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Impact of Taro Corms on Functional Low Fat Ice Cream Properties

Amal I. El- Dardiry[1]; Amal M. Ewis[2] and M. M. Abo-Srea[3]
[1]Dairy Chemistry Department, Animal Production Research Institute, A.R.C., Giza. Egypt
[2] Dairy Technology Department, Animal Production Research Institute, A.R.C., Giza. Egypt
[3] Dairy department, faculty of agriculture, Mansoura University. Egypt

ABSTRACT

The influence of adding Taro corms (*Colocasia esculenta L.)* on the physico-chemical, rheological, and organoleptic properties. Moreover, antioxidant compounds present in ice cream mixtures, and their resultant frozen products was studied. Taro corms , whether fresh or boiled, was added (partial substitute of ice cream mix), at a levels of 10, 20, and 30% , to the mixtures of the experimental treatments, after reducing their fat contents to 4%, and stabilizer/emulsifier mixture to 0.175 % , while the control treatment contained 8% fat, 15 % sugar, 12% MSNF% and 0.35% stabilizer/ emulsifier complex. Results indicated that, dry matter, fiber and pH values, were significantly increased in the mixtures of Taro corms as levels of addition increased. No significant differences were found in the contents of protein, fat, and carbohydrates among the Taro corms treatments. Data also showed significant differences between control treatment and the other Taro corms treatments in TS, fat and ash contents. *Specific* gravity , weight per gallon and freezing points of the mixes containing Taro corms , whether boiled or fresh , were found lower than the corresponding values of the control. Contrarily, viscosity as well as flow time of the Taro corms treatments were higher than that of the control. It could also be noticed an increase in the specific gravity and weight per gallon, and consequently in the overrun and melting resistances of the resultant low fat ice cream made by adding Taro corms. Control treatment characterized with higher values of overrun and melting resistance loss (%) than Taro corms treatments. On the other hand, control treatment had the lowest values of antioxidant compounds. All treatments were organoleptically accepted, and the ice cream with 20% boiled Taro corms characterized with slightly superior sensory properties, compared with the control, followed by 30% and 10% boiled Taro corms, in the same order. It could be recommended that the examined low fat ice cream with added 30% boiled Taro corms was of higher quality after reducing the fat content and stabilizer/emulsifier complex by half.

Keywords: - ice cream, low fat, Antioxidants, Taro corms, physical, chemical properties.

INTRODUCTION

Ice cream is a frozen dairy product, composed of a mixture of food ingredients like milk products, sweetening materials, stabilizers, colors, flavors, and egg products. Ice cream mix is the unfrozen mixture of the all the ingredients of ice cream with the exception of air and flavoring materials. The composition of ice cream is usually expressed as a % of its constituents. Stabilizers are the compounds added in very small quantities to strongly influence the formation and growth of ice crystal in the ice cream and to render the product with desired body and texture, and the total solids.

Taro corms, Colocasia esculenta L., is an annual herbaceous plant from tropical and sub-tropical regions and a member of the Araceae superfamily. It is low cost and widely consumed staple food in the human diet. Its corms provide important nutritional components such as carbohydrates, protein, lipids, Vits. (thiamine, riboflavin, niacin) , minerals, calcium oxalate, oxalic acid , unsaturated fatty acids and anthocyanins, and antioxidants. Taro corms, Further nutritional superiority and easy digestibility of Taro corms, compared with potato, sweet potato, cassava and rice (Van Damme *et al*., 1995, Niba,2003, Tarak *et al*., 2011, Subhash, Sarla, & Jaybardhan, 2012, Lim, Gayathri , 2014 and 2015).

Ice cream is one of the products known as a complicated colloid system, which contains air bubbles or foams dispersing in the unfrozen phase. Air bubbles or foams contribute to a soft texture, light body and retardation of ice cream melting. The volume of air bubbles or foams in ice cream relates to the overrun. The higher the overrun, the softer the ice cream, and the smaller air bubbles, which result in a fluffy texture and less acceptance to the consumers (Marshall, *et al* 2003 and Sofjan and Richard 2004).

To solve these problems and stabilize the air bubbles, quite many studies have been employing stabilizers to inhibit or limit the movement of air bubbles. Stabilizers used in ice cream are normally polysaccharide gums, which serve to enhance viscosity in the ice cream mix. (Chang and Richard 2002 andThaiudom and Goff. 2003). Many Stabilizers are used in ice cream making, e.g. locust bean gum , guar gum, κ-carrageenan and Fulfil 400 (mixture of gums and emulsifier). Stabilizer Replacing stabilizer with enzyme modified starch does not only lower the cost, but might also result in a better texture and lower melting point, and results in the inhibition of freeze-thawing very well (Seib, and Yangsheng 1990 and Zhang, *et al*. 2005).

