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PRODUCING SYNBIOTIC ICE CREAM

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ABSTRACT: In this study, Siwi roasted date seed powder was used as a powder product of the date factories to fortify ice cream with a coffee-like flavor. Roasted dates contain minerals, phenolic, and antioxidant compounds. In this study, we also used bifidobacteria as a probiotic. Seven ice cream treatments were made by adding 3.5, 4.5, and 5.5% roasted seed powder. Nescafe ice cream mix was prepared with the following composition: 4% fat, 13% milk solids not fat, 15% sucrose, 0.5% stabilizer, 2.5% Nescafe powder. Control ice milk was made without any additives, and another three treatments were made by adding 3.5, 4.5, and 5.5% roasted date seed powder. The other three treatments were made by adding roasted seed powder and encapsulated bifidobacteria. Nescafe powder was added for all treatments. Results showed that adding roasted seed powder increased the titratable acidity, while pH values had a contrary effect. Adding bifidobacteria did not significantly impact the specific gravity, weight per gallon, melting resistance, and overrun. Adding RDSP increased the overrun, melting resistance, specific gravity, weight per gallon, and viscosity. It also increased the total solids, ash, protein, and fat according to the addition. The most acceptable treatments are T_3 and T_4. So, it can be recommended that the T_4 is the best as it contains bioactive compounds and probiotic bacteria, and it gives the ice cream a desirable color and coffee-like flavor, but without caffeine.

Keywords: Bifidobacteria, date palm, prebiotic, antioxidant, coffee, functional, ice cream.

INTRODUCTION

Ice cream is palatable, nutritious, and inexpensive. One serving of vanilla ice cream supplies approximately 200 calories, 3.9 g of protein, 0.31 g of calcium, 0.104 g of phosphorus, 0.14 mg of iron, 548 IU of vitamin A, 0.038 mg of thiamine, and 0.236 mg of riboflavin.

Ice cream is a pure, clean, frozen product made from various milk products, dry or liquid forms of glucose, sucrose, or corn sugar, and water. It generally may contain an edible flavoring, and may or may not include an edible coloring, some egg products, and an added stabilizer. Ice cream is a frozen dessert classified based on composition into the following categories: plain, nut, fruit, mousse, bisque, puddings, custards, ices, sherbets, unique, and novelties. Ice milk is an ice cream-like product (Foster *et al.*, 1961). Ice milk is a frozen dessert containing 2-7% fat and 12-15% MSNF, sweetened, flavored, stabilizers, and emulsifiers (Arbuckle, 1972).

Date fruit (*Phoenix dactylifera* L.) is an essential fruit in some countries as a resource for nutrition and economy (Baliga *et al.*, 2011 and Briones *et al.*, 2011). According to the Food and Agriculture Organization (FAO, 2010), 7.85 million tons of date fruits were produced worldwide in 2010. According to the FAO, Egypt is the top producer of date fruit, with 1.7 million tons, representing 21% of global date production. Egypt exports around 50,000 tons of its annual production because the quality of local dates does not meet international standards.

The date palm is widely known as a richer nutritional source and natural medical agent. Date fruit is a significant source of carbohydrates and dietary fiber, and it contains proteins, minerals, vitamins, phenolic compounds, carotenoids, sterols, and triterpenoids. The beneficial potential of this fruit is well known in Arab countries and even worldwide. Date fruit has many health benefits, such as Glucose-lowering potential, anti-cancer activity, antioxidant activity,

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hypocholesterolemia-lowering potential, antimicrobial activity, anti-inflammatory activity, and bone-stimulating activity**,** which is attributed to the existence of bioactive substances such as carotenoids, polyphenols, triterpenoids, flavonoids, sterols, and some vitamins and minerals. Overall, Arabian date palms' nutritional values and pharmacological activities remain to be explained. Thus, this study states the history, nutritional, and health effects of Arabian date palm, highlighting the possibility of palm date components developing novel beneficial approaches for managing the abovementioned illnesses (Al-Faris *et al.,* 2021).

Sukari dates help increase hemoglobin levels in the blood (Arini Pradita Roselyn and Ari Khusuma, 2018). In addition, three types of antioxidants are the highest in dates, the first in flavonoids, which can help reduce inflammation and the risk of diabetes, Alzheimer's disease, and cancer. Carotenoids are antioxidants that can improve heart health and reduce the risk of eye-related disorders. The third type of phenolic acid is an antioxidant known for its anti-inflammatory properties that can help reduce the risk of cancer and heart disease (Rahmani, 2014).

