Using of Pumpkin (*Cucurbita moschata*) in Making Healthy Functional Ice Milk

Amira M. El-Kholy and F. M. Abbas
Dairy Department, Faculty of Agriculture, Suez Canal University, Ismailia 41522, Egypt

Received: *15/3/2015*

Abstract: Reduced fat and fat free pumpkin ice milk were prepared by replacing fat at ratios of zero, 20, 40, 60, 80 and 100% with pumpkin puree. Ice milk (52- 60% overrun) was produced using conventional techniques. The effect of pumpkin puree replacements on the specific gravity, weight per gallon, freezing point, apparent viscosity and some rheological parameters (at different aging time) were evaluated. Also, the sensory evaluation of pumpkin ice milk of different formulas was assessed. Increasing the proportion of pumpkin replacement increased the specific gravity and weight per gallon of the mixes comparing with control. Freezing point gradually decreased as the amount of *Cucurbita moschata* increased. Mixes apparent viscosity increased by increasing pumpkin ratios and with increasing aging time. Rheological parameters; plastic viscosity and consistency index had the same trend. Products made with replacement of fat at 80% and 100% pumpkin melted more slowly and were judged to have slight creamy flavour and formed a gel matrix compared with other treatments while the overrun decreased in a parallel to the replacing ratio of fat with pumpkin up to 60 % then increased. Calculated fibre content (g /100g) percentage increased as the amount of pumpkin increased. Sensory evaluation revealed that ice milk containing pumpkin (*Cucurbita moschata*) at levels 80% and 100% were given the highest scores compared to the other treatments as it acquired acceptable flavour, creamy texture. This study recommended that replacing fat content with pumpkin up to 80% and 100% gave ice milk of good quality accompany with retaining fat - like mouthfeel , and healthy product.

Keywords**:** low calorie ice milk, pumpkin ice milk, functional ice milk, *Cucurbita moschata*

INTRODUCTION

Ice cream and frozen desserts are mainly valued for their pleasant flavour, cooling effects and refreshing tastes (Barot Amit *et al*., 2014). The awareness of consumers for healthier and functional food has led to introduce ice cream manufacture in certain materials with nutritional and physiological properties such as probiotics (Akin *et al*., 2007), dietary fibers (Soukoulis *et al*., 2009), alternative sweeteners (Soukoulis and Tzia, 2010), natural antioxidants (Hwang *et al*., 2009) and low glycemic index sweetners (Whelan *et al*., 2008). Ice cream may also contain other food products such as fruit, which enhances its nutritive value (Temiz and Yesilsu, 2010). Therefore the use of natural additives to ice cream has an important role (Del Giovine and Piccioli, 2003).

Pumpkin (*Cucurbita moschata*) consider a good source of both carotenes and dietary fibers. It is rich in beta and alpha carotenes in addition to lutein (Rodriguez-Amaya, 1999). Beta carotene is one of several provitamin A compounds (Foster, 2004) and it is one of an important natural antioxidant. Pumpkin also had role in reducing the risk of developing certain types of cancer (Rodriguez-Amaya, 2003). Several advantages of using fruit fibres in ice cream production are: improvement in body due to the fibrous framework and melting properties, reduction of cold impression and enhancing of mixed viscosities like allowing freezing at higher overrun, causing no negative effect on the ice crystal sizes, and leading to a more homogenous air – bubble formation (Anonymous, 2000). Foods rich in dietary fibers (DF) constitute are important sector of the functional foods due to the several health benefits as anti cancer and anti – Oxidants and for lowering blood cholesterol (Arvantoyannis and Houwelingen, 2005). The recommended dietary fiber intakes (DFI) for adults were set to 38 g for men and 25 g for women per day (Trumbo *et al*., 2002).

The objective of this study was to investigate the possibilities of utilizing pumpkin which is characterized by its high nutritional value and healthy foods as a fat replacer in the manufacture of healthy and functional ice milk to replace fat partially or completely and investigate its effect on some physical, rheological and sensory properties of the resultant product.

MATERIALS AND METHODS

Materials:

Fresh buffalo's milk (9% SNF and 6% fat) was obtained from a private farm in Ismailia Governorate, and was separated to cream (50% fat) and skim milk which were used in ice milk making. Skim milk powder (Grade A- low heat - spray process-pasteurized) manufactured by Westfarm Foods (96% total solids), U.S.A.. Gelatin powder was obtained from Adwic (El Nasr Pharmaceutical chemicals). Sugar and Pumpkin (*Cucurbita moschata*) were purchased from local market.