MATERIALS AND METHODS

Materials:

Fresh buffalo's milk and fresh cream (60% fat) were obtained from the experimental station at Mahalet Moussa, Animal production Research Institute, Egypt. Skim milk powder imported from Holland, commercial grade of granulated sugar cane, vanilla powder (Vanilla (Chem. Rein 100 %) made by Boehringer Manheim GMB, Germany) were used, and Taro corms were obtained from the local market, Cairo, Egypt. A blend of stabilizer and emulsifiers (EXN 9080) was obtained from MIFAD (Misr Food Additives CO., Giza, Egypt).

Preparation of Taro corms:

Taro corms was cleaned, washed, peeled and cut into small pieces. Fresh Taro corms (FC) was mashed well by (electric) mixer, then kept in polyethelene bag under frozen condition (-20° C) until used.

Boiled Taro corms was prepared by soaking the cleaned small pieces of Taro corms in water (1kg Taro corms / 200 ml water), boiled for 10 min, minced and blended to get very fine particles paste, then kept frozen until used.

Chemical composition of Taro corms:-

Results in Table (1) were in agreement with those mentioned by Ezinne and Chinedum (2015).

Preparation of ice cream:

Control mix. was standardized to contain 8% fat, 12% S.N.F, 15% sugar, 0.35% stabilizer/ emulsifier complex. Taro corms were used either fresh or boiled, and added to the experimental treatments at levels of 10, 20 and 30%, reducing the fat content to 4%, and by adding the stabilizer/ emulsifier at 0.175 %, as indicated in Table (2). Mixes were homogenized, heat treated at 85±1°C for about 1 min., followed by rapid cooling to 5°C., and aged at the same temperature for 12 hr. After aging, 0.01% vanilla

powder was directly added to the 4 treatments, before frozen in batch freezer system (Qutofrigor E.21.8, Co., Paris). The frozen ice cream was packed in plastic cups (80 ml) and hardened at -20° C for 24 h before analyses. Ice cream was made according the Arbuckle, (1986)

Table 1. Proximate of average analysis (%) of fresh and boiled Taro corms.

Characteristics	Taro corms	
	Fresh	Boiled
Moisture %	57.25	58.68
Fat %	0.38	0.35
Protein %	6.22	6.13
Carbohydrate %	27.66	26.54
Ash %	3.24	3.11
Fiber %	5.25	5.17
pH value	6.51	6.43
Flavonoids (µg/100g)	88	73
Ascorbic acid(mg/100g)	31.54	29.18
Tanin	0.92	1.84
Carotenoid(µg/100g)	328	273
Ca(mg/100g)	140	136
Mg(mg/100g)	61	58
K(mg/100g)	52	48
P(mg/100g)	45	37
Na(mg/100g)	25	22

Table 2. Formulations of different ice cream mixes (g/kg mix).

Ingredients (g)	Control	Treatments		
		F_1 or B_1	F_2 or B_2	F_3 or B_3
Whole milk (6%fat)	739.0	692.00	575.20	451.70
Cream (60%fat)	60.4	02.00	08.70	21.50
Skim milk powder	47.1	54.00	64.30	75.00
Taro corms	-	100.00	200.00	300.00
Sugar	150	150.00	150.00	150.00
Stabilizer/emulsifier	3.5	1.75	1.75	1.75

$F_{1,2,3}$: Treatments with fresh Taro corms in ratios of 10,20,30% , respectively.
$B_{1,2,3}$: Treatments with boiled Taro corms in ratios of 10,20,30% , respectively

Methods of Analysis:

Dry matter, fat, total nitrogen, ash and fiber were tested due to AOAC, 2007), Specific gravity of the mixes and final frozen products according to Winton, (1958). The weight per gallon (kg) of ice cream mixes and the final frozen products were calculated as described byKessler, (1981), by multiplying the specific gravity of the mixes by the factor 3.793. Freezing points of the ice cream mixes were detected as given by FAO report, (1977), by using Digital thermometer (Digi-temp D 200/20, Germany). Overrun percent was calculated as mentioned by Wild and Clark, (1996), Melting resistance of the resultant ice cream by Segall and Goff, (2002), viscosity of ice cream mixes by Toledo , (1980) using Brookifield DV- E viscometer, minerals as mentioned in AOAC, (2007) using atomic absorption spectrometer. Free radical scavenging activity (RSA) of the (Brand-Williams *et al.,* 1995), and the total flavonoid contents of ice cream samples as described by Jia- Zhishen *et al*., (1999).

