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Physicochemical and Sensory Properties of Low-Fat Ice Cream Made with Inulin and Maltodextrin as Fat Replacers.

Abd El-Khair, A. A.*; A. A. Abd-Alla; A. H. Ateteallah and Noha A. Hassan

Dairy Science Dept. Faculty of Agric. Sohag Univ. Egypt



ABSTRACT

This study was performed to formulate and evaluate a low-fat, reduced-calories soft serve ice cream using inulin or maltodextrin as a fat replacer. Six batches of ice cream mixes with different fat content (2, 4, and 6%) was prepared by partial replacement of milk fat with either inulin or maltodextrin at levels of 2, 4, and 6% (w/w). A control batch was made with 8% milk fat without adding any fat alternatives. The chemical composition and physicochemical properties of ice cream mixes were determined. A sensory evaluation was also performed on the final products initially and monthly during storage at -18°C for two months. The results indicated that the use of either maltodextrin or inulin as a fat replacer in low-fat reduced-calorie ice cream formulations can improve the properties of these products. However, the type and level of fat replacer used affects differently on various physical properties such as density and viscosity. It has been also concluded that it was possible to formulate a low-fat, reduced-calorie ice cream with a healthier effect by adding inulin as a healthier fat replacer, alternative to maltodextrin. Good product was obtained with nutritional, technological, and sensory acceptance.

Keywords: inulin, maltodextrin, ice cream.

INTRODUCTION

The focus on health has become a powerful engine today even for luxury products such as ice cream. Although ice cream is delicious to all, it is rich in fat. Typically, ice cream contains 10 to 16% milk fat Adapa *et al.*, (2000). So, the cholesterol levels can be raised, if taken regularly. Hence, the formulation of reduced and low-fat versions would reduce excess calories and therefore make it healthier. The consumer over the past two decades demand has driven the food industry to decrease the amount of fat in its products. High fat intake ultimately considered as a risk factor for energy and weight gain, which leads to obesity Romieu *et al.*, (2017). Thus, overweight or obesity increases the risk of other metabolic diseases such as type 2 diabetes and cardiovascular disease Leitner *et al.*, (2017). An alternative approach is to use fat replacers, which will mimic the physical and sensory properties similar to fat, but offer much lower calories Zoulias *et al.*, (2002). These ingredients fall into two categories; those of a fatty nature and those based on proteins or carbohydrates Underdown *et al.*, (2011).

Carbohydrate-based fat replacers contain many types of modified starches or maltodextrins of various sources, cellulose derivatives, inulin, pectin, polydextrose and other dietary fibers Goff and Hartel, (2013). Guzeler *et al.*, (2011) reported that ice cream samples containing maltodextrin formed a more balanced taste in low calorie ice cream within 3 months of storage. Maltodextrin provides the same fat taste and helps foods to easily be broken into a smaller piece in the mouth. However, Goff and Hartel, (2013) reported that sometimes the use of maltodextrin in ice cream formulations can lead to off taste

when not sufficiently refined or fermented. Inulin is another type of carbohydrate-based fat replacer, a natural storage carbohydrate found in the roots and tubers of many plants, including wheat, onions, bananas, garlic, asparagus, Jerusalem artichoke, plums, agave, raisins and chicory. Inulin is a natural and healthy alternative to maltodextrin. It is a functional nutritional ingredient, which improves health and reduces the risk of many diseases. Being a prebiotic and dietary fiber, it helps to lower blood lipid levels Liu *et al.*, (2017). The energy value of inulin is much lower than other carbohydrates such as maltodextrin. It has also a much lower glycemic index than maltodextrin and does not affect blood sugar level Roshanravan *et al.*, (2017); Lightowler *et al.*, (2018), Wang *et al.*, (2019). In addition, it is likely to reduce total body fat mass and support the management of body weight Parnell and Reimer, (2009); Liber and Szajewska, (2013); Castro-Sanchez *et al.*, (2017). El-Nagar *et al.*, (2002) found that the addition of inulin to low-fat yogurt-ice cream had improved the flavor as a high-fat product. Many clinical nutrition studies have focused on the health benefits of inulin as a drug compared with maltodextrin as a placebo Watson *et al.*, (2019). However, little research has been reported on the functional properties of inulin compared with maltodextrin as an alternative to fat in low-fat ice cream, although different fat replacers may affect ice cream mix properties and product quality in different ways.

