World Journal of Dairy & Food Sciences 10 (2): 154-158, 2015
ISSN 1817-308X

DOI: 10.5829/idosi.wjdfs.2015.10.2.101168

Production of Healthy Ice Milk Using Stevia Extract as a Sweetener

H.M. Ali, E.A. Ahmed and KH.M. Adel

Department of Dairy, Faculty of Agriculture, Al Azhar University, Cairo, Egypt

Abstract: In this research, the suitability of using stevia extract as an alternative natural sweetener in making ice milk was studied. For this aim, five ice milk treatments were produced.Sucrose of ice milk mix was replaced by stevia extract at ratio 0,25,50,75 and 100% to make five formulations; control, T1, T2, T_3 and T_4 respectively. All treatments were analyzed chemically, organoleptically and microbiologically. Stevia ice milk had a higher melting resistant and a higher overrun while the total cost and the caloric value decreased compared to the control. Ice milk prepared by replacing 25% and 50% sucrose with stevia extract was adjudged on par with the control in sensory characteristics. Above 50% sucrose replacement led to low sensory properties.

Key words: Natural Sweetener · Chemical Composition · Organoleptic Analysis · Overrun

INTRODUCTION

Ice milk has a high nutrition value and is well assimilated by body. Therefore, it is largely consumed by different age groups. Ice milk is a mixture of milk, fat, sugar and stabilizer and sometimes contain taste/flavor and colored agent. The high sugar content of ice milk makes it in contradiction with the concept of healthy diet. Due to increasing the consumer demands and awareness for low calorie and functional foods, products made with alternative sweetener have become more popular recently. The incidence of metabolic disorders such as diabetes, cardiovascular disease, obesity is increasing depending on excessive consumption of sugar (glucose, fructose and sucrose) used in ice milk production. Therefore, the sucrose amount must be decreased for diabetic patient diets [1]. Alternative sugar such as saccharin aspartame and stevia can be used as sweeteners at foods [1]. Stevia is a plant growing in South America, China and South Korea. Stevia is a natural sweetener obtained from the leaves of *Stevia Rebaudiana* (*Bertani*). Stevia rebaudiana been selected as a source of the stevioside. Steviosides are considered to be a promising sugar substitute of non- caloric value and high sweetness. So the purpose of this study was to optimize the level of sucrose replacement with stevia extract in ice milk without affecting physicochemical and sensory properties of the product.

MATERIALS AND METHODS

Materials: The ingredients used in this research were fresh skim milk and fresh cream (40% fat and 7% Solids Not Fat; S.N.F) which was obtained after separation the fresh buffalo's milk ; supplied by the farm of Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.Anatural sweetener obtained from the leaves of Stevia rebaudiana plant which was purchased from Sugar Crops Institute, Giza, Egypt. Commercial grade granulated sugar cane (Sugar and Integrated Industries CO. Egypt), vanilla and Pectin were purchased from local markets. Indian carboxy methyl cellulose (C.M.C) (high viscosity minimum assay 95%) was purchased from local markets. Skim milk powder (S.M.P) (34% protein, 1.23 fats and 4% moisture) was obtained from The Nile Commercial CO.,Cairo, Egypt.

Methods

Extraction and Purification of Stevioside from Stevia Plant: The dried ground leaves of Stevia plant were extracted by water according to Nishiyama *et al*. [2]. The dried ground leaves were mixed with hot water (65°C) at different percentage of powder leaves/water ratio of 1:15, 1:25, 1:35, 1:45, 1:55, 1:65 and 1:75 (w/v). Stevia leaves were extracted by using hot water for 3 h as follow: The crude extract containing stevioside was filtered through Whatman No. 4 filter paper (filtrate A) and purified by addition of 5% Ca $(OH)_2$ (based on wt. of dried

Corresponding Author: H.M. Ali, Department of Dairy, Faculty of Agriculture, Al Azhar University, Cairo, Egypt.
E-mail: heshamsary77@gmail.com.

leaves). The addition of Ca $(OH)_2$ was repeated twice (filtrate B and C) and the filtrates were collected, passing through ion exchange column (packed with Amberlite IR-4B resin) to remove the undesirable colors at a rate of 1 ml/sec at 25°C. The elute (clear and colourless solution) containing stevioside was collected (in which pigments were adsorbed on resin) and then concentrated by using rotary evaporator at 45°C to the maximum concentration value. At each step total soluble solids (TSS), pH, Stevio side depigmentation and recovery were determined [3, 4].

