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Influence of Jerusalem Artichoke as Inulin Rich Component on Ice Milk Characteristics

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Abstract: Influence of Jerusalem artichoke powder as inulin rich component on ice milk characteristics was studied in this research. For this aim, ice milk ingredients (fresh buffaloes skim milk, skim milk powder, sugar, cream and Carboxy methyl cellulose (c.m.c) were mixed to obtained ice milk mix consisted of 5% milk fat, 14 % milk solids not fat (MSNF), 15 % sucrose, 0.2 % c.m.c. and 0.06% vanilla and divided to four portions. The first quantity was manufactured as a control. Jerusalem artichoke powder added at ratio 0.5, 0.75 and 1 % to create three treatments. All ice milk mixes pasteurized at 81°C/5sec and aged overnight at 4.0±2°C just before freezing in a batch freezer (at –5°C for 5-10 min.) then 0.06 % vanilla was added to each mix. Results showed that ice milk contained 2% milk fat and 1% Jerusalem artichoke powder had the highest score for sensory properties, melting rate and overrun. Also, it could be noticed that the lowest score was for the control.

Key words: Ice Milk Jerusalem Artichoke · Inulin · Sensory Evaluation · Overrun

INTRODUCTION

Inulin considered a nondigestable carbohydrate containing naturally fracto-oligo saccharides possesses some characteristics of dietary fibers [1]. Also considered a prebiotic which stimulates the selective growth of bifid bacteria and increases the absorption of calcium and reduces the tri glycerides content of the serum inside the liver [2]. Inulin has functional properties such as the ability to act as a fat or sugar replacers without adversely affecting flavor. Besides having stabilizers can reduce the crystal growth during storage and improve the creamy taste [3]. Jerusalem artichoke powder had higher content of crude protein, crude fiber, ash, crude fat and inulin [4]. Also Jerusalem artichoke powder considered an excellent source of oligosaccharides [5] and minerals, especially iron, potassium and phosphorus. It also, contains vitamin C, thiamine and niacin [6]. Therefore the aim of this research was to study the influence of Jerusalem artichoke powder as inulin rich component on ice milk characteristics.

MATERIALS AND METHODS

Materials: The ingredients used in this study were fresh skim buffaloes' milk (3.7% protein, 0.68% ash, 0.1% fat and 4.7% lactose) and fresh cream (40% fat) which were obtained after separation the fresh buffaloes' milk; supplied by the farm of Faculty of Agriculture, Al-Azhar University, Cairo, Egypt. Commercial grade granulated sugar cane (Sugar and Integrated Industries Co. Egypt), vanilla and Indian carboxy methyl cellulose (c.m.c) (high viscosity minimum assay 95%) purchased from local markets. Skim milk powder (34% protein, 1.23% fat and 4% moisture) was obtained from the Nile Commercial Co., Cairo, Egypt. Jerusalem artichoke tubers (*Helianthus tuberosus*) were provided from the Experimental Station, Agricultural Research Centre, El-Kanater El-Khayria, Egypt.

Methods

Preparation of Jerusalem Artichoke Powders (J.A.): Fresh Jerusalem artichoke tubers (JA) were washed with tap water to remove the dust followed by distilled water and cut into slices 2 mm in thickness using Braun slicer machine (Combi Max 700), then soaked in diluted citric acid solution (2%) to inhibit the activity of polyphenol oxidase as recommended by Tchoné *et al.* [7]. The obtained acidified slices were rinsed with distilled water, transferred to an electric drying oven and dried at 55°C for 12 hr. The dried plant samples were ground into a fine powder in a mill and sieved to pass through 20 mesh

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sieve. Finally, the obtained powders of J.A. packed in polyethylene bags and stored at room temperature in a dry place to avoid moisture absorption as recommended by Modler *et al.* [8].

Chemical Analysis of Jerusalem Artichoke Powder: Moisture, protein, fat, ash , fiber and Minerals contents (calcium, magnesium, sodium, potassium, copper, zinc and iron) and Inulin contents (g/100g) of *Jerusalem artichoke* powder were determined according to A.O.A.C. [9]. Total carbohydrates were calculated by difference as follows: Available carbohydrate = 100 - (% moisture + % protein + % fat + % ash+ % fiber).

