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Impact of Etenia 457 and Sativoside on Ice Cream Properties

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ABSTRACT

The main target of this study was preparing Ice cream more suitable for people who need low fat and low lactose in their diet. Four treatments beside control sample were achieved. Control formula of Ice cream mix contained 10% fat, 12% sugar, 11% SNF, 0.5% CMC and 0.5% vanilla. Experimental treatments were processed by using 25, 50, 75, 100 of both ingredients, Etenia 457 as fat replacer as well as Sativoside as sweetener. Ice cream samples were processed by the traditional method; Results showed that no clear variations in the TS%, P% and Ash% or acidity and pH values between control and other treatments. However, there were great differences in fat contents and calories values between control and other treatments. Mixes containing Etenia 457 and Sativoside seemed to be more viscous than control. On the other hand, it could be noticed large variations in the values of melting resistance degrees. Control sample had the best and favorite properties of melting behavior. sensory properties results showed that there were slight differences among all ice cream treatments. The ice cream samples containing fat replacer and sweetener had little lower flavor scores than control treatment. On the other hand, addition of Etenia 457 and Sativoside to ice cream formula caused a slight decrease in body & texture properties of final product also. The melting propertied degrees were varied also. For all total acceptability, all resultant ice cream treatments gained an acceptability and the control have the highest scores followed by other treatments (25, 50, 75, 100%) respectively.

Keywords: Ice cream, Etenia 457, Sativoside, Organoleptic evaluation, Physical properties.

INTRODUCTION

Ice cream and ice milk and frozen yoghurt are delicious and fancy dairy products consumed by all ages. They are considered complex food consist of small air cells dispersed in a partially frozen continuous aqueous phase and the quality of the final product is mainly related to the ingredients used (Zaky *et al*., 2019). Lactose is the main carbohydrate in milk and different dairy products, it is present at approximately 7.3% in ice cream (Karaman *et al*., 2014). Lactose is characterized by low water solubility and when it presents in combination with sucrose; especially; in frozen dairy products, it crystallizes faster than sucrose (Sormoli *et al*., 2013), leading to a defect known as grittiness (El-Batawy *et al*., 2019). Lactose stimulates the intestinal absorption and retention of calcium. It is digested in the small intestine, where the β-galactosidase-enzyme hydrolyses lactose into glucose and galactose. In lactose intolerant individuals, the ingested lactose is only partially hydrolyzed, or it is not hydrolyzed at all. Different ways were used to overcome the effect of lactose intolerance, such as removal of lactose from dairy products by the action of β-galactosidase, or by using fermentative microorganisms and by combining meals with exogenous β-galactosidase. Many ways could be used for avoiding the effect of lactose on lactose intolerant individuals such as recombination the dairy products that contain high content of lactose by using some other food ingredients which are free lactose and reduced the calories of the final product. Among these ingredients, sweeteners are already used as supplements of lactose in industrial scale (Bemiller and Huber, 2010). On another view, low or reduced fat-ice cream has great request for avoiding obesity and heart diseases. Nowadays, consumers are interested in consuming low-fat foods. Consequently, many fat replacers are utilized in low-fat ice cream that can mitigate textural and sensory defects caused by reducing fat content. Fat replacers are categorized into three groups based on their compositions: lipid, protein and carbohydrate based. Most common fat replacers used in ice cream include inulin, maltodextrin, polydextrose, milk proteins, soy proteins, dietary fibers, and starches. Reduced fat ice cream is a nutritionally altered product (compared to ice cream) which contains 25% less fat as compared to conventional ice cream. Light ice cream has one-third fewer calories or half the amount of fat of that found in regular ice cream. In another view, low-fat-ice-cream contains less than 3g fat per serving. But fat free, no fat, or nonfat ice cream is a product that contains less than 0.5g fat per serving. With these changes in descriptors, the total milk solids requirements of 20% still apply and all other aspects of ice cream described above still apply. As suggested by some authors, the fat content can influence the size of the ice crystals. Fat globules could mechanically impede the ice crystal growth. Since each type of fat exhibits a specific polymorphism function of its triacylglycerol composition, the thermal behavior of fats during the processing of ice cream may influence the physicochemical properties of the intermediate and final products (Trgo *et al*., 1999 and Granger *et al*., 2005). According the above introduction, reduce fat and lactose contents in ice cream may be affect the properties of the final product. So, the current search dealt with the using of fat replacer (Etenia 457) and natural sweetener (Stiviosiode) to prepare dairy products characterize by (low fat & low calories) content and determine their effects on the physicochemical and sensory properties.