Experimental procedures:

Preparation of pumpkin puree:

Pumpkin fruits (*Cucurbita moschata*) were washed and peeled, sliced into small pieces (after removing the funicular part and spongy portion containing seed), cooked for 25 min, then cooled to room temperature. Cooked pumpkin was mixed well in a laboratory type blender (Moulinex blender, France) and stored at -18°C until used. The cooked pumpkin had the values of 88.48, 1.17, 7.48, 0.87 and 1.50 % for moisture, protein, carbohydrate, ash and fiber, respectively.

Preparation of pumpkin ice milk:

The control mix formula (T1) was standardized to give 5% fat, 12.5% milk solids not fat, 15% sugar and 0.5% gelatin. Table (1) shows the selected compositions of pumpkin ice milk mix formulas and indicated that fat was replaced by pumpkin fruit at levels zero, 20, 40, 60, 80 and 100%. Table (2) shows the formulas of different ingredients for making low and fat free pumpkin ice milk. Ingredients were mixed together, heated at 70°C for30 min., cooled to 4°C and aged at that temperature overnight prior to freezing. The mixtures (2Kg mix for each treatment) were frozen in an ice cream freezing machine (Taylor-mate Model 156, Italy). The resultant ice milk was packaged in cups (100 ml), and put in deep freezer at -18°C for hardening according to Marshall and Arbuckle (1996) for 24 hr before analysis. The whole experiment was carried out in triplicates.

Methods of analysis:

Moisture, crude fiber, protein and ash content of pumpkin puree were determined according to A.O.A.C. (1990). The ice milk mix was analyzed for titratable acidity according to Ritchardson (1986), pH using digital pH meter, Jenway pH meter, Jenway Limited, England), Specific gravity (Winton, 1958), weight per gallon (Burke, 1947), freezing point (FAO Laboratory Manual, 1977), viscosity and rheological parameters were carried out using a Brookfield Digital Rheometer model DV-III+ (Brookfield Engineering Laboratories, Inc., MA, USA), equipped with a SC_4-21 spindle. Apparent viscosity was measured at 100 rpm. Measurements were made at temperature of 10°C in shear rate ranging from 9.3 to 93.0 S^{-1}. All rheological properties were performed in duplicates.

The overrun of resultant ice milk was determined according to (Marshall and Arbuckle, 1996), melting resistant (Tharp *et al*., 1997), specific gravity (Winton, 1958) and weight per gallon (Burke, 1947).

Sensory evaluation:

The sensory evaluation for resultant ice milk were carried out by 9 staff members of the Dairy Department, for flavour (45 points), body &texture (30 points), and appearance & colour (25 points).

Statistical analysis:

All obtained data were subjected to the statistical analysis and analysis of variance by the procedure of general linear model using CoStat (1998) under windows software version 6.311 and least significant difference (LSD) at (p<0.05).

Table (1): Selected composition of pumpkin ice milk mix formulas.

Composition	Formula No. %					
	T1	T2	T3	T4	T5	T6
Fat	5	4	3	2	1	0
Solids not fat	12.5	12.5	12.5	12.5	12.5	12.5
Sugar	15	15	15	15	15	15
Stabilizer	0.5	0.5	0.5	0.5	0.5	0.5
Pumpkin puree	0	1	2	3	4	5
Total solids	33	33	33	33	33	33

Table (2): Formulations of pumpkin ice milk mixes.

Ingredients	Formula No. g/kg					
	T1	T2	T3	T4	T5	T6
Cream (50% fat)	100	80	60	40	20	0
Buffalo's skim milk (9% SNF)	683.6	608.8	534.1	459.3	384.6	309.9
Skim milk powder (96% SNF)	61.4	69.4	77.3	85.25	93.2	101.1
Sugar	150	150	150	150	150	150
Gelatin	5	5	5	5	5	5
Pumpkin puree (11.52% TS)	-	86.8	173.6	260.4	347.2	434.4

RESULTS AND DISCUSSION

Mix Properties:

