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THE EFFECT OF ADDING AVOCADO-OIL ON THE NUTRITIONAL, MICROBIOLOGICAL AND RHEOLOGICAL PROPERTIES OF YOGURT

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Abstract
The avocado is a nutrient-rich fruit that has been shown to benefit health and diet qualities. In this study, avocado oil was added to milk for making yogurt to examine its effect on the chemical, rheological, microbial and sensory properties of yogurt. Avocado oil at 0.5%, 1% and 3 % and 5 % were added to the skim of reconstituted dried bovine milk. The developed yogurt was tested to evaluate the final product, including pH, chemical composition, acidity, and microbial properties as well as viscosity, spontaneous whey separation, water holding capacity, and hardness immediately following production and while being stored. Results show that yogurt made by adding 0.05% avocado oil had premium properties compared to the control and other additional treatments. More importantly, adding avocado oil enhanced its acceptability as well as provided more nutritious and healthy characteristics compared to plain yogurt. This is because avocado oil contains compounds of nutritional value, such as unsaturated fatty acids (MUFA and PUFA), as well as having compounds with biological activity, such as tocopherols, tocotrienols, phytosterols, carotenoids, and polyphenols, that help protect against diseases through the diet.

Keywords: Avocado oil, Yogurt, Rheological properties, Chemical properties.

تأثير اضافة زيت الافوكادو للبن الرائب على تحسين خصائصه التغذوية والميكروبيولوجية والريولوجية

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الخلاصة

يعتبر الافوكادو من الفواكه الغنية بالمواد المغذية التي يلاحظ فوائدها على جودة الغذاء الصحي. في هذه الدراسة اضيف زيت الافوكادو الى الحليب المحضر لتصنيع اللبن الرائب ودراسة تأثير هذه الاضافة على كل من الخصائص الكيميائية والريولوجية والميكروبيولوجية والحسية للمنتج. اضيفت التراكيز 0.05 و0.1 و1.0 و3.0% من زيت الافوكادو الى الحليب البقري المجفف المسترجع. أجريت الاختبارات لتقييم جودة المنتج النهائي وشملت تقدير الرقم الهيدروجيني والتركيب الكيميائي والحموضة الكلية والحمولة المكروبيولوجية بالإضافة الى اللزوجة ونضوح الشرش التلقائي وقابلية الخثرة على الاحتفاظ بالماء والصلابة بعد التصنيع مباشرة واثناء مدة الخزن على درجة حرارة 5±1 لمدة 14 يوما للوقوف على التغيرات في الخصائص الريولوجية التي قد تحدث اثناء الخزن، بالإضافة الى اجراء التقويم الحسي. أوضحت النتائج ان معاملة اللبن الرائب المصنع بإضافة زيت الافوكادو بنسبة 0.05% تميزت بأفضل الصفات مقارنة بمعاملة السيطرة ومعاملات الاضافة الاخرى. كما زادت اضافة زيت الافوكادو من خصائص القبول العام للمنتج، كما ان المنتج المطور ذو قيمة تغذوية وصحية اعلى مقارنة بمعاملة السيطرة وذلك لأن زيت الأفوكادو يحتوي على مركبات ذات أهمية غذائية، مثل الأحماض الدهنية غير المشبعة (MUFA وPUFA)، بالإضافة إلى مركبات ذات نشاط بيولوجية، مثل التوكوفيرول. والتوكوترينول والفيتوستيرول والكاروتينات والبوليفينول.

كلمات مفتاحية: زيت الافوكادو، اللبن الرائب، الخصائص الريولوجية، الخصائص الكيميائية.

Introduction

Due to their high nutritional content, yogurt and other dairy products that have undergone fermentation are very important economically. Most dairy products often contain a significant number of highly bioactive chemicals that are formed when milk proteins are broken down by enzymes (9). The US Food and Drug Administration defines yogurt as a nutritional product formed by lactic acid bacteria and having one or more of the dietary compositions of cream, milk, and partially or fully skimmed milk, in addition to lactic acid bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophilus* as culture bacteria (19).

