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Preparation of Non-Dairy Soft Ice Milk with Soy Milk

Atallah A Atallah[1*] **and Hassan Barakat**[2]

[1]*Department of Dairy Science, Moshtohor, Faculty of Agriculture, Benha University, Egypt*

[2]*Department of Food Technology, Moshtohor, Faculty of Agriculture, Benha University, Egypt*

[*]**Corresponding author:** Atallah A Atallah, Department of Dairy Science, Moshtohor, Faculty of Agriculture, Benha University, Egypt, Tel: +201225922632; Fax: +20132467786; E-mail: atallah.mabrouk@fagr.bu.edu.eg

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Abstract

This study examined the influence of different ratios of soy milk replacement of skim milk (the levels of 0:100, 25:75, 50:50, 75:25 and 100:0 soy milk to skim milk) on the chemical, physical, microbiological and sensory properties of soft ice milk. The results revealed that by increasing the replacement of soy milk the total solids, fat, protein, pH, overrun and viscosity of mixture increased while acidity and melt down decreased significantly ($P<0.05$) in all treatments. Addition of soy milk in soft ice milk treatments has no significant effect on the counts of total viable bacterial and yeasts and molds. Adding cocoa (1%) in the treatment completely removes the beany flavour of sensory evaluation. Also, soy milk replacement up to 50% has no significant effect on sensory properties. It was found that soft ice milk of SIM4 sample contain greater amount of Na, Ca and Fe while the lowest value of Na, Ca and Fe was recorded in SIM0 sample. The content of isoflavones as daidzein can be varied from 230.40 to 105.13 µg, 100 ml^{-1} while isoflavones as genistein range from 20 to 4.98 µg, 100 ml^{-1} for soft ice milk samples. The total phenols and antioxidant contents increased of mixture by increasing of soy milk. Soft ice milk samples contained different concentrations of amino acids. Finally, the best ratio of soft ice milk samples is 50:50 ratio of soy milk to skim milk.

Keywords: Soft ice milk; Chemical; Isoflavones; Antioxidant; Amino acids; Sensory

Introduction

The production of non-dairy food products has been pointed out as a novel trend in the production of functional foods [1]. The market of food products containing functional ingredients such as: prebiotics, probiotics, dietary fiber, soy and their products grows nearly 5% per year worldwide and the selling of these products resulted 19.6 billion US$ in 2013 [2].

Soybean is a rich source of vegetable protein which included in many foods. Soy products may have some advantages for consumer's health due to their hypolipidemic, anticholesterolemic and antiatherogenic properties as well as due to reduced allergenicity. It also has isoflavones, which can reduce the risk of most hormone-associated health disorders [3]. Interestingly, soymilk is derived from soybean with common processing procedure. It can be used as a suitable alternative for cow's milk in the production of dairy products such as ice cream, yoghurt and cheeses [4]. Protein content of soymilk and cow's milk is closely similar (3.5%-4.0%) and their amino acid pattern is fairly close to cow's milk except a deficient in sulphur containing amino acids. Soy protein contains all essential amino acids, which are present in valuable amount that closely match to those required for humans or animals. Indeed, soy protein having high digestibility up to 92%, which is similar to animal protein such as egg white and casein. Soy milk has about 60 to 90 % of cow's milk nutritional value. However, adding small amounts of methionine to soy milk gives equivalent nutritional value to cow's milk. The soybean seeds contain 13-25% oil, 30-50% protein, and 14-24% carbohydrates. The major fatty acids of soy bean oil are linoleic acid (55%), oleic acid (21%), palmitic acid (9%), stearic acid (6%) and other fatty acids (9%). The ratio of polyunsaturated fatty acid to saturated fatty acid is 82:18. Soy milk does not contain cholesterol and has been successfully utilized for the preparation of indigenous sweets [5].

Soymilk is used in the preparation of frozen desserts especially ice cream and ice milk. Ice cream is a frozen mixture of a combination of some milk components (carbohydrates, proteins, fats, vitamins and minerals), sweeteners, stabilizers emulsifiers and flavors. It may be defined as partially frozen foam with air contents of 40% to 50% by volume. It has higher nutritive, biological and caloric value [6]. In Egypt and according to the Egyptian Standard 1185-3/2005, the fat content of ice milk must not less than 3%. Anhydrous milk fat can be partially or totally replaced by vegetative oils. Therefore, the objective of this study was to prepare different soft ice milk by skim milk and soy milk. Chemical, physical, microbiology and sensory properties of different prepared soft ice milk formulas in order to select the favoured ratio of soymilk substituted level were investigated.

