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RESEARCH ARTICLE

Quality evaluation of soy milk ice cream prepared with *ipomoea batatas* starch and *meteroxylon sagu* powder as stabilizing agent

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ABSTRACT: Stabilizers are used in ice cream preparation for viscosity, air incorporation, melt down and texture improvement to attain attractive end product. Soybeans were used to produce soy milk. Soy milk used as a milk replacer due to its some important health aspects such protein, vitamin C, isoflavones, dietary fiber, omega-3-fatty acid and oligosaccharides. Starch was extracted form *Ipomoea Batatas*. *Meteroxylon Sagu* powder and *Ipomoea Batatas* starch analyzed against some quality characteristics such as pH, swelling power and solubility, water holding capacity, moisture, ash protein and viscosity. Ice cream was prepared by using soy milk with different concentration such as 0.25, 0.5 and 0.75% of starch and powder. Commercially used stabilizing agent Cremodan was kept as reference standard. Prepared ice cream mix was analyzed against some physicochemical and sensory parameters. Ice cream sample that contain *ipomoea batatas* starch 0.75% showed significant ($P<0.05$) outcomes against overrun, standup time, viscosity and melt-ability. Soy milk ice cream development with natural stabilizers such as starches can be cost effective and provide more health benefits.
Keywords: *Ipomoea Batatas*, *Meteroxylon Sagu*, Stabilizing agent, Soybean, Soy milk, Ice cream.

INTRODUCTION

Production of non-dairy food is a novel trend in functional food products (Kano *et al.,* 2002). Worldwide in the market of food products, prebiotic, probiotic, soy and their derivatives grow 4-5% per annum as a functional food ingredients (Granato *et al.,* 2010). Soy milk and soy milk based product have ability to replace cow milk as a potential source. Soybeans are consist of better amount of high quality proteins and carbohydrates but free from lactose and cholesterol. Soy milk is a potential milk substitute for vegetarians and lactose intolerance patients (Liu and Lin, 2000). Soybean high quality protein have many health benefits such as effecting the cholesterol metabolism and bile acid excretion through fecal (Tomat *et al.,* 2011). Soybean have different health promoting components such protein, vitamin C, isoflavones, dietary fiber, omega-3-fatty acid and oligosaccharides. Soybean composes of 38-40% protein, 14-16% dietary fiber,18-20% oil contents, 13-15% saccharides and 9-11% others micro nutrients (Kim *et al.,* 2005).

Stabilizers are used in ice cream preparation for viscosity, air incorporation, melt down and texture improvement to attain attractive end product. Stabilizers play important role as an important constituent in ice cream preparation. Functions of stabilizers in ice cream mix, change in acidity, improve in viscosity, surface tension and whipping time. The stabilizers like gelatin, guar gum, carrageenan, starches or pectin are used in milk products to enhance the following attributes, such as appearance, viscosity, texture and mouth feel. The amount of stabilizer in ice cream mix depends upon the type and quality to produce the attractive end product through their stabilizing effect.

Ipomoea batatas contain better amount of nutrients such as, vitamin A and C, calcium, iron, potassium and fiber. It is good and essential for vision, skin, bone health and immune function improvement (Khan *et al.,* 2008). *Ipomoea batatas* known as versatile raw material due to its different applications for feed, food, paper, pharmaceutical, cosmetic and textile industries. Sweet potato starch in food industry, used as a thickening and stabilizing agent to consolidate the mass of food (Burrel, 2003). Production of *Ipomoea batatas* in developing countries are 95% of the total world but in Pakistan 11,951 tons according to Ozturk *et al.,* (2012). Application of *Ipomoea batatas* starch in food industry in beverages, sauces, desserts, dressings, meat, dairy and bakery product (Sajilata *et al.,* 2006).

Meteroxylon sagu powder in food industry mainly used as stabilizing and thickening agent. *Meteroxylon sagu* palm mostly grown in Malaysia and Indonesia and contributed almost 70% of worldwide production. *Meteroxylon sagu* is good source of dietary fiber and carbohydrate but low in fat. Also contain better amount of minerals especially calcium and iron. *Meteroxylon sagu* is healthful fat substitute (Walter & Sam, 2002).