The pH value was measured using a pH meter, using Lab. pH meter with glass electrode, (Hanna digital pH meter). Carbohydrate contents of all samples were calculated by difference.

Sensory evaluation

The organoleptic properties of ice cream were evaluated by a taste panel of 12 panelists of Dairy Chemistry Department and Dairy Technology Department, Animal Production Research Institute, according to Marshall *et al.* (2003).

Statistical analysis

Data obtained (mean of three replicates) were statistical analyzed according to statistical analyses system user's guide (SAS, 1996).

RESULTS AND DISCUSSION

Table (3) shows the chemical composition of ice cream mixes made with different levels of Taro corms, whether fresh or boiled. Results indicated that the supplementation by Taro corms led to slight increase but significant differences in the total solids (T.S) contents of the Taro corms mixes. Contents of fat, protein, ash and carbohydrates were not significant differences, while the fiber increased significantly ($p<0.0001$) by increasing the levels of Taro corms. Furthermore, no significant differences were noticed between control and other treatments in protein and carbohydrates contents. Control mix. contained higher TS and fat content than the other treatments.

Table 3. Chemical composition of functional ice cream mixes fortified with fresh or boiled Taro corms.

Treatments	T.S %	Fat %	Protein %	Ash %	Fiber %	Carbohydrate* %
Control	35.816^{a}	8.05^{a}	4.712^{a}	1.132^{a}	-	21.922^{a}
			Ice cream with fresh Taro corms			
F_1	31.980^{u}	4.00^{v}	4.78^{a}	1.240^{v}	0.170^{c}	21.69^{a}
F_2	32.564^{c}	4.00^{v}	4.91^{a}	1.346^{v}	0.342^{v}	21.866^{a}
F_3	33.032^{v}	4.10^{v}	5.12^{a}	1.414^{v}	0.521^{a}	22.047^{a}
			Ice cream with boiled Taro corms			
B_1	31.825^{u}	4.00^{v}	4.74^{a}	1.230^{v}	0.167^{c}	20.688^{a}
B_2	32.430^{c}	4.00^{v}	4.90^{a}	1.339^{v}	0.340^{v}	21.851^{a}
B_3	33.012^{v}	4.10^{v}	5.10^{a}	1.410^{av}	0.518^{a}	21.984^{a}

Chemical composition of ice cream mixes: * Culculated by difference. $F_{1,2,3}$: Treatments with fresh Taro corms in ratios of 10,20,30% , respectively.
$B_{1,2,3}$: Treatments with boiled Taro corms . in ratios of 10,20,30% , respectively.
The means with the same letter at any position were not significant differ (P>0.05).

Table (4) shows the effect of Taro corms substitution of fat and stabilizer/ emulsifier on some properties of ice cream mixes. The specific gravity, and freezing point gradually increased ($p<0.0001$) with the increase of the added Taro corms levels. The higher freezing point in treatments of Taro corms could be due to the effect of T.S % differences and molecular weight of the solutes in the mix on the freezing point. (Marshall *et al*., 2003).

pH values had slightly increased with the progress of Taro corms level. Moreover, fresh Taro corms treatments were had slightly increase in pH values when compared with boiled ones. There were significant differences between the control and the other ones in the former parameters.

As appeared from the Figures (1&2), the addition Taro corms significantly increased ($p<0.0001$) the flow time and viscosity of the mixes. The differences in flow time and viscosity values between control and *Taro corms* treatments could be due to the differences in the chemical composition of these mixes (Table, 1). *Taro corms* is known to contain a high amount of starch, which is able to be gelatinized during the heat treatment, therefore, it may increase the viscosity and flow time of the resultant ice cream mix. Similar results were reported by Awad (2007). Results also revealed that the viscosity and flow time of the ice cream mixes were lower when fresh than in boiled Taro corms.

Table 4. Physical properties of functional ice cream mixes.