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MATERIALS AND METHODS

Materials:

Fresh buffalo skim milk was obtained from the local market of Damietta, while Skim milk powder produced by Poland was obtained from Carrefour of Cairo, Egypt. Fresh buffalo Cream (50% fat) was purchased from Carrefour of Cairo. Commercial table -sugar and liquid vanilla extract were obtained from local market of Damietta. Etenia 457 as fat replacer and Sativoside as sweetener were obtained from faculty of Agriculture, Alexandria University, Alexandria, Egypt. Bulking agents such as Maltodextrin powder and liquid Sorbitol (70%) were obtained from Food Industry Products Company, 10th of Ramadan City, Egypt. They used to improve the texture properties. Sodium carboxy methyl cellulose as stabilizer was obtained from faculty of Agriculture, Mansoura University, Mansoura, Egypt.

Methods:

Preparation of low caloric ice cream:

Control sample of vanilla ice cream mix was prepared to contain 10% fat, 12% sugar, 11% SNF, 0.5% CMC and 0.5% vanilla according to the method of Arbuckle (1986).

The fat and sugar contents were reduced in the treatments. Etenia 457 (as fat replacer) (1g instead of 1Kg fat) and Sativoside (as sweetener) (0.1g instead of 1Kg sugar) were added at five ratios (0, 25, 50, 75 and 100%) to each. Maltodextrin and Sorbitol (1:2 W/V) as sweetener were added also to the mix by the same levels (0, 25, 50, 75 and 100%) to achieve five final treatments, namely C "without any additives", T_1, T_2, T_3 and T_4 (Table, 1).all ice cream treatments and control were processed according to Arbuckle (1986). The final product was packed in PVC cups.

Table 1. ice cream treatments formula (1kg/100kg mix)

Ingredients	Level of replacement (%)				
	Control (C)	25 (T_1)	50 (T_2)	75 (T_3)	100 (T_4)
Cream (50% fat, 4.5% SNF*)	19.31	14.48	9.65	4.85	00
Liquid skim milk (0.5% fat, 9% SNF)	61.96	61.96	61.96	61.96	61.96
Dried skim milk (95% DM**)	6.65	6.67	6.69	6.71	6.73
Sugar	12	9.00	6.00	3.00	0
Stabilizer (CMC***)	0.5	0.5	0.5	0.5	0.5
Etenia 457	0	0.25	0.50	0.75	1
Stiviosiode	0	0.02	0.05	0.07	0.1
Sorbitol (70%)	0	2.57	8.08	14.57	18.20
Maltodextrin	0	1.60	4.52	7.446	9.70
Total	100	100	100	100	100

***SNF: Solids not fat** ****DM: Dry matter**
*****CMC: Sodium carboxy methyl cellulose**

Chemical analysis:

Dry matter (DM) was determined by the method, which described in AOAC (2012). The micro-kjeldahl procedure was followed for the determined of total crude nitrogen according to the official method of the AOAC (2012).

Fat Content was determined as according to the method described by AOAC (2012), Fat content for dairy product (ice cream product) was determined using Gerber tube according to Ling (1963).

The ash content was determined and calculated according to AOAC (2012).

The carbohydrates were calculated by difference according to (Pellet and Sossy, 1970) using following equation:

% Carbohydrate = 100 – Sum of (%Protein + %Fat + %Ash).

