Production and Characterization of Milk Dessert Supplemented with Date Seed Powder

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ABSTRACT: *Milk desserts are semisolid and complex matrices with a proteinaceous structure containing essential ingredients like* cow's milk*, starch, sugar, gelatin, and flavorings. In this study, the physicochemical, sensory properties, and probiotics viability of milk dessert enriched with date seed powder (0, 1.5%, and 3%) during 20 days of storage were investigated. The results indicated that acidity (14.4-26.7), dry matter (24.22%-27.77%), °Brix (22.65-24.39), ash (0.76-0.84), fat (3.61%-3.83%) and protein (3.95%-4.15%) content of milk dessert was increased in the presence of date seed powder. Adding date seed powder significantly increased the stability and viscosity of milk desserts. The viability of the Lactobacillus plantarum (L. plantarum) has improved in the presence of date seed powder; therefore, this food waste could be considered as a prebiotic component. Generally, the most acceptability of sensory evaluations was found in samples treated with 1.5% date seed powder.*

KEYWORDS: *Dessert; Probiotic*; *Physicochemical*; *Date seed.*

INTRODUCTION

Nowadays, there is a growing demand for dairy desserts as ready-to-eat and nutritious foods. Dairy desserts contain at least 50% fresh cow's milk or reconstituted milk, which is prepared with added substances such as flavorings, sweeteners, thickeners, and stabilizers after a heat treatment such as pasteurization. The consumption of dairy desserts formulated with carbohydrates, colorants, and flavors is increasing in Europe, America, and different countries. Consumers are also increasingly interested in functional dairy desserts; these, besides their nutritional values, may also have health benefits. As a functional food, producing dairy products like milk desserts containing probiotic bacteria and prebiotic fibers can be considered successful [1].

Several studies have previously shown that probiotics and prebiotics can provide positive results when used in various dairy products such as yogurt, fermented milk, cheese, dessert, and so on. *Frederico et al*. [2], considering

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the importance of probiotic viability, evaluated the viability of *Lactobacillus acidophilus* in the milk desserts supplemented with whey protein concentrate during storage. Similarly, *Di Criscio et al*. [3] investigated the survival of *Lb. casei* and *Lb. rhamnosus* strains in inulin-rich ice cream during storage. Further, *Sidhu et al*. [4] studied the viability of *Bifidobacterium and Lactobacillus acidophilus* in yogurt enriched with chickpea flour. Furthermore, a study on the use of a prebiotic ingredient, *Plantago psyllium* mucilage, in symbiotic Doogh was conducted by *Soltani Arabshahi* and *Sedaghati* [5].

The presence of probiotics is an essential quality indicator during the consumed period for probiotic products. Generally, 10^6 cfu/mL or cfu/g of viable probiotic cells has been accepted as the minimum level and $>10^7$ cfu/mL or cfu/g as the satisfactory level at the consumption time [6]. Because the survival ability of probiotics in dairy products is poor, prebiotics are used with probiotics to increase the survivability of probiotic bacteria and attain better effects on the host's health [7]. The application of prebiotic ingredients and probiotics in the milk dessert formulations can create symbiotic milk desserts that have beneficial effects on consumers. The most commonly used genera of probiotic bacteria are *Lactobacillus* and *Bifidobacterium*. Prebiotics are non-digestible, but fermentable compounds that can promote the growth and proliferation of beneficial bacteria in the gastrointestinal system [1, 8]. Symbiotic milk desserts possess antimicrobial, anticancer, anti-allergic, and immune–stimulating properties [9].

Date seeds are generated from date processing during the production of date chips, date chips, date syrup, etc. Date seeds contain compounds such as carbohydrates, dietary fiber, and polyphenols and are used as functional food [10]. In symbiotic food products, date seeds may have a protective effect on probiotic bacteria, improving the viability and activity of these bacteria during storage. However, to the best of our knowledge, no studies have been conducted to produce a symbiotic functional milk dessert with date seed powder as a prebiotic component and *L.plantarum* as a species of probiotic bacteria. Therefore, the present study focused on the date seed since scant attention has been paid to the prebiotic effects of these food wastes [1, 11].

Because of the growing importance of using functional foods in our everyday foods, the present study evaluated the production of symbiotic milk dessert (non-vegetarian) containing date seed powder and *L.plantarum* to promote the nutritional and functional properties of dairy desserts by evaluating their physicochemical, microbial and sensory characteristics.