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All over the world increase in population occur regularly, malnutrition is a major problem in developing countries due to the insufficient supply of protein. Animal source protein is expensive, to fulfil the demand in developing countries find alternative source of protein such as legume seeds (Romanchik-Cerpovicz *et al.,* 2011). Now a days, in ice cream manufacturing industries imported and costly stabilizers are used. So the purpose of this research, due to the importance of soy milk and carbohydrates, manufacturing soy milk based ice cream with best locally available natural stabilizers which can be used as a substitute to costly imported stabilizers.

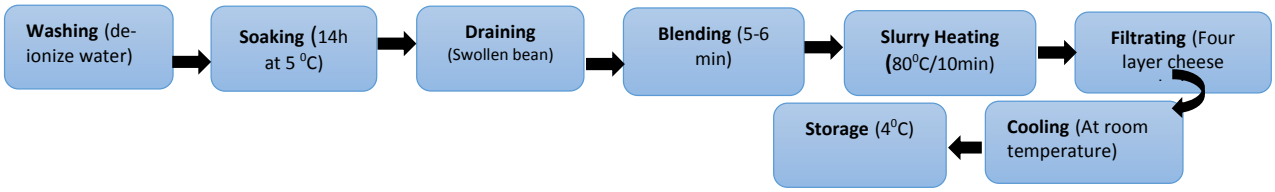
MATERIAL AND METHODS

2.1. Raw material

Soya beans, *ipomoea batatas* and *meteroxylon sagu* were purchased from the local market, Faisalabad. Soybean for soy milk production and *ipomoea batatas* for starch extraction. Other ingredients for ice cream manufacturing such as sugar, artificial flavor, egg yolk and color (FD&C yellow, 5) were also purchased from the local market, Faisalabad. Soy milk, starch, powder and ice cream all chemicals were obtained from Sigma Aldrich (USA) and Oxoid (UK).

2.2. Soy milk preparation

Soy milk was prepared according to the described by Pathomrungsiyounggul *et al.,* (2010). After preparation soy milk was cooled at room temperature and then kept at 4°C.



Flow diagram of the preparation of soy milk

2.3. Analysis of soy milk

Fat, pH, acidity, ash, total nitrogen and total solid contents were estimated according to the method described by AOAC (2003). The Solid not fat of soy milk was calculated by the method of Kirk and Sawyer (1991).

2.4. Extraction of starch

Starch from *Ipomoea batatas* was extracted by using the method described by Oladebeye *et al.,* (2009).

2.4.1. Analysis of ipomoea batatas starch and meteroxylon sagu powder

The pH of starch and powder were estimated by using the electronic digital pH meter AOAC (1984). Fat, total nitrogen, ash and moisture content were measured by the method of AOAC (2003) Water binding capacity, swelling power and solubility of dried starch and powder were calculated by the method of Garg and Jana (2011). The viscosity was measured by using Viscometer by the method of Mweta (2009).

2.5 Preparation of ice cream

Preparation of ice cream was done according to the method of Schmidt, (2004). After preparation, ice cream was filled in 100ml disposable cup for physicochemical and sensory evaluation.

2.6. Physicochemical analysis soy milk of ice cream

Ice cream pH was estimated by using the of pH meter AOAC (1984). Overrun of all ice cream samples were calculated by the method of Varnam and Sutherland (1994). Melt-ability of all ice cream samples were measured by the method of Olson *et al.,* (2003). Viscosity (cP) of all prepared samples were evaluated by using Brookfield viscometer (Sevim and Tekin, 2011). Standup time was calculated by method of Bhandari (2001).

2.7. Sensory evaluation

After storage of ice cream for 24 hours at -22°C, all ice cream samples were judge by 10 staff members of Institute of Home and Food Sciences, Government College University Faisalabad according to the method of Larmond (Larmond, 1977). Expert panel judge the impact of soy milk, *ipomoea batatas* and *meteroxylon sagu* on taste, flavor, texture and overall acceptability of ice cream.

