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Chia Seeds as Natural Stabilizer and Healthy Ingredient in Ice Milk Preparation

[1]Wafaa Mohamed Zaky, [1]Hayam Mohamed Abbas,
[2]Waheed Ibrahim Abd El-Aziz Nasr and [3]Waheed Ibrahim El-Desoki

[1]Dairy Department, National Research Centre, Giza. Egypt
[2]Dairy Technology Department,
Animal Production Research Institute Agriculture Research. Center, Giza, Egypt
[3]Dairy Department, Faculty of Agriculture Al-Azhar University Assiut Branch,Assiut, Egypt

Abstract: Background and aim: There is evidence for using natural materials and healthy ingredients in food processing. Stabilizers are usually used in dairy sector to thicken the body and improve the texture. Chia seeds are super food and have a good stabilizing behavior. So the aim of this article is to prepare ice milk with whole chia seeds instead of the commercial carboxy methyl cellulose (CMC). Materials and Methods: Four treatments were done, the first was manufactured with 0.5 % CMC and used as control. The other three treatments were prepared using 4, 6 and 8% (w/w) whole chia seeds to serve T1, T2 and T3 respectively. All treatments were used in ice milk manufacture to evaluate as stabilizer. Results: results showed that the pH values of ice milk treatments decreased as chia level increased and the acidity took an opposite trend. The specific gravity and weight per gallon also had the same trend. The overrun and viscosity considerably increased as chia level increased specially in T3. The resistance for melting was highly reduced as a result of chia seeds fortification. The rate of reduction was parallel with the chia level. Light-microscope examination showed that using chia seeds led to obtain homogenized structure and harmony distribution of air cells through the matrix. Conclusion: It could be concluded that using whole chia seeds powder improved the physical properties of ice milk samples and developed their melting quality beside their effect in enhancing the nutritive value of the final product. Supplementation with 6% chia seeds considered the most favorable and recommended treatment.

Key words: Ice Milk · Stabilizer · Chia Seeds · Viscosity

INTRODUCTION

Food producers generally used different ingredients in their industries such as colors, emulsifiers and stabilizers. The industry is always in need to update and improve the product quality and safety for consumers.

Hydrocolloids or food gums are widely used in food due to their ability to retain water. Among all those hydrocolloids, chia seed is considered strongly hydrophilic, capable of absorbing several times of their weight in liquids or water [1]. Chia (*Salvia hispanica* L) is a plant categorized under the mint family (*Labiatae*), super-division of Spermatophyte and kingdom of Plantae. Chia seed can be utilized as a coating with improved functional properties [2].Generally; Chia can be used as whole seeds, seed flour, mucilage, gel and butter. Its seeds have highly nutritive value; it contain about 90-93% dry matter; 15-25% protein; 30-33% fats; 26- 41% carbohydrates; 18-30% dietary fiber and 4-5% ash beside minerals especially calcium & iron as well as vitamins A& B [3]**.** It also possessed a high amount of antioxidants [4]. Generally; different researchers recommended the nutritive value and clinical effect of chia [5-7]**.** The approval of chia seed as a novel food, by the European Parliament, has led to high degree of its usage in a wide range of food products such as chocolate, tortillas, jam and beverages [3].

In dairy sector, some work was done. Where chia flour is used in manufacture of Soft cheese and yogurt also yoghurt mousse fortified with whole chia seeds was done [3]. Recently, chia gel was prepared to be used in ice cream preparation [4].

Corresponding Author: Hayam Mohamed Abbas, Dairy Department, National Research Centre,
33th El- Bohooth St. Giza. Egypt. Tel: + 2 01220634193; E-mail: prof.hayamabbas@yahoo.com.

Ice cream and ice milk are delicious and fancy dairy products consumed by all ages. They are complex food consists of small air cells dispersed in a partially frozen continuous aqueous phase. The quality of the final product is mainly related to the stabilizers or used gums. The stabilizer improve mouth feel by increasing the viscosity of the mix, enhance air incorporation, air cell distribution, consistency, storage stability as well as the melting properties [8]. Stabilizers also minimize the development of large crystals and ultimately to get desirable structure in ice cream [9, 10].

So; the present study is an attempt to replace the chemical stabilizer (CMC) with the whole seeds of chia plant to prepare functional and healthy ice milk.