Materials and Methods

Raw materials

Fresh skim milk was obtained from the herds of Faculty of Agriculture, Moshtohor, Benha University, Egypt. Skim milk powder (SMP-97% MSNF) was obtained from local market (Inc, Fresno, California, USA) and coconut oil (100% fat) was purchased from local market (B.G.I.O. Edible oils (SDNBHD), Malaya). Soy milk was purchased from Dairy Research and Food Technology Research Institute, Agriculture Research Center, Giza. Sucrose, cocoa and vanilla powders were purchased from the local market. Carboxyl methyl cellulose (CMC) was brought from the Pharmaceutical Chemicals Nasr Co., Abo-Zaabel, Egypt. Lecithin was obtained from American lecithin Co. supplied by Sigma Chemical Co. St. Louis, MO.

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Preparation of soft ice milk

For soft ice milk preparation, skim milk had been substituted by soy milk at 5 substitution levels as (0:100, 25:75, 50:50, 75:25 and 100:0%) to achieve appropriate treatments.

Five treatments were manufactured to study the effect of soymilk adding on soft ice milk properties. Table 1 illustrated the soft ice milk formulas. The amount of calculated fresh milk was added to the dry blend and mixed good in a high speed mixer for 1 min. All soft ice milk mixtures were heated at 85°C for 15 min then cooled down to 5°C and aged for about 24 h. Natural vanilla powder portion was added to the aged mixes before freezing. Soft ice milk mixtures were frozen in batch freezer (5 Kg each) then the resultant frozen soft ice milks were packed in plastic cups and stored at -22 ± 1°C. All experiments were carried out in triplicates and the mean values were tabulated.

Ingredients %	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Fresh skim milk	73.53	55.56	36.68	18.09	-
Skim milk powder	4	4	4	4	4
Soy milk	-	18.09	36.68	55.56	73.53
Sugar	17	17	17	17	17
Coconut oil	3	3	3	3	3
Stabilizer	0.3	0.3	0.3	0.3	0.3
Lecithin	0.25	0.25	0.25	0.25	0.25
Vanillin powder	0.1	0.1	0.1	0.1	0.1
Coca powder	2	2	2	2	2

Table 1: Different formulas of soft ice milk with soy milk substitution of cow skimmed milk by soy milk. SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk.

Chemical analysis

Total solids, carbohydrate, protein, fat, ash, pH and titratable acidity of samples were determined in accordance with AOAC methods [7].

Determination of isoflavones content

Isoflavones such daidzein and genistein in prepared soft ice milk were determined according to Ewald et al. [8] as follow: 0.5 g of sample was hydrolyzed in 40 ml of 62.5% aqueous methanol with 2 mg ml^{-1} of BHT and 10 ml of 6 M HCL at 90°C with reflux for 2 h. Methanol was added to all samples to 100 ml after hydrolysis, and the samples were finally sonicated for 5 min to remove oxygen before subjected to analysis using HPLC. The samples were separated using HPLC with reversed phase column manufactured by Shimadzu, Japan. The mobile phase consisted of 30% of acetonitrile in 0.025 M potassium dihydrogen phosphate (pH 2.4) with flow rate 1.3 ml/min. The compounds were detected by a UV detector set at 330 nm. The obtained beaks were identified using standards of daidzein and genistein and isoflavones content were calculated and expressed as µg 100 ml^{-1}.

Prepared ethanolic extract

Ethanolic extract of prepared soft ice milk were prepared as follows: 10 g samples was transferred to dark-coloured flasks and mixed with 200 ml of solvents with different polarities (water, methanol, ethyl-acetate, acetone, petroleum ether) respectively and stored at room temperature. After 24 h, infusions were filtered through Whatman No. 1 filter paper and residue was re-extracted with equal volume of solvents. After 48 h, the process was repeated. Combined supernatants were evaporated to dryness under vacuum at 40°C using Rotary evaporator. The obtained extracts were kept in sterile sample tubes and stored in a refrigerator at 4°C.

