Effect of some whey protein fractions on functional properties of ice milk

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Abstract: Background: functional properties of ice milk or ice cream mixes highly affected the quality and acceptability of final product. Mix ingredients are one of the important factors beside processing steps (methodology), which Cleary affect the functional properties of mixes. It well established that substituting milk solid not fat (MSNF) with whey protein concentrate enhanced the functional properties (hydration, gelling, surface active properties) of ice cream mixes. This research aimed to study the role of the two major whey protein fraction β-Lactoglobulin (β-LG) and alfa-lactalbumin (α-LA) to enhanced the functional properties of ice milk mixes. **Materials and Methods:** Ice milk treatments were manufactured with partial replacing skim milk powder with differentwhey protein fractions and evaluated for physical, rheological and organoleptic properties. **Results**: Effect of whey protein concentrate (WPC), β-Lactoglobulin (β-LG) and alfa-lactalbumin (α-LA) as a partial substitution (5%) of milk solid not fat (MSNF) on the functional properties of ice milk was studied, keeping control without substitution. Obtained results showed that no effect of addition on acidity. While the specific gravity was affected in both mixes and resultant ice milk containing whey protein fractions (β-LG and α-LA) and therefore the weight per gallon. overrun percent was higher than control in both WPC and -LG ice milk but lower in α-LA treatment. Freezing point and melting resistance also were affected by the incorporation of different whey protein and fractions.

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1. Introduction

Whey protein is a mixture of proteins with a wide ranging nutritional, biological and food functional attributes and therefore may have many potential uses. The main proteins are β-Lactoglobulin (β-LG) and alfa-lactalbumin (α-LA) They represent approximately 70-80% of total whey protein and are responsible for the hydration, gelling and surface active properties (emulsifying and foaming properties) of whey protein ingredients. These proteins are also used for their nutritional and therapeutic properties in low calorie diets and in intensive care enteral nutrition [1]. There are some studies on the effect of adding whey protein concentrate (WPC) to ice cream[2] recommended that ice cream can be produced with high quality by substituting MSNF with whey protein isolate (WPI). [3] indicated that it is possible to substitute egg yolk with WPC in Gelato. Using WPC in low fat ice cream increased overrun, melting resistance and decreased firmness of hardened product [4,]. The objective of this study was to evaluate functional properties of ice milk as affected by substitute of skim milk powder (SMP) with WPC, β-LG and α-LA.

2. Materials and Methods

2.1. Ingredients

Fresh buffalo's skim milk and fresh buffalo's milk were obtained from the herd of faculty of agriculture, Cairo University and used as an ingredient for preparing the ice milk mixes. Skim milk powder (SMP) was obtained from Abou El-Hool-Import/Export Co., Cairo Egypt. Whey protein concentrate, (β-LG) and (α-LA) were supplied by Davisco Foods International, Inc., USA. Commercial grade sugar, and vanilla were obtained from local market, and Sodium carboxymethyl cellulose (CMC) as a stabilizer was obtained from Mifad company, Giza Egypt.

2.2. Manufacture of ice milk

Ice milk mixes were prepared with the following composition, 4% fat, 13% solid not fat, 15% sugar and 0.25% stabilizer. Skim milk powder was used to supply the milk solid not fat, WPC, β-LG and α-LA were used to replace 5% of milk solid not fat in the base mix. Prepared mixtures were placed in a water bath until the temperature reached 80±1ºC for about 1 min., then rapidly cooled to 5±1ºC and aged approximately 24hrs at the same temperature. Mixes were whipped during freezing in CARPIGIANI

machine. The frozen ice milk was filled in plastic cups (80ml) which hardened at -18ºC [5].

2.3. Physical and chemical analysis

Titratable acidity of mixes was determined according to [5]. Overrun of ice milk samples was calculated by using the method given by [5]**.** The specific gravity of the ice milk mixes and ice milk samples was determined according to [6]**.** The weight per gallon (Lb) was calculated according to [7]. by multiplying the specific gravity by the factor of 8.34. Freezing point of ice milk mixes was measured as described in [8]. Melting resistance of ice milk was determined as mentioned by [9].

2.4. Sensory evaluation

Ice milk samples were judged by 10 panelists of staff members at Dairy Science Department, Cairo University. The samples scored for flavor (50), Body &Texture (40) and melting quality (10) as described by [10].

3. Results and Discussion

3.1. Properties of ice milk mixes with different whey protein fractions.

Properties of ice milk mixes made with WPC, β-LG and α-LA as a substitutes of MSNF are presented in Table (1).

Data presented in Table (3) showed no differences in titratable acidity values of ice milk mixes with different whey protein fractions. The obtained results are in agreement with [11], who mentioned that using whey solids had no significant effect on the acidity of ice cream mixes.

The effect of a partial substitution of skim milk powder with whey protein fractions on specific gravity (sp.gr.) of ice milk mixes shown in Table (1). The specific gravity values of ice milk mixes increased by substituting SMP with WPC and β-LG. These results are in agreement with [12]**;** while substituting SMP with α-LA causing a decrease in the specific gravity.