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2.8. Statistical analysis

Data statistically analyzed for the effects of above mention physicochemical parameters and sensory evaluation were done by CRD using SPSS software (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

3.1. Analysis of soy milk

Soy milk was analyze against different parameters. Values for these parameters such as, pH (6.71-6.74), acidity (0.27.0.29%), ash (0.70-0.74%) and protein (3.29-3.31%), SNF (10-10.3%) and total Solids (12.69-12.73%). Results obtained from present study are in line with the findings of Jooyandeh (2011).

3.2. Analysis of starch and powder

Ipomoea batatas starch and *meteroxylon sagu powder* were analyzed against different parameters in triplicates are presented in Table 2. For *ipomoea batatas* values of pH (5.39±0.10), solubility (3.29±0.3%), water holding capacity (82.65±0.5%), swelling power (10.07±0.2%), ash (0.72±0.04%), moisture (10.6±0.2%), protein (0.31±0.03%) and viscosity (7500±30cp). However, for *Meteroxylon sagu* values of pH (5.31±0.05), solubility (0.55±0.2%), water holding capacity (78.4±0.5%), swelling power (27.1±0.1%), ash (0.70±0.03%), moisture (10.2±0.3%), protein (0.35±0.02%) and viscosity (3550±30cp). *Ipomoea batatas* starch significantly greater in case of pH, water holding capacity, solubility and viscosity, whereas swelling power of *meteroxylon sagu* was higher than *ipomoea batatas*. The obtained results from this research are in line with the findings of Mweta *et al.,* (2009).

3.3. Analysis of soy milk ice cream

Table 3 shows that the pH values among all the treatments varies significantly ($p< 0.05$). Significant difference in pH was observed due to the stabilizer type and quantity. Stabilizers concentration and their interactions were found significant ($p<0.05$). On aging pH value among all treatments were increased, this trend is accordance with Akesowan (2002); Rezaei *et al.,* (2011). pH has direct influence on the flavor perception, due to compositional and biochemical changes during the aging (Kanbakan *et al.,* 2004). The highest mean value for pH before aging (7.24±0.03) and after aging (7.32±0.08) were recorded in T_5 while other have comparatively low pH. The obtained results indicate that the ice cream having 0.75% concentration of *Ipomoea batatas* starch had the least decreased in pH and due to the less production of acidity.

Different concentrations of *ipomoea batatas* starch and *meteroxylon sagu* powder on the viscosity of ice cream was significantly different ($P<0.05$) are shown in Table 3. A linear trend was observed in case of viscosity with an increase of stabilizer concentration. The highest mean value for viscosity before aging (3060±16) and after aging (4463±13) observed in T_5 and followed by T_0. Temperature, fat globule size, protein hydration, type and quantity of stabilizer are the factor which can affect the viscosity. Viscosity can also provide flavor and mouth feel to the ice cream mix (Hematyar *et al.,* 2012). Milk fat and protein concentrations are also effect the viscosity but in all the samples fat and protein were remain same, so viscosity was increase only due to differences in type and concentration of stabilizers (Tarkash and Yadolah, 2005). The rheological properties of ice cream mix also effected by water holding capacity of starch (Guinard *et al.,* 1994).

Statistical results indicate the significant ($P<0.05$) effect of stabilizers on the overrun among all treatments. The highest value for overrun (53.68±0.65) was observed for *ipomoea batatas* starch at concentration of 0.75% as compare to control treatment (52.54±0.26) shown in Table 3. Significant variation in overrun was found due to the different type and concentration of stabilizers. Overrun is directly related to the amount of air, it is important for product quality and profit. Due to decrease in overrun the ice crystal and air cells become smaller. Shrinkage in ice cream, occur due to collapse of weakened film and responsible for volume lose reported by Potter and Hotchkiss (1995).