The objective of this work was to compare the effects of replacing milk fat with inulin or maltodextrin on the physio-chemical and sensory properties of low-fat ice cream.

* Corresponding author.
E-mail address: ateteallah@yahoo.com
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MATERIALS AND METHODS

Materials:

Nonfat dry milk: Dairy America Inc., Fresno, USA.

Butter oil: AL Haloub cow pure butter oil (99.8% milk fat) produced in Holland was purchased from the local market, Sohag, Egypt.

Inulin: Frutafit® HD: Highly dispersible native inulin powder of medium average chain length (8-13 DP) imported from Sensus (Brenntag Química, SA, Barcelona, Spain).

Maltodextrin: Low dextrose equivalent maltodextrin powder (DE < 5) imported from Alpha Chemika, Andheri West, Mumbai, Maharashtra, India.

Sugar: Sucrose was purchased from the local market, Sohag, Egypt.

Vanilla: Vanilla powder was purchased from the local market, Sohag, Egypt.

Gelatin: Gelatin powder was purchased from the local market, Sohag, Egypt.

Preparation of ice cream: Ice cream was manufactured according to Marshall *et al.*, (2003); Arbuckle, (2013). All mixes were prepared in batches of 3 kg. A control batch of reduced-fat ice cream mix was formulated to contain 8% milk fat in the form of butter oil, 8.73% milk solid not fat, 16% sugar, 0.3% gelatin and 0.3% vanilla. For low-fat, reduced-calorie ice cream. group of six batches of mixes with different fat content (2, 4, and 6%) was prepared by partial replacement of butter oil with either inulin or maltodextrin at levels 2, 4, and 6% (w/w). The levels of inulin and maltodextrin selected in this study were based on preliminary experiments and available literature on their suitability for ice cream formulation. The other ingredients were the same as for the reduced-fat ice cream mixes. Low-fat ice cream batches were designated as LFIC (6% BO + 2% IN), LFIC (4% BO + 4% IN), LFIC (2% BO + 6% IN), LFIC (6% BO + 2% MD), LFIC (4% BO + 4% MD), LFIC (2% BO + 6% MD), respectively. {Low fat ice cream (LFIC), butter oil (BO) inulin (IN), maltodextrin (MD)}. All ingredients (except vanilla) were blended in a laboratory mixer at maximum speed for 10 minutes, pasteurized at 70°C for 30 minutes, cooled immediately to 4°C and aged at this temperature overnight. Vanilla was added to the mixes before freezing. The mixes were frozen using a soft serve ice cream machine (Guangli Machinery "Xinhui" Co., Ltd., Guangdong, China). Ice cream samples were filled in 100 ml of plastic containers and placed in a deep freezer at -18°C / 24 h for hardening. Experimental formulations were repeated twice for each ice cream formula. Samples of the ice cream mixes were evaluated for their chemical composition. Physical properties of the ice cream mixes and the final products were also evaluated. Sensory evaluation was performed on the final products initially and monthly during storage at -18°C for 60 days.

Analytical Methods:

Chemical composition, Titratable Acidity and pH-value were determined according to AOAC, (2012), carbohydrates were calculated by the differences.

Density, Weight per gallon and Apparent viscosity were determined by methods described in AOCS, (1999).

Overrun: The overrun of ice cream was calculated on a weight basis using a formula described by Marshall *et al.* (2003). The formula for overrun is as follows:

$$\text{Overrun \%} = \frac{[(\text{weight of unit volume of mix}) - (\text{weight of unit volume of ice cream})]}{(\text{weight of unit volume of ice cream})} \times 100.$$

Melting time: Melting time was determined as follows: Twelve grams of ice cream were scooped onto a dish after hardening for 48 hours and allowed to stand at room temperature (25±1°C) until completely melted. Time was measured using a stopwatch Conforti, (1993).

Sensory evaluation: Ice cream samples were judged after 1, 30, and 60 days of storage at -18°C by 7 panelists from Department of Dairy Sciences, Faculty of Agriculture, Sohag University, Egypt using a score test. The ice cream samples were evaluated for flavour (40), body & texture (30), color (15) and melting quality (15). Arbuckle (2013).

Statistical analysis: was measured according to SAS, (2012).