Table (3) showed that, replacing fat by pumpkin puree (*Cucurbita moschata*) increased the specific gravity and weight per gallon significantly (p< 0.05) of mixes, which was proportional to the rate of substitution. The same trend was found for titratable acidity but non significantly (p>0.05). Acidity increased slightly as percentage of pumpkin increased. On the other hand, pH values for (T5 and T6) were decreased significantly (p<0.05) as compared to control ice milk. The freezing point of the mix was lowered (p<0.05) with the increase in the added pumpkin puree and significantly (p<0.05) different among all treatments. These present results are in line with the finding of Ohmes *et al*. (1998) and El-Kholy (2005), they stated that , when fat is removed from ice cream and is replaced with non fat milk solids or other dissolved substances the freezing point is lowered. As it is seen in Table (3), the calculated fibre percentage of pumpkin ice milk ranged from 0.13 to 0.65 g/100g. Fibre percentage increased significantly ($p<0.05$) as the amount of pumpkin increased. The rheological parameters (apparent viscosity, plastic viscosity and consistency index) of ice milk mix during aging at 5˚C for 24 h are presented in (Table 4). Apparent viscosity of ice milk mixes and other rheological properties increased pronouncedly ($p<0.05$) by replacing fat with pumpkin either when fresh or after aging compared to the control. There was a positive ($p<0.05$) correlation between viscosity and the rate of replacement Table (4). This may be due to the higher fibre contents of pumpkin which was responsible for gel forming viscous, as well as particle size and high water holding capacity of fibre (Vani and Zayas, 1995 and Hassan, 2005).

Table (3): Effect of *Cucurbita moschata* as a fat replacer on some properties of reduced fat and fat free pumpkin ice milk mixes.

Properties	Formula No. *					
	T1	T2	T3	T4	T5	T6
Specific gravity (gm/cm^3)	1.1100^{e}	1.1154^{de}	1.1209^{cd}	1.1265^{bc}	1.1321^{ab}	1.1379^{a}
Weight/gallon (Kg)	5.046^{f}	5.0707^{e}	5.0957^{d}	5.1211^{c}	5.1466^{b}	5.1730^{a}
Acidity (%)	0.22^{a}	.022^{a}	0.22^{a}	0.23^{a}	0.24^{a}	0.24^{a}
pH value	6.35^{a}	6.35^{a}	6.35^{a}	6.33^{ab}	6.31^{b}	6.31^{b}
Freezing point (°C)	-2.44^{e}	-2.45^{e}	-2.53^{d}	-2.59^{c}	-2.64^{b}	-2.68^{a}
Fiber %	0^{f}	0.13^{e}	0.26^{d}	0.39^{c}	0.52^{b}	0.65^{a}

*T2, T3, T4, T5 and T6 different mixes containing 1, 2, 3, 4 and 5 % pumpkin puree respectively.
a, b, c, d, e & f: means with the same letter among the treatments are not significantly different ($p<0.05$).

Table (4): Rheological parameters of reduced fat and fat free mixes of pumpkin ice milk during different aging period at 5°C.

Aging Time	Formula No. *						Mean **
	T1	T_2	T_3	T_4	T_5	T_6	
			Apparent Viscosity (m Pas)				
0 hour	12	37	46	84	153	386	119.66^{d}
4 hours	18	41	57	102	179	473	145.00^{c}
8 hours	34	91	111	233	349	567	230.83^{b}
24 hours	119	216	278	465	558	797	405.50^{a}
Mean **	45.75^{F}	96.25^{E}	123^{D}	221^{C}	309.75^{B}	555.75^{A}	
			Plastic viscosity (m Pas)				
0 hour	11.5	24.1	38.3	71.3	129.8	285.8	93.46^{d}
4 hours	14.6	35.5	49.5	71.4	150.1	344.1	110.86^{c}
8 hours	27.6	68.5	90.4	182.6	269.0	395.5	172.26^{b}
24 hours	85.3	158.4	210.2	329.3	391.8	398.7	262.28^{a}
Mean **	34.75^{F}	71.62^{E}	97.1^{D}	163.65^{C}	235.17^{B}	356.025^{A}	
			Consistency index (m Pas)				
0 hour	0.90	8.60	9.97	21.8	29.1	123.4	32.29^{d}
4 hours	3.48	14.1	14.6	62.1	88.3	165.5	58.01^{c}
8hours	7.37	46.6	48.1	62.1	94.4	231.4	81.66^{b}
24 hours	49.9	85.1	106.6	228.4	270.3	620.0	226.71^{a}
Mean **	15.41^{F}	38.6^{E}	44.81^{D}	93.6^{C}	120.52^{B}	285.075^{A}	

*T2, T3, T4, T5 and T6 different mixes containing 1, 2, 3, 4 and 5% pumpkin puree respectively.
**a, b, c & d and A, B, C, D, E & F: means with the same letter among the treatments and aging period respectively are not significantly different ($p<0.05$).