Manufacture of Ice Milk: Ice milk ingredients (buffalo's skim milk, skim milk powder, sugar and CMC) were mixed to obtain ice milk mix consisted of 5% milk fat, 14 % milk solids not fat (MSNF), 15% sucrose and 0.5 % stabilizer [5] and divided to five portions. Sucrose of ice milk mix was replaced by purified stevia extract at ratio 25, 50, 75 % and 100% to create four treatments noting that 0.2 % pectin was added to the previous treatments to improve the body that can result from lack of sucrose. The latter served as a control (without purified Stevie extract). All ice milk mixes were pasteurized at 81°C/5sec. and aged overnight at 4.0±2°C. Just before freezing in a batch freezer (at –5°C for 5-10min.), 0.06 % vanilla was added to each mix. The resultant ice milk was filled into plastic cups, covered and hardened in a deep freezer at –30°C for 24 h before analysis. Three replicates were made from each treatment [6].

Analysis of Ice Milk Mix: pH value was measured using a Swiss Gallenkampstick pH meter with glass electrode. Moisture, fat, total nitrogen (TN) and Ash contents of ice milk were determined according to AOAC [7]. The protein content was obtained by multiplying the percentage of TN by 6.38 for milk ingredients and 6.25 for plant ingredients. Carbohydrate content was calculated by difference [100 – (moisture + protein + fat + ash)] [8].

Viscosity of ice milk mix was determined using Swiss made viscometer Drug type TV aunevitesse. Readings (CP) were taken after aging using spindle at 4.0±2°C. Three readings were recorded for each mix.

Analysis of Frozen Ice Milk: Overrun was calculated for all treatments using the weight-volume method [9]. Meltdown of frozen ice milk was determined according to Arndt and Wehling [10] by carefully cutting the foamed plastic cups from the ice milk samples (~ 100 gm), placing the samples onto wire mesh over a glass funnel fitted on a conical flask and weighing the amount of ice milk drained into the conical flask at 30°C every 10 min until the entire sample had melted. The total viable bacteria, coliform and moulds & yeasts counts were determined according to APHA [11].

Sensory Properties: Organoleptic propertiesof different treatments were assessed by members of the department according to the following score card [5]. Flavour 30, Body & Texture 30, Melting quality 20 and Appearance 20.

RESULTS AND DISCUSSION

Decrease of total solids of Stevia ice milk occurred when stevia extract was added. So fat, protein and ash percentage increased proportionally in these samples. Carbohydrate percentage was reduced greatly with increased levels of sucrose replacement. However, level of stevia extracted not have a major effect on the freezing point of ice milk mixes. Freezing point depends on number of soluble molecule present in the solution.So whenever the level of sucrose decreased the freezing point increased [12]. It was noticed from the data located in the previous table that the Viscosity values increased with the proportion of stevia extract.Also it could be observed that the pH values were not affected by addition of stevia extract (Table 1).

Results displayed in Table (2) show that the highest percentage of the stevia extract components was the moisture followed by the total carbohydrates, protein and ash respectively. It was also noted that the stevia extract total count and its PH was alkaline.

It was observed from the results presented in Figure (1) that the caloric value of all treatments was lower than that of the control. This is due to decreased level of sucrose which was a major contributor to calorie value in treated samples.

Results in the arbitration diagram (Fig. 2) show that treatment No. 2 and treatment No. 1 have the same sensory properties almost achieved by the control. While the rest treatments had a lower score than the control, the reason for this is due to a lack of total solids with them as a result of the replacement of sucrose with stevia extract.