MATERIALS AND MATHODS

- Fresh buffalo milk (16.4% T.S; 6.5% fat and 3% protein) was obtained from the Dairy Production Unit, Animal Production Res. Inst. Agric. Res. Center. Giza Egypt.
- Sweet cream (65% fat) which was laboratorial prepared.
- Skim milk powder (96% T.S); commercial sucrose and cacao powder (84 % TS; 3 % lipid and 3% protein) were purchased from the local market.
- Carboxy-methyl cellulose (CMC); as stabilizer; was obtained from the Pharmaceutical Chemicals Nasr. Co., Abo-Zaabel, Qalubia, Egypt.
- Chia seeds (*Salvia hispanica* L) in the form of packed whole seed was obtained from Bob's Red Mill Natural Foods Inc. Milwaukie, OR97222 U.S.A. the chemical composition was recorded in percent as

Total solid	96.60
Dietary fiber	24.50
Fat	33.16
Protein	21.34
Ash	04.60
Carbohydrate	16.00

In the present study, we used chia seeds in concentrations of 4, 6 and 8% as preliminary panel testing indicated that such percentages were accepted, while 2 and 10% chia seeds were rejected due to poor sensory properties.

Ice Milk Processing: Ice milk was manufactured according to Marshall *et al.* [11].

Whole buffalo milk was heated to 40°C and separated into cream (65% fat) and skim milk (10.5% S.N.F) by using mechanical separator (Cerezo).

Four Mixes Were Prepared As:

- Control mix (C) containing 4% fat, 11% SNF, 16% sucrose and 0.5% CMC
- Treatment mixes 1-3 (T1, T2 and T3) containing the same constituents in addition to whole chia seeds (4, 6 and 8%, respectively) blended with the mixture instead of CMC and the above mentioned formula was re-adjusted. All powder materials such as sugar, stabilizer, skim milk powder and cacao (2%) were mixed with fresh skim milk for 2 min. then the cream was blended. All components were added slowly and dissolved by using a mixer (Heidolph No. 111, Type RZR1; Germany) to reach a complete hydration. Ice milk mixes were homogenized (EURO TURRAXT 20b, IKA lobortechnik 27000 minG1) at 60°C for 5 minThe mixes were pasteurized at 81°C /15sec, cooled to 5°C, aged overnight at 5.0±2°C then frozen in a batch freezer (Ice cream freezing machine type IGLC, Italy). The resultant ice milk was filled into plastic cups, covered and hardened in a deep freezer at -18°C for 24 h before analysis.

Analytical methods

Physicochemical analyses

Total solids, fat, total protein, ash contents and acidity were measured according to AOAC [12]. The pH value of ice milk mix samples was measured using a laboratory pH meter with glass electrode (HANNA, Instrument, Portugal).

Physical analyses

- Specific gravity of ice milk mix and the final product was measured as mentioned by Abd El-Aziz *et al*. [8].
- Weight per gallon of ice milk mix and resultant product was calculated according to Arbuckle [13].
- Freezing point of ice mix was also measured using thermometer.
- Flow rate of ice milk samples was determined as mentioned recently by Attalla and El- Hussieny [3].
- The overrun of final product was calculated according to Arbuckle [13].
- Melting rate of ice milk samples estimated as mentioned by Bolliger *et al.* [14].

Apparent Viscosity: Apparent viscosity of ice milk mix samples was determined using a Brookfield Synchro- Lectric viscometer (Model LVT; Brookfield Engineering Inc. Stoughton, MA). Readings were taken at the speed of 2-30 sec., in 100 ml ice milk mix at 25°C. Apparent viscosity was expressed as centipoises (CP) as mention by Abd El-Aziz *et al.* [8].

Rheological Properties: Firmness and Gumminess were determined for ice milk samples using the double compression apparatus (Multi test 1d Memesin, Food Technology Corporation, Slinfold, W. Sussex, UK). Experiments were carried out as recently mentioned by Abbas *et al*. [15] using a compression test that generated a plot of force (N) versus time (S). A 25 mm diameter perplex conical-shaped probe was used at five different points on the sample surface. In the 1st stage, the sample was compressed by 80% of their original depth at a speed of 2 cm/min during the pretest, compression and relaxation of the sample. From the force-time curve, the following parameters were determined according to the definition given by the IDF [16].

Firmness (N) = maximum force of the 1st compression
Cohesiveness = area under the 2nd compression/ area under the 1st compression (A2/A1).
Gumminess (N) = Firmness × cohesiveness.

