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MANUFACTURE OF LOW FAT ICE MILK

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ABSTRACT

Effect of replacing milk fat with Littesse® (a carbohydrate based fat repalcer) on the quality of ice milk was studied. 25, 50, 75 and 100% of milk fat was replaced by the same amount of Littesse®. Substitution of milk fat with Littesse® caused a significant increase in specific gravity, weight per gallon and titratable acidity, while decreased the freezing point of ice milk mixes. The increase or decrease was proportional to the rate of replacement. Replacement of milk fat with Littesse® up to 50% had no significant effect on the overrun of ice milk, but a further increase in the rate of replacement decreased the overrun. On the other hand, substitution of milk fat with Littesse® caused a significant increase in specific gravity, weight per gallon, melting resistance at first 60 min and next 30 min, titratable acidity and carbohydrate content, while decreased total protein, fat contents and calorific values, but it did not affect the total solid and ash contents of the resultant ice milk. Replacement of milk fat with Littesse® up to 50% increased the scores of organoleptic properties of the product, but ice milk which made by replacing 50% of milk fat with Littesse® was the most acceptable treatment, while the treatment made by replacing 75% milk fat was not significantly different from control one.

Key words: ice milk, low fat, fat replacer, Littesse®.

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INTRODUCTION

Frozen desserts are very popular in Egypt. Ice milk is one of the most popular frozen desserts in Egypt. Therefore, its production has been increased markedly recently. The nutritive value of ice milk is based not only on the nutritive value of milk, but also increased digestibility and additives which were added during the manufacture of ice milk (Arbucle, 1986). Recently ice milk has been used to deliver probiotic bacteria to consumers (Hekmat and McMahon, 1992; Kebary, 1996 and Kebary and Hussein, 1997).

Lipids play crucial functional and sensory roles in food products. They carry, enhance and release the flavours of other ingredients. Lipids also interact with other ingredients to develope mould and texture, flavour perception, flavour stability, flavour generation and the overall sensation of food (Giese, 1996 and deRoose, 1997). Over the past decade, there has been substantial interest in the development of a new range of dairy products which are similar to the existing products but in which the fat content is substantially reduced to avoid the health problems associated with fat such as diabetes, hypertension, atherosclerosis, gall bladder disease and heart disease (Williams, 1985 and Giese, 1996). Using fat substitutes to replace fat in food while keeping the same functional and organoleptic properties. Available fat substitutes can be classified as carbohydrate-based, protein-based and fat-based fat replacers (Giese, 1996).

The objectives of this study were to investigate the possibility of making a good quality low fat ice milk using a carbohydrate based fat replacer and monitor the changes of low fat ice milk quality during frozen storage.

MATERIALS AND METHODS

Ingredients:

The following materials were used in preparing ice milk: buffaloe's milk (the herd of the Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt), Littesse® a carbohydrate based fat replacer (Danisco cultor America Inc., Ardsley, NY, USA), non-fat dry milk (Ecoval N.V., Paris, France), sucrose (Egyptian Sugar and Distilleries Company, El-Hawamdia, Egypt), vanilla (Aromisr, Egyptian Sugar and Distilleries Company, Food Flavours and Essences Factory, Cairo, Egypt) and emulsifier-stabilizer (Palsgaard 5936, Palsgaard Industries A/S, Juelsminde, Denmark). Cream was obtained by separating fresh buffaloe's milk in the pilot plant of Department of Dairy Science and Technology, Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt.

Manufacture of ice milk:

Control vanilla ice mix (C) with 4% fat, 13% non-fat milk solids, 15% sugar and 0.5% emulsifier-stabilizer was prepared (Farag *et al.,* 1993). 5 batches of ice milk mixes (each of 5 kg) were prepared by substituting 0, 1, 2, 3 and 4% milk fat with the same weight of Littesse®. Cream was added to skim milk and heated to about 50°C and non-fat dry milk and fat replacer were mixed together and were added, while stirring (Heidolph Stirrer, Heidolph-Elektro, Kelheim, Germany). The emulsifier-stabilizer blend was weighted in a 600 ml beaker, followed by alquot of skim milk, left for 1 hr to hydrate, heated and then added to the mix. Sugar was added and the mix was further stirred for 15 min. All mixes were heated at 69°C for 30 min, then cooled to 20°C. Ice milk mixes were aged for 12 hr at 4°C. Vanilla was added prior to freezing. All ice mixes were frozen in a batch-freezer (Cattabriga, Bologna, Italy). Ice milk mixes were frozen till proper consistency was obtained, packed in plastic cups and hardened at -20°C for one day. Frozen ice milk was stored at -20 ± 2°C for 8 weeks. The experiment was triplicated.

