therefore, the difference was significant (Table 3).

Table 2: Yield of experimented chakka from evaporated milk

<table>
<thead>
<tr>
<th>Quantity of milk (l)</th>
<th>Heating temperature/ time</th>
<th>Quantity of evaporated milk (ml)</th>
<th>Quantity of curd (kg)</th>
<th>Quantity of shrikhand (g)</th>
<th>Quantity of whey (ml)</th>
<th>Drainage time (h)</th>
<th>Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>45-70°C/3 h</td>
<td>1.0</td>
<td>1.0</td>
<td>702</td>
<td>300</td>
<td>4 h</td>
<td>28</td>
</tr>
</tbody>
</table>

3.2.3 Effect on acidity of control and experimental shrikhand

The acidity content of shrikhand from T0 to T3 was found in the range of 0.72 to 0.90. The highest mean was recorded in treatment of T3 (0.90±0.03). The difference between the mean value of T0-T1 (0.05), T0-T2 (0.02), T1-T2 (0.01), T1-T3 (0.01), T2-T3 (0.02) was less than the C.D. value (0.01). Therefore, the difference was non-significant (Table 3).

3.2.4 Effect on moisture of control and experimental shrikhand

The moisture content of shrikhand from T0 to T3 was found in the range of 21.6 to 23.8%. The highest mean was recorded in treatment of T3 (23.8±0.2). The difference between the mean value of T0-T1 (0.4), T0-T2 (0.6), T1-T2 (0.6), T1-T3 (0.3), T2-T3 (0.2) was less than the C.D. value (0.7). Therefore, the difference was non-significant (Table 3).

3.2.5 Effect on protein of control and experimental shrikhand

The protein content of shrikhand from T0 to T3 was found in the range of 2.8 to 3.0%. The highest mean was recorded in treatment of T3 (3.0±0.1). The difference between the mean value of T0-T1 (0.1), T0-T2 (0.2), T1-T2 (0.1), T1-T3 (0.2), T2-T3 (0.1) was less than the C.D. value (0.2). Therefore, the difference was non-significant (Table 3).

3.2.6 Effect on fat of control and experimental shrikhand

The fat content of shrikhand from T0 to T3 was found in the range of 1.1 to 1.3%. The highest mean was recorded in treatment of T3 (1.3±0.1). The difference between the mean value of T0-T1 (0.1), T0-T2 (0.1), T1-T2 (0.1), T1-T3 (0.1), T2-T3 (0.1) was less than the C.D. value (0.1). Therefore, the difference was non-significant (Table 3).
Table 3: Average data for different parameters of control and experimental samples

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>C.D. at 0.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory parameters (Headonic scale Score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flavor</td>
<td>7.15±0.03</td>
<td>7.44±0.04</td>
<td>8.52±0.04</td>
<td>7.58±0.08</td>
<td>0.047</td>
</tr>
<tr>
<td>CA</td>
<td>7.7±0.35</td>
<td>7.6±0.42</td>
<td>8.1±0.22</td>
<td>8.3±0.44</td>
<td>0.725</td>
</tr>
<tr>
<td>Consistency</td>
<td>8.5±0.70</td>
<td>7.9±0.54</td>
<td>7.8±0.57</td>
<td>7.6±0.54</td>
<td>0.783</td>
</tr>
<tr>
<td>Sweetness</td>
<td>7.8±0.75</td>
<td>8.0±0.35</td>
<td>7.7±0.44</td>
<td>7.5±0.35</td>
<td>0.641</td>
</tr>
<tr>
<td>OA</td>
<td>7.4±0.82</td>
<td>8.1±0.22</td>
<td>8.5±0.35</td>
<td>7.6±0.65</td>
<td>0.680</td>
</tr>
</tbody>
</table>

Mean±SE; N=7, CA=Colour and appearance, OA=Overall acceptability

3.2.3 Effect on flavor of control and experimental shrikhand

The sensory score for flavour in control and experimental samples were in range of 7.15 to 8.52, which gradually obtained a higher score from treatment T0 to T2. The highest mean score was recorded in the sample of T0 (8.52±0.04) followed by T3 (7.58±0.08), T1 (7.44±0.04) and T0 (7.15±0.03). The difference between the mean values of T0-T1 (0.29), T0-T2 (1.38), T0-T3 (0.43), T1-T2 (1.08), T1-T3 (0.14), T2-T3 (0.94) was greater than the C.D value (0.047). Therefore, the difference was significant (Table 3).