El-Arem *et al.* (2011) found that the date seed weight is 11.18% of the date fruit weight.

Usually, a seed is composed of proteins, carbohydrates, and lipids, which are either in wax, fat, or oil form. The fat contents ranged from 5.7 to 12.7% (Nehdi *et al.,* 2010). The fatty acids contents of date seed oil contained over 50% oleic acid ($C_{18:1}$) of the fatty acid content and represents the primary fatty acid in the oil, followed by 19% linoleic acid ($C_{18:2}$), lauric acid ($C_{12:0}$) and 10% palmitic acid ($C_{16:0}$) (Nehdi *et al.,* 2010).

Different transformation types occur in date seeds during thermal processing, essential in forming coca or coffee's mild aroma and characteristic taste. These changes in the intensity of brown color (Rahman *et al.,* 2007; El-Sheikh *et al.,* 2014).

Additional roasted date seed powder in ice cream enhanced the rheological characteristics of ice cream mixes, except for the flow behavior index. These increases were related to the added RD ratio. These changes may be due to the thickening effect of the soluble fibers and fiber contents of the RDs (Soukoulis *et al.,* 2009). Date seeds have many functional properties, such as water holding capacity, foaming ability, solubility, and emulsion properties (Bouaziz *et al.,* 2013).

Probiotics are live micro-organisms (Bacteria or yeasts), which when ingested or locally applied in sufficient numbers confer one or more specified, demonstrated health benefits (FAO/WHO, 2001). Bifidobacteria are probiotic bacteria that show antagonistic effects towards some pathogens, reduce the risk of diarrhea, normalize bowel movements, enhance immune functions, reduce cholesterol levels, reduce the risk of eczema, synthesize several vitamins, protect from cancer, and relieve lactose intolerance symptoms (Martin *et al.,* 2015). Because of these health benefits, there has been a growing interest in using bifidobacteria in the dairy industry. The efficacy of added probiotic bacteria depends on the dose level. To achieve their health benefits, they must be in specific numbers in the gastrointestinal tract ($10^6 – 10^7$ cfu / g).

The objectives of this study were to investigate the effect of incorporating roasted date seed powder and bifidobacteria on the quality of ice cream, monitor the changes during storage, and monitor the viability of bifidobacteria during storage.

MATERIALS AND METHODS

Ingredients

Dried date fruits in the "Tamar stage" were obtained from the local market. Fresh bulk buffalo's milk (obtained from the herd of Faculty of Agriculture, Menoufia University, Shibin El-Kom, Egypt. Cream was obtained by separating fresh buffalo's milk in the pilot plant of Department of Dairy Science and Technology, Faculty of Agriculture, Menoufia University, Shibin El-Kom, Egypt. Sucrose, Nescafe powder was obtained from (local market), Stabilizer (Mercol IC) obtained from Meer Corporation, North Bergen, NJ, USA. Skim milk powder was

obtained from Hoogwegt International BV, Arnhenn, the Netherlands (Fat: 1.25% Max, Lactose: 56% Max, Ash 8.2% Max, Moisture: 4% Max, Protein in MSNF: 34% Min). *Bifidobacterium infantis* ATCC 15697 was gratefully obtained from Cairo Mircen, Ain Shams University, Egypt. *Bifidobacterium infantis* ATCC 15697 was activated individually by three successive transfers in modified MRS (Ventling and Misty, 1993) followed by three consecutive transfers in sterile 10% reconstituted non-fat dry milk and was incubated at 37°C under anaerobic conditions using Gas Pak (Baltimore Biological Laboratories (BBL), Cockysville, MD, USA). Five milliliters from each active bifidobacterial strain were inoculated separately into flasks containing 95 ml of modified MRS and incubated for about 18 hours at 37°C under anaerobic conditions. Cells were harvested by centrifugation at 1500 × g for 15 min and washed twice with sterile saline solution. Bifidobacterial cells from each strain were suspended individually in sterile saline to about 1.0×10^{10} cfu/mL. Cells from each strain were micro-entrapped individually in calcium alginate gels according to the method described by Sheu and Marshall (1993).