EXPERIMENTAL SECTION

Materials

The seeds of Mazafati palm date (Phoenix dactylifera L.) were provided by a domestic market in Tehran, Iran. Food-grade corn starch, gelatin, and vanilla were prepared by the Golha company. Sodium hydroxide (99%), Sulfuric acid (98%), Isoamyl -alcohol (98%), Boric acid (95%), MRS Agar and MRS Broth was brought from Merck company. Cultures of *L. Plantarum* PTCC 1058 were provided by the Iranian Society for Research in Science and Technology (IROST) in Tehran, Iran. *L. Plantarum* in a Lyophilized form (around 10^7 cfu/mL) was cultured in an MRS broth medium applying a CO_2 incubator (Memmert, Munich, Germany) at 37°C for 24 hours.

Preparation of roasted date seed powder

The date seeds of Phoenix dactylifera were separated from date fruit under sanitary conditions. The soaked seeds were rinsed in distilled water and dried at 50 °C for 48 h. The dried seeds were then roasted at 125 ° C for 30 minutes until the grains turned light brown. In the following, the roasted seeds were ground using a miller (Buhler-Miag laboratory disc mill) and passed through a sieve (pore size 420 µm). The powder produced from the seeds was called roasted date seed powder powder (DSP) and was stored refrigerated at 5 °C for testing [12].

Production of milk dessert

The milk dessert was prepared using 190 mL of whole milk (3%), 20 g of sugar, 5 g of gelatin, 7 g of corn starch, 0.2 g of vanilla, and different concentrations of DSP (Control (0), 1.5% (T_1), and 3% (T_2)). Pasteurized whole milk (3% fat) was mixed with sugar, gelatin, vanilla, and different concentrations of DSP; it was stirred well at 85°C with a magnetic stirrer (IKA, Staufen, Germany) at 250 rpm for 10 minutes. Subsequently, the dispersion was heated at 90°C for 20 minutes and cooled down until 40 °C. Then, 10^7 cfu/mL of *L.plantarum* was added, and the mixture was kept until the temperature reached 15 °C. The dessert was put in 200 mL plastic containers, which had the lids

sanitized with a 0.5% sodium hypochlorite solution and stored in the refrigerated temperature for 20 days [13].

Samples preparation

The milk dessert was ground in a mixer (Kimia Novin, Iran) for 5 min. The mixed sample was then evaluated for various physicochemical, microbial, and sensory properties [14].

Physicochemical determination

The pH of the samples was measured using a digital pH meter (Taiwa, AZ 86502). Titratable acidity has been measured with 0.1 N NaOH in titrated samples [13]. The samples were analyzed for dry matter and ash content using the gravimetric method in the oven (Memmert, Germany) and furnace (Tehran Godazeh saz, Iran), respectively [14]. The fat and protein content of the samples were measured using the method developed by Gerber and Macro Kjeldahl [13].

Syneresis was quantified with 10 g of the sample by centrifugation, as the percentage of the supernatant liquid after centrifugation of the gel for 20 min at 2790 g. The apparent viscosity of the dairy desserts was evaluated using a viscometer (DV II + LV, Brookfield, Middleboro, MA, USA) equipped with spindle 4. Samples were poured into the measuring tank, and the measurements were carried out at fourteen angular speeds of a viscometer spindle ranging from 1.5 to 100.0 rpm at 20°C [13].

Microbial tests

For the microbiological analysis, 10 g of the samples were homogenized into a sterile glass with 90 mL of a sterilized saline solution (0.95% w/v) to obtain the initial dilution (1/10). By applying this dilution, several decimal dilutions were prepared using the same diluent. To measure the quantity of *L. plantarum*, dilutions were added to MRS agar containing vancomycin (10 mg/L) using the Pour Plate technique. Subsequently, cultured plates were incubated using a CO_2 incubator (Memmert, Munich, Germany) at 37°C for 72 hours. Results of bacterial counts were presented as Log cfu/g [15]. Dairy desserts were evaluated on days 1, 10, and 20 of storage.

Sensory analysis

A panel of 12 consumers, consisting of 6 women and 6 men aged 20 to 30, evaluated the sensory parameters of a dessert using a 5-point hedonic scale ranging from 1 (dislike extremely) to 5 (like extremely). The parameters included color, taste, flavor, texture, and overall acceptability, which were analyzed on the 20th day of storage. 20 g of dessert samples were prepared in numbered plates and distributed to the panelists at a temperature of 4 ± 1°C before they had a meal (to increase sensory sensitivity). After each test, the panelists rinsed their mouths with water [16].