Jerusalem Artichoke Ice Milk Manufacture: Ice milk ingredients (fresh buffaloes skim milk, skim milk powder, sugar, cream and Carboxy methyl cellulose (c.m.c)) were mixed to obtained ice milk mix consisted of 5% milk fat, 14 % milk solids not fat (MSNF), 15 % sucrose , 0.2 % c.m.c. and 0.06% vanilla [10] and divided to four portions. The first quantity was manufactured as a control. Jerusalem artichoke powder added at ratio 0.5, 0.75 and 1 % to create three treatments. All ice milk mixes pasteurized at 81°C/5sec. and aged overnight at 4.0±2°C. just before freezing in a batch freezer (at -5°C for 5-10 min.) then 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.

Analysis of Jerusalem Artichoke Ice Milk Mixes: Moisture, total solids, fat, protein and ash contents of Jerusalem artichoke ice milk were determined according to A.O.A.C. [11]. The protein content was obtained by multiplying the percentage of T.N. by 6.38 for milk ingredients and 6.25 for plant ingredients. Total carbohydrate content was calculated by difference [100 – (moisture + protein + fat + ash)] Apurba *et al*. [12]. pH value was measured using a Swiss Gallenkamp stick pH meter with glass electrode. 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 Jerusalem Artichoke Ice Milk: Overrun was calculated for all treatments using the weight-volume method [13]. Meltdown of frozen ice milk was determined according to Arndt and Wehling [14], by carefully cutting the foamed plastic cups from the ice milk samples (~ 100 g), 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 count of bacteria, coliform and moulds & yeasts counts were determined according to A.P.H.A. [15]. Organoleptic properties of different treatments were assessed by members of the department according to the following score card [10]. Appearance 30, Flavor 30, Body 20 and Texture 20.

Statistical Analysis: The data obtained from three replicates were analyzed by (ANOVA) using the SPSS statistical package program and differences among the means were compared using the Duncan's Multiple Range test [16]. A significant level of 0.05 was chosen.

RESULTS AND DISSCUSSION

Results displayed in Table (1) showed that the dried Jerusalem artichoke contained 6.0, 8.33, 1.3, 6.4, 6.2 and 21.43% for moisture, protein, fat, ash, crude fiber and other carbohydrates respectively. Also it was observed that the inulin percentage was 56.34%, so the Jerusalem artichoke considered a good source of inulin. These results are in agreement with that observed by Ahmad [17].

Table 1: Chemical composition of Jerusalem artichoke powder:

Components	(% dry matter)
Moisture	6.0
Protein	8.33
Fat	1.3
Ash	6.4
Fiber	6.2
Inulin	56.34
Other Carbohydrates	21.43

Table 2: Minerals content (mg/100g) of Jerusalem artichoke powder:

Elements	Mineral content (mg/100g weight basis)
Macro minerals	
Potassium (K)	41.2
Calcium (Ca)	23.6
Sodium (Na)	5.01
Magnesium (Mg)	48.2
Micro minerals	
Copper (Cu)	1.7
Manganese (Mn)	2.96
Iron (Fe)	13.14
Zinc (Zn)	6.14

Table 3: Ingredients of control and Jerusalem artichoke ice milk mixes (g/kg):

Ingredients g/kg	C	T1	T2	T3
Liquid skim milk	642	642	642	642
Fresh cream (fat 40%)	125	100	75	50
Skim milk powder	80.4	80.4	80.4	80.4
Sucrose	150	150	150	150
C.M.C	2	2	2	2
Vanillin (ml)	0.6	0.6	0.6	0.6
Jerusalem Artichoke	----	5	7.5	10
Water (ml)	----	20	42.5	65
Total	1kg	1kg	1kg	1kg

C, control 5% fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2% fat.