Preparing date seed powder

The date seeds were taken off the date fruit, washed to free them from any adhering date flesh, and then dried under the sun for two days. As described by El-Sheikh *et al.* (2014) heat date seed to 125°C for 30 min until the seeds color turned to light brown to obtain cocoa flavor then washed to remove any remaining date flesh, it was necessary to increase the roasting process to 180°C for 60 min to get a dry date seed with coffee like flavor as well as the seeds become more straightforward to milling. The roasted seeds were crushed in a mortar, followed by a high-speed laboratory miller (using Braun Power Max MX 2000 Blender, Germany), then sieved (60 mesh) to obtain fine powder of roasted date seeds, which was stored till use in a freezer.

Manufacture of ice cream

It was essential to investigate the effect of adding roasted seed date powder and the survival of encapsulated bifidobacteria during the manufacturing of ice cream and its freezing storage for 10 weeks on the quality of ice cream.

Nescafe ice cream mixes were prepared according to the method of Khader *et al.* (1992) with the following composition: 4% fat, 13% milk solids not fat, 15% sucrose, 0.5% stabilizer, 2.5% Nescafe powder. Control ice milk was made without any additives, and another three treatments were made by adding 3.5, 4.5, and 5.5% roasted date seed powder. The other three treatments were made by adding roasted seed powder, as mentioned previously, and adding encapsulated bifidobacteria. *As explained, bifidobacterium infantis ATCC 15697 was added to three batches of ice milk*. All treatments were heated at 69°C for 30 minutes, cooled, and then aged overnight at 4°C. Entrapped bifidobacteria strains were added two hours before freezing to disperse the bacteria. The level of the addition of *Bifidobacterium infantis* was calculated to introduce approximately 1.5×10^8 cfu/g of viable bifidobacteria in ice milk. Nescafe powder and roasted date seed powder were added before freezing, and ice cream mixes were frozen in a batch-type freezer (Cattabriga, Bolongia, Italy). The ice cream was packaged in plastic cups, hardened for 24 hours, and stored at -20 ± 2°C for 10 weeks. Each ice milk treatment was analyzed when fresh (0 time) and every two weeks for chemical and sensory evaluation. The whole experiment was performed in triplicate.

Physical and chemical analysis

The overrun of the ice milk was determined using the method of Arbuckle (1986). The specific gravity of ice milk mixes and ice milk samples was determined according to Winton (1958). Weight per gallon of ice milk mixes in kilograms (kg) was directly calculated according to Burke (1947) and Arbuckle (1986). The melting resistance of ice milk was determined according to Reid and Painter (1933). The viscosity of ice milk mixes was measured using a coaxial cylinder viscometer (Bohin V88, Sweden).

Chemical analysis

Fat content, titratable acidity, and pH values

were determined according to Ling (2008). The pH value was measured using a pH meter (Jenway LTD, Felsted Dunmow, Essex, UK). Total solids, ash, and total protein were determined according to the Official Method (A.O.A.C., 2012).

Microbiological analysis

Bifidobacterial count

Samples from each ice milk mix were taken from the resultant ice milk when fresh and once every two weeks to count bifidobacteria. One milliliter of thawed sample containing beads was suspended in 9 mL sterile phosphate buffer (1M, pH 7.5), followed by gentle shaking at room temperature for 10 min to release bifidobacteria from beads (Sheu *et al.*, 1993).

Modified MRS agar was used to enumerate bifidobacteria (Ventling and Mistry, 1993). To each 100 ml of modified MRS, 5.0 ml of the following solution was added before pouring plates (Samona and Robinson, 1991).

- Neomycine sulphate 0.8% w/v.
- Paromycine sulphate 0.2% w/v.
- Nalidixic acid 0.3% w/v.
- Lithium chloride 6.0%.

Plates were incubated under anaerobic conditions at 37°C for 72 hr.

Sensory evaluation

Ten panelists from the Staff members and graduated students at the Department of Dairy Science and Technology, Department of Food Science and Technology, Faculty of Agriculture, Menoufia University evaluated the organoleptic properties of each batch of Nescafe ice milk at zero time and the 4^{th}, 8^{th} and 10^{th} week of storage period according to score sheets described by Mahmoud *et al.* (2013).

Statistical analysis

Data were analyzed using the wholly randomized block design and 2 × 3 factorial design. Newman-Keuls. A test was used to make multiple comparisons (Steel and Torrie, 1980) using the CoState program. Significant differences were determined at $P \leq 0.05$.