Statistical analysis

Experiments were performed in triplicate, and the significant differences between the means were analyzed using one-way ANOVA and LSD post hoc tests (SPSS, version 22, 2016). Differences were considered significant at $P<0.05$. The nonparametric data were analyzed by applying the Kruskal-Wallis tests.

RESULTS AND DISCUSSION

Effect on Physicochemical Analysis

Table 1 shows pH and acidity levels for various dessert samples over the cold storage. The pH reduction was accompanied by an increment in acidity over the storage period. For the control sample, the highest pH and the lowest acidity were recorded on the first day. The sample containing 3% DSP (T_2) revealed the lowest pH levels and the highest acidity value. The pH and acidity values of the dessert samples ranged from 6.09 to 6.8° and 14.4 to 26.7 (°D), respectively. The results were in line with the pH limits (6.3-6.8) for dessert samples as determined by the Iranian National Standards Organization (INSO) (ISIRI 14681, 2012). These results also correspond to the range reported by Szwajgier and Gustaw [17], which was 6.25-6.36 for the pH values of dairy desserts. Similarly, *Aguilar-Raymundo et al*. [13] reported pH values ranging from 6.35 to 7.12 for commercial vanilla custard.

Therefore, the results confirmed that the addition of DSP significantly reduced the pH and increased the acidity of the dessert samples as compared to the control ones ($p<0.05$). Acidity is an essential indicator to determine the quality of dairy products and is associated with the presence of natural organic acids. The increasing acidity trend in the treated samples corresponded to the *LAB* viability results. The sample having higher *LAB* viability exhibited higher acidity. It seems, therefore, that DSP could provide a valuable source of nutrients for *LAB* and serve as a suitable carbon source for the growth of probiotics. DSP has been reported to contain significant

Table 1: Physico-chemical characteristics of milk dessert samples with different concentrations of date seed powder (DSP) during storage

Types		pH			Acidity (ºD)		
Days		1st day	10th day	20th day	1st day	10th day	20th day
Samples	Control	6.85 ± 0.03 Aa	6.78 ± 0.0٥Aa	6.7 ± 0.٠٢Aa	14.4± 0.1Ac	16.4± 0.08 Ac	17.7 ± 0.09Ac
	T_1	6.5± 0.٠1 Ab	6.45 ± 0.٠2Ab	6.3± 0.٠٥ Ab	19.5 ± 0.٠9Ab	21.4± 0.1 Ab	22.46 ± 0.1Ab
	T_2	6.26 ± 0.٠٤Ac	6.09 ± 0.٠1 Ac	6.03± 0.٠٦ Ac	23.5 ± 0.3Aa	24.06± 0.2 Aa	26.7 ± 0.2Aa
		Dry matter (%)			° Brix		
		1st day	10th day	20th day	1st day	10th day	20th day
	Control	24.22 ± 0.٠٤Ac	24.45 ± 0.٠2Ac	24.66± 0.05Ac	22.65 ± 0.2Ac	22.74± 0.06 Ac	22.83 ± 0.07Ac
	T_1	25.44 ± 0.٠٣Ab	25.88 ± 0.٠٤Ab	25.99± 0.٠٥Ab	23.25 ±0.٠8Ab	23.45± 0.1 Ab	23.61 ± 0.2Ab
	T_2	27.61 ± 0.٠4Aa	27.68 ± 0.٠2Aa	27.77± 0.02Aa	24.12 ± 0.2Aa	24.28± 0.09 Aa	24.39 ± 0.1Aa
		Protein (%)			Fat (%)		
		1st day	10th day	20th day	1st day	10th day	20th day
	Control	3.95 ± 0.12Ab	4.01 ± 0.٠6Ab	4.03± 0.08 Ab	3.61 ± 0.09Ab	3.69 ± 0.13Ab	3.79± 0.1 Ab
	T_1	4.08 ± 0.٠7Aa	4.12 ± 0.11Aa	4.14± 0.٠٥ Aa	3.76 ± 0.٠5Aa	3.83 ± 0.16Aa	3.84± 0.٠9 Aa
	T_2	4.12 ± 0.٠8Aa	4.14 ± 0.٠7Aa	4.15± 0.12 Aa	3.74 ± 0.٠6Aa	3.77 ± 0.11Aa	3.83± 0.07 Aa
				Ash (g/100)			
			1st day	10th day	20th day		
	Control		0.76 ± 0.٠5Ac	0.77 ± 0.٠6Ac	0.77± 0.02 Ac		
	T_1		0.78 ± 0.٠٣Ab	0.79 ± 0.٠1Ab	0.8± 0.٠٥ Ab		
	T_2		0.83 ± 0.٠3Aa	0.83 ± 0.٠2Aa	0.84± 0.02 Aa		