Light Microscope Examination: The internal structure of ice milk samples was achieved using *Light Olympus Microscope* (*CX41*) *CMOS Color Camera* (*SC100*).

Sensory Properties Evaluation: Ice milk samples were evaluated for their sensory properties by regular test panelists from staff members of both Dairy department, National Research Centre and Animal Production Res. Inst. Agric. Res. Center; Giza; Egypt.

The used scores were 10 points for appearance; 10 points for melting quality; 30 points for body and texture and 50 points for flavor according to the score card suggested by Kaul and Mathur [17].

RESULTS AND DISCUSSION

Characteristics of Ice Milk Mixes

Physicochemical Properties: Table (1) showed the chemical composition of the four different prepared formulas of ice milk as well as their acidity percent and pH values. Results revealed that the total solid content ranged between 31.19 to 31.63 % while the fat percent ranged between 3.9 to 4.2 %. Protein content values were from 4.58 to 4.88 % and there were no clear differences in the chemical composition of the different preparations because the formula was previously adjusted in all of them.

Table 1: Characteristics of Ice Milk Mixes Supplemented with Different Levels of Chia Seeds.

	Treatments			
Items	C	T1	T2	T3
Total solids (%)	31.19	31.31	31.56	31.63
Fat (%)	4.2	4.1	4.0	3.9
Total protein (%)	4.58	4.72	4.81	4.88
Ash (%)	0.84	0.86	0.92	0.97
Carbohydrates (%)	21.57	21.63	21.83	21.88
pH value	6.59	6.27	6.15	6.12
Titratable acidity (%)	0.17	0.22	0.25	0.28

C: Control T1: Ice milk with 4% Chia seeds
T2: Ice milk with 6% Chia seeds T3: Ice milk with 8% Chia seeds

Table 2: Physical properties of ice milk mixes supplemented with different Levels of chia seeds

	Treatments			
Item	C	T1	T2	T3
Freezing point (°C)	- 2.4	- 2.5	- 2.8	- 2.9
Specific gravity (g/cm^3)	0.962	0.954	0.950	0.941
Weight per gallon (kg)	3.671	3.648	3.619	3.591
Flow rate (min : sec)	0 : 37	3 : 26	4 : 30	5 : 18

C: Control T1: Ice milk with 4% Chia seeds
T2: Ice milk with 6% Chia seeds T3: Ice milk with 8% Chia seeds

It could be observed that the pH values decreased as the Chia seeds level increased; control sample had 6.59 and its value decreased to be 6.27, 6.15 and 6.12 for T1, T2 and T3 respectively. The acidity percent took an opposite trend. These results were within the normal range as reported by Salama *et al.* [18].

Physical Properties: The main physical properties of ice milk mixes prepared by using different levels of chia seeds were presented in Table (2). The degree of freezing point was -2.4°C for control, reached -2.5, -2.8 and -2.9° C for the other three treatments in the same order. The specific gravity and the weight/ gallon deceased also as the level of chia seeds increased. Flow rate was also increased in the treatments rather than control sample. The data are in agreement with those obtained by Abd El-Aziz *et al*. [8] who used cress seeds and flaxseed Mucilage in preparing ice cream and Salama *et al*. [18] who used dry leaves and oil of *Moringa oleifera* in preparing ice milk.

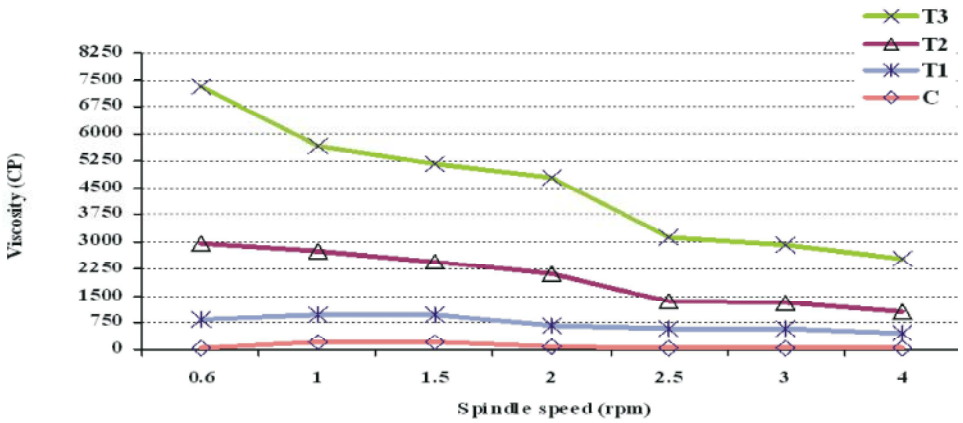


Fig. 1: Viscosity behavior of ice milk mixes supplemented with different levels of chia seeds
C: Control T1: Ice milk with 4% Chia seeds
T2: Ice milk with 6% Chia seeds T3: Ice milk with 8% Chia seeds.