RESULTS AND DISCUSSION

1- Chemical composition of low-fat ice cream mix:

Table 1 shows the chemical composition of low-fat ice cream mixes made of inulin or maltodextrin as fat replacers. The total solids content increased significantly with the addition of both types of fat replacers, especially with maltodextrin. This increase was proportional to the level of fat replacer added. Fat content in all mixes was significantly different ($P \leq 0.05$) from each other depending on the composition. Replacing fat with inulin or maltodextrin caused a significant decrease ($P \leq 0.05$) in fat content ice cream mix. The results in Table (1) showed also no statistically significant differences ($P > 0.05$) in protein content of all mixes. The average protein content of all mixes was about 3.9%, with no significant effect of inulin or maltodextrin in the formulation. Tiwari *et al.*, (2015) noted that the protein content of low-fat ice cream prepared with the incorporation of inulin in a different ratio showed no significant difference between the samples. Carbohydrates content: The use of both fat replacers in ice cream formulation significantly affected the carbohydrate content of ice cream mixes ($P \leq 0.05$). The results showed higher levels of total carbohydrate content in ice cream mix with increased levels of inulin or maltodextrin. Tiwari *et al.*, (2015) reported that increased insulin levels significantly increased the carbohydrates of all low-fat ice cream formulations. The results showed slight differences in ash content between different ice cream mixes.

2. Physico-chemical properties of low-fat ice cream mixes:

Table 2 shows the results of the Physico-chemical properties of low-fat ice cream mixes made with inulin or maltodextrin as a fat replacer. The results in Table 2 showed that the density values of ice cream mixes increased with increasing the levels of inulin or maltodextrin. This increase may be due to high total solids and lower fat in the mixes. Fat density is lower than all other ice cream ingredients, therefore, the lower the fat content, the greater the density of the mix. The weight values per gallon of ice cream mixes were consistent with the density values (Table 2). The density of ice cream mix vary from 1.0544 to 1.1232 g/mL for a 10% fat mix Goff

and Hartel, (2013). Akbari *et al.*, (2016) reported that reducing fat as well as high inulin levels increased significantly the density of ice cream. Table 2 shows also the average viscosity values (cP) for ice cream mixes containing inulin or maltodextrin as fat replacers. As shown, there were significant differences ($P \leq 0.05$) in viscosity values among different mixes. Replacement of fat with maltodextrin showed higher viscosity values in ice cream mixes compared to inulin. This may be due to the difference in the water binding capacity and the properties of gel formation of both fat replacers. Inulin has been reported to form cryogel in the inulin added ice cream Soukoulis *et al.*, (2010). Maltodextrin gel can easily combine with liquid and solid fats and form a stable

emulsion gel Guzeler *et al.*, (2011). The viscosity of inulin mixes decreased with increasing level of replacement, while viscosity of maltodextrin mixes increased dramatically with increasing level of replacement. High viscosity values can be attributed to the ability of maltodextrin to improve the ice cream network, which restricts serum areas, thereby increasing viscosity. Several studies on the effect of inulin on the rheological properties of the ice cream mix have shown that adding inulin at different levels to the ice cream mix increases the viscosity compared to the control. Interactions between inulin and liquid ingredients in the ice cream mix can immobilize free water and increase the viscosity of the ice cream mix.

Table 1. Chemical composition of low-fat ice cream mixes made with inulin or maltodextrin as a fat replacer

Mixes	Chemical composition (%)				
	T.S	Fat	Protein	Carbohydrate	Ash
Control (8% BO)	34.10 ^e	8.0 ^a	3.94 ^a	21.37 ^c	0.79 ^{b,c}
LFIC (6% BO + 2% IN)	34.46 ^c	5.9 ^b	3.70 ^a	24.08 ^{b,c}	0.78 ^c
LFIC (4% BO + 4% IN)	35.90 ^b	4.1 ^c	3.97 ^a	27.03 ^{ab}	0.80 ^{ab}
LFIC (2% BO + 6% IN)	37.01 ^a	2.2 ^d	3.92 ^a	30.10 ^a	0.79 ^{b,c}
LFIC (6% BO + 2% MD)	34.83 ^c	5.9 ^b	3.96 ^a	24.18 ^{b,c}	0.79 ^{b,c}
LFIC (4% BO + 4% MD)	35.91 ^b	3.8 ^c	3.94 ^a	27.36 ^{ab}	0.81 ^a
LFIC (2% BO + 6% MD)	37.05 ^a	2.0 ^d	3.97 ^a	30.28 ^a	0.80 ^{ab}

Low fat ice cream (LFIC), butter oil (BO) inulin (IN), maltodextrin (MD)

^{a,b,c} Means within the same column with different superscripts are significantly different ($p \leq 0.05$).