For each sample, the time in which the first drop of melted ice cream fell was noted. *Ipomoea batatas* starch and *meteroxylon sagu* powder addition in ice cream at different concentrations showed significant ($P<0.05$) effect on the standup time. The ice cream sample contain 0.75% concentration of *ipomoea batatas* starch having highest value of standup time before and after aging 12.50±0.12, 18.15±0.14 respectively, while lowest values before and after aging 7.31±0.11, 10.30±0.10 respectively were observed in *meteroxylon sagu* at 0.25% concentration (Table 4). Present study show that significant difference in standup time due to binding ability, by increasing the concentration of stabilizers. The normal standup time for ice cream is 13 minutes at 20°C (Marshall and Arbuckle, 1996).

The meltdown will define by the quality of the final product, meltdown decrease by the incorporation of air. It was observe that at all concentrations of both stabilizers have significant effect ($P<0.05$) among all treatments according to time (0, 15, 30, 45, 60 and 75min.). Overall the lowest melt-ability 60.23 after 75min was observed for *ipomoea batatas* starch at 0.75% concentration and highest melt-ability 70.34 after 75min was observed for *meteroxylon sagu* at 0.25% concentration. Ice cream having high overrun began melting slowly and vice versa depending upon the binding ability of stabilizers. The melt-ability of ice cream was affected by composition, additives, amount of air incorporation, ice crystals nature, fat globules network, type and quantity of stabilizers (Koxholt *et al.,* 2001).

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Quick melting also occur due to low freezing point and environmental conditions, the melting is reduce by controlling the outside temperature and heat transfer. Homogenization process improves melting property of ice cream (Goff, 2001).

Sensory evaluation

Sensory attributes of soy milk ice cream were effected by different type and concentration of stabilizer. Samples of soy milk Ice cream were evaluated for appearance, taste, flavor, body/texture and overall acceptability, by the judge's panel. Statistically all the sensory parameters of soy milk ice cream were significantly ($P<0.05$) affected by the different concentration of *ipomoea batatas* starch and *meteroxylon sagu* powder (Table 5). The ice cream sample got highest score awarded by judges panel containing 0.75% *ipomoea batatas* starch followed by the ice cream containing 0.5% *trapa natans* starch and control treatment. While ice cream containing *meteroxylon sagu* as a stabilizers got the lowest scores. Difference in all sensory parameters was observed due the difference of starch color and taste because the *meteroxylon sagu* is fermented taste and brighter in color on drying but *ipomoea batatas* is sweet in taste and white in color.

CONCLUSION

Locally prepared soy milk was successfully used to prepare soy milk based ice cream. Main objective of this research work to prepared soy milk ice cream for consumers due to their different health benefits anti-allergenic, anti cholesterolemic, anti atherogenic and hypolipidemic properties. Recommended stabilizer for ice cream could be *ipomoea batatas* starch at 0.75% for best viscosity, over-run, meltdown, standup time and sensory parameters. It is concluded that ice cream made with locally available *ipomoea batatas* starch as stabilizer showed the comparable results from commercially used imported stabilizer. Therefore, by using locally available stabilizers, the production cost can be minimized and foreign exchange can be saved. Moreover, soy milk ice cream also has potential for commercialization as a frozen dessert.

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Table 1: Different concentrations of *ipomoea batatas* and *Meteroxylon sagu* powder in ice cream preparation

Treatment*	Control (Cremodan)	*Ipomoea batatas* starch (%)	*Meteroxylon sagu* (%)	Total
T_0	0.5	0	0	0.5
T_1	0	0.25	0	0.25
T_2	0	0	0.25	0.25
T_3	0	0.5	0	0.5
T_4	0	0	0.5	0.5
T_5	0	0.75	0	0.75
T_6	0	0	0.75	0.75

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Table 2: Physicochemical analysis of *ipomoea batatas* starch and *meteroxylon sagu* powder

Parameters	*Ipomoea batatas* starch	*Meteroxylon sagu* powder
pH	5.39±0.10	5.31±0.05
Solubility %	3.29±0.3	0.55±0.2
Water holding capacity %	82.6±0.5	78.4±0.5
Swelling power %	10.07±0.2	27.1±0.1
Ash %	0.72±0.04	0.70±0.03
Moisture %	10.6±0.2	10.2±0.3
Protein %	0.31±0.03	0.35±0.02
Viscosity (cp)	7500±30	3550±30