Table 4: Effect of replacing milk fat with Jerusalem artichoke powder on some physio-chemical properties of ice milk mixes:

Component	C	T1	T2	T3
Dry matter %	34.405^{A}	33.458^{AB}	32.573^{AB}	31.688^{B}
Protein %	5.746^{A}	5.681^{A}	5.622^{A}	5.559^{A}
Fat %	4.8^{A}	4.0^{B}	2.9^{C}	2.0^{D}
Ash %	0.988^{B}	1.116^{AB}	1.119^{AB}	1.197^{A}
Fiber %	0.0^{D}	0.52^{C}	0.75^{B}	1.1^{A}
Total Carbohydrate %	22.871^{A}	22.141^{A}	22.182^{A}	21.832^{A}
Acidity	0.18^{A}	0.18^{A}	0.18^{A}	0.17^{A}
pH	6.61^{A}	6.62^{A}	6.65^{A}	6.69^{A}
Viscosity	27^{C}	28^{C}	30^{B}	32^{A}
Freezing point	-10^{A}	-11.4^{B}	-11.6^{C}	-11.5^{BC}

C, control, 5%fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2% fat

Minerals Content of Jerusalem Artichoke Powde: Analyzed minerals of Jerusalem artichoke as shown in (Table 2) indicated that Potassium, Calcium, Sodium, Magnesium, Copper, Manganese, Iron and Zinc contents were 41.2, 23.6, 5.01, 48.2, 1.7, 2.96, 13.14 and 6.14 mg/100g respectively. These results are in agreement with those mentioned by Thanonkeo [18] and Wafaa *et al.* [19].

Ingredients of Control and Jerusalem Artichoke Ice Milk Mixes (g/kg): Ingredients of control and Jerusalem artichoke ice milk mixes (g/kg) shown in Table (3). The milk fat of ice milk mixes substituted by Jerusalem artichoke powder as inulin rich component and fat replacer at the percentages of 0.5, 0.75 and 1% for treatments contained 4, 3 and 2% milk fat respectively.

Effect of Replacing Milk Fat with Jerusalem Artichoke Powder on Some Physio-Chemical Properties of Ice Milk Mixes: As shown in (Table 4) the substation of milk fat by Jerusalem artichoke powder has a significant effect on the fat and fiber percentage between the control and the others treatments at ($P \leq 0.05$). Also, the effect of replacing milk fat by Jerusalem artichoke powder on the protein, total carbohydrate, pH and acidity percentage was not significant at ($P \leq 0.05$). While it was obvious from (Table 4) that the substitution of milk fat by Jerusalem artichoke powder increased the viscosity of ice milk mixes and decreased the freezing point of frozen ice milk. These results are in agreement with those mentioned by Issariyachaikul [20].

Effect of Replacing Milk Fat with Jerusalem Artichoke Powder on Organoleptic Properties of Resultant Ice Milk: From (Figure 1) it could be observed that ice the milk contained 2% milk fat and 1% Jerusalem artichoke powder had the highest score. This may be due to the balanced flavor between Jerusalem artichoke, sucrose and serum solids and due to its good body & texture and appearance. Also, it could be noticed that the lowest score was for the control.

Effect of Replacing Milk Fat with Jerusalem Artichoke Powder on Melting Rate of Resultant Ice Milk: It could be observed from Fig. 2 that the melting rate of ice milk decreased by increasing the Jerusalem artichoke powder percentage. This may be due to the lowest melting rate of Jerusalem artichoke treatments than the control. These results are in agreement with those mentioned by Issariyachaikul [20].

Effect of Replacing Milk Fat with Jerusalem Artichoke Powder on Overrun of Resultant Ice Milk: As shown in Figure 3 it could be noticed that the highest overrun was for the 1% Jerusalem artichoke ice milk then 0.75% Jerusalem artichoke ice milk. Also it could be observed that the lowest overrun was for the control. These results are in agreement with those mentioned by Wafaa *et al.* [19].

It may be observed from the results presented in Figure 4 that the caloric value of all treatments was lower than that the control. This is due to decreased level of milk fat which was a major contributor to calorie value in treated samples.

The Effect of Replacing Milk Fat with Jerusalem Artichoke Powder on Total Count, Coliform and Molds & Yeasts of Resultant Ice Milk: It was obvious from the results shown in Table 5 that the total count of bacteria in all frozen ice milk containing Jerusalem artichoke powder decreased than the control. This decreased reflective extreme carefully in hygienic precautions during its preparation. Also, it could be observed that the coliform bacteria and molds & yeasts were absent in all frozen ice milk treatments. These results are in agreement with those mentioned by Egyptian Standard Specifications [21].