Table 2. Physicochemical properties of low-fat ice cream mixes made with inulin or maltodextrin as a fat replacer

Mixes	Physicochemical properties				
	Density (g/ml)	Weight per gallon (pound)	Apparent viscosity (cP)	pH-value	T.A (%)
Control (8% BO)	1.0779 ^b	8.9896 ^b	57 ^d	6.60 ^a	0.21 ^c
LFIC (6% BO + 2% IN)	1.0933 ^a	9.1181 ^a	50 ^e	6.61 ^a	0.22 ^b
LFIC (4% BO + 4% IN)	1.0970 ^a	9.1489 ^a	37 ^f	6.57 ^a	0.23 ^a
LFIC (2% BO + 6% IN)	1.0980 ^a	9.1573 ^a	25 ^g	6.56 ^a	0.23 ^a
LFIC (6% BO + 2% MD)	1.0840 ^b	9.0405 ^b	73 ^c	6.61 ^a	0.21 ^c
LFIC (4% BO + 4% MD)	1.0980 ^a	9.1573 ^a	89 ^b	6.68 ^a	0.22 ^b
LFIC (2% BO + 6% MD)	1.0984 ^a	9.1606 ^a	110 ^a	6.62 ^a	0.22 ^b

Low fat ice cream (LFIC), butter oil (BO) inulin (IN), maltodextrin (MD)

T.A%: Titratable acidity percentage (as lactic acid).

^{a,b,c} Means within the same column with different superscripts are significantly different ($p \leq 0.05$).

3. Physical properties of resultant low-fat ice cream:

The physical properties of resultant low-fat ice cream made with inulin or maltodextrin as fat replacers are shown in Table 3. The results showed a significant increase

($P \leq 0.05$) in the density of experimental ice cream formulas with increased inulin or maltodextrin levels added. Also, the weight per gallon of experimental ice cream formulas followed the same direction density.

Table 3. Physical properties of low-fat ice cream formulas made with inulin or maltodextrin as a fat replacer

Formulas	Physical properties			
	Density (g/ml)	Weight per gallon (pound)	Overrun (%)	Melting time (min.: sec.)
Control (8% BO)	0.9130 ^d	7.6144 ^d	27.90 ^c	39:00 ^a
LFIC (6% BO + 2% IN)	0.9171 ^c	7.6486 ^c	26.66 ^d	27:18 ^f
LFIC (4% BO + 4% IN)	0.9252 ^b	7.7162 ^b	28.56 ^b	28:36 ^e
LFIC (2% BO + 6% IN)	0.9487 ^a	7.9122 ^a	29.60 ^a	32:00 ^d
LFIC (6% BO + 2% MD)	0.9176 ^c	7.6527 ^c	20.63 ^e	29:00 ^e
LFIC (4% BO + 4% MD)	0.9256 ^b	7.7195 ^b	18.33 ^f	33:00 ^c
LFIC (2% BO + 6% MD)	0.9490 ^a	7.9146 ^a	16.63 ^g	35:00 ^b

Low fat ice cream (LFIC), butter oil (BO) inulin (IN), maltodextrin (MD)

^{a,b,c} Means within the same column with different superscripts are significantly different ($p < 0.05$).

The data in Table 3 and Fig. 1 shows that fat replacement by inulin and maltodextrin led to significant changes ($P < 0.05$) in ice cream overrun. The low-fat ice cream formulations obtained in the present study showed overrun values ranged from 16.63% to 29.6%. These values are similar to those set by Goff, (2002), where the gas phase varied widely from 10% to 15% to values of up to 50%. It can also be noted that the overrun values of ice cream increased significantly ($P \leq 0.05$) with inulin addition and decreased with the addition of maltodextrin compared with control. The increase or decrease in overrun

values was proportional to the level of addition of each fat replacer. The lowest overrun value was obtained in the formula containing 6% maltodextrin, while the highest value was obtained in the formula made with 6% inulin. This increase in overrun may be due to the effect of inulin in reducing viscosity, which improved the ability of mixes to palpate and thus increase the overrun values or may also be due to the interaction between inulin and some milk proteins forming a complex matrix in the frozen ice cream. This strong complex matrix, along with fat globules, may have entrapped more air bubbles, which were stabilized by