Treatments	Specific gravity (g/ml)	Weight per gallon(kg)	Freezing point (°C)	pH value
Control	1.1809[b]	4.4792[b]	-2.2[a]	6.1[d]
	Ice cream with Taro corms			
F_1	1.0574[g]	4.0107[g]	-2.25[b]	6.15[c]
F_2	1.0985[f]	4.1666[f]	-2.31[c]	6.21[b]
F_3	1.1204[e]	4.2497[e]	-2.37[d]	6.30[a]
	Ice cream with boiled Taro corms			
B_1	1.1241[d]	4.2637[d]	-2.37[d]	6.13[cd]
B_2	1.1613[c]	4.4048[c]	-2.43[e]	6.18[bc]
B_3	1.1843[a]	4.4920[a]	-2.48[f]	6.24[ab]

Physical Properties of the resultant ice cream:

Results presented in Table (5) revealed that the physical properties of ice cream were affected by the level of added Taro corms. Both specific gravity and weight per gallon of the resultant ice cream gradually increased by the proportional increase of Taro corms substitution ($p<0.0001$), which could be explained on the basis of the increase of the overrun, which gained ($p<0.0001$) in the resultant ice cream. Also, as the level of Taro corms content in the mix. increased, the melting resistance significantly increased, and Ice cream contains 30% of boiled *Taro corms* significantly exhibited the highest loss in the melting resistance ($p<0.0001$) . Overrun was found, generally, higher in control ice cream than in the other Taro corms treatments, and melting resistance differently behaved . It is, noteworthy; to mention that there is a positive relationship between the melting resistance and freezing point of ice cream.

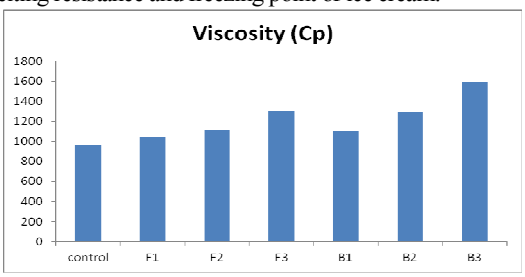

Figure 1. Viscosity of functional ice cream mixes

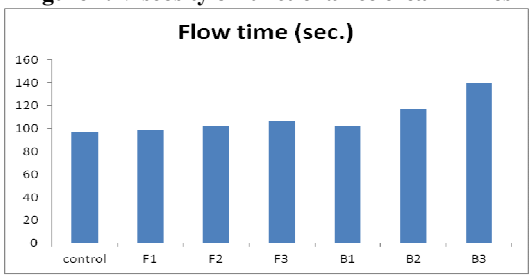

Figure 2. Flow time of functional ice cream mixes.

Table 5. Physical properties of the resultant functional ice cream.

Treatments	Specific gravity	Weight per Gallon (kg)	Overrun %	Melting resistant loss% after (min)					
				15	30	45	60	75	90
Control	0.6863[d]	2.6032[c]	72.06[a]	18.5[a]	42.63[a]	76.75[a]	86.12[a]	97.5[a]	100
			Ice cream with fresh Taro corms						
F_1	0.6857[e]	2.6008[d]	54..21[f]	15.2[b]	27.14[b]	62.71[b]	79.32[b]	96.3[a]	100
F_2	0.6881[b]	2.6099[b]	59.65[e]	12.1[c]	23.56[c]	59.71[c]	78.42[c]	92.5[b]	100
F_3	0.6925[a]	2.6267[a]	61.89[d]	4.68[d]	19.82[d]	56.33[d]	77.23[d]	88.4[c]	100
			Ice cream with boiled Taro corms						
B_1	0.6699[g]	2.541[g]	67.80[c]	3.99[e]	14.83[e]	40.84[e]	71.13[e]	86.3[d]	100
B_2	0.6812[f]	2.5769[f]	70.93[b]	0.0[f]	12.90[f]	37.56[f]	64.15[f]	72.1[e]	100
B_3	0.6867[c]	2.5977[e]	72.92[a]	0.0[f]	10.18[g]	34.92[g]	61.13[g]	64.9[f]	100

Antioxidant activity :

The effect of adding different ratios of Taro corms on the radical scavenging activity (RSA) of the resultant ice cream are illustrated in Table (6). Supplementation with Taro corms increased significantly the (RSA) in the resultant ice cream. As the level of Taro corms increased, the values of (RSA) increased. (RSA) of fresh Taro corms treatments (supplemented with 10, 20 and 30%) were 40.22, 46.03 and 51.28 respectively, while the corresponding values of boiled ones were 39.02, 45.11 and 50.07 , in order . This means that the addition of Taro corms , whether fresh or boiled, resulted in significant increase in the values of RSA in the resultant ice cream, compared with the control. This supports and encourages the use of Taro corms (as a result for its nutritional and healthy benefits) in the production of low fat functional ice cream . These results were Similar to results reported by Ezinne Awad and Chinedum Eleazu (2015).