(Fig. 3) shows the overrun of frozen ice milk as affected by addition of stevia extract. The overrun was lower in the control than that in other treatments. The overrun percentage decreased in the order:

Table 1: Effect of different levels of sugar replacement with Stevia extract on some physico-chemical properties of ice milk mix

Levels of sucrose reduction (%)	Levels of Stevia extract addition (%)	Constituents (%)							
		Total solids	Protein	Fat	Ash	Total carbohydrates	PH	Freezing points	Viscosity
0(control)	0	37	5.6	4.9	1.3	25.12	6.57	-10.6	10
25	25	33.4	5.9	4.94	1.33	21.55	6.49	-10.1	11
50	50	29.5	6	5.11	1.36	17.13	6.88	-9.9	14
75	75	25.6	6.03	5.32	1.4	12.88	6.96	-9.6	15
100	100	20.7	6.3	5.4	1.45	7.55	6.98	-9.4	17

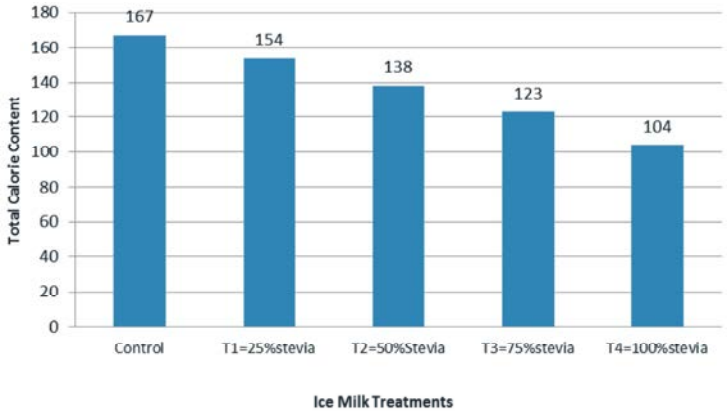

Fig. 1: Effect of different level of sugar replacement with Stevia extract on total calorie content of ice milk treatments.

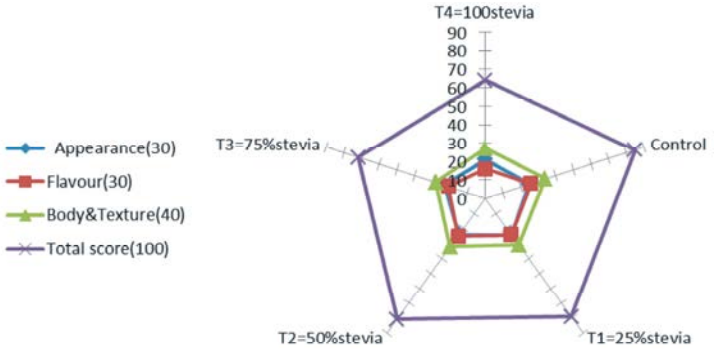

Fig. 2: Effect of different levels of sugar replacement with Stevia extract on organoleptic properties of ice milk mix.

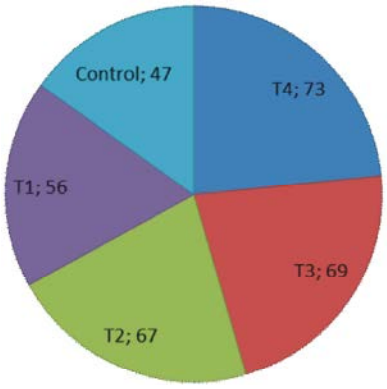

Fig. 3: Effect of different levels of stevia extract on the overrun percentage of frozen ice milk.

T1, 25% of sucrose in ice milk mix substituted with stevia extract; T2, 50% of sucrose in ice milk mix substituted with stevia extract; T3, 75% of sucrose in ice milk mix substituted with stevia extract; T4, 100% of sucrose in ice milk mix substituted with stevia extract.