fat globules, resulting in higher values of overrun. On the other hand, the ice cream mix containing maltodextrin is highly viscous, which reduces molecular movement and makes it difficult to integrate air cells and distribute them uniformly. The increased viscosity may be the main cause of reduced whipping capacity, which impedes the ability of the mix to beat and thus reduce overrun Fernandes *et al.*, (2017). The melting properties are influenced by the three structural components that make up the dispersion phase of ice-cream: ice, air and fat Pintor *et al.*, (2017). As shown in Table 3 and fig. 2, when milk fat was replaced by inulin or maltodextrin, the melting time was significantly reduced ($P \leq 0.05$). The melting time of all formulas was significantly shorter ($P \leq 0.05$) than control, and this may be mainly associated with a low fat content. Therefore, the control formula made without replacing fat had the longest melting time. Hyvonen *et al.* (2003) reported a similar phenomenon in ice cream where the contents of fat of different types (dairy and vegetables) changed from 0 to 18%.

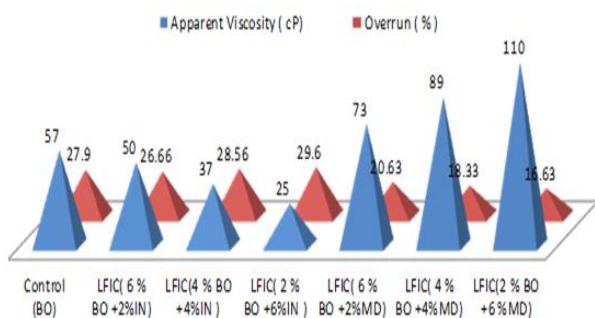


Fig. 1. overrun of low-fat ice cream formulations as affected by apparent viscosities of the mix. Low fat ice cream (LFIC), butter oil (BO) inulin (IN), maltodextrin (MD)

The ice creams containing fat melt more slowly than the low-fat ice creams because the fat slows the rate of heat transfer through the ice creams Tiwari *et al.*, (2015) and Akbari *et al.*, (2016). The results also revealed that maltodextrin formulas were significantly slower ($P \leq 0.05$) in melting than inulin formulas. This may be due to the high ability of maltodextrin to bind water and enhance viscosity compared to inulin. In the contest for this, the formulas in which inulin was used, the melting took place earlier. It has been reported that in low-fat ice cream, inulin acts as a stabilizer, due to its capacity to retain and immobilize large amounts of water, causing less crystallization and longer melting time Karaca *et al.*, (2009) and Meyer *et al.*, (2011). However, with the increase in the proportion of both fat replacers, the melting time gradually increased, perhaps due to the water binding effect of inulin and maltodextrin, which in turn leads to a more stable gel network. The maximum melting time for experimental formulations was recorded using 6% maltodextrin while the minimum was recorded using 2% inulin. The process of melting in ice cream can also be described in relation to the free movement of molecules. Inulin may act as a stabilizing agent due to its ability to bind water. Thus, water molecules become unable to move freely between other molecules of the mix. Inulin (with its

ability to reduce freedom of movement) seems to delay the melting of the product and may also be due to high overrun, as air is a good insulator; increased overrun may also decrease the melting rate.

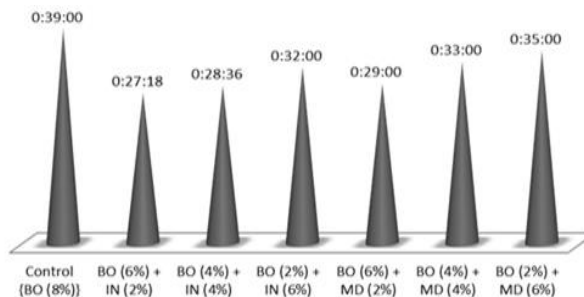


Fig. 2. the type and level of fat replacer as a function of melting time in low-fat ice cream formula. butter oil (BO) inulin (IN), maltodextrin (MD)

