Quality evaluation of ice cream prepared with Sagudana (Meteroxylon Sagu) and Sweet Potato (Ipomoea Batatas) starch as stabilizing agent

Aysha Sameen¹, Muhammad Faisal Manzoor², Nuzhat Humá³, Amna Sahar⁴ and Umair Sattar¹

¹National Institute of Food Science and Technology, Faculty of Food, Nutrition and Home Science, University of Agriculture, Faisalabad

²Institute of Home and Food Sciences, Faculty of Sciences and Technology, Government College University Faisalabad, Pakistan

Corresponding Author: ayshasameen@uaf.edu.pk

ABSTRACT

Stabilizers are commercially used in ice cream preparation to improve viscosity, air cell distribution, air incorporation, texture and melt down to achieve desirable finished product. In this study, Ice cream samples were prepared using Ipomoea Batatas starch and Meteroxylon Sagu powder as stabilizers. The sample having commercially available blend (Cremodan) was kept as reference standard. The prepared ice cream was analyzed for physico-chemical (overrun, meltdown, viscosity and standup time) and sensory characteristics at 0.25%, 0.5% and 0.75% concentration of stabilizers. Results showed that ice cream prepared with 0.75% of Ipomoea Batatas starch showed significant (p<0.05) differences in term of overrun, meltdown, standup time, viscosity compare to Meteroxylon Sagu powder and control cremodan. The sensory evaluation findings reported highest score for ice cream samples prepared with 0.75% Ipomoea Batatas starch followed by sample containing 0.5% commercial stabilizer and 0.5% Ipomoea Batatas starch. These results concluded Ipomoea Batatas starch @ 0.75% concentration can be a cost effective and good alternate of traditional stabilizers used for ice cream preparation.

Key words: Sagudana, Sweet potato starch, Stabilizing agent, Ice cream, Overrun

INTRODUCTION

Ice cream is a nutritious, palatable and comparatively less expensive food. No other food attains much popularity and has a fascinating appeal as ice cream (Goff, 2002). A compositional range for ice cream components which is used in mixture is milk fat 9-16%, MSNF 9-11%, corn syrup solids 3-6%, sucrone 10-12%, stabilizer and emulsifier 0-0.5%, total solid 37-44% and water 56-63% (Goff, 1997). Stabilizers are valuable constituent of ice cream mix. Stabilizers slightly change the acidity of the mix, enhance the viscosity, whipping time and surface tension. The stabilizer like gelatin, starch or pectin are used in milk to improve the following ice cream characteristics such as appearance, mouth feel, viscosity and texture. The quantity of stabilizer which is used depends on the quality and kind compulsory to produce the desirable stabilizing effect in the final product.

Sweet potato starch alone account for 60-70% of calories intake of human (Chandan, 2006). Sweet potato is highly nutritive and good source of vitamins (A and C), minerals (iron, potassium, calcium) and fiber. It is essential for immune function, vision, skin and bone health (Khan et al. 2008). Beside its nutritive value, starch is a very versatile raw material it has many application in food, feed, pharmaceutical, paper, textile and cosmetic industries. In the food industry, starch used as a thickener to increase the solid content, to consolidate the mass of food as a stabilizer (Burrel, 2003). In developing countries, the production of sweet potato about 95% of the world. In Pakistan, sweet potato production is 11,951 tons according to Ozturk et al. (2012). In food industry application of starch in bakery product, beverages, dessert, sauces, dressings, meat and dairy product (Sajilata et al. 2006).

Sagu powder (Meteroxylon sago) is principally used as a thickening and stabilizing agent in the food industry. Sagu palm which is mostly grown in the islands of Malaysia and Indonesia and contributed almost 70%of all sagu production. Sagu is rich in carbohydrate. Nutritionally, low in fat and high in dietary fiber and minerals such as iron and calcium sagu is healthful fat replacer (Walter and Sam, 2002). Presently in ice cream industries imported and costly stabilizers blends are using. So, the purpose of present research to discover the best locally available natural and halal stabilizers which can be used as substitute to...
costly imported stabilizers and can be used in small and large ice cream industries.

MATERIALS AND METHODS

Procurement of raw material
The fresh milk, milk cream and other ingredients such as sugar, skim milk powder, stabilizer (sagudana, sweet potato starch) artificial flavor and food grade color (FD&C yellow, 5) was purchased from the local market.