[a] Samples included (Control (0% DSP), T_1 (1.5% DSP), and T_2 (3% DSP))

[a]Means within each column followed by different letters (a–b) show a significant difference (P<0.05) between treatments at the same time

[b]Means within each row followed by different letters (A–B) show significant differences (P<0.05) for treatment during the storage period

concentrations of carbohydrate compounds, especially non-digestible ones like dietary fiber, which is a well-known promoter for LAB [11]. Consistent with our study, *Majzoobi et al*. [18] reported that by increasing the level of wheat germ, the acidity of dairy desserts was increased. In comparison with our study, *Kaur* and *Goswami* [19] reported that the pH value of dairy desserts increased significantly with increasing stevia concentration.

Table 1 represents changes in the dry matter, °brix, and ash of different dessert samples over the storage time. The results showed that the addition of DSP had a significant effect on these parameters of dessert samples, as compared to the control samples ($p<0.05$).On the 20th day, the highest dry matter, °brix, and ash could be observed for the samples containing 3% DSP. The lowest dry matter, °brix, and ash content belonged to the control sample on the first day. The amount of dry matter, °brix, and ash of all samples was incremented over the storage time; however, these changes were insignificant ($p>0.05$).

DSP could be regarded as an excellent source of functional components, including protein and carbohydrates. Adding DSP to dessert samples significantly increased the dry matter, °brix, ash, and titratable acidity [11, 13]. A sample having a higher amount of DSP had a higher amount of dry matter, °brix, ash, and titratable acidity. Similarly, *Aguilar-Raymundo et al.* [13] reported that adding raw chickpea flour to the dairy dessert increased the soluble solids (°brix). Consistent with our results, *Tarrega et al*. [20] reported values ranging from 23.5 to 28.3 for the °brix of commercial custards, the formulation of which included milk, cream, gelatin, cross-linked starch, and milk powder. Also, *Yangilar* [21] observed ash values ranging from 0.92 to 1.1 for ice cream enriched with date fiber.

Table 1 shows the protein and fat content of different dessert samples during cold storage. The protein content of the dessert samples was increased insignificantly ($p>0.05$), but the fat content increased significantly during 20 days of storage time ($p<0.05$). On the first day, the least protein and fat content were detected in the control sample. On day 20, the sample containing 3% DSP (T_2) had the highest protein and fat content. The results, thus, showed that adding

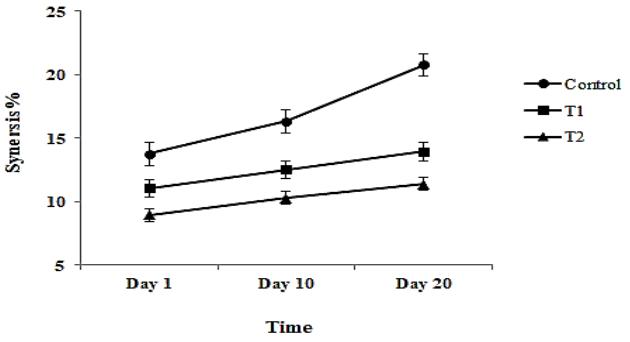

Fig. 1: The syneresis (%) of milk dessert samples containing different concentrations of palm kernel powder (DSP) during storage (Control (0% DSP), T_1 (1.5% DSP), and T_2 (3% DSP)

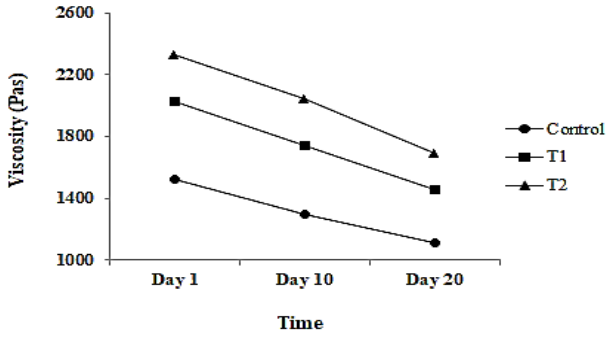

Fig. 2: The viscosity of milk dessert samples containing different concentrations of palm kernel powder (DSP) during storage (Control (0% DSP), T_1 (1.5% DSP), and T_2 (3% DSP))

DSP significantly increased the protein and fat content of treated samples, as compared to the control sample ($p<0.05$). The presence of fat and protein in date seeds has been reported by several researchers [11, 22]. This might be due to the incorporation of DSP in the dessert samples, which would improve their protein and fat content.