4. Sensory properties of resultant low-fat ice cream:

Table 4 shows the sensory properties of low-fat ice cream containing fat replacers. The results of fresh ice cream samples showed that control ice cream has slightly higher ratings compared to maltodextrin treatment, while inulin-containing formulations were higher than the control. Inulin-containing samples with all ratios showed higher flavour scores than both control and maltodextrin-containing samples. The best results were 45.37 for the 4% inulin replacement level. Contrary to our findings, Karaca *et al.*, (2009) found that reducing fat in ice cream with the addition of carbohydrate-based fat replacers received a lower degree of flavor than the control. The low-fat ice cream with the addition revealed that the addition has significantly improved the sensory properties of low-fat ice cream, including flavour, melting quality and body & texture. The improvement in body & texture may be associated with increased hardness, while improved melting quality may be related to increased meltability of ice cream. Kaur and Gupta, (2002) reported that due to the long chain length of inulin, it is less soluble than oligo-fructose and has the ability to form microcrystals when sheered in water or milk. These crystals are not discretely perceptible in the mouth, but they react to form a smooth creamy texture and provide a fat-like mouth feel. Body and texture showed that all samples containing fat replacers were higher than the control and the highest score (27.37) were obtained with the addition of 4% inulin. There was no significant difference in color between control and all fat replacement samples. Guzeler *et al.*, (2011); Sonwane and Hembade, (2014) reported that there was no significant effect of polydextrose and maltodextrin on the colour and appearance of low-fat ice cream. However, Barazandegan *et al.*, (2013) reported that the use of inulin and maltodextrin as two fat replacers in prebiotic cocoa ice cream reduced the value of lightness; however, yellowing and redness values increased and samples containing both fat replacers were darker compared to the control. After 30 days of storage, the flavor, body & texture, and color decreased in most samples including the control, while the melting quality did not change significantly. After 60 days of storage, there was some deterioration in the sensory qualities of samples including control particularly in terms

of body, texture and flavor. This may be due to the effect of storage on the flavor, the longer the storage period, the less the quality of flavor. In general, low-fat ice cream formulations showed good sensory properties, at the end of the storage period, despite some deterioration in properties. Overall acceptance indicated that the sample containing 4% inulin was the highest.

On other hand, low-fat ice cream (2% fat) with 2, 3 or 4% inulin had a lower melting rate but higher hardness than control (10% fat). However, the sensory evaluation of the low-fat formula with 4% inulin showed no difference from control.

Table 4. Sensory properties of low-fat ice cream formulas made with inulin or maltodextrin as a fat replacer.

Formulations*	Storage period (days)	Sensory attributes				
		Flavour (50)	Body & Texture (30)	Color (10)	Melting quality (10)	Overall acceptance (100)
Control (8% BO)	1	40.47	23.58	8.33	7.62	80.00
LFIC (6% BO + 2% IN)	"	43.25	25.75	9.13	8.37	86.50
LFIC (4% BO + 4% IN)	"	45.37	27.37	9.44	8.93	91.11
LFIC (2% BO + 6% IN)	"	41.00	24.04	8.62	8.31	80.97
LFIC (6% BO + 2% MD)	"	37.06	25.45	8.46	7.90	78.87
LFIC (4% BO + 4% MD)	"	40.00	25.31	8.75	8.53	82.59
LFIC (2% BO + 6% MD)	"	36.87	26.37	8.00	8.41	79.65
Control (8% BO)	30	38.19	21.81	8.00	7.56	75.56
LFIC (6% BO + 2% IN)	"	40.75	25.25	8.84	8.37	83.21
LFIC (4% BO + 4% IN)	"	41.87	27.30	8.58	8.75	86.50
LFIC (2% BO + 6% IN)	"	40.41	23.81	8.19	8.08	80.49
LFIC (6% BO + 2% MD)	"	35.79	24.54	7.88	7.69	75.90
LFIC (4% BO + 4% MD)	"	37.63	25.18	8.29	8.38	79.48
LFIC (2% BO + 6% MD)	"	31.93	26.50	8.00	8.18	74.61
Control (8% BO)	60	36.00	21.25	7.50	7.19	71.94
LFIC (6% BO + 2% IN)	"	39.41	24.56	8.41	7.68	80.06
LFIC (4% BO + 4% IN)	"	40.00	26.50	8.68	8.68	83.86
LFIC (2% BO + 6% IN)	"	39.43	22.56	8.00	7.38	77.37
LFIC (6% BO + 2% MD)	"	33.87	21.60	7.81	6.62	69.90
LFIC (4% BO + 4% MD)	"	37.00	22.00	7.69	8.00	74.69
LFIC (2% BO + 6% MD)	"	30.88	24.43	6.00	7.56	68.87