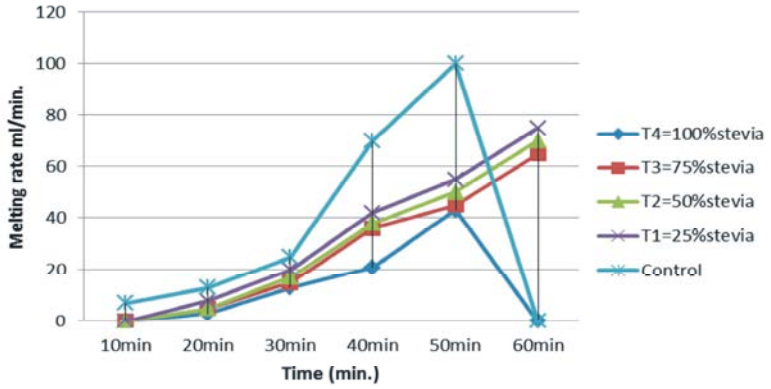

Fig. 4: Effect of different levels of stevia extract on the ice milk melting rate

Table 2: Chemical composition and microbiological analysis of Stevia Extract

	Stevia Extract								
Items	Moisture%	T.S%	Protein%	Ash%	Total Carbohydrates%	PH	Total counts	Coliform	Moulds & Yeasts
	98.5	1.5	0.3	0.134	1.06	10.4	1□10^2 CFU/ml	Not Found	Not Found

Table 3: Effect of different levels of stevia extract on the total viable bacteria, coliform andmoulds&yeasts counts of frozen ice milk

Ice milk treatments	Total counts	Coliform	Moulds & Yeasts
Control	$2x10^4$	NF	NF
T1	$3.1x10^6$	NF	NF
T2	$1.3x10^6$	NF	NF
T3	$1x10^4$	NF	NF
T4	$1x10^3$	NF	NF

NF, not found; T1, 25% of sucrose in ice milk mix substituted with stevia extract; T2, 50% of sucrose in ice milk mix substituted with stevia extract; T3, 75% of sucrose in ice milk mix substituted with stevia extract; T4, 100% of sucrose in ice milk mix substituted with stevia extract.

Table 4: Economical study for the control andstevia ice milk treatments

			Ice milk treatments									
			Control		T1		T2		T3		T4	
Raw materials	Unit	Price (L.E)	Quantity kg.	Value L.E	Quantity kg.	Value L.E	Quantity kg.	Value L.E	Quantity kg.	Value L.E	Quantity kg.	Value L.E
Sucrose	Kg.	4.5	0.375	1.68	0.281	1.26	187	0.84	94	0.42	-	-
C.M.C	Kg	30	0.0125	0.375	0.0125	0.375	0.0125	0.375	0.0125	0.375	0.0125	0.375
Pectin	Kg	60	-	-	0.005	0.3	0.005	0.3	0.005	0.3	0.005	0.3
Vanillin	Kg.	150	0.0006	0.09	0.0006	0.09	0.0006	0.09	0.0006	0.09	0.0006	0.09
Skim buffaloes' milk	Kg.	2.9	1.595	4.6	1.595	4.6	1.595	4.6	1.595	4.6	1.595	4.6
Powder skim milk	Kg.	36	0.202	7.2	0.202	7.2	0.202	7.2	0.202	7.2	0.202	7.2
Stevia leaves	Kg.	40	-	-	0.0025	0.1	0.005	0.2	0.0075	0.3	0.01	0.4
Tap water	L		-	-	0.31	-	0.67	-	0.103	-		
o.138	-											
Total cost of 1Kg.=total cost/2.5				5.54		5.57		5.44		5.31		518

T1, 25% of sucrose in ice milk mix substituted with stevia extract; T2, 50% of sucrose in ice milk mix substituted with stevia extract; T3, 75% of sucrose in ice milk mix substituted with stevia extract; T4, 100% of sucrose in ice milk mix substituted with stevia extract.

T4> T3> T2>T1> control. The increase in overrun percentage could be attributed to the better functional properties (whipping ability) of pectin, stevia extract and the increasing viscosity [13] [14].

The results in Figure (4) indicated that the melting resistance of ice milk increased with increased percentage of stevia extract. This may be due to the increase in viscosity of ice milk. Because of stevia extract addition to ice milk mixes probably formed stable gel networks reducing its melting rates [15] [1].

Results presented in Table (3) show the microbiological enumeration in frozen ice milk treatments. It was obvious from the results that the total counts of bacteria in frozen ice milk containing 50,75 and 100% stevia extract decreased in proportion to increase the replacement of sucrose by stevia extract. The decrease in total counts of bacteria may be attributed to the high viscosity and the lack of available water in frozen ice milk containing stevia extract. Also, it could be observed that the coliform bacteria and moulds & yeasts were absent in all frozen ice milk treatments.