Therefore, it seems that the increment in the protein and fat content of dessert samples during cold storage is due to the decrease in their moisture content; this is confirmed by the increasing trend of dry matter during storage. For comparative purposes, our results are in agreement with those of *Yangilar* [21], who reported fat values ranging from 3.86 to 4.63 for date fiber-enriched ice cream. These data are also consistent with those found by *Djaoud et al*. [22], who reported protein values from 2.65 to 3.14% and corresponding fat values from 1.44 to 2.16% for dairy desserts.

Syneresis percentage and viscosity analysis

Protein gels in dairy products are formed from a solid network surrounded by a liquid phase; the critical amount of aggregation (crystallization) is required for gel formation. Syneresis is a phenomenon that adversely affects the quality of milk desserts [13, 23]. The syneresis percentage of different milk dessert samples over the storage time can be observed in Fig. 1. On the 1st day, the least syneresis was detected for the T_2 samples containing 3% of DSP. On the 20th day, the control sample exhibited the highest syneresis. The results, thus, revealed that the syneresis percentage of dessert samples increased significantly over the cold storage ($p<0.05$). Although, during cold storage, the reorganization of starch molecules can lead to water release (syneresis), the addition of DSP can significantly increase water retention capacity ($p<0.05$) and produce a highly stable dessert [23]. The presence of DSP in the dairy dessert formulation led to a positive interaction between the three-dimensional network of gelling agent chains and dessert liquid. The date seeds contain about 11% fats, 6% proteins, and 52% dietary fiber, as well as a considerable number of phenolic compounds. It seems, therefore, that proteins and polysaccharides in DSP interact synergically with the gelling agent to avoid undesirable syneresis. A similar result was reported by *Choobkar et al*. [23], which showed that incorporating fish gelatin in a pudding formulation significantly reduced the syneresis ($p<0.05$). The results follow the finding of *Wang et al*. [24] on the effect of adding whey protein and pectin on yogurt syneresis. Consistent with our results, Aguilar-*Raymundo et al*. [13] reported a significant increase in the syneresis percentage of dairy desserts enriched with chickpea flour during 12 days of storage.

Fig. 2 shows the apparent viscosity of various dairy dessert samples over the storage time. As observed, the apparent viscosity of all samples decreased significantly over the storage time ($P<0.05$). Such a behavior could be explained by the reduction in the formation of the network with a lower amount of interparticle bonds over the 2۰ days of cold storage [25]. In contrast to our results, *Bierzunska et al*. [26] found an increment in the apparent viscosity of yogurt samples supplemented with polymerized whey protein and whey protein concentrate after 10 days of storage. The results, thus, indicated that the presence of DSP caused a significant increase in the viscosity of the dessert samples compared to the control ($p<0.05$). It seems that the interaction of dietary fiber with water increased the viscosity of dessert samples.

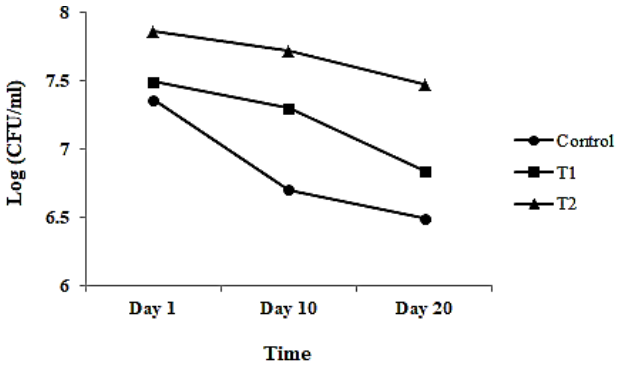

Fig. 3: L.Plantarum viability of milk dessert samples containing differentconcentrations of palm kernel powder (DSP) during storage (Control (0% DSP), T_1 (1.5% DSP), and T_2 (3% DSP))