Caloric value was calculated using the figures of Renner and Renz Schauen (1986)

Total acidity was determined according to AOAC (2012). The pH value of samples was measured by using laboratory pH meter (Acumen portable AP61, Fisher Scientific) in 10 ml of samples as described by AOAC (2012).

Physical properties:

Specific gravity was determined according to Khalil and Blassy (2011).

Apparent viscosities of mixes were determined using a Bohlin coaxial cylinder viscometer (Bohlin Instrument Inc., Sweden) and expressed as mPa according to (Atallah and Barakat, 2017).

Overrun percentage was determined according to Pon *et al*., 2015 by using the following equation:

$$On\ \% = 100\ (Wm - Wic)/Wic$$

Where:

On (%) is the overrun percentage
Wm (g) is the weight of a given volume of mix
Wic (g) is the weight of same volume of ice milk

Melting rate was determined by using iron wire mesh screen (Analysensieb, Retsch, D-5657 Haan, and Germany) and carried out according to the method of El-Nagar *et al*. (2002) with some modifications.

Sensory properties of both ice cream and frozen samples were evaluated by a panel of 10 trained, expert, and specialized judges from the staff members of the dairy department, Faculty of Agriculture, Damietta University. The applied arbitration card suggested by (Kaul *et al*., 1982) was used.

RESULTS AND DISCUSSION

Chemical composition of low-calories and low-fat Ice cream samples:

Chemical characters of Ice cream mixes containing different level of fat replacer and sweetener are presented in Table (2). It could be not that these replacements had no significant or clear differences in dry maters and total protein among all treatments as well as the total solid content was adjusted in all treatments and control to 37%. These slight changes in dry matters and protein percentage of different Ice cream mixes could be related to the slight differences in weight of formula ingredients in the mix. The control and T2 treatments gained the highest and lowest values of dry maters respectively. However, the corresponding values for protein contents were 4.00, 3.9, 3.88, 4.11 and 4.02% for C, T_1, T_2, T_3 and T_4, respectively. These observations are comparable with those reported by (Arbuckle, 1972).

Fat contents were pronouncedly varied where control samples contained 9.7%. This value was decreased to be 7.2, 4.8, 3.2 and 0.1% in T_1, T_2, T_3 and T_4, respectively. These reduces are logic as the replacement of milk fat with fat replacer and achieve the target of this study.

For ash content, it could be observed that it was slightly decreased with increasing the ratio of supplements added in the blend. This decrease may be due to lower ash content in ingredients compared with control as mentioned in Table (2). These data were in compatible with those reported by (Arbuckle, 1972).

For caloric values, there were significant changes in their numbers. Control sample gained the highest value (177.3 Kcal/100g), while T_4 have the lowest value (60.30 Kcal/g). So, it can be observed that the aim of this research was achieve and it can prepare low calories Ice cream for the individual people.

No clear variations were observed in the pH values between the treatments and control. All values were ranged among Their values were 6.50 to 6.44. The same trend was not for acidity percent; where it was ranged between 0.23%

in control and 0.23% in T_1. These results were paralleled with findings of (El-Batawy *et al*., 2019).

Table 2. Chemical characters of low-fat & low-calories Ice cream mix.

Property	Treatments				
	C	T_1	T_2	T_3	T_4
Dry Matter %	35.49	35.32	34.80	34.84	34.77
Fat %	9.7	7.2	4.8	3.2	0.1
Protein%	4.00	3.90	3.88	4.11	4.02
Ash%	1.201	0.950	0.930	0.900	0.840
Caloric value (Kcal/100g)	177.3	150.5	125.2	95.1	60.30
pH value	6.45	6.44	6.44	6.46	6.50
Acidity%	0.23	0.23	0.24	0.25	0.26

C: 0 replacement; T_1: 25% replacement; T_2: 50% replacement; T_3: 75% replacement; T_4: 100% replacement.