Physical and chemical analysis:

Each ice milk mix was tested before freezing for titratable acidity and pH values (Ling, 1963), Freezing point (FAO, 1977), specific gravity (Winton, 1958) and weight per gallon (Burke, 1947). Fresh samples of ice milk were tested for overrun (Arbuckle, 1986), specific gravity (Winton, 1958), weight per gallon (Burke, 1947) and melting resistance (Ried and Painter, 1933). Samples of ice milk were analyzed at zero time and every two weeks for titratable acidity and pH values (Ling, 1963). Samples from all treatments were analyzed at zero time and at the 8th week of storage period for total solids, total protein, fat and ash contents according to Ling (1963). Carbohydrates were calculated by difference. Total energy was calculated based on conversion (actors as follows: protein 4, carbohydrates 4 and fat 9 and expressed as kcal / 100 g ice milk.

Sensory evaluation:

Organoleptic properties of each ice milk treatment were assessed by ten panelists from the staff members of Department of Dairy Science and Technology and Department of Food Science and Technology, Faculty of Agriculture, Minufiya University, Shibin El-Kom according to Kebary and Hussein (1997).

Statistical analysis:

The obtained data were analyzed using factorial experiment and randomized block design. Newman Keuls test was followed to make the multiple comparisons using Costat program (Steel and Torrie, 1980). Significant differences were determined at $p < 0.05$.

RESULTS AND DISCUSSION

Specific gravity and weight per gallon of ice milk mixes followed almost similar trends (Table 1). Replacement of milk fat with Littesse® (a carbohydrate based fat replacer) caused a significant increase ($p < 0.05$) in both weight per gallon and specific gravity (Table 1) and this increase was proportional to the replacement rate. Replacement of 25% of milk fat with Littesse® did not affect significantly ($p > 0.05$) the specific gravity or weight per gallon, while above that replacing specific gravity and weight per gallon increased as the amount of Littesse® was increased (Table 1). These results might be due to the higher specific gravity of Littesse® compared with that of milk fat. These results are in agreement with those reported by Hussein and Badawi (1999) and Hussein (2008).

Freezing point of ice milk mixes decreased gradually as the rate of replacement milk fat with Littesse® was increased (Table 1). Ice milk mix that was made by replacing 25% of milk fat with Littesse® was not significantly different from control mix ($p > 0.05$) (Table 1). The reduction in freezing point might be due to the presence of soluble carbohydrates in fat replacer which dissolved and

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Table (1). Effect of using Littesse® as a milk fat replacer on some properties of ice milk mix.

Treatments* / Prosperities	C•	L1	L2	L3	L4
Specific gravity	1.1128d	1.1150d	1.1186c	1.1228b	1.1325a
Weight / gall (kg)	4.2129d	4.2213d	4.2348c	4.2709b	4.2877a
Freezing point (C)	-2.3a	-2.4ab	-2.6c	-2.7d	-2.8e
Titratable acidity	0.213b	0.223b	0.227b	0.243a	0.247a

* Each value is the mean of three replicate.
C• : Control ice milk made with 4% fat.
L1 : Ice milk prepared by adding 3% fat milk + 1% Littesse® as fat replacer.
L2 : Ice milk prepared by adding 2% fat milk + 2% Littesse®.
L3 : Ice milk prepared by adding 1% fat milk + 3% Littesse®.
L4 : Ice milk prepared by adding 4% Littesse®.
Means with different superscript letters in the same row are significantly different according to N-K method at 0.05 level of probability, letter A is the highest mean followed by B, C, … etc.

consequently lower the freezing point of ice milk mixes (Kebary and Hussein, 1997 and Hussein and Badawi, 1999).

Replacement of milk fat with Littesse® caused a significant increase ($p < 0.05$) in titratable acidity of ice milk mixes especially when higher rates of replacement were used (75 and 100%) (Table 1). On the other hand, acidity of ice milk treatments were almost stable during storage period up to 6 weeks, then increased during the last two weeks of storage period. Moreover, ice milk treatments were not significantly different ($p > 0.05$) from each other in pH values, which means replacement of milk fat did not affect significantly the pH values of the resultant ice milk (Tables 4, 7).