Yogurt is widely used around the world because of its high nutritional value and therapeutic properties (26). It differs from other products by the type of fermentation (lactose to lactic) during the production process, making it easily digestible; during digestion, calcium becomes available for absorption in the alimentary canal (33). The health benefits of yogurt are attributed to the starter bacteria, and include treatment of digestive system disturbances (29), reducing cancer risks, reducing blood cholesterol levels, and improving lactose digestion, especially for cancer patients with lactose intolerance (29).

Natural or synthetic fruit purees or juices are typically used to flavor yogurt, and vary depending on consumer preferences. Fruit flavors like strawberry, raspberry, carrot, apple, pineapple, lemon, or orange essences and concentrates are also commonly added to yogurt drinks (34).

Yogurt benefits from fruit additions (16), including avocado which is a typical fruit of several varieties. It contains high concentrations of bioactive substances, such as soluble phenolics, ascorbic acid, vitamin E, and carotenoids, as well as other vitamins. It also has high levels of manganese, phosphorus, iron, and potassium, up to twice the protein content of other fruit, and very little salt, in addition to folate, vitamin C, â-carotene, thiamin, riboflavin, and nicotinic acid (18). The avocado has a medium-calorie density (1.7 kcal/g) due to its 80% water and dietary fiber content. Unlike other fruits, avocados have low sugar content and 15% oil that is rich in monounsaturated fatty acids, promoting carotenoid absorption (1).

Low-density lipoprotein (LDL) cholesterol is a major factor in atherosclerotic heart disease, and avocados provide a good source of monounsaturated oleic acid, which has been found to lower blood levels of LDL cholesterol (37). The fruit is also a good source of linoleic acid, an important fatty acid. It has been utilized in traditional medicine in Latin America and Africa to treat diabetes, hypertension, renal disorders, and other ailments, as well as has antipyretic and analgesic properties (3). Studies with laboratory animals (rats) have demonstrated that avocado has several effects, such as being hypotensive (14), antioxidant, and hypocholesterolemic (28).

In this study, avocado oil was added to milk for making yogurt to examine its effect on the chemical, rheological, microbial and sensory properties of yogurt.

This study examined the effect on the chemical, rheological, microbial and sensory properties of yogurt made from milk added with avocado oil.

Materials and Methods

Materials: For this research, whole powdered milk (Al-Mudhish- Oman State) was obtained from the local markets in Hilla city, yogurt starters were imported from the Danisco Corporation (France), and avocados obtained from the local markets in Baghdad. The starter cultures contained homogeneously mixed *Streptococcus salivarius* subsp thermophiles and *Lactobacillus delbrueckii* subsp *bulgaricus*.

Methods:

Avocado oil extraction: The oil was obtained using the cold-press extraction method described by (17).

Yogurt manufacture: Yogurt was produced using a 1:13 milk powder to water ratio and divided into four treatments. The first treatment comprised whole milk without avocado oil as a control (A1), while the second (A2), third (A3), and fourth (A4) treatments were made with skim milk to which avocado oil had been added at 0.5%, 1 % and 3% and 5 %, respectively. All the treatments were heated for ten minutes at 90° C and then cooled to 42° C. They were then inoculated by directly adding the starter culture containing *Streptococcus salivarius* subsp *thermophiles* and *Lactobacillus delbrueckii* subsp *bulgaricus*, following the instructions provided by the producer (Danisco - France). The treatments were filled in containers (working volume 100 ml) and incubated at 42 ± 2° C until fermentation. They were refrigerated for 14 days at 1° C until the required tests were performed shortly after production (35).

Physical-chemical methods: The AOAC (11) method was used to assess the moisture content, and the AOAC (12) method of directly burning samples in a muffle furnace was used to establish the ash percentage. (26) provided the methodology for determining the overall nitrogen percentage. The AOAC (10) was used to determine the amount of fat and the carbohydrate percentage calculated based on the following equation:

Carbohydrates % = (100-% (fat+ moisture+ ash + protein)).

The AOAC (12) was used to determine total acidity with pH measured using a pH meter (model 211 type HANNA).

Viscosity: Based on Abbas et al. (2), the apparent viscosity was measured with a Brookfield DVII + viscometer (Brookfield Engineering Lab Inc., Stoughton, Massachusetts) using axial spindle No. 4 at a speed of 10 rpm/min for 60 seconds and a sample volume of 150 ml after 1, 7 and 14 days.

