Effect of moringa(Moringa oleifera) extract on physicochemical, microbiological and sensory properties of yogurt

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Abstract
The current study aims in addition to having a high nutritional value and a variety of useful nutrients, moringa has several significant biological uses, particularly its ability to effectively treat a wide range of illnesses caused by bacteria, viruses, and other pathogens. To increase the amount of moringa in the final product, various kinds of aqueous extract are used. The following were included in the study: Two concentrations of the moringa aqueous extract 1% and 2% per kilogram of milk as well as a control experiment in which yogurt was created from whole milk fat with the addition of moringa aqueous extract promote the production of yogurt from whole milk. The most significant outcomes attained are. Following manufacture, the moisture content of the yogurt treatments that included aqueous extract remained comparable to that of the control treatment. They showed a decline in their values for all treatments when the moisture content was stored at 5±1 °C for 28 days. All post-manufacturing yogurt treatments had comparable percentages of total acidity. a noticeable rise in their levels following every treatment during storage. After manufacture, the pH values of the resulting yogurt were comparable for all treatments; however, a noticeable, minor drop in values was noted during storage. When compared to the control, the aqueous extract that was added to the yogurt enhanced the results of rheological tests, such as those measuring viscosity and water retention.
The T2 treatment with a 2% concentration received the highest ratings and performed exceptionally well in every sensory category, demonstrating the superiority of the yogurt treatments enhanced with aqueous extract, according to the results of the sensory evaluation. This led to the current study, which sought to fortify milk used to make yogurt in high proportions.
Keywords: Microbiological, Moringa, Physicochemical, Yogurt.

Introduction

Moringa oleifera Lam. (Moringaceae), commonly known as horse radish tree, drumstick tree, moringa tree and ma-rum tree, is medium-sized, evergreen tree and widely grown in tropical and subtropical regions. Moringa is a highly valued plant, distributed in many countries. [6]. Moringaceae family consists of 14 known species. Of these, M. oleifera is the most widely known and utilized species. The plant is a native of the sub-Himalayan regions of North West India, and is now indigenous to many countries all over the world. The tree
ranges in height from 5-12 meters with an open umbrella-shaped. [23 .[
Moringa is medium-sized, evergreen tree and widely grown in tropical and subtropical regions. The plant is a native of the sub-Himalayan regions of North West India, and is now indigenous to many countries in Africa, Arabia, South East Asia, the Pacific, the Caribbean islands and South America. The tree ranges in height from 5-12 meters with an

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open, umbrella-shaped crown, straight short trunk with corky, whitish bark, soft, spongy wood. It has slender, wide spreading, drooping, fragile branches [6]; [23.[

Moringa is a highly valued plant, distributed in many countries. It has an impressive range of medicinal uses with high nutritional value owing to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds. In fact, moringa is said to provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach. [6] [46]. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. M. oleifera seed, a natural coagulant is extensively used in water treatment. [26.[

Every part of M. oleifera is a store house of important nutrients and anti-nutrients. The leaves of M. oleifera are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper. Vitamins like beta-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also present in M. oleifera [36]. Phytochemicals such as tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids and reducing sugar present along with anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate [10]. Moringa leaves also have a low calorific value and can be used in the diet of the obese. The pods are fibrous and are valuable to treat digestive problems and thwart colon cancer [40]. Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. Moringa leaves powder can provide 17 times more calcium than milk. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2 mg of iron while moringa leaf powder has 28 mg of iron. [22]. A good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for the synthesis of DNA and RNA. M. oleifera leaves show around 25.5-31.03 mg of zinc/kg, which is the daily requirement of zinc in the diet [9]. PUFAs are linoleic acid, linolenic acid and oleic acid, these PUFAs have the ability to control cholesterol. Research show that moringa seed oil contains around 76% PUFA, making it ideal for use as a substitute for olive oil [34 .[

Natural phenolic compounds have received increasing interest in the last few years, since a great amount of them can be found in plants and consumption of vegetables and beverages with a high level of such compounds may reduce the risk of development of several diseases due to their antioxidant power, among other factors [24]. Phenolic compounds constituting one of the most widespread groups of substances are the products of secondary metabolism in plants. More than 8000 phenolic structures have been characterized, which involve essential activities in the reproduction and growth of the plants, play important role as defense agents against pathogens, parasites, and predators, as well as promotion to the color of plants [17 .[

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Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds [21]. In fact, moringa is said to provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach. [46]. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes. The leaves are rich in minerals, vitamins and other essential phytochemicals [22]. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers [37 .[

The chemical composition of the different parts of the moringa tree may vary depending on the differences in variety of plant, cultivation, climate, ripening stage, the harvesting time and the extraction or analytical method used [41]. Moringa leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [48 .[

M. oleifera different parts used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. M. oleifera seed, a natural coagulant is extensively used in water treatment [26]. India is the largest producer of moringa with an annual production of 1.1 to1.3 million tons of fruits. Moringa is grown in home gardens in Odisha and as living fences in southern India and Thailand [44]. In Egypt, little knowledge is known about moringa, although Moringa peregrina is a native tree and growing wild in Sinai Mountains since 3000 BC. The ancient Egyptians used its oil for skin protection from sun as well as for wound healing [1] [23 .[

Yogurt is a fermented milk product obtained from the fermentation of lactose sugar by starter bacteria. It has a number of benefits for humans [31]. It is rich in many nutrients such as protein, calcium, fat, and vitamins such as vitamin D, riboflavin, vitamin B6, and vitamin B12. Yogurt is considered the most beneficial. From milk, the reason for this is the presence of live therapeutic bacteria that are important for the digestive system and that can lead to health benefits when consumed in sufficient quantities [4.[