Overrun of ice milk did not change significantly ($p > 0.05$) by replacing milk fat up to 50% with Littesse®, while increasing the replacement rate above that decreased the overrun of the resultant ice milk (Tables 2, 7). These results may be due to the increase in viscosity and / or reduction in freezing point (Khalafalla et al., 1975 and Kebary, 1996).

Specific gravity and weight per gallon of all ice milk treatments followed almost similar trends, while they were conversely correlated with the overrun (Tables 2, 7). Replacement of milk fat with Littesse® caused a significant increase ($p < 0.05$) in specific gravity and weight per gallon and this increase was proportional to the rate of replacement (Tables 2, 7). Similar results are reported by Hussein and Badawi (1999).

Substitution of milk fat caused a significant ($p < 0.05$) increase in melting resistance after 60 min and the next 30 min of the resultant ice milk (Tables 3, 7) and this increase was proportional to the rate of replacement (Tables 3, 7). This increase in melting resistance which means the decrease of melting rate could be attributed to the increase in ice mix viscosity and / or the reduction in freezing point (Khalafalla et al., 1975).

Chemical composition of ice milk treatments is presented in Table (5). Replacement of milk fat with Littesse® caused a significant decrease of total protein and fat contents and the calorific values of the resultant ice milk treatments, while caused a significant increase in carbohydrates content. The decrease of total protein, fat and calorific values and the increase of carbohydrates were proportional to the rate of replacement (Tables 5, 7). On the other hand, ice milk treatments were not significantly different ($p > 0.05$) from each other, which means replacement of milk fat with Littesse® had no significant effect on ash content of the resultant ice milk treatments.

Scores of organoleptic evaluation are shown in Table (6). Replacement of milk fat with Littesse® did not affect significantly ($p > 0.05$) the scores of flavour, while scores of Body, texture, melting quality and the total scores increased by replacing the milk fat with Littesse® up to 50% replacement rate. Then these scores decreased with further increasing of replacement rates (Tables 6, 7).

Table (2). Effect of using Littesse® as a milk fat replacer on some properties of ice milk.

Treatments* / Properties	C•	L1	L2	L3	L4
Overrun (%)	64.43	64.55	64.34	63.72	62.49
Weight / gall (kg)	2.4898	2.3764	2.5781	2.5970	2.1446
Specific gravity	0.657	0.672	0.681	0.686	0.693

* Each value is the mean of three replicate.
• See Table (1).

Table (3). Melting resistance (loss % at 30°C) of low fat ice milk.

Treatments*	First 60 min	Next 30 min	Last 30 min
C•	30	50	20
L1	20	43	33
L2	20	35	42
L3	10	25	49
L4	5	20	53

* Each value is the mean of three replicate.
• See Table (1).

Table (4). Acidity content and pH values of ice milk made with Littesse® as fat substitute during storage period.

Treatments*	Acidity (%)					pH values				
	Storage period (week)					Storage period (week)				
	0	2	4	6	8	0	2	4	6	8
C•	0.21	0.27	0.32	0.38	0.40	6.90	6.82	6.77	6.76	6.75
L1	0.22	0.29	0.33	0.38	0.42	6.85	6.75	6.71	6.71	6.70
L2	0.24	0.29	0.34	0.39	0.44	6.83	6.70	6.65	6.62	6.61
L3	0.24	0.30	0.35	0.41	0.46	6.78	6.67	6.63	6.61	6.59
L4	0.25	0.33	0.38	0.44	0.50	6.73	6.64	6.60	6.58	6.54

* Each value is the mean of three replicate.
• See Table (1).

Table (5). Gross composition of ice milk made with Littesse® as fat replacer.

Treatments*	Total solid (%)		Total protein (%)		Fat (%)		Ash (%)		Carbohydrate (%)		Calorific values (kcal / 100 g)	
	Fresh	8 weeks	Fresh	8 weeks	Fresh	8 weeks	Fresh	8 weeks	Fresh	8 weeks	Fresh	8 weeks
C•	31.125	31.020	5.305	5.280	4.000	4.000	1.165	1.130	20.655	20.610	139.84	139.56
L1	30.570	30.550	5.190	5.150	2.970	2.925	1.150	1.160	21.060	21.020	131.73	131.00
L2	30.470	30.245	5.035	4.985	2.000	1.925	1.305	1.275	22.130	22.060	126.66	125.50
L3	30.925	30.575	4.935	4.910	0.975	0.935	1.310	1.265	23.705	23.555	123.33	122.27
L4	31.510	30.370	4.740	4.815	0.075	0.040	1.385	1.345	24.310	24.170	116.87	116.30

* Each value is the mean of three replicate.