Determination of total phenolic content

The total phenolic content of ethanolic extract of prepared soft ice milk was determined colorimetrically, using the Folin-Ciocalteu method, as described by Makkar et al. [9]. Aliquots of the extract were taken in a test tube and made up to the volume of 1 ml with distilled water. Then 0.5 ml of Folin-Ciocalteu reagent (1:1 with water) and 2.5 ml of sodium carbonate solution (20%) were added sequentially in each tube. The mixture was stirred and allowed to stand in the dark for 40 min and the absorbance was recorded at 725 nm against the reagent blank using a model UV/VIS 1201 spectrophotometer (Shimadzu, Kyoto, Japan). The measurements were compared to a standard curve of prepared gallic acid (GA) solution, and the total phenolic content was expressed as milligrams of gallic acid equivalents (GAE) per 100 g sample (mg of GAE 100 ml^{-1}).

Assay of antioxidant activity

The free radical scavenging activity using the 1.1-diphenyl-2-picryl-hydrazil (DPPH) reagent was determined according to Brand-Williams et al. [10]. Each extract of soft ice milk (0.1 ml) was added to 2.9 ml of 6×10^{-5} mol methanolic solution of DPPH. The absorbance at 517 nm was measured after the solution had been allowed to stand in the dark for 60 min. The Trolox calibration curve was plotted as a function of the percentage of DPPH radical scavenging activity. The final results were expressed as micromoles of Trolox equivalents (TE) per 1 g (µmol TE 100 ml^{-1}).

Determination of amino acids profile

The amino acids profile of the soft ice milk was performed following the protocol of Walsh and Brown [11].

Micro-elements

Micro-elements such as Na, K, Ca, Mg and Fe were spectrophotometery determined in soft ice milk samples according described method by AOAC [12].

Physical analysis

Viscosity was determined by a Brookfield viscometer (model DV-II +pro, Brookfield engineering laboratories, Inc, Ma, USA). The samples were taken before and after a period of aging with spindle number 4 at 100 rpm, and at 14 ± 1°C [13]. The overrun value was determined according to the method described by[14]. The melting test of all samples were calculated according to the volume of liquid which drained off from 25-30 g of soft ice milk samples and placed on a siver with 2-mm openings up to10 minutes at 25 ± 2°C [15].

Microbiological examination

Total viable bacterial (TVB), yeasts and moulds (YM) and coliform group were enumerated according to IDF [16]; IDF [17] and APHA [18], respectively.

Sensory evaluation

Twelve trained panelists of the staff members from the Food Technology and dairy science Departments, Faculty of Agriculture, Benha University, in the age range of 20 to 57 years were asked to evaluate the prepared soft ice milk samples towards Taste, odor, body/texture, color and overall acceptability according to Clarke [19].

Statistical analysis

The statistical analysis was carried out using statistical program (MSTAT-C 1989) with multi-function utility regarding to the experimental design under significance level of 0.05 for the whole results. Multiple comparisons applying LSD were carried out according to Snedecor and Cochran [20].

Results and Discussion

Chemical analysis of prepared soft ice milk

shows the chemical composition of soft ice milk with manufactured with different levels of soy milk substitute material. Total solids (TS) contents of prepared soft ice milk were ranged from 33.67-34.23% as adding soy milk increased the TS contents significantly (P<0.05). The treatment containing 100% soy milk had the highest content of TS while the lowest content of TS was recorded in the treatment containing 100% skimmed milk. These results of this study are in agreement of Razavi et al. [21] and Pourahmad and Ahanian [22] whose shown that TS content increased with increasing the amount of soy bean milk. The data revealed that fat content was ranged from 2.99-3.40% of prepared soft ice milk. The fat content of soft ice milk increased with increasing amounts of soy milk. content of soy milk is higher than fat content of skim milk. Razavi et al. [21] and Pourahmad and Ahanian [22] found that samples containing soy milk have the highest fat contents when compared with samples containing skim milk. The protein content was ranged from 4.91-5.26% of soft ice milk samples. Adding soy milk to soft ice milk mixes increased significantly (P<0.05) protein content compared to the SIM0 samples. This may be due to that protein content of soy milk (3.6%) is higher than protein content of skim milk (3.4%) as similarly reported by Bisla et al. [4]. The highest ash content was recorded in SIM4 (1.34%) while the lowest of ash content was found in SIM0 (1.12%). Moreover, Abdullah et al. [23] reported that the ash content increased in treatments containing high amounts of soy milk. The carbohydrate content of soy milk-based soft ice milk varied from 19.52-19.58%. The effect of skim milk substitution by soy milk was not significant (P>0.05). So that with increasing levels of soy milk substituting, a significant difference is not observed in the total carbohydrate content, because soy milk contain soluble and non-soluble sugars (including dietary fiber). Due to the sugars in soy milk, are mainly types of raffinose, stachyose and insoluble sugars, so increasing of soy milk level may had no effect on the total carbohydrate content [21]. These results are in agreement with Pourahmad and Ahanian [22].