3.2.4 Effect on sweetness of control and experimental shrikhand

The sensory score for sweetness in control and experimental samples were in range of 7.5 to 8.0, which gradually obtained a higher score from treatment T0 to T1. The highest mean score was recorded in the sample of T1 (7.8±0.75) followed by T3 (7.7±0.44) and T0 (7.5±0.35). The difference between the mean values of T0-T1 (0.20), T0-T2 (0.10), T0-T3 (0.30), T1-T2 (0.30), T1-T3 (0.50), T2-T3 (0.20) was lesser than the C.D value (0.64). Therefore, the difference was not significant (Table 3).

3.2.5 Effect on overall acceptability of control and experimental shrikhand

Overall acceptability score in samples of different treatments and control were analyzed. The highest mean overall acceptability score was recorded in treatment of T (8.5±0.70) followed by T1 (8.1±0.22), T3 (7.6±0.65) and T1 (7.4±0.82). The difference between the mean values of T0-T1 (0.70), T0-T2 (1.10) and T2-T3 (0.90) was greater than the C.D value (0.68) and that of T0-T3 (0.20), T1-T2 (0.40) and T1-T3 (0.50) was less than the C.D value. Therefore, the difference was non-significant (Table 3).

3.3 Chemical characteristics of control and experimental shrikhand

The chemical composition (Carbohydrate content, Fat, protein, ash, total solids, moisture) of different treatment samples are given in Table 4.

3.3.1 Effect on carbohydrate content of control and experimental shrikhand

The highest mean carbohydrate percentage in treatments samples was recorded in sample T0 (33.45±0.02) followed by T1 (32.47±0.02), T2 (31.63±0.02) and T3 (30.47±0.02) (Table 4). It slowly decreased from T0 to T3, because of the decreasing levels of chakka and increasing amount of Malta orange juice. The difference between the mean values of T0-T1 (0.98), T0-T2 (1.82), T0-T3 (3.16), T1-T2 (0.84), T1-T3 (2.18), T2-T3 (1.34) was greater than the C.D value (0.033). Therefore, the difference was significant. This may be because of the composition of the ingredients utilized.

3.3.2 Fat percentage of control and experimental shrikhand

From the different treatments (Table 4) noted the highest mean fat percentage in T0 (8.82±0.01), T1 (8.71±0.02), T2 (8.66±0.01) and T3 (8.15±0.02). The fat percentage of the control was found to be more than that of other treatment samples because of characteristic fat % in evaporated milk obtained and used in the preparation of shrikhand., it slowly decreased from T1 to T3, because of the replacement of chakka with the Malta orange juice. The difference between the mean values of T0-T1 (0.66), T0-T2 (0.56), T0-T3 (0.50), T1-T2 (0.11), T1-T3 (0.16) and T2-T3 (0.05) was more than the C.D value (0.023). Therefore, the difference was significant.

3.3.3 Protein content of control and experimental shrikhand

Among the different treatment samples, treatment T0 (Control) noted the highest mean protein percentage (6.94±0.00) which reduced significantly from T0 to T3 (6.27±0.01 for T1, 6.18±0.01 for T2 and 5.96±0.01 for T3). The protein percentage of the control was found to be more than that of other treatment samples on account of characteristic protein % in evaporated milk used in the preparation of shrikhand, it slowly decreased from T1 to T3, because of the replacement of chakka with the Malta orange juice. The difference between the mean values of T0-T1 (0.67), T0-T2 (0.76), T0-T3 (0.98), T1-T2 (0.09), T1-T3 (0.31) and T2-T3 (0.22) was greater than the C.D value (0.015). Therefore, the difference was significant (Table 4).