RESULTS AND DISCUSSION

Ice cream mix properties

- Titratable acidity

Adding roasted date seed powder increased titratable acidity (Khalil and Blassey, 2016). Incorporating encapsulated bifidobacteria didn't significantly affect ($P \geq 0.05$) the titratable acidity (Kebary *et al.*, 1998).

- pH value

Adding roasted date seed powder decreased pH (Khalil and Blassey, 2016).

Incorporating encapsulated bifidobacteria didn't significantly ($P > 0.05$) affect pH value (Kebary *et al.*, 1998).

- Viscosity

Incorporating roasted date seed powder significantly increased ($P \leq 0.05$) the viscosity according to the rate of addition (Khalil and Embaby, 2012, and El-Samahy *et al.*, 2015). Adding bifidobacteria did not have a significant ($P > 0.05$) effect on the viscosity of ice cream mixes.

- Specific gravity and weight per gallon

It was noticed that specific gravity and weight per gallon were significantly ($P \leq 0.05$) higher than those of low-date roasted seed powder. Adding bifidobacteria didn't have a significant ($p > 0.05$) effect on the specific gravity and weight per gallon (Kebary *et al.*, 1998). Adding encapsulated bifidobacteria did not significantly affect ($P > 0.05$) the melting resistance of ice cream treatments.

Fresh ice cream properties

- Overrun

It was shown that adding roasted date seed powder significantly ($P > 0.05$) increased overrun. This increase parallels viscosity values (Khalil and Blassey, 2016). Adding encapsulated bifidobacteria did not considerably affect the overrun of ice cream treatments.

- Specific gravity and weight per gallon

Specific gravity and weight per gallon increased significantly ($P \leq 0.05$) by increasing the addition of the roasted date seed powder due to the viscosity (Khalil and Blassey, 2016).

Incorporating encapsulated bifidobacteria did not significantly affect ($P > 0.05$) the specific gravity weight per gallon of ice cream treatments (Kebary *et al.*, 1998).

Table 1: Effect of adding roasted date seed powder (RDSP) and bifidobacteria on some properties of ice cream mixes.

Treatments¤	Acidity	pH value	Specific gravity	Weight per gallon (kg)	Viscosity (m pas)
C*	0.235^{C}	6.50^{A}	1.1132^{D}	4.214^{D}	137.3^{D}
T_1	0.319^{BC}	6.42^{AB}	1.1138^{C}	4.217^{C}	168.8^{C}
T_2	0.322^{BC}	6.42^{AB}	1.1143^{BC}	4.229^{C}	182.7^{C}
T_3	0.425^{AB}	6.25^{BC}	1.1148^{A}	4.222^{A}	238.2^{B}
T_4	0.429^{AB}	6.26^{BC}	1.1153^{A}	4.224^{A}	239.0^{B}
T_5	0.550^{A}	6.15^{C}	1.1144^{B}	4.220^{B}	240.7^{A}
T_6	0.553^{A}	6.17^{C}	1.1146^{B}	4.221^{B}	243.3^{A}

¤ Each value in the table was the mean of three replicates.
Different letters within the same column indicate significant differences in multiple comparisons. The letter 'A' represents the highest mean, followed by 'B', 'C', and so forth. Differences were considered significant at the 0.05 level ($P \leq 0.05$).
* C = Control Nescafe ice cream made with 4% milk fat.
T_1, T_3, and T_5 = Ice cream prepared by adding 3.5, 4.5, and 5.5% RDSP.
T_2, T_4, and T_6 = Ice cream prepared by adding 3.5, 4.5, and 5.5% RDSP and adding *Bif. infantis* (encapsulated cells), respectively.

- Melting resistance

The melting resistance of the resultant ice cream is expressed in Table 2 as the loss in weight percent of the initial weight. Adding roasted date seed powder slightly increased the melting rate due to its higher Freezing point depression. This could also be attributed to the roasted date seed powder's contents in sugars and minerals (Khalil and Blassey, 2016). The melting resistance of all ice cream treatments after the last 30 min had a contradictory trend compared to the first 60 min. These results align with those reported by Kebary & Hussein (1997) and Mousa *et al.* (2008).

Table 2: Effect of adding RDSP and bifidobacteria on some properties of ice cream.