Properties	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Total solids	33.67^{c}	34.01^{b}	34.10^{b}	34.16^{a,b}	34.23^{a}
Protein	4.91^{c}	5.11^{b}	5.20^{a}	5.21^{a}	5.26^{a}
Fat	2.99^{d}	3.03^{d}	3.12^{c}	3.21^{b}	3.40^{a}
Ash	1.12^{c}	1.17^{c}	1.23^{b}	1.29^{b}	1.34^{a}
Carbohydrate	19.58^{a}	19.55^{a}	19.52^{a}	19.53^{a}	19.56^{a}
Acidity	0.19^{a}	0.18^{a}	0.17^{a}	0.16^{a}	0.15^{b}

Table 2: Chemical properties of produced soft ice milk with substitution of cow skimmed milk by soy milk. SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. ^{a,b,c,d}: Means with the same letter in the same raw are not significantly different (p>0.05).

Isoflavones of soft ice milk

Data in Table 3 illustrated the content (μg 100ml^{-1}) of two isoflavones present in soy milk such daidzein and genistein. In general, the different levels of replacement levels of soy milk with skim milk has a significant effect (P<0.05) on the isoflavones content. The content of isoflavones as daidzein was varied from 105.13 to 230.64 μg 100 ml^{-1} while isoflavones as genistein range from 4.98 to 20.14 μg 100 ml^{-1} for soft ice milk samples. Soy foods are suggested to provide a protective effect on the breast, intestine, liver, bladder, prostate, skin and stomach from cancer development [24]. The major active components in soybean are isoflavones such as genistein and daidzein. Genistein, which possesses weak estrogenic activity, has been shown to act in animal models as an antiestrogen and, therefore, may play a protective role in hormonally influenced cancers, such as breast cancer [25].

Properties	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Daidzein	ND	105.13^{d}	151.40^{c}	200.35^{b}	230.64^{a}
Genistein	ND	4.98^{d}	10.00^{c}	15.46^{b}	20.14^{a}

Table 3: Isoflavones contents of different prepared soft ice milk with substitution of cow skimmed milk by soy milk (μg 100 ml^{-1}). SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. ^{a,b,c,d}: Means with the same letter in the same raw are not significantly different (p>0.05).

The total phenolic and antioxidant of soft ice milk

The total phenols content ranged from 45.12 to 115.54 mg GAE 100 g^{-1} in the soft ice milk samples (Table 4). Results showed that by increasing the substitution of soy milk the total phenols contents increased in soft ice milk samples. The total phenols content was higher significantly (P<0.05) in soft ice milk containing 100% soy milk while sample containing 100% skim milk was lower. Content of phenolic compounds soy food was affected by genetic factors, environmental factors or soy food processes [26].

Properties	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Total phenolic (mg GAE 100 g^{-1})	ND	45.12 d	62.64c	95.37b	115.54a
Antioxidant activity (µm Trolox 100 g^{-1})	ND	15.82 d	501.27 c	817.60b	1198.43a

Table 4: Total phenolic and antioxidant contents of different prepared soft ice milk with substitution of cow skimmed milk by soy milk. SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. a,b,c,d: Means with the same letter in the same raw are not significantly different (p>0.05).