3.3.4 Ash content of control and experimental shrikhand

Ash percentage of different treatments and control, the highest mean ash percentage was recorded in the samples of T0 (0.75±0.00) followed by T1 (0.62±0.01), T2 (0.52±0.00) and T3 (0.43±0.00). An addition of Malta orange juice (15, 20 and 25 per cent) by replacing chakka significantly reduced ash in finished product as compare to control. It indicates significant difference between the treatment (P<0.05). The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean value of T - T (0.14), T - T (0.23), T - T (0.32), T - T (0.09) and T - T (0.18) was greater than the C.D value (0.011). Therefore, the difference was significant (Table 4).

3.3.5 Total solids percentage of control and experimental shrikhand

The highest average value of total solid percentage (49.72±0.03) was obtained in the treatment T0 followed by T1 (48.33±0.02), T2 (47.35±0.02) and T3 (45.24±0.01). It slowly decreased from T0 to T3, because of the decreasing levels of chakka and increasing amount of Malta orange juice which resulted in dilution. The difference between the mean values of T0-T1 (1.34), T0-T2 (2.37), T0-T3 (4.48), T1-T2 (1.04), T1-T3 (3.14) and T2-T3 (2.11) was greater than the C.D value (0.027). Therefore, the difference was significant (Table 4).
3.3.5 Moisture percentage of control and experimental shrikhand

The moisture percentage in shrikhand samples of different treatments and control, the highest mean moisture percentage was recorded in sample of T3 (54.76±0.02) followed by T2 (52.65±0.02), T1 (51.17±0.01) and T0 (50.29±0.02). The moisture content of the control was found to be lesser than that of other treatment samples, it slowly increased from T1 to T3, because of the higher moisture content in the Malta orange juice. The difference between the mean values of T0-T1 (0.88), T0-T2 (2.36), T0-T3 (4.47), T1-T2 (1.48), T1-T3 (3.59) and T2-T3 (2.11) was greater than the C.D value (0.031). Therefore, the difference was significant (Table 4).

3.3.6 Acidity percentage of control and experimental shrikhand

Acidity percentage in shrikhand samples was recorded highest in treatment T3 (1.19±0.01) followed by T2 (1.06±0.01), T1 (0.92±0.02) and T0 (0.86±0.02). The acidity percentage of the control was found to be lesser than that of the prepared Malta orange juice shrikhand samples and it slowly increased from T0 to T3. The difference between the mean values of T0-T1 (0.88), T0-T2 (2.36), T0-T3 (4.47), T1-T2 (1.48), T1-T3 (3.59) and T2-T3 (2.11) was greater than the C.D value (0.031). Therefore, the difference was significant (Table 4).

3.3.7 pH of control and experimental shrikhand

The observed pH values in different treatment samples of shrikhand noted was highest for T0 (4.68±0.00) followed by T1 (4.65±0.01), T2 (4.58±0.03) and T3 (4.52±0.01). The pH of the shrikhand sample is very important because it helps in the formation of optimum consistency. The difference between the mean values of T0-T1 (0.03), T0-T2 (0.10), T0-T3 (0.15), T1-T2 (0.07), T1-T3 (0.13) and T2-T3 (0.06) was greater than the C.D value (0.027). Therefore, the difference was significant (Table 4).

3.4 Nutritional properties of optimized product

3.4.1 Crude fiber content in control and evaporated milk shrikhand

The average of crude fiber percentage in evaporated and Malta orange juice supplemented shrikhand was T0 (0.0±0.00), T1 (0.69±0.01), T2 (0.89±0.02) and T3 (0.97±0.02). The highest average value of crude fiber percentage was obtained in the treatment T1 because of higher fiber content in Malta orange juice and its increasing level from T1 to T3. The difference between the mean values of T0-T1 (0.70), T0-T2 (0.90), T0-T3 (1.19), T1-T2 (0.20), T1-T3 (0.50) and T2-T3 (0.30) was greater than the C.D value (0.021). Therefore, the difference was significant (Table 4).