Table 3: Physical properties of ice milk samples supplemented with different levels of chia seeds.

	Treatments			
Item	C	T1	T2	T3
Specific gravity (g/cm^3)	0.694	0.671	0.636	0.622
Weight per gallon (kg)	2.661	2.573	2.443	2.354
Overrun %	49.91	53.80	68.74	72.23
Melting resistances	18.36	15.22	11.72	5.64
as loss % after:15 min.				
30 min.	51.19	44.78	36.53	21.17
45 min.	82.36	70.61	58.15	48.70
60 min.	91.14	81.04	72.13	64.41
75 min.	100.00	90.22	86.35	75.92
90 min.	-	100	95.03	86.76
105 min.	-	-	100	100

C: Control T1: Ice milk with 4% Chia seeds
T2: Ice milk with 6% Chia seeds T3: Ice milk with 8% Chia seeds.

Apparent Viscosity: Viscosity is defined as the resistance of the fluid to flow caused by internal friction [19]. The viscosity values (CP) of ice milk mixes containing chia seeds compared with those containing CMC as control mix are shown in Fig. (1). Data showed that viscosity values increased as chia seeds ratio raised in T1, T2 and T3 ice milk mixes respectively. Increment the viscosity values are explained by the gelling effect of chia seeds when raised. Similar observations were found also by Abd El-Aziz *et al.* [8], Salama *et al.* [18], Farhoosh and Riazi [20], Alakali *et al.* [21], Karazhiyan *et al*. [22], Moreira *et al*. [23] and Coorey *et al*. [24].

Physical Properties of Final Product: The physical properties of the final product were recorded in Table (3). The specific gravity and the weight / gallon values decreased as the chia seeds level increased; while the overrun considerably increased as chia seeds level increased. It was noticeable in T3 than other treatments when compared with control. The same table revealed also that the resistance for melting clearly reduced as a result of chia seeds fortification. The rate of reduction was parallel with the added chia seeds proportion. The findings previously reported by Abd El-Aziz *et al*. [8] and Salama *et al*. [18] confirmed these results.

Rheological Behavior of the Final Product: From Fig. (2), it could be observed that the values of firmness as well as gumminess increased as the proportion of chia increased. The firmness was 0.7 N for control sample reached to 2 N in T3; while gumminess was 0.2 N for control become 0.8 N for T3. Adding chia seeds increased both firmness and gumminess of the final product as result of their gelling properties which is due to their high content of fiber (24.50%) and protein (21.34%) as these components can bind water. So, chia seeds could be used as stabilizing and thinking agent. These results were in agreement with those obtained by Abd El-Aziz *et al*. [8] and Salama *et al*.[18].

Light Microscope Examination: Fig. (3) revealed the inside structure and consistency of ice milk samples. The examination was carried out on control sample and preferable sample (T2) which supplemented by 6% chia seeds. Chia seeds produced harmony distribution of air cells through the matrix, enhanced air incorporation and air cell distribution. Chiaseeds has an ability to retain water as all hydrocolloids action.