Table 3: Comparison of mean values for physicochemical parameters of soy milk ice cream influenced by treatments

Treatment*	pH		Viscosity (cP)		Overrun %
	Before Aging	After Aging	Before Aging	After Aging	
T_o	7.23±0.05^{c}	7.30±0.10^{cd}	2960±10^{e}	4260±14^{e}	52.54±0.26^{d}
T_1	7.15±0.07^{b}	7.22±0.11^{b}	2370±11^{c}	3470±15^{c}	43.36±0.64^{b}
T_2	7.10±0.08^{a}	7.16±0.09^{a}	1970±15^{a}	2760±17^{a}	38.48±0.60^{a}
T_3	7.19±0.04^{c}	7.25±0.07^{c}	2656±14^{d}	3856±12^{d}	46.85±0.58^{c}
T_4	7.14±0.06^{bc}	7.20±0.11^{b}	2138±20^{b}	3036±21^{b}	40.76±0.70^{a}
T_5	7.24±0.03^{cd}	7.32±0.08^{cd}	3060±13^{ef}	4463±13^{ef}	53.68±0.65^{e}
T_6	7.19±0.09^{e}	7.27±0.06^{c}	2453±10^{cd}	3553±10^{cd}	43.20±0.52^{bc}

*See Table (1)
LSD at 0.05 for overrun %: 1.79938| Treatments: 0.556 | Time: 0.5625 | Interactions: 1.1797

Table 4: Comparison of mean values for physicochemical parameters of soy milk ice cream influenced by treatments

Treatments*	Standup time (min.)		Melt ability % Time (min.)				
	Before aging	After aging	15	30	45	60	75
To	11.50±0.1^{d}	17.25±0.17^{d}	1.30^{c}	5.18^{d}	19.83^{b}	40.83^{b}	62.42^{b}
T1	9.55±0.14^{c}	14.45±0.18^{c}	1.00^{b}	4.00^{c}	24.20^{c}	45.20^{c}	66.65^{d}
T2	7.31±0.11^{a}	10.30±0.10^{a}	2.02^{d}	8.06^{e}	30.20^{e}	51.20^{e}	70.34^{e}
T3	10.25±0.15^{cd}	15.23±0.11^{cd}	0.66^{a}	2.64^{b}	21.20^{b}	41.20^{b}	62.89^{b}
T4	8.10±0.12^{b}	12.15±0.13^{b}	1.56^{cd}	6.20^{d}	27.56^{d}	47.20^{d}	67.75^{d}
T5	12.50±0.12^{e}	18.15±0.14^{e}	0.34^{a}	1.38^{a}	18.96^{a}	39.23^{a}	60.23^{a}
T6	9.15±0.13^{c}	13.10±0.10^{c}	1.20^{c}	4.80^{c}	26.50^{d}	45.45^{c}	65.20^{c}

*See Table (1)
LSD at 0.05 value for melting resistance |Treatments: 0.556 |Time: 0.5625|Interactions: 1.1797

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Table 5: Comparison of means for sensory attributes of soy milk ice cream as influenced by treatments

Treatment	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Flavor	7.4±0.54	6±0.83	5.4±0.54	6.8±0.70	5.8±0.89	7.8±0.83	6.2±0.81
Taste	7.6±0.54	6.2±0.70	5.5±0.50	6.9±0.81	5.9±0.53	7.9±0.70	6.4±0.85
Appearance	7.7±0.83	6.2±0.83	5.6±0.52	7.2±0.83	6.4±0.54	8.0±0.70	6.8±0.80
Body/Texture	7.6±0.54	5.8±0.80	5.4±0.50	6.7±0.70	5.8±0.89	7.8±0.83	6.4±0.80
Overall acceptability	7.8±0.83	6.0±0.70	5.8±0.80	7.0±0.83	6.2±0.85	8.0±0.70	6.6±0.70

*See Table (1)

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CONFLICTS OF INTEREST
"The authors declare no conflict of interest".