• See Table (1).

Table (6). Sensory evaluation of ice milk made with Littesse® as fat substitute.

Treatments*	Flavour (50)					Body and texture (40)					Melting quality (10)					Total scores (100)				
	Storage period (weeks)					Storage period (weeks)					Storage period (weeks)					Storage period (weeks)				
	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8
C•	44	45	44	45	43	35	34	5	35	35	9	10	9	9	8	88	89	88	89	86
L1	45	45	45	44	45	34	35	5	34	34	10	9	9	9	8	89	89	89	87	87
L2	47	46	46	45	45	36	5	35	35	35	10	10	9	9	9	93	92	90	89	89
L3	45	45	44	44	44	34	4	34	33	34	8	8	8	7	7	87	86	86	84	85
L4	43	43	42	42	42	32	3	32	32	31	8	7	7	7	7	83	83	81	81	80

* Each value is the mean of three replicate.

• See Table (1).

Table (7). Statistical analysis of low fat ice milk properties.

Properties of ice milk	Effect of treatments						Effect of storage period (weeks)					
	Multiple comparisons♦						Multiple comparisons•					
	Mean squares	C•	L_1	L_2	L_3	L_4	Mean squares	0	2	4	6	8
Overrun (%)	2.169*	A	A	A	B	C						
Specific gravity	5.502*	D	C	B	AB	A						
Weight / gall (kg)	7.888*	D	C	B	AB	A						
Melting resistance:						A						
First 60 min	183.15*	E	D	C	B	A						
Next 30 min	217.26*	E	D	C	B	A						
Last 30 min	15.07*	A	B	C	D	E						
Titratable acidity	0.006*	B	B	B	B	A	0.069*	B	B	B	AB	A
pH values	0.050*	A	A	A	A	A	0.131*	A	B	B	B	B
Composition:												
Total solids (%)	0.363	A	A	A	A	A	0.780	A				A
Total protein (%)	0.183*	A	B	C	D	E	7.605	A				A
Fat (%)	9.768*	A	B	C	D	E	8.000	A				A
Ash (%)	0.033	A	A	A	A	A	0.009	A				A
Carbohydrate (%)	10.579*	E	D	C	B	A	0.016	A				A
Calorific value (kcal/100 gm)	305.333*	A	B	C	D	E	3.881	A				A
Organoleptic properties:												
Flavour	15.320	A	A	A	A	A	2.120	A	A	A	AB	B
Body and texture	17.080*	B	B	A	C	D	0.580	A	A	A	A	A
Melting quality	9.480*	B	B	A	C	D	2.280	A	A	A	A	A
Total scores	136.800*	B	B	A	B	C	7.600*	A	A	AB	AB	B

• See Table (1). * Significant at 0.05 level ($p \leq 0.05$).

♦ For each effect the different letters in the same row means the multiple comparisons are different from each other, letter A is the highest mean followed by B, C, … etc.

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The most acceptable ice milk treatment was that made by replacing 50% of milk fat with Littesse®, while ice milk treatment that made by replacing 75% of milk fat with Littesse® was not significantly ($p > 0.05$) different from control ice milk that was made with milk fat only (Tables 6, 7).

It could be concluded that it is possible to replace milk fat with Littesse® up to 75%, without significant effect on the quality of the resultant ice milk and consequently reduce the calorific values of the resultant ice milk.

REFERENCES

Arbuckle, W. S. (1986). Ice Cream, 4th ed. Avi Publishing Company inc., Westport, CT.

Burke, A. D. (1947). Practical ice cream. The Olsen Publishing Co., Milwaukee, WI.

deRoose, K. B. (1997). How lipids influence food flavour. Food Technol., 51 (1):60 – 62.

FAO (1977). Regional Dairy Development and Training Center for the Near East. Laboratory Manual, Spring. 1977.

Farag, S. I.; Khader, A. E.; Mousa, A. M. and Et-Batawy, A. M. (1993). A study on ice cream. 1- On the use of high fructose corn syrup as a sweetener. Egyptian J. Dairy Sci., 21: 97 – 107.