Ice milk properties:

The properties of the resultant ice milk from different treatments are illustrated in Table (5). The specific gravity and weight per gallon were higher ($p<0.05$) for ice milk treatments (T3 and T4) comparing with control and other treatments, while treatment (T6) had specific gravity and weight per gallon comparable to control ice milk. The level of pumpkin puree in mixes affected ($p<0.05$) the overrun values. The overrun decreased as substitution of fat increased significantly ($p< 0.05$) up to 60% pumpkin compared with control ice milk, then increased pronouncedly ($p<0.05$) and reached 55.16 and 55.99% for treatments T5 and T6 respectively. This increment in the overrun which was observed by increasing the replacement ratios of fat at 80% and 100% pumpkin might be due to the better functional properties (whipping and foam ability). It was clearly indicated that as the specific gravity and weight per gallon decreased, the overrun increased. Mahran *et al*. (1984) stated that the specific gravity of ice milk is inversely proportional to changes occurring in the overrun.

As it is seen in Table (6), the increase of melting resistance of ice milk was proportional ($p<0.05$) to the amount of pumpkin (*Cucurbita moschata*) used. Melting resistance of ice milk was expressed as the loss in weight percent of the initial weight of the tested formula during 60 min (Table 6). The control ice milk and ice milk with 20 % of fat replacement showed lower ($p<0.05$) melting resistance than the rest of ice milk treatments made with replacement of fat. It was found that the melting resistance was related to viscosity and freezing point of the mix. These results are in accordance with those of Arbuckle (1986), Salem *et al.* (2003), Salama and Azzam (2003), El-Kholy (2005) and Abbas (2006). This may be due to their lower content of water holding constituents (Hassan, 2005). On the other hand, the initiation of fluid release was slower ($p<0.05$) for treatments T6, T5, T4, and T3 respectively. This might be due to its higher emulsion stability. Generally, as the mix viscosity increased, the resistance of ice milk to melting increases (Arbucle, 1986; Salem *et al*., 2003).

Table (5): Effect of *Cucurbita moschata* as a fat replacer on some properties of reduced and fat free pumpkin ice milk.

Properties	Formula No.*					
	T1	T2	T3	T4	T5	T6
Specific gravity (g/cm^3)	0.729^d	0.738^c	0.744^b	0.749^a	0.730^d	0.729^d
Weight/gallon (Kg)	3.314^e	3.355^c	3.382^b	3.405^a	3.318^d	3.314^e
Overrun (%)	52.21^c	51.10^d	50.60^e	50.30^f	55.16^b	55.99^a

*T2, T3, T4, T5 and T6 different mixes containing 1, 2, 3, 4 and 5 % pumpkin puree respectively.
a, b, c, d, e & f: means with the same letter among the treatments are not significantly different ($p<0.05$).

Table (6): Effect of *Cucurbita moschata* as a fat replacer on melting resistance (loss %) of ice milk within 60 min.

Treatments*	Melting resistance (loss %) after				Mean**
	15 min	30 min	45 min	60 min	
T1	11.20	44	93	96.40	61.15^A
T2	9.60	38	79.2	96.20	55.75^B
T3	8.30	36.75	68.70	89.90	50.91^C
T4	5.80	36.64	68.66	89.69	50.19^D
T5	0.40	35.54	66.70	89.50	48.03^E
T6	0.30	30.77	58.20	79.46	42.18^F
Mean**	5.93^d	36.95^c	72.41^b	90.19^a	

*T2, T3, T4, T5 and T6 different mixes containing 1, 2, 3, 4 and 5 % pumpkin puree respectively.
**a, b, c & d and A, B, C, D, E & F: means with the same letter among the treatments and melting down duration respectively are not significantly different ($p<0.05$).