Economical Study for Stevia Ice Milk Mixes: The economic costs for the different ice milk mixes were discussed in this part. Table (4) shows the price list for the raw materials which were used in ice milk mixes. It was obvious from the same Table, the total cost for 1 kg of different ice milk mixes were 5.54, 5.57, 5.44, 5.31 and 5.18 (L.E) for control, T1, T2, T3 and T4 respectively. From these values it could be observed that the total cost of 1 kg frozen ice milk containing purified stevia extract was equal to the control price while the cost of rest treatments decreased by 2-6.5% about the control. This decrease could be attributed to the lower price of purified stevia extract when compared to the price of sucrose.

REFERENCES

1. Ozemir, C., E. Dagdemir, S. Ozdemir and O. Sagdic, 2008. The effect of using alternative sweeteners to sucrose on ice cream quality. Journal of Food Quality, 31(4): 415-428.
2. Nishiyama, P.M. Alvarez and L.G. Vieira, 1992. Quantitative analysis of reflectance spectroscopy. J. Sci. Food Agric., 59: 277-281. Make references like this style.
3. Brandle, J.S.A., 1998. *Stevia rebaudiana*: Its agricultural, biological andchemical properties (Review). Can. J. Plant Sci., 78: 527-536.
4. Esmat Abou-Arab, A., A. Azza Abou-Arab and M. Ferial Abu Salem, 2010. Physico-chemical assessment of natural sweeteners steviosides produced from *Stevia rebaudiana* bertoni plant. African Journal of Food Science, 4(5): 269- 281.
5. Marshall, R.T., H.D. Goff and W.R. Hartel, 2003. Ice cream. 6th ed. Kluwer Academic/Plenum Pub., NY, USA
6. Arbucle, W.S., 1996. "Ice-cream". 5td ed., Chapon & Hall, New York, U.S.A.
7. AOAC, Association of Official Analytical Chemists, 2007. Official Methods of Analysis. 18th ed., Benjamin Franklin Station Washington, D.C., USA. Make references like this style.
8. Apurba Giri, H.G. Ramachandra Rao and V. Ramesh, 2012. Effect of partial replacement of sugar with stevia on the quality of kulfi. J. Food Sci. Technol., DOI 10.1007/s13197-012-0655-6
9. Adapa, S., H. Dingeldein, K.A. Schmidt and T.J. Herald, 2000. Rheological properties of ice cream mixes and frozen ice creams containing fat and fat rMarshel, R.T. and W.S. Arbuckle, 1996. "Ice – cream". 5td ed., Chapon & Hall, New York, U.S.A.
10. Arndt, E.A. and R.L. Wehling, 1989. Development of hydrolyzed and hydrolyzed isomerized syrups from cheese whey ultrafiltration permeate and their utilization in ice cream. J. Food Sci., 54(4): 880-884.
11. APHA (American Puplic Health Association, 1992. Compendium of methods for the microbiological examination of foods. 3TH. ED. (APHA).Washington, DC.
12. Savita, S.M., K. Sheela and S. Sharan, 2004. Stevia rebaudiana – a potential component for food industry. Trends Carbo Chem., pp: 9-14.
13. Ozemir, C., E. Dagdemir, S. Ozdemir and O. Sagdic, 2008. The effect of using alternative sweeteners to sucrose on ice cream quality. Journal of Food Quality, 31(4): 415-428.
14. Pon, S.Y.W.J. and G.H. Chong, 2015. Textural and rheological properties of stevia ice cream. Department of Food Technology, Faculty of Food Science and Teghnology, University Putra Malaysia, 43400, Serdang, Selang, Malaysia.
15. Arbucle, W.S., 1986. "Ice-cream". 4th Ed., the AVI puplishing CO. Inc. West port. Connecticut, U.S.A.
16. El-Nagar, G.F. and V. Kuri, 2001. Rheological quality and stability of yog-ice cream with added fibers. In the Proceedings of the 8th Egyptian Conference of Dairy Sci. and Tech., pp: 525.