The antioxidant activity of soft ice milk containing soy milk was higher than of that containing skim milk (Table 4). Also, the antioxidant activity value was significantly different (P<0.05) between all samples of soft ice milk. So that sample containing 100% soy milk (SIM4) has the highest value (1198.43 µm Trolox 100 g^{-1}) of antioxidant activity while sample containing 100% skim milk (SIM0) has the lowest value (15.82 µm Trolox 100 g^{-1}) of antioxidant activity.

Amino acid profiles of soft ice milk

Soft ice milk samples contain different concentrations of the essential and non-essential amino acids (Table 5). Actually, SIM0 sample recorded highest concentrations of amino acids, especially in isoleucine, leucine, lysine, methionine, theronine, valine, histidine, glutamic acid, proline and tyrosine than the other treatments. Also, SIM4 sample contained highest values of phenylalanine, arginine, alainine, aspartic acid, cysteine, glycine and serine when compared with the other treatments. The breakdown of leucine takes place in the liver and skeletal muscles [27]. It undergoes transamination in the muscles by transferring into glutamine or alanine that ultimately convert to glucose in the liver through gluconeogenesis; a unique pathway for the maintenance of blood glucose level [28]. Hence, dietary proteins rich in essential and branched chain amino acids particularly leucine provide health benefits that are not usually observed for diets containing protein from other sources [29].

Amino acids	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Essential amino acids					
Isoleucine	4.98	4.95	4.91	4.9	4.88
Leucine	10.41	9.98	9.61	9.1	7.93
Lysine	11.32	10.42	9.1	7.05	5.94
Methionine	3.11	2.64	2.35	2.1	1.41
Phenylalanine	4	4.12	4.23	4.64	5.14
Theronine	5.12	4.89	4.56	4.08	3.49
Valine	5.44	5.07	4.95	4.79	4.72
Histidine	3.25	3.03	2.77	2.63	2.55
Non-essential amino acids					
Arginine	3.68	4.97	5.67	6.47	7.2
Alanine	3.01	3.12	3.45	3.71	4.12
Aspartic acid	8.32	9.65	9.74	9.9	10.87
Cystein	1.05	1.15	1.22	1.39	1.58
Glutamic acid	23.57	20.34	19.25	16.87	15.98
Glycine	2.1	2.35	2.87	2.99	3.75
Proline	14.32	12.09	10.08	6.89	4.81
Serine	4.65	4.68	4.69	4.7	4.74
Tyrosine	7.61	6.81	5.92	4.89	3.84

Table 5: Amino acids profiles of different prepared soft ice milk with substitution of cow skimmed milk by soy milk (mg g^{-1}). SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. a,b,c,d: Means with the same letter in the same raw are not significantly different (p>0.05).

Mineral content of soft ice milk

The micro-elements (Na, K, Ca, Mg and Fe) of soft ice milk made by replacing skim milk by soy milk at different levels are presented in Table 6. The results indicated that SIM0 sample contained highest percentage of K (19.51 mg 100 ml^{-1}) and Mg (0.13 mg 100 ml^{-1}) when compared with the other treatments. Also, the highest value of Na (20.11 mg 100 ml^{-1}), Ca (2.99 mg 100 ml^{-1}) and Fe (0.64 mg 100 ml^{-1}) was recorded in SIM4 sample while the lowest value of Na, Ca and Fe was observed in SIM0 sample. Micro-nutrients play a vital role in metabolism. Good quality ice cream should have adequate amounts of important micro-elements. Mittal et al. [30] found that cow milk contained less iron (Fe) and calcium (Ca) than soy milk in comparing with soy milk.

Micro-elements	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Na	14.12e	18.91d	19.12c	19.92b	20.11a
K	19.51a	12.63b	12.20c	12.00d	11.79e
Ca	0.61e	1.20d	2.11c	2.70b	2.99a
Mg	0.13a	0.09b	0.06c	0.05c	0.04c
Fe	0.21d	0.35e	0.46c	0.53b	0.64a

Table 6: Micro-elements contents of different prepared soft ice milk with substitution of cow skimmed milk by soy milk (mg 100 ml^{-1}). SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75%

soy milk and SIM4: soft ice milk with 100% soy milk. [a,b,c,d]: Means with the same letter in the same raw are not significantly different (p>0.05).