Extraction of starch
Sweet potato starch was extracted without chemical by following the method described by Oladebeye et al. (2009).

Analysis of sweet potato and Sagudana powder
Ash content, moisture, and crude protein were measured by the method described in AOAC (2000), pH was determined by using pH meter (WTW series pH-720). Water holding capacity, swelling power and solubility of starch were estimated by method described by Garg and Jana (2011). Viscosity of starch was evaluated by using Brookfield DV-E viscometer by following method reported by Mweta (2009).

Ice cream preparation
The ingredients like stabilizers, sugars, and skimmed milk powder were weighed and mixed with liquid milk and milk cream through constant mechanical stirring. Sweet potato starch and sagudana powder were used in different concentrations (0.25, 0.5 and 0.75%) as shown in Table (1). The mixture was pasteurized for 30 min at 72°C and then homogenization was done with electric homogenizer (U/MIN 7000 Type B-1 Elek tromischer Made in Germany). After the homogenization, ageing was perfumed for 5 hours at 4 °C. The mixture was further subjected at low temperature of –1 to –9°C along with whipping of air for ice cream (Schmidt, 2004). The ice cream physicochemical and sensory evaluation was filled in disposable cups (100 mL).

Physico-chemical and sensory evaluation
The viscosity was estimated by Brookfield DV-E viscometer according to the method of Sevim et al. (2001). Meltdown and standup time were determined according to method of Bhandari (2001). While calculation of overrun was done by the method described Varam and Sutherland (1994). Sensory evaluation was carried out by panel of 5 judges using 9-point hedonic scale (Larmond, 1977).

Statistical analysis
Data statistical analyzed for the effects of the factors on standup time, viscosity, over-run, meltdown time and sensory evaluation was performed by CRD using SPSS software to determine the level of significance (Steel et al. 1997). The factors were: type of stabilizers (sweet potato starch, sagudana powder) and concentration (0.25, 0.5 and 0.75%).

RESULTS AND DISCUSSION

Analysis of starch and powder
Sagudana powder and sweet potato starch was subject to different analysis. All the analyses were performed in triplicate and mean values are presented in Table 2. For sweet potato values for pH (5.38-5.60), swelling power (10.05-10.28%), solubility (3.30-3.33%), water holding capacity (82.70-83.54%), moisture (10.5-10.6%), ash (0.71-0.75), protein (0.30-0.33%) and viscosity (7550-7562cp). However, for sagudana for pH (5.30-5.50), swelling power (25.1-27.2%), solubility (0.55-1.0%), water holding capacity (78.2-79.5%), moisture (10.2-10.5%), ash (0.70-0.74), protein (0.35-0.38%) and viscosity (3550-3605cp). pH, water holding capacity, solubility and viscosity of sweet potato starch were greater than sagudana powder whereas swelling power of sagudana was higher than sweet potato. The results obtained in present study are in line with the findings of Mweta et al. (2009).

Analysis of ice cream
Mix viscosity
The effect of different concentrations of sweet potato starch and sagudana powder on mix viscosity of frozen ice cream are shown in Table 3 and Figure 1. All concentrations of sweet potato starch and sagudana powder showed significant (P<0.05) effect on viscosity of ice cream among all treatments. The linear increase of viscosity was observed with increasing the concentration of starch sweet potato and sagudana. The highest value for viscosity was achieved for sweet potato starch at concentration of 0.75% a compare to the controlled. The factors which can affect the viscosity include temperature, type, concentration, state of stabilizer and fat globule size. Viscosity can also provide mouth feel and flavor to the ice cream (Hemayyar et al. 2012). If milk protein and fat are increase then viscosity is also increase but whereas in all the samples these components were equal so viscosity was increase only due to differences in type and quantity of stabilizers (Tarkash & Yadolah, 2005). High water holding capacity of a stabilizer effected the rheological properties of mix (Guinard et al. 1994) so undoubtedly increase in viscosity is depending upon the quantity of stabilizers (Rosalina et al. 2004).
Table 1. Different concentrations of sweet potato starch and sagudana powder in ice cream preparation

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>Sweet potato starch (%)</th>
<th>Sagudana (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>T1</td>
<td>0</td>
<td>0.25</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>T2</td>
<td>0</td>
<td>0.5</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>T3</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>T4</td>
<td>0</td>
<td>0.75</td>
<td>0.5</td>
<td>0.75</td>
</tr>
<tr>
<td>T5</td>
<td>0</td>
<td>0.75</td>
<td>0</td>
<td>0.75</td>
</tr>
<tr>
<td>T6</td>
<td>0</td>
<td>0</td>
<td>0.75</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Table 2. Physicochemical analysis of sweet potato starch and sagudana powder