Sensory evaluation:

Table (7) represents the sensory evaluation of final product. The results obtained revealed that the reduction of fat up to 5% (100% of fat replacement) with pumpkin puree improved significantly ($p<0.05$) the body & texture as compared to control and treatment 2 (20% pumpkin puree). Bahr (1996) stated that fiber ingredients improving texture, appearance, moisture control and shelf life in products. Controlled water absorption, creates altered or finer-sized particles for better mouthfeel. Fibers also, control the water migration in frozen products that was promoted by freezing and thawing cycles. Increased pumpkin up to 60%, 80% and 100% replacement of fat, the scoring of flavour, appearance & colour and the overall liking scores were increased. However, differences in flavour scores of ice milk from different treatments were found not significant ($p<0.05$). Ice milk with pumpkin was characterized by a yellow colour due its carotein content. This colour was accepted by the panelists. No significant ($p>0.05$) differences were found in scores for colour and appearance between different treatments.

The foregoing results indicated that the importance of using pumpkin fruit (*Cucurbita moschata*) in ice milk making as a fat replacer not only for improving various quality characteristics and physical properties, but also for healthy reasons. It could be concluded that formulas (T5 & T6) containing 80% and 100% pumpkin replacement of fat are recommended for the manufacture of functional pumpkin ice milk with high quality and considered a good source of dietary fibers (0.52–0.65%) as compared with 20, 40 and 60% replacement (0.13–0.39%)

CONCLUSION

Low fat ice milk with high nutritional value and good physical and organoleptic properties can be successfully prepared by replacing up to 100% of fat in the mix with pumpkin (*Cucurbita moschata*). The obtained products can be considered as functional ice milk varieties.

Table (7): Sensory evaluation of reduced fat and fat free pumpkin ice milk.

Properties	**Formula No.** *					
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
Flavour (45)	43^{ab}	42^{b}	43^{ab}	44^{a}	44^{a}	44^{a}
Body & texture (30)	28^{b}	28^{b}	29^{ab}	29^{ab}	29^{ab}	30^{a}
Colour & appearance (25)	24^{a}	25^{a}	24^{a}	25^{a}	25^{a}	25^{a}
Total (100)	95^{b}	95^{b}	96^{ab}	98^{ab}	98^{ab}	99^{a}

*T2, T3, T4, T5 and T6 different mixes containing 1, 2, 3, 4 and 5% pumpkin puree respectively.
a, & b: means with the same letter among the treatments and are not significantly different ($p<0.05$).

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استخدام القرع العسلي في صناعة مثلوج لبنى صحي

أميرة محمد الخولى، فوزي محمد عباس
قسم الألبان – كلية الزراعة - جامعة قناة السويس – ٤١٥٢٢ الاسماعيلية – جمهورية مصر العربية

يهدف البحث إلى دراسة إمكانية استبدال دهن اللبن جزئيا أو كليا بالقرع العسلي في صناعة المثلجات اللبنية، و تأثير استخدام القرع العسلي كبديل للدهن على بعض الخصائص الطبيعية والريولوجية والحسية للمثلوج الناتج. فقد تم استبدال دهن اللبن في مخاليط المثلجات اللبنية باستخدام معجون القرع العسلي بنسب ٢٠، ٤٠، ٦٠، ٨٠ و ١٠٠%.
أظهرت النتائج أن استخدام نسب مختلفة من معجون القرع العسلي كبديل للدهن وكذلك زيادة نسب الاستبدال لدهن اللبن له تأثير على خواص مخاليط المثلجات، حيث يؤدى إلى خفض كل من الـ pH و نقطة التجمد وله تأثير غير معنوي على الحموضة. كذلك أدى زيادة نسب معجون القرع العسلي إلى زيادة الوزن النوعي و الوزن للجالون وزيادة اللزوجة الظاهرية وبعض الخصائص الريولوجية لمخاليط المثلجات اللبنية. كما أظهرت النتائج إلى زيادة المقاومة للانصهار و محتوى الألياف بزيادة نسب القرع العسلي المضافة محل دهن اللبن في الناتج النهائي وانخفاض الريع حتى نسبة استبدال ٦٠% ثم يزداد. وأوضحت نتائج التحكيم الحسي أن المثلوجات الناتجة نالت قبولا لدى المحكمين و كانت المثلوجات الناتجة من المخاليط التي تم إحلال معجون القرع العسلي بنسب ٨٠% و ١٠٠% محل دهن اللبن قد حصلت على أعلى درجات التقييم الحسي.
لذلك توصى الدراسة بأنه يمكن استبدال القرع العسلي محل دهن اللبن في مخاليط المثلجات اللبنية بنسب ٨٠% و ١٠٠% للحصول على منتج لبنى جيد من حيث الخواص الحسية و غنى بالألياف الغذائية مما يعطى قيمة غذائية و صحية للمنتج.