Water holding capacity: Water holding capacity was determined according to (30), as follows:

$$WHC\ (\%) = [1-(W2/W1)] \times 100$$

Where, W1= weight of the pellet after centrifugation, g. and W2= initial weight of the sample, g.

Spontaneous whey separation: Based on (7), whey separation was measured by placing a cooled yogurt cup at an angle of 45° for 2 hr at 5^{o} C, taking out the clear whey from the surface with a syringe, and then re-weighting the cup.

Hardness: Hardness analysis was carried out according to the method mentioned by (7), using the Brookfield CT3 texture analyzer with a 2 cm diameter plastic cylinder that was projected at a strength of 5 g on the product to penetrate a 2-cm depth at a speed of 1 mm/sec.

Total solids: Total solids were calculated as per (7). About 3 g of yogurt samples were placed in aluminum pans that had been pre-weighed (Wt. empty pan), weighed (Wt. before drying), and (Wt. after drying) in an atmospheric oven at 100^{o} C.

Microbiological analysis: Total bacteria count was determined by making a serial dilution of 10 of 1 g of each sample of yogurt. Thereafter, 0.1 mL of each dilution of yogurt sample was placed on nutrient agar plates and incubated at 35^{o} C for 48 h. The same procedure was used for counting coliform bacteria, except that nutrient agar was replaced with MacConkey agar and Mannitol Salt Agar. Molds and yeasts were determined by the method mentioned in (13).

Sensory evaluation: Panelists comprising experienced scientists in the food science college performed sensory tests in accordance with the organoleptic evaluation list, as suggested by (6).

Statistical analysis: The Statistical Analysis System-SAS program was used to examine the effect of different factors (treatment and storage period) on study parameters while least significant difference (LSD) was used to significantly compare between means (27).

Results and Discussion

Chemical composition: Table 1 depicts the chemical makeup of yogurt made with various amounts of avocado oil. While the moisture content of the control treatment was higher than all treatments on days 1, 7, and 14, this difference was insignificant. Adding 0.5%, 1%, 3%, and 5% of avocado oil increased the fat, protein, ash content, and pH value of yogurt in the A1, A2, A3, and A4 treatments compared with the control during storage time. It is evident across all treatments that the samples' moisture content steadily declined as avocado oil concentrations rose proportionately throughout the course of the first 7 days and then again after 14 days of storage. This might be caused by evaporation during storage, where the avocado oil probably does not affect the moisture of the samples.

Table 1: Chemical composition of different yogurt treatments.

Treatment	Storage (days)	Moisture %	Fat %	Protein %	Carbohydrates %	Ash %	pH value	Titration acidity
C	1	86.98	3.2	4.27	4.88	0.67	4.68	0.81
	7	86.95	3.22	4.29	4.86	0.68	4.59	0.89
	14	86.89	3.25	4.32	4.84	0.7	4.43	1
A1	1	86.96	3.4	4.15	4.84	0.65	4.58	0.93
	7	86.93	3.43	4.18	4.79	0.67	4.51	0.99
	14	86.88	3.45	4.21	4.77	0.69	4.45	1.02
A2	1	86.86	3.5	4.14	4.86	0.64	4.48	0.98
	7	86.84	3.52	4.17	4.81	0.66	4.46	1.01
	14	86.81	3.55	4.19	4.76	0.69	4.43	1.05
A3	1	86.84	3.6	4.11	4.81	0.64	4.45	1
	7	86.82	3.62	4.14	4.77	0.65	4.46	1.03
	14	86.79	3.65	4.17	4.71	0.68	4.43	1.05
A4	1	86.83	3.7	4.1	4.74	0.63	4.3	1
	7	86.81	3.72	4.13	4.7	0.65	4.44	1.05
	14	86.78	3.74	4.17	4.62	0.69	4.41	1.07
LSD value		0.458 NS	0.251 *	0.0871 *	0.154 *	0.0576 *	0.137 *	0.0657 *
*** (P≤0.05).**								

After 14 days preservation, all treatments, including the control, had the highest percentages of fat content. The fat content of treatments gradually increased as their concentrations increased compared to the control treatment. The control treatment and the avocado oil treatments did not differ from one another.