<table>
<thead>
<tr>
<th>Physicochemical analysis</th>
<th>Sweet potato starch</th>
<th>Sagudana powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.38±0.10</td>
<td>5.30±0.05</td>
</tr>
<tr>
<td>Swelling power %</td>
<td>10.05±0.2</td>
<td>27.2±0.1</td>
</tr>
<tr>
<td>Solubility %</td>
<td>3.30±0.3</td>
<td>0.55±0.2</td>
</tr>
<tr>
<td>Water holding capacity %</td>
<td>82.70±0.5</td>
<td>78.2±0.5</td>
</tr>
<tr>
<td>Moisture %</td>
<td>10.5±0.2</td>
<td>10.2±0.3</td>
</tr>
<tr>
<td>Ash %</td>
<td>0.71±0.04</td>
<td>0.70±0.03</td>
</tr>
<tr>
<td>Protein %</td>
<td>0.30±0.03</td>
<td>0.35±0.02</td>
</tr>
<tr>
<td>Viscosity (cp)</td>
<td>7550±40</td>
<td>3550±30</td>
</tr>
</tbody>
</table>

Table 3. Comparison of means for physico-chemical analysis according to different stabilizers

<table>
<thead>
<tr>
<th>Treatments</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity (cP)</td>
<td>2950±20</td>
<td>2360±21</td>
<td>1950±18</td>
<td>2646.7±16</td>
<td>2126.7±15</td>
<td>3053.3±16</td>
<td>2443.3±15</td>
</tr>
<tr>
<td>Meltdown (mL/10min)</td>
<td>19.93±0.15</td>
<td>24.20±0.12</td>
<td>30.20±0.13</td>
<td>21.20±0.11</td>
<td>27.56±0.16</td>
<td>18.96±0.14</td>
<td>26.50±0.13</td>
</tr>
<tr>
<td>Overrun (%)</td>
<td>52.58±0.27</td>
<td>43.74±0.62</td>
<td>38.49±0.63</td>
<td>46.87±0.60</td>
<td>40.70±0.75</td>
<td>52.64±0.94</td>
<td>43.24±0.67</td>
</tr>
<tr>
<td>Standup time (min.)</td>
<td>11.20±0.10</td>
<td>9.45±0.05</td>
<td>7.21±0.11</td>
<td>10.2±0.15</td>
<td>8.01±0.12</td>
<td>12.10±0.12</td>
<td>9.05±0.13</td>
</tr>
</tbody>
</table>

Table 4. Comparison of means for sensory characteristics as influenced by treatments

<table>
<thead>
<tr>
<th>Treatments</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavor</td>
<td>7.4±0.54</td>
<td>6.0±0.83</td>
<td>5.4±0.54</td>
<td>6.8±0.70</td>
<td>5.8±0.89</td>
<td>7.8±0.83</td>
<td>6.2±0.81</td>
</tr>
<tr>
<td>Taste</td>
<td>7.6±0.54</td>
<td>6.2±0.70</td>
<td>5.5±0.50</td>
<td>6.9±0.81</td>
<td>5.9±0.53</td>
<td>7.9±0.70</td>
<td>6.4±0.85</td>
</tr>
<tr>
<td>Appearance</td>
<td>7.7±0.83</td>
<td>6.2±0.83</td>
<td>5.6±0.52</td>
<td>7.2±0.83</td>
<td>6.4±0.54</td>
<td>8.0±0.70</td>
<td>6.8±0.80</td>
</tr>
<tr>
<td>Body/Texture</td>
<td>7.6±0.54</td>
<td>5.8±0.80</td>
<td>5.4±0.50</td>
<td>6.7±0.70</td>
<td>5.8±0.89</td>
<td>7.8±0.83</td>
<td>6.4±0.80</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>7.8±0.83</td>
<td>6.0±0.70</td>
<td>5.8±0.80</td>
<td>7.0±0.83</td>
<td>6.2±0.85</td>
<td>8.0±0.70</td>
<td>6.6±0.70</td>
</tr>
</tbody>
</table>
Fig. 1. Mix viscosity of ice cream prepared using sweet potato starch and sagudana powder stabilizer