3.4.2 Ascorbic acid content of control and evaporated milk shrikhand

The highest average value of ascorbic acid percentage (0.042±0.01) was obtained in the treatment T3. This may be due to the inherited acid present in Malta orange juice incorporated in shrikhand samples which goes on increasing from T1 to T3. The difference between the mean values of T0-T1 (0.10), T0-T2 (0.32), T0-T3 (0.38), T1-T2 (0.20), T1-T3 (0.28) and T2-T3 (0.07) was greater than the C.D value (0.014). Therefore, the difference was significant (Table 4).

3.5 Textural parameters of evaporated milk shrikhand

The textural parameters such as firmness/hardness, consistency, Cohesiveness and index of viscosity are given in Table 4 and illustrated in Figure 2, 3, 4 and 5.

3.5.1 Firmness/hardness (g) of control and experimental shrikhand

Average firmness/hardness (g) in evaporated and Malta orange juice supplemented shrikhand was recorded as T0 (696.75±178.75), T1 (490.73±196.17), T2 (407.14±209.) and T3 (364.33±199.33). The highest average value of firmness/hardness (g) (696.69) was obtained in the treatment T3. This may be because of addition of increasing order of Malta orange juice from T1 to T3. The difference between the mean values of T0-T1 (205.96), T0-T2 (289.54), T0-T3 (332.36), T1-T2 (83.59), T1-T3 (126.40) was greater than the

### Table 4: Average data for different parameters of control and experimental samples

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>C.D. at 0.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate %</td>
<td>33.45±0.02</td>
<td>32.47±0.02</td>
<td>31.63±0.02</td>
<td>30.47±0.02</td>
<td>0.033</td>
</tr>
<tr>
<td>Fat %</td>
<td>8.82±0.01</td>
<td>8.71±0.02</td>
<td>8.66±0.01</td>
<td>8.15±0.02</td>
<td>0.023</td>
</tr>
<tr>
<td>Protein %</td>
<td>6.94±0.00</td>
<td>6.27±0.01</td>
<td>6.18±0.01</td>
<td>5.96±0.01</td>
<td>0.015</td>
</tr>
<tr>
<td>Ash %</td>
<td>0.75±0.00</td>
<td>0.62±0.01</td>
<td>0.52±0.00</td>
<td>0.43±0.00</td>
<td>0.011</td>
</tr>
<tr>
<td>Total solid %</td>
<td>49.72±0.03</td>
<td>48.33±0.02</td>
<td>47.35±0.02</td>
<td>45.24±0.01</td>
<td>0.027</td>
</tr>
<tr>
<td>Moisture %</td>
<td>50.29±0.02</td>
<td>51.17±0.01</td>
<td>52.65±0.02</td>
<td>54.76±0.02</td>
<td>0.031</td>
</tr>
<tr>
<td>Acidity (% LA)</td>
<td>0.86±0.02</td>
<td>0.92±0.02</td>
<td>1.06±0.01</td>
<td>1.19±0.15</td>
<td>0.112</td>
</tr>
<tr>
<td>pH</td>
<td>4.68±0.00</td>
<td>4.65±0.01</td>
<td>4.58±0.03</td>
<td>4.52±0.01</td>
<td>0.027</td>
</tr>
<tr>
<td>Nutritional parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude fiber %</td>
<td>0.0±0.00</td>
<td>0.69±0.01</td>
<td>0.89±0.02</td>
<td>0.97±0.02</td>
<td>0.021</td>
</tr>
<tr>
<td>Ascorbic acid %</td>
<td>0.025±0.00</td>
<td>0.030±0.01</td>
<td>0.033±0.01</td>
<td>0.042±0.01</td>
<td>0.014</td>
</tr>
<tr>
<td>Textural properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firmness (g)</td>
<td>696.75±178.75</td>
<td>490.73±196.17</td>
<td>407.15±209.41</td>
<td>364.33±199.33</td>
<td>82.224</td>
</tr>
<tr>
<td>Consistency (g/sec)</td>
<td>16695.68±5764.48</td>
<td>12023.70±4300.31</td>
<td>9869.79±4759.07</td>
<td>8866.15±4612.57</td>
<td>41082</td>
</tr>
<tr>
<td>Cohesiveness (g)</td>
<td>-313.35±34.27</td>
<td>-313.16±51.03</td>
<td>-277.57±45.15</td>
<td>-263.96±47.89</td>
<td>55.104</td>
</tr>
<tr>
<td>Index of Viscosity (g/sec)</td>
<td>-6.96±2.67</td>
<td>-18.88±16.21</td>
<td>-17.36±7.10</td>
<td>-21.89±12.40</td>
<td>12.190</td>
</tr>
<tr>
<td>Microbiological Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPC (cfu/g)×10³</td>
<td>7.05±0.01</td>
<td>7.12±0.01</td>
<td>7.14±0.01</td>
<td>7.18±0.01</td>
<td>0.012</td>
</tr>
<tr>
<td>Yeast and mold (cfu/g)×10¹</td>
<td>5.75±0.03</td>
<td>6.21±0.03</td>
<td>6.32±0.02</td>
<td>6.37±0.01</td>
<td>0.038</td>
</tr>
<tr>
<td>Coliform (cfu/ml)</td>
<td>3.63±0.02</td>
<td>4.20±0.03</td>
<td>4.61±0.02</td>
<td>4.86±0.01</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Mean±SE, Average of three replications
C.D value (82.22). Therefore, the difference was significant but that for T2-T3 (42.81) was less than the C.D value. Hence, the difference was non-significant (Table 4) and figure 2 also explains the same.