The protein content of the yogurt treatments A1, A2, A3, and A4 was 4.15, 4.14, 4.11, and 4.1%, respectively after one day of storage. After 14 days, however, it was higher than after one and seven days storage. This increase can be explained by the ongoing reduction in the yogurt's moisture content over the course of storage. The control and treatments in this study did not differ from one another. The ash content of the treatments A1, A2, A3, and A4 was 0.65, 0.64, 0.64, and 0.63%, respectively after one day of storage. After 14 days, however, the ash level was higher than it was after the first and seventh day. This increase can be explained by the ongoing reduction in the yogurt's moisture content over the course of storage. The control and treatment treatments in this study did not differ from one another. Ash content was affected by the addition of avocado oil in the yogurt samples compared to the control treatment.

In the same context, no significant differences were noted between the control and the addition treatments in pH content. After 14 days of storage, the pH values were lower for all treatments, but the treatments' pH values were greater than those of the control treatment. The pH values of all yogurt treatments declined during the 14 days of storage; these results agree with (20), and this pH reduction during storage may have contributed to the lactose turning into lactic acid during storage (33). The titratable acidity of all the treatments and control samples was determined after storing at 4^{o} C for the 1, 7, and 14 days (Table 1). With the progression of the storage periods, there was no statistically significant difference in the titration acidity of any of the tested samples. It was observed that the control samples' titration acidity values were greater than those of the treatments of samples. This may be the cause of some microorganisms being partially or completely inactivated by the various avocado oil treatments, notably for gram-positive bacteria, as a result of the avocado oil seeping into the bacteria and affecting their cell surfaces.

The yogurt's low and constrained water content prevented the active compounds in the plant extracts from reaching the active or inactive sites in the bacteria, obstructing their ability to form a protective layer (coat around the bacterium) against microorganisms. Furthermore, the temperature in the refrigerator did not influence the growth of lactic acid bacteria. Table 1 shows that the pH values for all treatments with storage decreased. After 14 days at 5° C, the pH of the control treatment reached 4.43, while it was 4.45, 4.43, 4.43, 4.41 for A1 to A4, respectively. These results are consistent with (7). The decrease in pH values with storage is due to the continued activity of starter bacteria, which convert lactose into lactic acid during storage, though the process is slow (21).

Rheological characteristics:

Viscosity: Table 2 shows the viscosity values for the different yogurt treatments. It was 1350 centipoise immediately after 1 day of manufacturing for the control, while for the avocado oil-added treatments they were 1285, 1240, 1213, and 1165 for A1 to A4, respectively. It can be concluded that a significant difference exists between the control and the addition treatments, and among the different addition treatments. For all treatments, viscosity increased during storage. After 14 days, it reached 1630 centipoise for the control and 1670, 1630, 1620, and 1560 centipoise for the avocado oil-added treatments A1, A2, A3, and A4, respectively. This is in agreement with (5) who showed that after 14 days storage, the viscosity values of the positive and negative control treatments increased. This might be because of the drop in pH of the yogurt, which increases its hardness and, as a result, raises its viscosity.

Spontaneous whey separation: The presence of whey on the yogurt's jelly surface is known as spontaneous whey separation (22) as it occurs on its own without any outside assistance. The quantities of fresh whey for the various yogurt treatments previously stated are shown in Table 2. For the control treatment after one day of production it was 4.85 ml/100 gm, while for the treatment with added avocado oil they were 5.8, 5.7, 5.43, and 5.2 ml/100 gm for A1, A2, A3 and A4, respectively. Less whey was secreted from the control than the avocado oil-added treatments. Due to the fat in the control treatment, the moisture content increased while total solids decreased, and more whey was expelled. This improved the yogurt's ability to hold water and prevent whey from being excreted to the surface (38).

With storage, whey secretions declined, as noted by (7), who reported that the starter bacteria's metabolic activity and the drop in net pressure inside the protein matrix were the cause of the reduced whey separation of yogurt from 55.8% on the first day of storage to 51.3% on the 21st day. The values after 14 days for the control treatment were 4.65 ml/100 gm., and for yogurt with avocado oil added treatment, were 4.87, 4.73, 4.71, and 4.69 ml/100 gm for A1, A2, A3 and A4 treatments, respectively. Also, the avocado oil-added treatments decreased the ability to separate the whey after 14 days storage by a substantial percentage than the control treatment as the oil reduced the possibility of growth of starter bacteria, thus reducing acidity and increasing the water holding capacity (7).