Giese, J. (1996). Fats, oils and fat repfacers. Food Technol., 50 (4): 78 – 84.

Hekmat, S. and McMahon, D. J. (1992). Survival of Lactobacillus acidophilus and Bifidobacterium bifidum in ice cream for use as a probiotic food. J. Dairy Sci.. 75: 1415 – 1422.

Hussein, S. A. (2008). Production and properties of probiotic low-fat frozen yoghurt (zabady) with alive Bifidobacteria bifidum. Minufiya J. Agric. Res., 33 (6): 1391 – 1404.

Hussein, S. A. and Badawi, R. M. (1999). Effect of fat substitutes on physicochemical and organoleptic of low fat ice milk. Minufiya J. Agric. Res., 24: 923.

Kebary, K. M. K. (1996). Viability of Bifidobacterium bifidum and its effect on quality of frozen Zabady. Food Res. Int., 29: 431 –

437.

Kebary, K. M. K. and Hussein, S. A. (1997). Quality of ice cream as influenced by substituting non-fat dry milk with whey-bean proteins coprecipitates. Egyptian J. Dairy Sci., 25 (2): 311 – 325.

Khalafalla, S. M.; Mahran, G. A.; Abdet-Hamid, L. B. and Fares, F. M. (1975). The use of whey solids in ice cream. Egyptian J. Dairy Sci., pp. 43 – 50.

Ling, E. R. (1963). Dairy Chemistry, Vol. II, Practical. Chapman and Hall, London.

Reid, W. H. E. and Painter, W. E. (1933). The freezing properties stability and physical quality of chocolate ice cream. Miss. Agric. Exp. Sta. Bull., p. 185.

Steel, R. G. D. and Torrie, J. H. (1980). Principles and Procedures of Statistics; A Biometricai Approach, 2nd edn, McGraw-Hill, New York.

Williams, S. R. (1985). Nutritional and Diet Therapy. Times Mirror / Mosby, College Publishing, St. Louis, Toronto and Stanta Clara.

Winton, A. L. (1958). Analysis of Food, 3rd edn. Wiley, New York, p. 6.

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الملخص العربي

تصنيع المثلوج اللبنى المنخفض الدهن

إبراهيم إبراهيم بدران 1 – أحمد السيسى2 – سلمى فاروق محمود2
1 قسم علوم وتكنولوجيا الألبان – كلية الزراعة – جامعة المنوفية
2 قسم بحوث الألبان – معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – القاهرة

يهدف هذا البحث إلى دراسة استبدال دهن اللبن بواسطة الليتييس ®Littesse (بديل دهن ذو أصل كربوهيدراتى) على الخواص الطبيعية والكيماوية والحسية للمثلوج اللبنى . لذلك تم استبدال 25 ، 50 ، 75 ، 100% من دهن اللبن بواسطة نفس النسبة من الليتيس .

ولقد أوضحت النتائج المتحصل عليها بعد تحليلها إحصائياً ما يلى : أدى استبدال دهن اللبن بواسطة الليتيس إلى زيادة كل من الوزن النوعى والوزن بالجالون والحموضة بينما أدت إلى خفض نقطة التجمد لمخلوط المثلوج اللبنى . أدى استبدال دهن اللبن بواسطة الليتيس إلى زيادة كل من الوزن النوعى ، الوزن بالجالون ، المقاومة للانصهار عند 60 دقيقة الأولى والـ 30 دقيقة الثانية ، والحموضة ، ونسبة الكربوهيدرات ، بينما انخفضت نسب البروتين الكلى ، الدهن ، وكمية الطاقة ، فى حين أنها لم تؤثر على كل من نسبة الجوامد الصلبة ونسبة الرماد وذلك للمنتج النهائى . لم تتأثر نسبة الريع للمثلوج اللبنى بزيادة معدل استبدال دهن اللبن حتى نسبة 50%، ثم انخفض الريع بزيادة معدل استبدال دهن اللبن بمعدل أعلى من ذلك . أدى استبدال دهن اللبن بواسطة الليتيس حتى نسبة 50% إلى تحسين الخواص الحسية وكانت المعاملة المصنعة باستبدال 50% من دهن اللبن بواسطة الليتيس هى أكثر العينات قبولا ، بينما لم تختلف المعاملة المصنعة باستبدال 75% من دهن اللبن بواسطة الليتيس عن العينة الكنترول .