Treatments¤	Overrun	Specific gravity	Weight per gallon (kg)	Melting Resistance		
				First 60 min	Next 30 min	Last 30 min
C*	62.13^{D}	0.6381^{D}	2.818^{D}	32.5^{E}	40.3^{D}	29.5^{A}
T_1	64.65^{B}	0.6523^{C}	2.950^{C}	33.8^{D}	42.6^{C}	26.6^{B}
T_2	64.18^{B}	0.6623^{C}	2.953^{BC}	33.9^{D}	42.4^{C}	26.0^{B}
T_3	66.13^{A}	0.6673^{B}	2.571^{A}	35.5^{C}	44.5^{B}	24.2^{C}
T_4	66.08^{A}	0.6673^{B}	2.562^{A}	35.5^{C}	44.7^{AB}	24.0^{C}
T_5	64.65^{BC}	0.6798^{A}	2.541^{B}	36.9^{B}	45.1^{B}	21.3^{D}
T_6	65.18^{BC}	0.6793^{A}	2.545^{B}	37.2^{A}	45.3^{A}	21.0^{D}

¤, * See Table (1).

- Properties of ice cream during storage

Adding roasted date seed powder decreased all pH values of ice cream treatments (Khalil and Blassey, 2016) (Tables 3, 4). Titratable acidity

had a contradictory pH value. Titratable acidity and pH value did not change significantly (P > 0.05) during storage. Similar results were reported by Badawi *et al.* (2010).

Ice cream treatments with encapsulated bifidobacteria were not significantly different from other treatments in pH value and titratable acidity.

Table 3: Effect of adding RDSP and bifidobacteria on the Titratable acidity during refrigerated storage.

Treatments▫	Storage period (weeks)			
	0	4	8	10
C*	0.235^{Da}	0.235^{Da}	0.239^{Da}	0.243^{Da}
T_1	0.319^{Ca}	0.321^{Ca}	0.322^{Ca}	0.325^{Ca}
T_2	0.322^{Ca}	0.324^{Ca}	0.325^{Ca}	0.329^{Ca}
T_3	0.425^{Ba}	0.425^{Ba}	0.427^{Ba}	0.430^{Ba}
T_4	0.429^{Ba}	0.432^{Ba}	0.435^{Ba}	0.435^{Ba}
T_5	0.550^{Aa}	0.550^{Aa}	0.553^{Aa}	0.555^{Aa}
T_6	0.553^{Aa}	0.552^{Aa}	0.555^{Aa}	0.556^{Aa}

▫, * See Table (1).
The small letters possess a storage period. The means with the same letter at any position were not significantly different (P > 0.05).

Table 4: The effect of adding RDSP and bifidobacteria on pH value during refrigerated storage.

Treatments▫	Storage period (weeks)			
	0	4	8	10
C*	6.80^{Aa}	6.78^{Aa}	6.75^{Aa}	6.72^{Aa}
T_1	6.62^{Ba}	6.60^{Ba}	6.56^{Ba}	6.54^{Ba}
T_2	6.60^{Ba}	6.57^{Ba}	6.55^{Ba}	6.51^{Ba}
T_3	6.40^{Ca}	6.37^{Ca}	6.34^{Ca}	6.31^{Ca}
T_4	6.36^{Ca}	6.32^{Ca}	6.30^{Ca}	6.28^{Ca}
T_5	6.15^{Da}	6.12^{Da}	6.08^{Da}	6.02^{Da}
T_6	6.12^{Da}	6.08^{Da}	6.02^{Da}	6.00^{Da}

▫, * See Tables (1&2).

Chemical composition

The ash content in food varies. The content of ash and minerals in food is essential to get the ash or minerals needed by the body. (Hanggara, Astuti dan Setyani, 2016). Protein is one of the food groups that are found in large amounts (macronutrients). Protein is an essential nutrient for the body because it functions as fuel, a building block, and a regulator. In addition, protein also forms new cells to replace damaged tissues and as an energy source (Hanggara, Astuti, and Setyani, 2016). Fat is a source of essential fatty acids, a means of transport, and a solvent for vitamins A, D, E, and K. The use of fat in food is not only to add calories, but also to improve texture and taste. The fat component gives the product physical characteristics such as aroma, taste, texture and appearance. Product characteristics disappear when the fat in the food is reduced or eliminated (Dewanti and Rahayuni, 2013).