Water holding capacity: Syneresis is a key factor in assessing the quality of yogurt and fermented milk. As the casein gel network contracts, it causes the separation of whey during storage. As a result, it manifests as a crack layer that is apparent on the yogurt's surface and has a negative impact on customer perception (36). The water holding capacity for the control and other treatments is shown in Table 3. After one day’s storage the water retention percentage for the control was 55.33%, and 60.42, 61.55, 63.14 and 65.33% for the A1 to A4 treatments, respectively. This is in good accord with (4) which showed the water holding capacity for yogurt made from skimmed milk at 18.90%. In contrast, it was 25.27, 27.31, 32.50, and 33.41%, respectively for yogurt with beta-glucan immediately after production, with higher beta-glucan additions raising WHC levels. It was also found that storage time length impacts the capacity to hold water. The readings after 14 days increased with all treatments and longer storage times with the control registering 64.66% and the avocado oil treatments at 71.23, 72.65, 72.99 and 76.55% for A1 to A4.

Table 2. Rheological characteristics of different yogurt treatments

Treatment	Storage (days)	Viscosity (centipoise)	Spontaneous whey separation (ml/100 gm)	Water holding capacity (%)	Hardness (gm)
C	1	1350	4.85	55.33	65.5
	7	1460	4.73	60.21	77.3
	14	1630	4.65	64.66	85.1
A1	1	1285	5.8	60.42	55.9
	7	1460	4.96	65.34	68.3
	14	1670	4.87	71.23	79.5
A2	1	1240	5.7	61.55	56.1
	7	1490	4.91	65.89	69.2
	14	1630	4.73	72.65	73.7
A3	1	1213	5.43	63.14	59.9
	7	1460	4.88	68.49	65.7
	14	1620	4.71	72.99	71.6
A4	1	1165	5.2	65.33	61.1
	7	1330	4.77	71.21	69.3
	14	1560	4.69	76.55	74.41
LSD value		4.775 *	0.153 *	0.898 *	0.797 *
*** ($P \leq 0.05$).**					

The addition of avocado oil increased the yogurt's water retention capacity compared to the control treatment after 14 days of storage. This result was the same for all avocado oil-added treatments; this is consistent with (24) who found the water holding capacity of raspberry-enriched yogurt increasing from 70.57% to 72.94% after 16 days refrigeration. Similar results were obtained by (32) in a low-fat yogurt with seed gum and locust bean gum. (33) reported that water retaining capacity in the control and yogurt treatments supported by calcium and fruit increased over the first 7 days of storage and remained constant till the 14th day. This may be due to the evolution of the protein network with the longer storage duration (31).

Hardness: Hardness is also a critical factor affecting the textural characteristics of yogurt. When the pH level of yogurt hits the isoelectric point of the casein, it may hold the most water. After this, the water released by the yogurt may become increasingly acidic. The drop in pH and casein aggregation brought on by disulfide linkages between the casein and denatured whey proteins affects the the gel's structural strength (25).

Table 2 shows the hardness values for the various yogurt treatments. The hardness for the control treatment after 1 day of manufacturing was 65.5gm, and 55.9, 56.1, 59.9, and 61.1 gm for the A1 to A4 yogurt avocado oil treatments, respectively. This is a significant difference between the two types of treatments. Hardness was noted to be impacted by storage times, increasing across all treatments as storage times rose, particularly after 14 days. For the control it was 85.1, while for the avocado oil treatments they were 79.5, 73.7, 71.6, and 76.55 gm for A1 to A4, respectively, as similarly noted by (15).

FTIR measurements: The Fourier transform infra-red spectra of yogurt samples in different concentrations of avocado oil are shown in Fig.1. Each figure explains how yogurt can express the characterization of functional treatment for avocado oil.