Physiochemical Properties:

The specific gravity of the Ice cream samples fortified with different ratios of Etenia 457 and Sativoside were presented in Table (3). Its value for control was 1.302. This value was reduced to be 1.203, 1289, 1233 and 1248 for T_1, T_2, T_3 and T_4 in order. It could be not that the specific gravity values were decreased due to using the fat replacer and sweetener. These data were in accordance with those obtained by (Abbas *et al*., 2019).

Table (3), also revealed that viscosity values were increased with an increase of fat replacer and sweetener in the Ice cream formulation. Mixes containing Etenia 457 and Sativoside seemed to be more viscous than control. However, T4 gained the highest value among other treatments and control 23 Mpa. These results are in agree with those obtained by (Alizadeh *et al*. (2014).

Overrun:

Air cells are incorporated into Ice cream mix in the freezing process and lead to an increase in Ice cream volume, measured as overrun. Using fat replacer & sweetener in preparing of low fat & and low calories Ice cream led to decreasing in the overrun values as shown in Table (3). So, the control gained the highest overrun value when compared with other treatments (67). The values of overrun were in opposite with the values of viscosity. The present results are in the average acceptance with those obtained by (Alizadeh *et al*., 2014).

Table 3. Physical properties of resultant low-calorie Ice cream

Character assessed	Treatments				
	C	T_1	T_2	T_3	T_4
Specific gravity	1.302	1.203	1.289	1.233	1.248
Viscosity (Mpa)	14	16	20	21	23
Overrun%	67	65	62	59	55
Melting resistance (loss%) after:					
5 min	2.502	4.923	5.890	6.897	70.74
10 min	17.291	37.461	39.980	43.942	48.567
15 min	33.881	62.372	66.876	50.541	70.543

C: 0 replacement; T_1: 25% replacement; T_2: 50% replacement; T_3: 75% replacement; T_4: 100% replacement.

Melting resistance:

As shown in Table (3), it could be not that there were large variations in the values of melting resistance degrees. Control sample had the best and favorite properties of melting behavior; however, these properties were decreased in the treated samples. After 5 min. C sample possessed 2.502% while T_1, T_2, T_3 and T_4 gained 4.923, 5.890, 6.897 and 70.74% After 5 min. While after 10 min. the values become 17.291, 37.461, 39.980, 43.942 and 48.567% for C, T_1, T_2, T_3 and T_4 samples, respectively. The corresponding values after 15 min researched 33.881, 66.876, 62.372, 50.541 and 70.543% in the same order. These data agree with the findings of several investigators by (Akbari *et al*., 2016)

Organoleptic properties:

Table (4), presents the sensory properties evaluation of resultant Ice cream samples processed with different level of fat replacer and sweetener to produce low calories and low-fat product. The results showed that there were slight differences among all Ice cream treatments in total organoleptic scores. The Ice cream samples containing fat replacer and sweetener had little lower flavor scores than control treatment. The score of flavors were 50, 49, 48, 48 and 45 points for C, T_1, T_2, T_3 and T_4, respectively. This may be due to the lost or lacking milk fat and its natural flavor. Milk fat also plays a significant role in Ice cream flavor during storage because fat acts as a main carrier for important flavor notes. Fat can impact Ice cream flavor in three ways: by contributing to the rich, full and creamy flavor in Ice cream; by participation in hydrolysis and oxidation reactions; by helping in perception of flavorful volatile ingredients in the final product (Prindiville *et al*., 1999).

On the other hand, addition of Etenia 457 and Sativoside to Ice cream formula caused a slight decrease in body & texture properties of final product. The points of body & texture of C sample was 39 while their value increased to 40 in T_1. Their values began to decrease again to reach 38, 36 and 35 in T_2, T_3 and T_4 in order. The melting propertied degrees were varied also. The T_1 sample had the best and favorite melting properties; it possessed 10 points. Both control and T_3 gained 9 points, however T_3 had 7 while T_4 gained 6 scores. For all total acceptability, T_1 samples (25% replacements) gained the higher scores (99 points). The control possessed 99 followed by T_2 (95 points); T_3 (91 points) and then T_4 which gained 86 points. Generally, panelists preferred the samples containing stevia and cocoa to others. But, Yogiraj *et al*. (2014) determined that the increase of stevia amount added to Ice-cream samples were decreased the sensory quality. These data agree with the findings of several investigators by Thomas *et al*.,(2016).