Total solids, protein, ash, and fat content increased at a faster rate with the addition of RDSP. These results are shown in Tables 5,6,7,8. This is because the date seeds are very rich in nutrients, which contain considerable amounts of

protein, fat, and carbohydrates with higher fiber content (71.89%). These results are consistent with those obtained by Habib & Ibrahim (2009) and Mistrello *et al.* (2014). Incorporating bifidobacteria did not have a significant effect ($P > 0.05$). Total solids, protein, ash, and fat (Kebary *et al.*, 1998). As the storage period proceeded, the total solids, protein, ash, and fat contents did not change significantly ($P > 0.05$). Similar results were reported by Kebary *et al.* (2007), Badawi *et al.* (2008), and Kebary *et al.* (2009).

Bifidobacteria count

The counts of bifidobacteria in all ice cream treatments decreased slightly (Table 9) during freezing and hardening (first day), which might be due to the protection of bifidobacteria by encapsulation. Kim and Youn (1995) reported that immobilization of bifidobacteria in alginate beads increased survival. The results revealed that even storage ice cream treatments for 10 weeks contained counts of bifidobacteria higher than those that should be present to achieve the health benefits. Therefore, ice cream treatments could be a good source for delivering these probiotic bacteria to consumers.

Table 10 shows changes in organoleptic properties during storage. The scores of flavors, body, texture, and organoleptic properties of all ice cream treatments are shown. Fresh ice cream was not significantly different from each other.

Their level of maturity influences the color of the dates. The most commonly consumed date type is rutab, with the highest level of maturity marked by the fruit's color, brownish red. In addition, the brownish red color of dates is influenced by an increase in their antioxidant content (Arizal, 2015).

Dates have a sweet taste that is influenced by their maturity level. At the highest maturity level, the taste of dates will be sweeter because the sucrose content in dates increases, as it has been converted into invert sugar (Arizal, 2015).

Changes in the texture of the ice cream to become denser with the addition of the Sukari date fruit paste because the dates contain high fiber, namely 6.4 – 11.5% (Arizal, 2015) With the addition of foods that contain high fiber, it can affect the texture of the food to become denser (Lestari, 2015).

Although the panelists accepted many ice cream treatments, the most acceptable treatments were T_3 and T_4, which were made by adding 4.5% roasted date seed powder. All ice cream treatments ' total scores of organoleptic properties were almost stable during the first eight weeks, then decreased slightly as the storage period progressed up to the end (Table 10). These results agree with those reported by Zedan *et al.* (2001) and Kebary *et al.* (2004).

It could be concluded that the most acceptable treatment was T_4, which was made by adding 4.5% roasted date seed powder and containing encapsulated bifidobacteria. This ice cream treatment will be used as a good source for delivering bifidobacteria, and the counts should be present to achieve their health benefits.

Table 5: The effect of adding RDSP and bifidobacteria on total solids during refrigerated storage.

Treatments▫	Storage period (weeks)			
	0	**4**	**8**	**10**
C*	33.06^{Da}	33.00^{Dab}	32.66^{Db}	32.44^{Db}
T_1	35.98^{Ca}	35.06^{Cab}	34.98^{Cb}	34.02^{Cb}
T_2	36.02^{Ca}	36.71^{Cab}	35.02^{Cb}	35.95^{Db}
T_3	38.01^{Ba}	38.89^{Bab}	37.40^{Bb}	37.06^{Bb}
T_4	38.25^{Ba}	39.20^{Bab}	38.10^{Bb}	38.90^{Bb}
T_5	40.05^{Aa}	40.95^{Aab}	40.46^{Ab}	40.45^{Ab}
T_6	40.20^{Aa}	40.71^{Aab}	40.75^{Ab}	41.79^{Ab}

▫, * See Tables (1&2).

Table 6: The effect of adding RDSP and bifidobacteria on protein content during refrigerated storage.

Treatments¤	Storage period (weeks)			
	0	4	8	10
C*	5.31^{Da}	5.33^{Da}	5.32^{Da}	5.32^{Da}
T_1	5.40^{Ca}	5.42^{Ca}	5.40^{Ca}	5.38^{Ca}
T_2	5.42^{Ca}	5.37^{Ca}	5.36^{Ca}	5.33^{Ca}
T_3	5.51^{Ba}	5.47^{Ba}	5.47^{Ba}	5.44^{Ba}
T_4	5.50^{Ba}	5.43^{Ba}	5.43^{Ba}	5.40^{Ba}
T_5	5.60^{Aa}	5.62^{Aa}	5.62^{Aa}	5.59^{Aa}
T_6	5.63^{Aa}	5.58^{Aa}	5.50^{Aa}	5.57^{Aa}

¤, * See Tables (1&2).