Fig. 2. Meltdown time (ml/10min.) of ice cream prepared using sweet potato starch and sagudana powder stabilizers

Fig. 3. Overrun (%) of ice cream prepared using sweet potato starch and sagudana powder stabilizers

Fig. 4. Standup time (min.) of ice cream prepared using sweet potato starch and sagudana powder stabilizers

Melt down
The melt down effect of stabilizer in ice cream are shown Table 3 and Figure 2. It was observed that all concentrations of sweet potato starch and sagudana powder have significant (P<0.05) melt down effects among all treatments. The lowest meltdown was observed for sweet potato starch at 0.75% concentration and highest meltdown was observed for sagudana powder 0.25% concentration. Melting
resistance is significantly affected by type and concentration of stabilizers. The melt down of ice cream was affected by its composition and additives and many other, such as the amount of air incorporated, ice crystals nature and fat globules network formed during freezing (Koxholt et al. 2001). Ice creams have high overrun began to melt slowly and whereas ice creams have low overrun melted quickly. The primary cause of quick melting is low freezing point and then environmental conditions (Marshall & Arbuckle, 1996). The melting of the ice is controlled by the outside temperature and heat transfer. Homogenization improves melt down property of ice cream (Goff, 2001). Ice cream has desirable melting quality when the melted ice cream is very similar in characteristics to that of the original mix (Bhandari, 2001). Results of study describe a correlation between results of over-run and meltdown time as over-run enhances meltdown.

**Over run**

The results showed that among all treatments different concentration of sweet potato starch and sagudana powder have significant (P<0.05) effect on overrun. The highest value was observed for sweet potato starch at concentration of 0.75% shown in Table 3 and Figure 3. Stabilizer type and quantity had a significant effect on over-run. As overrun decreases, ice crystals and air cells become smaller in size. However, there is the counter balancing effect of weakening of the structure because of thinning of the unfrozen material among the air cells and ice crystals (Marshall et al. 2003). Potter and Hotchkiss (1995) described the shrinkage in ice cream due to collapse of weakened films of mix, causing the ice cream to lose volume. Due to loss of air the shrinkage was reported by Rothwell (1993). Amount of air in ice cream is directly related to the over run, is important because incorporation of air affect the product quality and profits. The less incorporation of air produce soggy and too much produce a fluffy ice cream (Igoe, 1979).

**Standup time**

The period which elapsed before the first drop of melted ice cream fell was noted for each sample. Addition of sweet potato starch and sagudana powder at different concentrations showed significant (P<0.05) effect on the stand-up time of ice cream mix. The highest stand-up time in minutes was also observed in ice cream samples having 0.75% concentration of sweet potato starch, while the lowest stand-up time was observed in ice cream sample having 0.25% sagudana powder concentration shown in Table 3 and Figure 4. Stabilizer type and quantity had a significant effect on the standup time of ice cream mix. Investigation show that significantly difference in standup time by increasing the concentration of stabilizers. The period which elapsed before the first drop of melted ice cream fell was noted for each sample. Ice cream with high melting quality begins to show definite melting within 10-15 minutes when placed at room temperature. The standup time for normal ice cream is 13 min. at 20 °C (Marshall and Arbuckle, 1996).

**Sensory evaluation of ice cream**

Samples were organoleptically evaluated for appearance, taste, flavor, body/texture and overall acceptability, by the panel of 5 judges. All the sensory parameters of sweet potato starch and sagudana powder were non-significantly affected by ice cream samples except sweet potato starch at 0.75% concentration significantly effected as compare to controlled (Table 4). The ice cream sample get highest awarded by judge’s panel containing 0.75% sweet potato starch followed by the ice cream containing 0.5% sweet potato starch. While ice cream containing sagudana powder stabilizers got the lowest scores.

**Conclusions**

Stabilizer that could be recommended for this product was sweet potato starch at 0.75% for best viscosity, meltdown, over-run and sensory characteristics. It is concluded that ice cream made with locally available sweet potato starch as stabilizer showed the comparable results from commercially used imported stabilizer. Therefore, by using locally made and available stabilizers blends, the production cost can be minimized and foreign exchange can be saved. The ethical concerns have resulted in a global interest for Halal and natural stabilizer.

**Acknowledgment**

All the authors do not have any affiliations with in any organization for any financial interest in the subject materials discussed in this manuscript. There is no conflict of interest among authors regarding the submission of this research work.

**REFERENCES**