3.5.2 Consistency (g sec) of control and experimental shrikhand
Average consistency (g sec) in evaporated and Malta orange juice supplemented shrikhand was found to be T0 (16695.68±57634.48), T1 (12023.70±4300.31), T2 (9869.79±4759.07) and T3 (8866.15±4612.57). The highest value was noted for the treatment T0 which may be due to the addition of increasing order of Malta orange juice from T1 to T3 resulting in the loose consistency (Figure 3). The difference between the mean values of T0-T1 (30671.96), T0-T2 (32825.87), T0-T3 (33829.50), T1-T2 (21532.91), T1-T3 (3157.55), T2-T3 (1003.64) was less than the C.D value (41082.41). Therefore, the difference was non-significant (Table 4).

3.5.3 Cohesiveness (g) of control and experimental shrikhand
Average cohesiveness (g) in evaporated and Malta orange juice supplemented shrikhand was found to be T0 (-313.35±34.27), T1 (-313.16±51.03), T2 (-277.57±45.15) and T3 (-263.96±47.89). The difference between the mean values of T0-T1 (18.19), T0-T2 (35.78), T0-T3 (49.39), T1-T2 (17.59), T1-T3 (31.20), T2-T3 (13.61) was less than the C.D value (55.10). Therefore, the difference was non-significant (Table 4). Figure 4 also describes the cohesiveness pattern of samples.

3.5.4 Index of viscosity in (g sec) of control and experimental shrikhand
Average index of viscosity in (g sec) in evaporated and Malta orange juice supplemented shrikhand was depicted in figure 5 and from Table 4 these were found to be T0 (-6.96±2.67), T1 (-18.89±16.21), T2 (-17.36±7.10) and T3 (-17.36±7.10). The difference between the mean value of T0-T1 (-11.93), T0-T2 (-10.40), T1-T2 (-1.52), T1-T3 (-3.00), T2-T3 (-4.52) was less than the C.D value (12.19). Therefore, the difference was non-significant whereas that of T0-T3 (-14.93) was greater than the C.D value. Therefore, the difference was significant.