Table 7: The effect of adding RDSP and bifidobacteria on fat content during refrigerated storage.

Treatments¤	Storage period (weeks)			
	0	4	8	10
C*	4.00^{Da}	4.00^{Da}	3.98^{Da}	3.98^{Da}
T_1	5.01^{Ca}	5.00^{Ca}	4.97^{Ca}	4.96^{Ca}
T_2	5.00^{Ca}	5.02^{Ca}	4.98^{Ca}	4.97^{Ca}
T_3	6.00^{Ba}	6.03^{Ba}	6.00^{Ba}	5.98^{Ba}
T_4	6.01^{Ba}	6.05^{Ba}	6.00^{Ba}	6.00^{Ba}
T_5	7.00^{Aa}	7.01^{Aa}	6.99^{Aa}	6.99^{Aa}
T_6	7.02^{Aa}	7.06^{Aa}	7.00^{Aa}	7.00^{Aa}

¤, * See Tables (1&2).

Table 8: The effect of adding RDSP and bifidobacteria on ash content during refrigerated storage.

Treatments¤	Storage period (weeks)			
	0	4	8	10
C*	1.13^{Da}	1.13^{Da}	1.11^{Da}	1.16^{Da}
T_1	2.25^{Ca}	2.23^{Ca}	2.22^{Ca}	2.28^{Ca}
T_2	2.27^{Ca}	2.25^{Ca}	2.27^{Ca}	2.25^{Ca}
T_3	3.50^{Ba}	3.52^{Ba}	3.50^{Ba}	3.54^{Ba}
T_4	3.51^{Ba}	3.56^{Ba}	3.56^{Ba}	3.57^{Ba}
T_5	4.05^{Aa}	4.08^{Aa}	4.05^{Aa}	4.10^{Aa}
T_6	4.07^{Aa}	4.15^{Aa}	4.15^{Aa}	4.17^{Aa}

¤, * See Tables (1&2).

Table 9: The effect of adding RDSP and bifidobacteria on bifidobacteria count (cfu × 10^7 / gm) during refrigerated storage.

Treatments ▫	Storage period (weeks)			
	0	4	8	10
C*	ND	ND	ND	ND
T_1	ND	ND	ND	ND
T_2	20	13	8	7
T_3	ND	ND	ND	ND
T_4	25	17	9	8
T_5	ND	ND	ND	ND
T_6	26	19	9	8

▫, * See Table (1).

Table 10: The effect of adding RDSP and bifidobacteria on organoleptic properties during refrigerated storage.

Treatments ▫	Flavour (50)				Body & texture (40)				Melting quality (10)				Total scores (100)			
	Storage period (weeks)															
	0	4	8	10	0	4	8	10	0	4	8	10	0	4	8	10
C*	45	43	42	42	35	36	35	33	8	8	7	7	88 D	87 D	82 D	82 D
T_1	45	43	43	43	37	37	35	36	9	9	8	8	91 C	89 C	87 C	87 C
T_2	45	43	43	43	36	36	35	35	9	9	8	8	90 C	88 C	86 C	86 C
T_3	48	47	44	43	38	37	36	36	9	9	8	8	95 A	93 A	88 A	90 A
T_4	48	47	44	43	38	37	36	36	9	9	9	8	95 A	91 A	89 A	91 A
T_5	45	44	43	42	39	38	36	34	9	9	8	7	93 B	90 B	87 B	88 B
T_6	45	45	42	42	39	38	36	35	9	8	7	7	93 B	91 B	88 B	89 B

▫, * See Table (1).

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إنتاج آيس كريم وظيفي وداعم للحيوية

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إن الهدف من هذه الدراسة هو إنتاج آيس كريم ذو خصائص وظيفية وداعم للحيوية وذلك عن طريق إضافة مسحوق نوى البلح والذي له خصائص جيدة من الناحية الصحية حيث يتميز بارتفاع مُحتواه من البروتين والدهن والألياف والكربوهيدرات وفي نفس الوقت بإضافة البكتريا الداعمة للحيوية والتي لها خواص جيدة للصحة والتي يُمكن بالتالي أن تصل إلى المُستهلك. ولذلك تم تصنيع ٧ معاملات وكانت كالتالي:

المُعاملة الكنترول: صُنِّعت من لبن جاموسي ٤% دهن و ٣ مُعاملات أخرى بإضافة مسحوق نوى البلح بنسب ٣,٥ ، ٤,٥، ٥,٥% و ٣ مُعاملات أخرى بإضافة مسحوق نوى البلح بالإضافة إلى كبسولات البفيدوبكتريا.