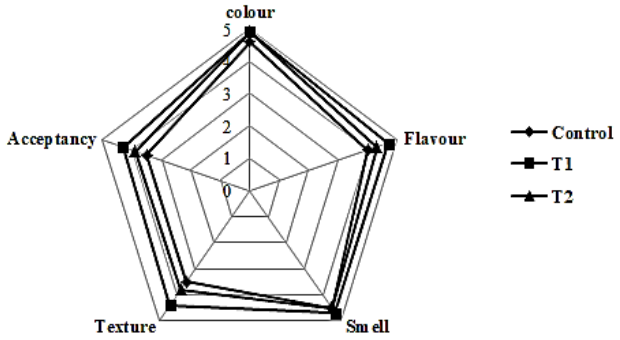

Fig. 4: Sensory evaluation of milk dessert samples with different concentrations of date seed powder (DSP) on the 20th day (Control (0% DSP), T_1 (1.5% DSP), and T_2 (3% DSP))

Similarly, *Mohammed et al*. [27] reported the effect of date pits on viscosity and pudding stability. The results attributed to the apparent viscosity behavior were comparable to those of other researchers in which bamboo shoot dietary fiber was used to improve milk pudding viscosity [28].

Survival of L. plantarum

The survival of probiotic bacteria is one of the important challenges in the production of probiotic foods. Fig. 3 shows the variation of *L. plantarum* numbers in milk dessert samples during cold storage. The number of *L. plantarum* decreased significantly during 20 days of storage; the lowest number of bacteria was recorded for the control samples on the 20th day ($p<0.05$). In dairy products, bacteriostatic and/or bactericidal factors, such as low pH, organic acids, high redox potential, hydrogen peroxide, molecular oxygen, bacterial competition, and changing temperatures, during storage can decrease the viability of *LAB* [8, 29]. The results showed that the viability of *L. plantarum* in dessert samples manufactured with DSP increased significantly, as compared to the control ($p<0.05$). After 20 days, the log number of *L. plantarum* in dessert samples containing 1.5% and 3% DSP was 6.84 and 7.47, respectively. DSP had an activating effect on the growth of *L. plantarum*, with the potential to be used as a source of prebiotics [11]. Similarly, *Al-Thubiani* and *Ahmad Khan* [11] also confirmed an increase in the population of *Lactobacillus paracasei* ssp *paracasei* in the presence of the date seed. Also, *Darwish et al*. [12] reported adding roasted date kernel powder increased the *L. acidophilus* viability significantly during cold storage ($p<0.05$).

Sensory evaluation

The results related to the comparison of the data obtained from the evaluation of panelists on the 20th day of storage in terms of color, flavor, smell, texture, and general acceptance using the chi-square test can be observed in Fig. 4. Regarding the smell and color parameters, all samples had the same acceptance and no significant difference was seen in any of the samples on the 20th day. The results, thus, revealed that there were significant differences ($P<0.05$) in terms of flavor, texture, and general acceptance of dessert samples on the 20th day. The highest flavor scores belonged to the T_1 sample with 1.5% DSP, while the lowest ones belonged to the control sample. It seems, therefore, that roasting date seed led to the generating compounds responsible for the distinctive and desirable flavor of the T1 treatment containing 1.5% DSP [30]. The highest texture score was related to the T_1 sample, while the lowest one was recorded for the control sample. After 20 days of storage, the T_1 treatments had the highest general acceptability score. However, the presence of DSP was found to adversely affect the texture and general acceptance of some dessert samples. Similarly, *Jrad et al*. [31] revealed that the presence of date powder significantly enhanced the taste and flavor score and the general acceptance of Greek yogurt. In line with our research, *Choobkar et al*. [23] reported that adding cinnamon powder had a positive effect on the overall acceptability of pudding products.

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CONCLUSIONS

In the present research, it was found that adding DSP at the level of 1.5% and 3% increased the viability of *L. plantarum* significantly. Therefore, this demonstrated the possibility of incorporating DSP into probiotic dairy products. The increasing trend of probiotic numbers in treated samples over storage was associated with an increment in acidity. Higher acidity was found in samples containing higher survivability of the LAB. The addition of DSP also significantly reduced the syneresis rate compared to the control sample. The results showed that the addition of DSP increased the viscosity of the treated desserts. An elevated DSP concentration enhanced the amount of fat, protein, dry matter, and ash in the treated samples. The milk dessert sample (T1) containing 1.5% DSP had a satisfactory probiotic content and overall acceptability score at the end of the storage period (20 days). Based on all the data available in this study, T1 samples were found to be the most suitable treatment to produce symbiotic dairy desserts.

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