Physical analysis of soft ice milk

The results in Table 7 showed that different levels of soy milk substitute with skim milk have significant effect (P<0.05) on pH of soft ice milk samples. As increasing ratios of soy milk substitution, pH increases. Also the treatment containing 100% soy milk (SIM4) had the highest of pH was related to the treatment containing 100% skim milk (SIM0). Because pH of soy milk is about 7 or neutral [22] and is more compared to skim milk that slightly has as acidic pH about 6.5. For this reason, pH of soy milk ice is higher than skim milk ice. This is in line with the results reported by Sutar et al. [31] and Gracas Pereira et al. [32] shown that with substituting skim milk with soy milk extract, pH of ice cream mixture increases.

Properties		Soft ice milk with different soy milk levels				
		SIM0	SIM1	SIM2	SIM3	SIM4
pH		6.56^b	6.59^a	6.62^a	6.66^a	6.70^a
Viscosity (cP)	Before aging	277.21^e	322.10^d	341.48^c	370.76^b	399.27^a
	After aging	4158.12^e	4831.51^d	5122.14^c	5561.35^b	5989.11^a
Overrun (%)		88.94^c	89.01^c	89.11^b	89.25^a	89.32^a
Meltdown (%)		15.32^a	15.01^b	14.64^c	14.23^d	13.56^e

Table 7: Physical properties of different prepared soft ice milk with substitution of cow skimmed milk by soy milk. SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. [a,b,c,d]: Means with the same letter in the same raw are not significantly different (p>0.05).

The viscosity of the soft ice milk mixtures before and after aging was determined. Results indicated that adding soy milk as a substitute material of skim milk have a significant effect (P<0.05) on viscosity of different prepared soft ice milk (Table 7). Interestingly, SIM4 sample had the highest viscosity while SIM0 sample had the lowest viscosity before and after aging. Bisla et al. [4] stated that ice milk treatments containing soy milk with more fat which increasing the total solids content. Increasing the total solids will increase the viscosity of soft ice milk mixture. Also, many researchers demonstrated that viscosity of ice cream mixture containing soy milk increased due to higher content of soy protein and capacity of soy protein for interaction and binding with water. Moreover, soy proteins have higher water holding capacity; this ability is one of the most important functional properties of soy-based ingredients [33].

Consequently, as for the overrun, the obtained results observed that incorporating of soy milk at different substituting levels of skim milk had a significant effect (P<0.05) on manufactured samples. Increasing ratios of soy milk substitution, the overrun content increased in soy based soft ice milk than the SIM0 treatment (Table 7). Abdullah et al. [23] showed that with increasing total solid, overrun increased and they confirmed that highest amount of total solids can be observed in treatments containing the highest amount of soy milk. Also, the overrun increased when soy protein content increased which increase the viscosity of soy-based soft ice milk. These results are similar to obtained results by Gracas Pereira et al. [32].

Melt down values show the resistance of the soft ice milk to melt under outer conditions. This property of the ice milk will define the quality which has a relation with incorporated air in the product. High soft ice milk volume will ultimately lead to increase melt down values. Data in Table 7 revealed that adding soy milk indicated high significant (P<0.05) effect on melt down property of prepared soft ice milk. Melt down values of soft ice milk decreased with the increase soy milk level. The highest melt down value was recorded in SIM0 sample (15.32%) while the lowest melt down value was observed in SIM4 treatment (13.56%). The results indicated that increasing levels of soy milk decreased the melt down value of prepared soft ice milk. These results are similar to obtained results by Gracas Pereira et al. [32].

Microbiological analysis

The changes of total viable bacterial (TVB) and yeasts and molds (YM) counts in soft ice milk with different levels of soy milk substituting are shown in Table 8. The TVB counts of ice milk treatments ranged between 4.50 to 4.55 log cfu g^{-1} . Moreover, the YM counts varied between 0.25 to 0.27 log cfu $g\text{-}^{1}$ in all ice milk samples. Statistically, there is no significant (P>0.05) effect of adding different levels of soy milk on TVB and YM of soft ice milk samples while coliform bacteria was not detected in all treatments. This can be attributed to the hygienic condition granted during process Atallah [34].