وتم تخزين المعاملات في الفريزر لمدة ١٠ أسابيع حيث أخذت العينات وهي طازجة وبعد ٤، ٨، ١٠ أسابيع لإجراء التحليلات الكيماوية والريولوجية والحسية عليها.

ولقد أوضحت النتائج المُتحصل عليها بعد تحليلها إحصائيًا ما يلي:

- انخفضت قيم الـ pH بدرجة بسيطة بإضافة مسحوق نوى البلح ولكن لم تتأثر قيم الـ pH بإضافة كبسولات البفيدوبكتريا، بينما أخذت الحموضة اتجاه مُعاكس لقيم الـ pH.
- أدى إضافة مسحوق نوى البلح إلى زيادة في لزوجة مخلوط الآيس كريم وهذه الزيادة كانت تتناسب طرديًا مع مُعدل الإضافة، بينما لم تُؤثر إضافة البفيدوبكتريا المُكبسلة على لزوجة مخلوط الآيس كريم.
- حدثت زيادة في الريع بزيادة نسبة إضافة مسحوق نوى البلح، بينما لم يتأثر الريع في العينات المُضاف لها كبسولات البفيدوبكتريا عن الغير مُضاف لها.
- حدثت زيادة في الكثافة النوعية والوزن بالجالون بزيادة مُعدل إضافة مسحوق نوى البلح لكنها لم تتأثر في العينات المُصنَّعة بالبفيدوبكتريا المُكبسلة عن الغير مُكبسلة.
- أدت زيادة إضافة مسحوق نوى البلح إلى زيادة المُقاومة للانصهار لكنها لم تختلف أيضًا في العينات المصنعة بإضافة البفيدوبكتريا المُكبسلة عن الغير مُكبسلة.
- اختلفت قيم الـ pH بدرجة بسيطة بزيادة نسبة الإضافة حيث انخفض بزيادة مُعدل الإضافة وعلى العكس ارتفعت الحموضة بدرجة خفيفة بزيادة الإضافة. لم تختلف نسب الحموضة وقيم الـ pH في العينات المُضاف لها كبسولات البفيدوبكتريا عن الغير مُضاف لها، ومن ناحيةٍ أخرى لم تختلف نسب الحموضة وقيم الـ pH بمرور فترة التخزين.
- حدثت زيادة في نسب كلٍ من الجوامد الكلية والبروتين الكلي والرماد والدهن بزيادة نسب الإضافة لكن من ناحيةٍ أخرى لم تتأثر في العينات المُضاف لها كبسولات البفيدوبكتريا عن الغير مُكبسلة. ومن ناحيةٍ أخرى لم تتأثر قيم الجوامد الكلية والبروتين الكُلي والرماد والدهن بمرور فترة التخزين.
- انخفضت أعداد البفيدوبكتريا بدرجة بسيطة بمرور فترة التخزين وبالتالي ظل عددها أكبر من العدد المفروض تواجده لتحقيق الفوائد الصحية.
- اتخذت الخواص الحسية المُختلفة (النكهة، القوام والتركيب وخواص الانصهار والمجموع الكُلي) نفس الاتجاهات تقريبًا.
- وحصلت المُعاملة T_3 ، T_4 على أعلى الدرجات حيث لم تتغير الدرجات الممنوحة لكل المعاملات معنويًا أثناء الثمانية أسابيع الأولى من التخزين ثم بدأت الدرجات في الانخفاض بنهاية فترة التخزين.

وبذلك يُمكن التوصية بأن المُعاملة T_4 هي الأفضل والتي تحتوي على ٤,٥% مسحوق نوى البلح وفي نفس الوقت داعم للحيوية.

الكلمات المفتاحية: بفيدوباكتيريا، نخيل التمر، البروبايوتيك، مضاد الأكسدة، القهوة، الوظائفية، الآيس كريم.