Low fat ice cream (LFIC), butter oil (BO) inulin (IN), maltodextrin (MD)

CONCLUSION

The use of either maltodextrin or inulin as a fat replacer in low-fat reduced-calorie ice cream formulations can improve the properties of these products. However, the type and level of fat replacer used affects differently on various physical properties such as density, viscosity, overrun and melting rate as well as the sensory qualities of the final product. It can be concluded that it was possible to formulate a low-fat, reduced-calorie ice cream with a healthier effect by adding inulin as a healthier fat replacer, alternative to maltodextrin. Good product was obtained with nutritional, technological and sensory acceptance.

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الخواص الفيزيائية والكيميائية والحسية للمنتجات القشدية منخفضة الدهون المصنعة من الإنيولين والمالتودكسترين كبدائل للدهن

عبدالعال عابدين علي عبدالخير ، عبد الله عبد اللطيف عبدالله ، عطيت الله حسن عطيت الله و نهى عبد الصادق أحمد حسن
قسم علوم الألبان - كلية الزراعة - جامعة سوهاج

أجري هذا البحث بهدف مقارنة تأثير استبدال دهن اللبن جزئياً بابتين من بدائل الدهن هما الإنيولين والمالتودكسترين- على الخواص الكيميائية والفيزيائية لمخاليط المنتجات القشدية قليلة الدهن، وأثر ذلك على الخواص الكيميائية والفيزيائية والحسية للمنتج النهائي، حيث تم تصنيع 6 دفعات باستبدال جزء من الزبد المسال إما بالإنيولين أو المالتودكسترين بنسبة 2، 4، 6 %، و تم تحضير دفعة للمقارنة من الزبد المسال دون إضافة أي بديل للدهن. وتم تحليل مخاليط المنتجات القشدية المحضرة وكذلك المنتج النهائي الطازج والمخزن على درجة حرارة - 18 درجة مئوية لمدة شهرين. وقد أشارت النتائج إلى أن استبدال الدهن بالإنيولين أو المالتودكسترين أدى إلى زيادة في نسبة الجومد الصلبة الكلية والكربوهيدرات وانخفاض في نسبة الدهن في مخاليط المنتجات القشدية وكانت هذه الزيادة أو الانخفاض متناسبة مع مستوى الإضافة بينما لم تتأثر نسب البروتين والرماد. زادت الكثافة والوزن للجالون لمخاليط المنتجات القشدية مع تضمين كلا النوعين من بدائل الدهن وكانت هذه الزيادة متناسبة مع نسب الإضافة. وقد انخفضت لزوجة المخاليط بشكل ملحوظ نتيجة استبدال دهن اللبن بالإنيولين، بينما زادت اللزوجة بشكل كبير مع استخدام المالتودكسترين وكان معدل الانخفاض أو الزيادة في اللزوجة متناسباً مع نسب الإضافة. زادت نسبة الحموضة في المخاليط المصنعة من كلا النوعين من بدائل الدهن زيادة طفيفة في جميع مستويات الاستبدال تقريباً بينما لم يتأثر رقم الحموضة بشكل كبير. زادت نسبة الرغيع في المنتجات القشدية بشكل كبير بإضافة الإنيولين، بينما انخفضت بإضافة المالتودكسترين، وكان معدل الزيادة أو الانخفاض متناسباً مع نسب بدائل الدهن المضافة. انخفض زمن انصهار المنتجات القشدية بشكل كبير نتيجة استبدال دهن اللبن بكل النوعين من بدائل الدهن خاصة الإنيولين، ومع ذلك فقد زاد زمن الانصهار - نسبياً- مع زيادة نسب الإضافة. وقد أشارت نتائج التقييم الحسي العام إلى أن تركيبة المنتجات القشدية التي احتوت على 4٪ إنيولين قد حصلت على أعلى درجة في نهاية فترة التخزين. وقد خلصت النتائج إلى أنه من الممكن تكوين مخاليط منتجات قشدية منخفضة الدهن وقليلة السعرات الحرارية ذات تأثير صحي أفضل وذلك بإضافة الإنيولين بدلاً من المالتودكسترين كبديل للدهن، فضلاً عن كونها تعتبر منتجات جيدة من الناحية التغذوية وتتميز بالقبول الحسي.