Sensory evaluation of ice milk

Color was not affected by the addition of boiled Taro corms and low level of fresh one (10%), while the body and texture & melting resistance were improved. Ice cream supplemented with fresh Taro corms gained slightly lower score points in the body and texture & melting resistance. Treatment with added 20 % boiled Taro corms gained slightly higher organoleptic scores points, compared to the other treatments including the control. On the other hand , treatment supplemented with 30 % fresh Taro corms achieved the lowest scores.

Table 6. Antioxidant activity (%) of functional ice cream.

Treatments	Antioxidant activity (%)
Control	25.14[d]
	Ice cream with fresh Taro corms
F_1	40.22[c]
F_2	46.03[b]
F_3	51.28[a]
	Ice cream with boiled Taro corms
B_1	39.02[c]
B_2	45.11[b]
B_3	50.07[a]

Table 7. Organoleptic properties of functional ice cream.

Treatments	Flavor (45)	Body& texture (35)	Appearance &color (10)	Melting properties (10)	Total score (100)
Control	45[a]	35[a]	10[a]	9[ab]	99[a]
			Fresh Taro corms		
F_1	44[a]	32[b]	10[a]	7[c]	93[c]
F_2	44[a]	32[b]	9[a]	8[bc]	93[c]
F_3	42[a]	33[ab]	8[a]	9[ab]	92[c]
			Boiled Taro corms.		
B_1	45[a]	33[ab]	10[a]	9[ab]	97[b]
B_2	45[a]	35[a]	10[a]	10[a]	100[a]
B_3	45[a]	34[ab]	9[a]	10[a]	98[ab]

CONCLUSION

The processing of low fat ice cream with functional properties can be applied by using Taro Corms either fresh or boiled by substitution on ice cream mix until 30%. The final product characterized by the same properties which are in the full fat product and have an increasing on the antioxidant compound.

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تأثير استخدام كورمات القلقاس علي خواص الايس كريم منخفض الدهن

أمل إبراهيم الدرديرى[1]، أمال محمد عويس[2] و متولى محمد ابوسريع[3]

[1] قسم كيمياء الألبان، معهد بحوث الإنتاج الحيواني،مركز البحوث الزراعية، جيزة، مصر

[2] قسم تكنولوجيا الألبان، معهد بحوث الإنتاج الحيواني، مركز البحوث الزراعية، جيزة، مصر

[3] قسم الألبان،كلية الزراعة، جامعة المنصورة

لدراسة تأثير اضافة القلقاس الطازج أو المعامل بالغليان الي الايس كريم منخفض الدهن والمثبت علي الخواص الكيماوية والطبيعية والريولوجية والحسية والمحتوي من مضادات الاكسدة. تم اضافة 10 , 20, 30 % من القلقاس الطازج أو المعامل بالغليان الي مخلوط الايس كريم لانتاج ايس كريم منخفض الدهن (4 % دهن , 0.175 % , 15 % سكر , 11 % جوامد مصل) ومقارنة صفات الناتج النهائي بعينة مقارنة محتوية علي (8 % دهن , 0.35 % , 15 % سكر , 11 % جوامد مصل). أوضحت النتائج ارتفاع محتوي معاملات القلقاس سواء الطازجة أو المعاملة بالغليان من مضادات الاكسدة واللزوجة عن عينة المقارنة في حين انخفضت قيم الوزن النوعي والكثافة ونقطة التجمد والمقاومة للانصهار في جميع معاملات القلقاس (الطازج والمعامل بالغليان) مقارنة بالكنترول. ارتفعت قيم المادة الصلبة والالياف والوزن النوعي والكثافة والمقاومة للانصهار فيما بين معاملات القلقاس مع ارتفاع نسبة الاضافة سواء الطازجة او المعاملة بالغليان في حين لم توجد فروق معنوية فيما يتعلق بالدهن والبروتين والكربوهيدرات وكانت جميع هذه القيم في معاملات القلقاس بنوعيها اقل من الموجودة في عينة المقارنة. حققت جميع معاملات القلقاس الطازج والمعامل بالغليان درجات تقييم حسي مقبولة وكانت افضلها معاملات القلقاس المغلي المحتوي علي 20 % مقارنة بالكنترول تلاها المعاملات المحتوية علي 30 , 10 % علي التوالي. لذا يوصي بإضافة القلقاس المعامل بالغليان بنسب استبدال تصل الي 30 % لعمل ايس كريم منخفض الدهن والمثبت (4 % دهن , 0.175 % مثبت) والمشابه في خواصه للايس كريم المحتوي علي نسب مرتفعة من الدهن والمثبت (8 % , 0.35 % علي التوالي) للاستفادة بالفوائد الصحية والاقتصادية المتعلقة بعملية الاضافة.