The transmittance spectra revealed comprehensive fingerprints on the interactions between the co-adsorbent molecules and the avocado oil due to the presence of different functional units and the corresponding bond vibration. The emergence of the board and strong band at around 702.05 cm^{-1} was due to the stretching vibration of alkynes (–C≡C–H: C–H). The presence of the band at approximately 1635.7 cm^{-1} was due to the C=O amide bond stretching (23). The weak band at about 2079.4 cm^{-1} belongs to the (C ≡ C) stretch. The presence of an intense band at around 3419.2 cm^{-1} was due to the O–H stretch. Notably, the solvent showed strong intermolecular hydrogen bonds, which enabled the extension of crystal lattice networks on the avocado oil. The durability of the intermolecular aggregated patterns was further confirmed by the appearance of sharp bands related to the adsorbed hydrogen bonded alkynes despite some solvent content-dependent variations. The presence and transmission of functional chemical treatment binding vibrations are a basic indication of the interaction between avocado and yogurt.

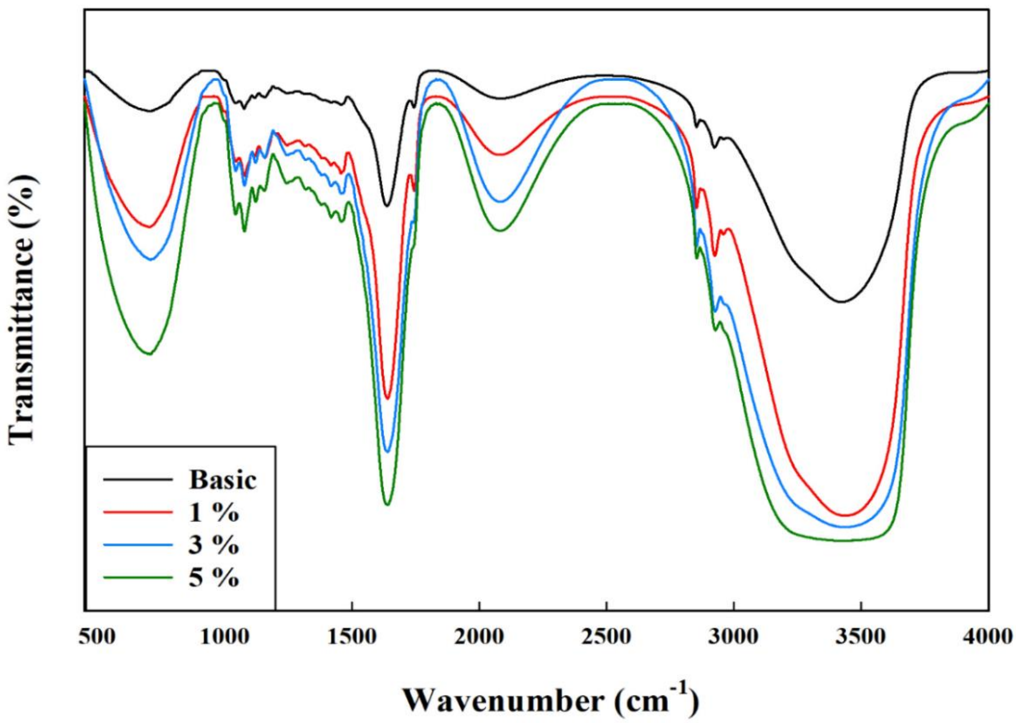

Fig. 1: FTIR spectra of the yogurt samples in different concentrations of avocado oil.

Fig 1. shows the yogurt under study's recorded FTIR spectrum in the 500–4000 cm^{-1} region as a function of solvent content with increasing avocado oil percentages.

The findings imply that the trend in each sample is approximately the same as the transmission profiles, except that the peaks became sharper without losing any functional treatment; for example, amides (carboxylic acid derivatives) are observed at 1635.7 cm^{-1}. This phenomenon is due to the strong intermolecular hydrogen bonding of yogurt, which forms an extensive crystalline structure (23). Also, the existence of the hydrogen-bound carboxylic treatment signals and the surface-adsorbed carboxylate stretching indicates the consistency of intermolecular patterns of aggregation, with slight variability based on the amount of solvent added.