Weight/gallon is a reflection of specific gravity as it is the result of multiplying sp.gr. by 8.34 therefore they follow the same trend as sp.gr.

The freezing point of ice cream mixes was affected by substitution. The mixes showed lower freezing point with substituting (SMP) by WPC and the lowest freezing point was found with control that could be due to it's higher content of lactose and ash than β-LG or α-LA treatments. [2,13].

3.2. Effect of partial replacing skim milk powder with different whey protein fractions on some properties of resultant ice milk.

Data tabulated in Table (4) showed that, specific gravity values of resultant ice milk decreased with incorporating whey protein fraction in the formula. These results are in line with those of [14, 15, 16].

As regards weight/ gal (Lb) values of obtained ice milk samples, the same trend of specific gravity was found. Data presented in the same Table (4) shoed the percentage of overrun for all ice milk treatments. The values of overrun% ranged between 44.45% and 53.8%. The highest value of overrun was found when (β-LG) incorporated in ice milk mix, while the lowest one was recorded with (α-LA) treatment.

3.3. Melting properties of resultant ice milk with different whey protein fractions.

Considering melting property, consumers regard good ice cream or ice milk as having minimum drop loss and good shape retention upon melting [17] however, melting properties influence consumer acceptance of ice cream. For example, in warm climates a high melting points is desired [18].

Data presented in Table (5) showed that the lowest melting resistance was found with α-lactalbumin samples followed by whey protein concentrate samples and the last one was β-Lactoglobulin treatments which show higher melting resistance than other treatments but less than control.

3.4. *Sensory quality attributes of ice milk samples with different whey protein fractions.*

Sensory panel evaluation is an important indicator of potential consumer preference. The results in Table (6) clearly indicate that the highest score of sensory evaluation was obtained with hey protein concentrates (90.3) and (β-LG) (98.7) samples, while the lowest one (86.2) was recorded when (α-LA) incorporated with ice milk samples.

Table (1). chemical composition of whey protein fractions.

Whey protein fractions	Chemical composition			
	Moisture	Fat	Protein	Ash
Whey protein concentrate	5.1	5.9	78.1	2.5
β-Lactoglobulin	5.0	0.3	97.8	1.8
α-lactalbumin	5.0	0.1	97.4	2.1

Table (2). Formulation of ice milk mixes with different whey protein fractions as a substitute of milk solid not fat (g/kg mix).

Ingredients	T_1 Control	T_2	T_3	T_4
Sugar	150	150	150	150
Stabilizers	2.5	2.5	2.5	2.5
Vanilla	0.1	0.1	0.1	0.1
S.M.P	20	13.5	13.5	13.5
WPC	----	6.5	----	----
β-LG	----	----	6.5	----
α-LA	----	----	----	6.5
Std. buffalo's milk	827.4	827.4	827.4	827.4
	1000	1000	1000	1000

T_1 : Control (without substitution of milk solid not fat)
T_2 : 5% whey protein concentrate substitution of milk solid not fat
T_3 : 5% β-Lactoglobulin (β-LG) substitution of milk solid not fat
T_4 : 5% alfa-lactalbumin (α-LA) substitution of milk solid not fat

Table (3). properties of ice milk mixes with different whey protein fractions.

Treatments	Titratable acidity% (As lactic acid)	Specific gravity	Weight/gl (Lb)	Freezing point (ºC)
T_1	0.20	1.138	9.490	- 2.9
T_2	0.20	1.149	9.58	- 2.8
T_3	0.20	1.187	9.89	- 2.1
T_4	0.21	1.089	9.08	- 2.2

Table (4). Effect of partial replacing skim milk powder with different whey protein fractions on some properties of resultant ice milk.

Treatments	Specific gravity	Weight/gl (Lb)	Overrun (%)
T_1	0.899	7.497	46.9
T_2	0.801	6.680	52.8
T_3	0.793	6.613	53.8
T_4	0.844	7.038	44.45

Table (5). Melting properties of resultant ice milk with different whey protein fractions.

	Treatments			
	T_1	T_2	T_3	T_4
After (min.)	Melting %			
60	30.48	45.24	39.40	51.86
90	72.45	78.08	76.85	83.99
120	84.06	87.02	86.36	91.81

Table (6). Sensory quality attributes of ice milk samples with different whey protein fractions.

Treatments	Flavor (50)	Body & Texture (40)	Melting quality (10)	Total (100)
T_1	43.3	36	8.6	87.9
T_2	45	36.8	8.5	90.3
T_3	45.6	35.9	8.4	89.7
T_4	43.1	35.1	8.2	86.2

Conclusion

Functional and sensory properties of ice milk can be enhanced by incorporating β-Lactoglobulin fraction or whey protein concentrate as a substitute of the milk solid not fat. The obtained results showed that this substitution improved the melting quality, overrun % and sensory properties of the resultant ice milk samples.

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