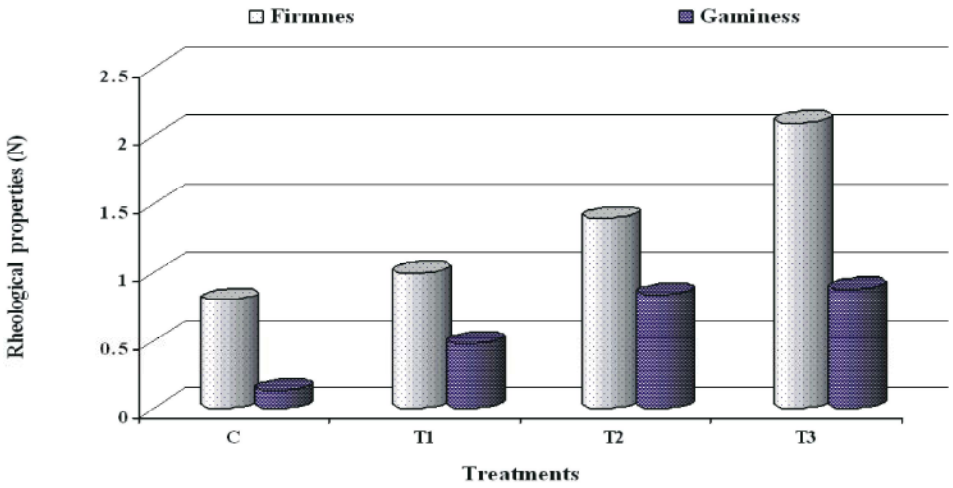
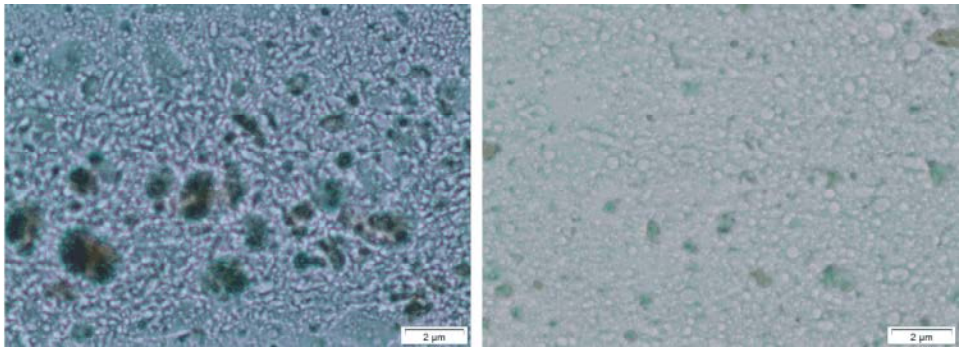


Fig. 2: Rheological behavior of ice milk supplemented with different levels of chia seeds

C: Control T1: Ice milk with 4% Chia seeds

T2: Ice milk with 6% Chia seeds T3: Ice milk with 8% Chia seeds



A (Control) B (Sample supplemented by 6% chia seeds).

Fig. 3: Micrograph of Ice Milk Samples Supplemented with Different Levels of Chia Seeds.

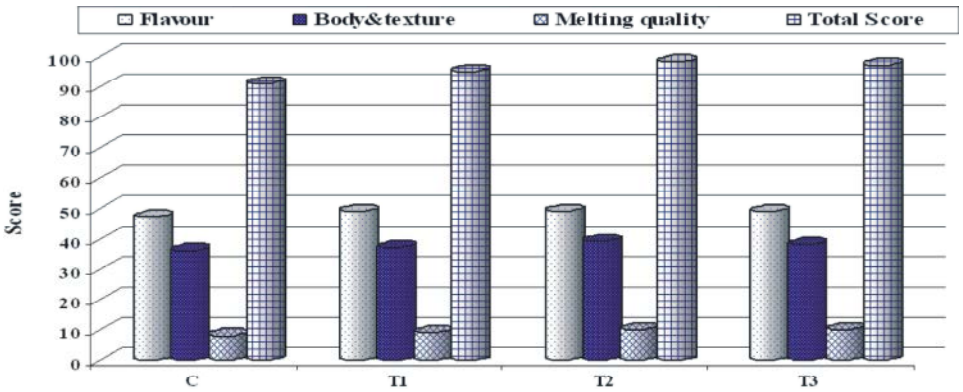


Fig. 4: Sensory evaluation of ice milk containing different levels of chia seeds

C: Control T1: Ice milk with 4% Chia seeds

T2: Ice milk with 6% Chia seeds T3: Ice milk with 8% Chia seeds

Sensory Evaluation of Supplemented Ice Milk: As shown in Figure (4), chia seeds did not clearly affect the flavor properties of ice milk product. Their values ranged between 47 to 49 scores. The considerable effect was observed in body& texture scores as well as melting quality scores. Chia seeds clearly improved these

properties as it hold more water and gave moderate air pours as confirmed by light microscope result (Fig. 3). The T2- sample (Supplemented by 6%) had the highest total acceptability where it gained 98 scores against 89 scores for control one.

CONCLUSION

Whole chia seeds were used successfully in preparing healthy functional ice milk. It could be used as natural stabilizer instead of the commercial chemical stabilizer. Incorporation of 6% (w/w) chia seeds gave the most favorable sensory properties. So we recommended using Chia seeds in other food products.

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