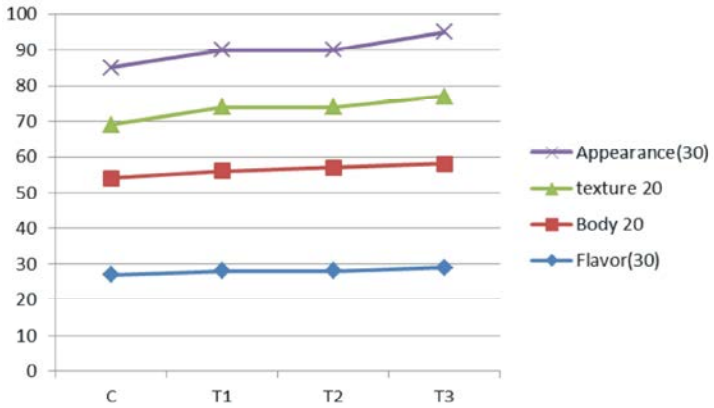

Fig. 1: Effect of replacing milk fat with Jerusalem artichoke powder on organoleptic properties of resultant ice milk: C, control, 5% fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2% fat

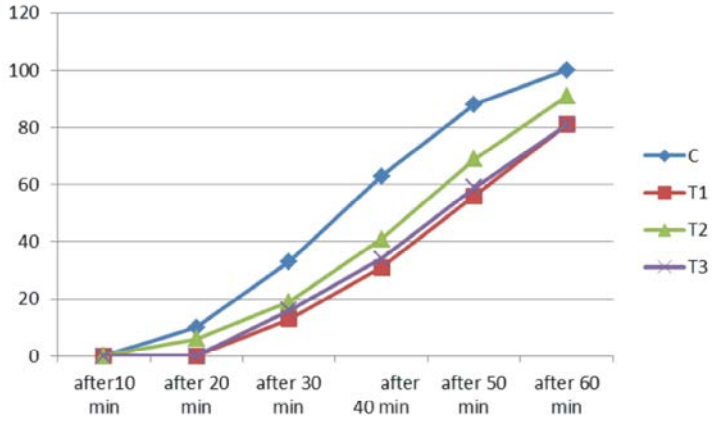

Fig. 2: Effect of replacing milk fat with Jerusalem artichoke powder on melting rate of resultant ice milk: C, control, 5% fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2% fat

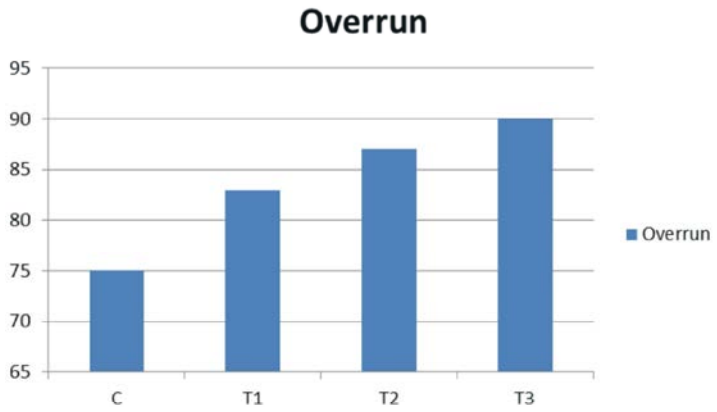

Fig. 3: Effect of replacing milk fat with Jerusalem artichoke powder on overrun of resultant ice milk: C, control, 5% fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2% fat

Table 5: Effect of replacing milk fat with Jerusalem artichoke powder on total count, coliform and mold & yeast of resultant ice milk:

Properties	C	T1	T2	T3
Total Count	35×10^1	27×10^1	32×10^1	24×10^1
Coliform	NF	NF	NF	NF
Mold &yeast	NF	NF	NF	NF

C, control, 5% fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2 % fat. NF: not found

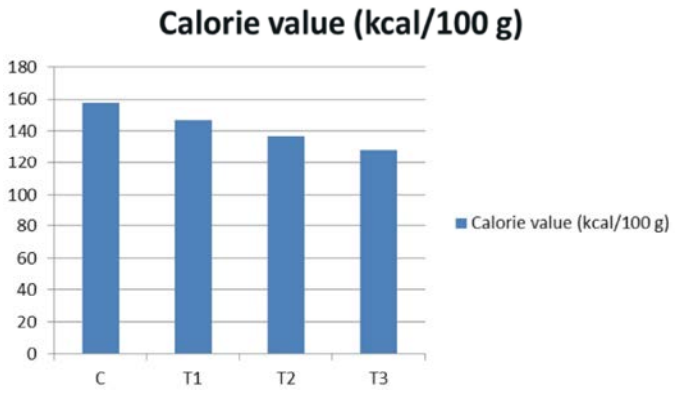

Fig. 4: Effect of replacing milk fat with Jerusalem artichoke powder on the total calorie content of resultant ice milk: C, control, 5% fat; T1, 0.5% J.R, 4% fat; T2, 0.75% J.R, 3% fat and T3, 1% J.R, 2% fat