Table 4. Organoleptic scores of resultant low fat and low calories Ice cream samples.

Property (points)	Treatments				
	C	T_1	T_2	T_3	T_4
Flavor (50)	50	49	48	48	45
Body & texture (40)	39	40	38	36	35
Melting quality (10)	9	10	9	7	6
Total score (100)	98	99	95	91	86

C: 0 replacement; T_1: 25% replacement; T_2: 50% replacement; T_3: 75% replacement; T_4: 100% replacement.

CONCLUSION

It could prepare an ice cream with low fat contents and low calories to be more suitable for individual people. No clear or significant variations were observed between the data obtained for ice cream from the properties which were studied. Finally, it could conclude that, Etenia 457 could be successfully used as partial fat mimetic in frozen desserts manufacture until 50%, while Sativoside could preferably be used for frozen desserts sweetening as sugar substitute up to 75%.

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تأثير إضافة الاستفيا والاتنيا 457 علي خصائص الآيس كريم

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تهدف الدراسة الي إعداد عينات من الآيس كريم أكثر ملاءمة للأفراد الذين يحتاجون إلى نسبة منخفضة من الدهون والسكر في نظامهم الغذائي، تم إعداد أربعة معاملات بجانب عينة المقارنة، احتوت عينة المقارنة علي 10٪ دهون و 12٪ سكر و 11٪ SNF و0.5٪ CMC و0.5٪ فانيليا، تم إستخدام 25٪ من 457 Etenia كبديل للدهون و 25٪ Sativoside كمحلي في المعاملة الاولي وفي المعاملات الثلاثة الأخري 50 و 75 و 100٪ من كلا المكونين. تم تصنيع عينات الآيس كريم بإستخدام الطريقة التقليدية، وقدرت الخصائص الفيزيائية والكيميائية للمخاليط ، وأظهرت النتائج عدم وجود فروق واضحة في TS٪ و P٪ و Ash٪ والحموضة وقيم الأس الهيدروجيني في حين ظهرت إختلافات واضحة في محتويات الدهن وقيم السعرات الحرارية بين عينة المقارنة وباقي المعاملات موضع الدراسة. أظهرت النتائج أن الخلطات المحتوية على 457 Etenia و Sativoside كانت أكثر لزوجة من عينة المقارنة، ومن جانب آخر، لوحظ اختلافات كبيرة في درجات مقاومة الانصهار، وكان لعينة المقارنة أفضل الخصائص والأفضلية لسلوك الذوبان؛ ومع ذلك، انخفضت هذه الخصائص في العينات المعالجة بعد 5 دقائق و 10 دقائق وبعد 15 دقيقة. كذلك أظهرت نتائج الخواص الحسية وجود إختلافات طفيفة بين جميع معاملات الآيس كريم، وكانت عينات الآيس كريم المحتوية على بديل الدهن والمحليات ذات درجات نكهة أقل من عينة المقارنة، ومن ناحية أخري، تسببت إضافة 457 Etenia و Sativoside في خلطة الآيس كريم في انخفاض طفيف في خصائص القوام والتركيب للمنتج النهائي، كما إختلفت اجمالي درجات التقييم الحسي بين جميع المعاملات ما عدا المعاملة الاولي وعينة المقارنة حيث حصلت عينة T_1 وعينة المقارنة على (99 نقطة)، تلاهما T_2 (95 نقطة)؛ T_3 (91 نقطة) ثم T_4 الذي سجلت 86 نقطة. من خلال النتائج فإنه يمكن استخدام المواد البديلة للدهن والسكر موضع الدراسة بنجاح في انتاج ايس كريم مناسب لذوي الاحتياجات الخاصة من الدهن والطاقة علي الا تزداد نسب الاستبدال عن 75 %.