3.6 Microbiological parameters of control and experimental shrikhand
3.6.1 Standard Plate (cfu/g) count
Standard Plate (cfu/g) count at 10^3 dilution was observed for all the treatment samples. The highest mean standard plate count was noted in treatment T3 (7.18±0.01) and lowest for T0 (7.05±0.01). The difference between the mean values of T0-T1 (0.06), T0-T2 (0.09), T0-T3 (0.12), T1-T2 (0.02), T1-T3 (0.06) and T2-T3 (0.04) was greater than the C.D value (0.012). Therefore, the difference was significant.

3.6.2 Yeast and Mould (cfu/g) count
The Yeast & Mould count (cfu/g) in shrikhand samples of different treatments and control noted the highest mean for T3 (6.37±0.01) followed by T2 (6.32±0.02), T1 (6.21±0.03) and T0 (5.75±0.03). The difference between the mean values of T0-T1 (0.45), T0-T2 (0.57), T0-T3 (0.61), T1-T2 (0.61), T1-T3 (0.11) and T2-T3 (0.16) was greater than the C.D value.
Therefore, the difference was significant among the treatment samples.

3.6.3 Coliform count
The result of coliform test count of control and experimental samples of shrikhand is 3.63±0.02 for T0, 4.20±0.03 for T1, 4.61±0.02 for T2 and 4.86±0.01 for T3. The difference between the mean values of T0-T1 (0.57), T0-T2 (0.99), T0-T3 (1.23), T1-T2 (0.42), T1-T3 (0.66), T2-T3 (0.24) was greater than the C.D value (0.033). Therefore, the difference was significant.

4. Conclusion
The optimized product contained 20% *Malta* orange juice, and it was highly acceptable without adversely affecting the sensory attributes of shrikhand. Physicochemical analysis for optimized product contained fat (8.71%), protein (6.18%), total solids (47.35%), ash (0.61%), carbohydrate (31.63%), Ascorbic acid (0.033%), crude fiber (0.89%), titratable acidity (1.06% L.A.). Overall acceptability score for treatments T0, T1, T2 and T3 were 231.2, 238.75, 229.33, 217.44 (Rs/Kg) respectively. Optimised product T2 cost lower than the control product. Hence it can be inferred that the utilization of *Malta* orange juice in evaporated milk *shrikhand* was cost effective. The selling cost for 100 g shrikhand is Rs. 23.87.

### Table 5: Cost analysis of control and experimental samples

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount required for 1000 gm. Mix (in gm.) from evaporated milk.</th>
<th>Rate in Rs/Kg</th>
<th>Cost in Rs/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>T0</strong></td>
<td><strong>T1</strong></td>
<td><strong>T2</strong></td>
</tr>
<tr>
<td>Chakka</td>
<td>770</td>
<td>690</td>
<td>670</td>
</tr>
<tr>
<td><em>Malta</em> orange juice(ml)</td>
<td>0</td>
<td>100</td>
<td>130</td>
</tr>
<tr>
<td>Sugar</td>
<td>230</td>
<td>210</td>
<td>200</td>
</tr>
<tr>
<td>Total raw material cost</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Cost of process like heating</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Labour cost (self, etc.)</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Overhead cost (packaging, space, equipment)</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Profits</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Total Cost (Rs. Per Kg) for different Treatment</td>
<td>231.2</td>
<td>238.75</td>
<td>229.33</td>
</tr>
</tbody>
</table>

4.7 Cost analysis
As seen from Table 4, Cost (Rs.) per Kg of Treatment samples is highest for T1 (238.75) and lowest for T3 (217.44). Experimental samples of treatment T0 and T2 was 231.2 and 217.44 Rs per Kg respectively. Optimised product T2 cost lesser than the control product. Thus it can be inferred that the utilization of *Malta* orange juice in evaporated milk *shrikhand* was cost effective. The selling cost for 100 g *shrikhand* is Rs. 23.87.


16. FSSAI. Food Safety and Standard Authority of India manual, 2015.

17. FSSAI. Food Safety and Standard Authority of India manual, 2017.