Properties	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Total viable bacteria	4.50^a	4.53^a	4.55^a	4.51^a	4.50^a
Yeasts and molds	0.25^a	0.27^a	0.25^a	0.26^a	0.27^a

Table 8: Microbiology examinations of different prepared soft ice milk with substitution of cow skimmed milk by soy milk. SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. [a,b,c,d]: Means with the same letter in the same raw are not significantly different (p>0.05).

Sensory characteristics

Table 9 shows the effect of incorporating different levels of soy milk on sensory characteristics of soft ice milk. Results showed that different ratios of substituting levels of soy milk with skim milk have a significant effect (P<0.05) on taste, odor, texture, color and overall acceptability of the treatments. There is no significant deference among SIM0, SIM1 and SIM2 in taste, odor, texture, color and overall acceptability. Substituting more than 50% of skim milk exhibited a significant difference in organoleptic properties between SIM3 and SIM4. However, since that soy milk has beany flavour with increasing levels of soy milk the score of taste decreased. Volatile and non-volatile components of soybean have considerable effect. The volatile components are responsible for the gassy and beany flavours, while the non-volatile compounds originate astringent flavour and bitter flavour [35]. Abdullah et al. [23] found that soy milk with the highest amount of skim milk, improves taste and flavour of ice cream, because increasing skim milk reduces astringent taste of soy milk. Also, the sample 50:50% of soy milk and cow's milk creates the highest consistency in soft ice milk, this indicates that soy milk and cow's milk together have a synergistic effect and cause created more tightly and stronger texture. Addition of soy milk increased the desirability and decreasing color score. But, the addition of soy milk would increase amine compounds, which react with aldehydes via Maillard reaction to form dark pigments (melanoidins), for this reasons treatments containing high percentage of soy milk are darker than others as presented previously [13].

Properties	Soft ice milk with different soy milk levels				
	SIM0	SIM1	SIM2	SIM3	SIM4
Taste (5)	4.64^{a}	4.59^{a}	4.49^{ab}	3.20^{b}	2.89^{c}
Odor (5)	4.61^{a}	4.58^{a}	4.51^{ab}	3.40^{b}	2.10^{c}
Texture (5)	4.66^{a}	4.61^{a}	4.60^{a}	3.30^{b}	2.40^{c}
Color (5)	4.67^{a}	4.65^{a}	4.65^{a}	4.43^{b}	3.71^{c}
Overall acceptance (5)	4.65^{a}	4.59^{a}	4.56^{a}	3.21^{b}	2.26^{c}

Table 9: Sensory evaluation of different prepared soft ice milk with substitution of cow skimmed milk by soy milk. SIM0: soft ice milk with (100% skim milk), SIM1: soft ice milk with 75% skim milk + 25% soy milk, SIM2: soft ice milk with 50% skim milk + 50% soy milk, SIM3: soft ice milk with 25% skim milk + 75% soy milk and SIM4: soft ice milk with 100% soy milk. ^{a,b,c,d}: Means with the same letter in the same raw are not significantly different (p>0.05).

Conclusions and Recommendations

Soy milk was successfully used to prepare soft ice milk. The treatment containing 50% soy milk and 50% skim milk was selected as the most desirable sample. Moreover, substitution of soy milk with different levels has significantly (P<0.05) affected the total solids, fat, protein, ash, acidity, pH, overrun, viscosity and melt down values of soft ice milk. SIM0 sample recorded highest concentrations of amino acids, especially in isoleucine, leucine, lysine, methionine, theronine, valine, histidine, glutamic acid, proline and tyrosine than the other treatments. Also, SIM4 sample contained highest values of phenylalanine, arginine, alainine, aspartic acid, cysteine, glycine and serine when compared with the other treatments. The results showed that, different substitution levels of soy milk had significant (P<0.05) effects on taste, flavour, texture, color and overall acceptability of samples. Adding cocoa powder completely removed beany flavour of soy milk, and soft ice milk had quite appropriate overall acceptance. Finally the treatment contains 50% soy milk and 50% skim milk was selected as the most desirable treatment in terms of sensory evaluations and was recommended for the production of soy milk based high quality soft ice milk.

Conflict of Interest

Author has declared that there is no conflict of interest.

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