Microbial properties: Avocado oil was added to yogurt to improve its antimicrobial as well as other rheological properties. The microbial properties of the control treatment deteriorated as storage proceeded and some *E. coli* cells, moulds and yeast were detected on day 7 and increased by day 14. Adding increasing concentrations of avocado oil improved the antibacterial and antimicrobial properties of the manufactured yogurt. Indeed, avocado oil can inhibit quorum system-mediated virulence factors that are produced by bacteria such as pyocyanin and violacein. Additionally, it was found that using avocado oil at sub-minimum inhibitory levels would considerably inhibit biofilm formation, swarming motility, and exopolysaccharide production (EPS) (8). This observation was confirmed in this study, where no bacterial, mould and yeast growths were detected in all the A1 to A4 avocado oil-added treatments (Table 3). According to these findings, avocado oil has strong antimicrobial effects and may prove to be a potent anti-QS and antibiofilm agent against infections.

Table 3: Total bacterial, coliform, mold, and yeast content in yogurt.

Treatment	Storage (days)	Starter bacteria	Mould and yeast	*E.coli*
C	1	68	---	---
	7	75	8	6
	14	22	16	12
A1	1	65	---	---
	7	80	---	---
	14	25	---	---
A2	1	67	---	---
	7	73	---	---
	14	20	---	---
A3	1	61	---	---
	7	72	---	---
	14	21	---	---
A4	1	59	---	---
	7	71	---	---
	14	19	---	---
LSD value		2.358 *	4.075 *	4.118 *
*** (P≤0.05).**				

Sensory evaluation: Table 4 shows the sensory evaluation for all mentioned yogurt treatment parameters, such as flavor, texture, acidity, and appearance, with the A1 treatment producing the highest score on the first day of manufacture at 97.1. This may be due to the role of avocado oil at this percentage in transferring desirable qualities, including color, aroma, taste, and texture. Nevertheless, the control and the other added avocado-oil treatments (A2, A3 and A4) also received high scores at 96.7, 94.4, 94.3 and 94 respectively. Thus, it is evident that adding 0.1% avocado oil played a clear role in preserving the sensory characteristics of the yogurt. At the end of 14 days storage, the score for sensory evaluation for the control was 87.87, while those for the yogurt with added avocado oil treatments A1, A2, A3, and A4 were 90.2, 86.5, 83.05 and 79.8, respectively. Treatments A4 and A1 had the lowest and highest evaluation scores, respectively for the yogurt treatments both on the first day of production and during the 14-day storage period.

Table 4: Sensory evaluation results for the yogurt treatments during storage at a temperature of 5±1° C.

Treatment	Storage (days)	Flavor 45°	Textures 35°	Acidity 10°	Appearance 10°	Total 100°
C	1	43.5	33.2	10	10	96.7
	7	41.6	31.1	10	10	92.7
	14	39.76	30.11	9	9	87.87
A1	1	44.2	32.9	10	10	97.1
	7	42.55	31.85	10	10	94.4
	14	40.1	30.22	9	9	88.32
A2	1	43.3	32.1	9	10	94.4
	7	42.24	31.33	9	10	92.57
	14	39.65	29.85	9	8	86.5
A3	1	43.5	32.8	9	9	94.3
	7	41.43	31.32	9	9	90.75
	14	38.95	29.1	8	7	83.05
A4	1	43.4	32.6	9	9	94
	7	41.22	30.33	9	9	89.55
	14	38.15	28.65	7	6	79.8
LSD value		0.641 *	1.182 *	1.679 *	0.683 *	1.134 *
*** ($P \leq 0.05$).**						

Conclusions

Avocado oil was added to the milk used in preparing yogurt and the effects on its chemical, rheological, microbial and sensory properties were investigated. Four concentrations of avocado oil were added to the skim reconstituted dried bovine milk and its effects on the yogurt studied immediately following production and when stored at room temperature. Effects evaluated included pH, chemical composition, titration acidity, and rheological characteristics such as viscosity, spontaneous whey separation, water holding capacity, and hardness. Based on the results, the A1 yogurt treatment which included avocado oil had higher pH values than the control and enhanced rheological qualities compared to the other additional treatments using the same attributes. These findings can contribute towards developing new strategies for enhancing the qualities as well as consumer experiences of yogurt.

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The authors declare no conflict of interest.

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