REFERENCES

1. Flamm, G., W.Glinsmann, D. Kritchevsky, L. Prosky and M. Roberfroid, 2001. Inulin and oligofructose as dietary fiber: a review of the evidence. Critical Reviews in Food Science and Nutrition, 41(5): 353-362.
2. Kaur, N. and A. K. Gupta, 2002. Applications of inulin and oligofructose in health and nutrition. Journal of Biosciences, 27(7): 703-714.
3. Akoh, C.C., 1998. Fat replacers. Food Technology, 52(3): 47-53.
4. Cieslik, E., A. Kopec and W. Praznik, 2005. Healthly properties of Jerusalem artichoke flour (*Helianthus tuberosus* L.). Electronic Journal of Polish Agricultural Universities. Series Food Science and Technology, 2(08).
5. Roberfroid, M., 1993. Dietary fiber, inulin and oligofructose: a review comparing their physiological effects. Critical Reviews in Food Science & Nutrition, 33(2): 103-148.
6. Seiler, G.J., 1990. Protein and mineral concentrations in tubers of selected genotypes of wild and cultivated Jerusalem-artichoke (*Helianthus tuberosus*, Asteraceae). Economic Botany, 44(3): 322-335.
7. Tchoné, M., G. Bärwald and C. Meier, 2005. Polyphenol oxidases in Jerusalem artichoke (*Helianthus tuberosus* L.). British Food Journal, 107(9): 693-701.
8. Modler, H.W., J.D. Jones and G. Mazza, 1993. Observations on long-term storage and processing of Jerusalem artichoke tubers (*Helianthus tuberosus*). Food Chemistry, 48(3): 279-284.
9. A.O.A.C., 2000. Official Methods of Analysis of the Association of Official Analytical Chemists International 17th Ed. Published by the Association of Official Analytical Chemists International, Suite 400, 2200 Wilson Boulevard, Arlington, Virginia 22201-3301. USA.
10. Marshall, R.T., H.D. Goff and W.R. Hartel, 2003. Ice cream. 6th ed. Kluwer Academic/Plenum Pub., NY, USA.
11. A.O.A.C., 2012. Association of Official Analytical Chemists, Official Methods of Analysis. 18th ed., Benjamin Franklin Station Washington, D.C., USA.
12. 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.
13. 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 Marshel, R.T. and W.S. Arbuckle, 1996. "Ice - cream". 5th ed., Chapon & Hall, New York, U.S.A.
14. 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.
15. A.P.H.A., 1992. American Public Health Association Compendium of methods for the microbiological examination of foods. 3th edn. Washington, DC.
16. SPSS, 1998. Statistical Package for the Social Sciences, for windows. Release, 9.0.0, standard Version SPSS. Inc.
17. Ahmad, S.S.A., 2010. Production and Evaluation of Some Low Calorie Natural Sweeteners as Substitutes for Sucrose. M.Sc. Thesis, faculty of Ain Shams University.

18. Thanonkeo, P., 2007. The batch ethanol fermentation of Jerusalem artichoke using Saccharomyces cerevisiae. KMITL Science and Technology Journal, 7(2-1).
19. Wafaa, A.A., I.M. Mona and R.S. Attia, 2005. Some Specified Products Prepared from Jerusalem artichoke (*Helianthus tuberosus*, L.) Tubers. Alexandria Journal of Agricultural Research, 50(3): 75.
20. Issariyachaikul, L., 2008. Development of modified fat ice cream products using inulin as a fat replacer (Doctoral dissertation, Mahidol University).
21. Egyptian Standard Specifications, 2005. Ice milk and ices (ice cream), Published by Egyptian Organization for Standardization and Quality Control, 3-1185.