In addition to the conversion of lactose sugar into lactic acid after the fermentation process [13], the process of converting lactose sugar into lactic acid in yogurt solved the problem of intolerance to lactose sugar and indigestion by a number of people who suffer from a deficiency of the lactase enzyme, as using yogurt without No side effects [43.[

Yogurt is one of the most common dairy products in the world and is widely consumed. Therefore, yogurt is a popular food [25]. Yogurt may be a modern food, but it has ancient origins that may extend thousands of years since the existence of cows, sheep, and goats. Although its original homeland has not been determined, it is believed to be native to the Middle East [14]. It is believed that it was discovered about 5000 years ago BC in Mesopotamia [32.[

Yogurt is the milky product resulting from the fermentation of lactose by the lactic acid bacteria Streptococcus thermophilus and Lactobacillus delbrueckii subsp bulgaricus.

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The semi-solid milk curd results from the three-dimensional protein network formed during fermentation [50]. The acid produced during this process reduces the negative charges of milk protein molecules when the pH of the milk becomes less than 6.0 [14.[

The casein particles begin to aggregate and the solubility of the colloidal calcium phosphate present in milk increases. As the pH continues to decrease towards pH 5.0, the interactions between the casein particles increase and become more complex. The decrease in charge of the casein particles leads to a decrease in the negative charge in general and then a decrease in the net negative charge and then to low electrostatic, in this process, the casein particles and denatured whey proteins will intertwine in the form of chains or clusters through hydrophobic and electrostatic bonds, which leads to giving the structure of a gel or milk curd. The peak solidity of this curd occurs when the pH reaches 4.6, which is the electrical neutralization point of casein [35.[

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Despite the fact that yogurt bacteria are not among the types of bacteria endemic in the intestines, they have many health benefits, such as facilitating protein digestibility, reducing sensitivity to lactose, helping in the absorption of mineral salts, controlling intestinal health, and strengthening immune systems. Therefore, it is recommended to eat yogurt at a rate of 200-400 grams/day. For adults and 600-800g/day for children and pregnant women per day [14] many studies have also indicated that yogurt has several physiological and preventive functions, including preventing human immunodeficiency virus infection, autism, constipation, diabetes, obesity, preventing urinary tract infections, anti-cancer effects, and lowering blood cholesterol levels [28] [12[

The current study was conducted and aimed to support one of the most widely consumed types of foods, which is yogurt, which provides the consumer with a number of micronutrients, as well as macronutrients such as carbohydrates, proteins, and fats. It is a low-cost method in addition to being a basic or almost daily food for many consumers.

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and quality of two grapevine cultivars (Vitis vinifera L.) [4.[

Material and Methods

Moringa Oleifera leaves were collected from a private farm located in Al-Najaf Governorate, Iraq, in the middle of October 2024

Whole milk were obtained from the local market of Al-Najaf city. Solvents, chemicals, and reagents were obtained from El-Gomhouria Company, Al-Najaf , Iraq, and Sigma–Aldrich (Steinheim, Germany). All chemicals and reagents used were of analytical grade.

strains of bacteria from Streptococcus thermophilus and Lactobacillus delbrueckii Subsp bulgaricus produced by the French company Danisco, in addition to direct yogurt mixtures.

Preparation of leaf extract

The leaves were washed with distilled water and dried at 45 o C to a constant weight. The seeds also were dried under the same conditions. Then the dried samples were ground to powder form, and finally, stored in light dark bottles at 4 o C for further use .

Milk tests

A sample of the milk was taken and the components of whole milk used in the manufacture of yogurt were tested using a programmed lacto flash dairy components estimator. The percentage of fat, protein, total solids and non-fat solids were estimated.

Yogurt manufacturing

Yogurt was made according to the method followed by [49] and as follows: A quantity of raw cow's milk (full-fat mixture) and used in manufacturing yogurt. The milk was exposed to a temperature of 90°C for 10 minutes and then cooled to a temperature of 42°C. Then it was divided into two halves, the first half was left untreated and used in the manufacture of yogurt with control treatment C as for the second half, it was divided into two parts, to which moringa extract was added at a rate of 1% and 2%, represented by treatments T1 and T2. The samples of the treatments were mixed with an electric mixer to ensure they were well mixed, and inoculated with the starter Streptococcus thermophilus and Lactobacillus delbrueckii Subsp bulgaricus.

With direct addition and the quantity indicated by the company at a rate of 3%, it was packed in 100 ml plastic containers and incubated at 42±2 degrees Celsius until complete coagulation, approximately 4-5 hours, until the pH dropped to 4.6. Then it was removed from the incubator and transferred to the refrigerator for cooling and preservation at a temperature of (5±1) until the necessary tests are carried out after 1, 7, 14,21 and 28 days of manufacturing.

Physicochemical tests for yogurt

Estimating moisture

The percentage of moisture in yogurt was estimated by placing 2 grams of the sample in a weighed ceramic bowl and placing it in a drying oven at a temperature of 105°C until the weight stabilized, according to what was stated in [8.[

Titritable Acidity

The titritable acidity was estimated by weighing 10 grams of the sample in a beaker, adding a few drops of phenolphthalein reagent to it, then flushing with 0.1 NaOH until the pink color appeared, according to what was stated in [8.[

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pH

Estimate the pH of yogurt samples by placing the pH meter sensor directly into the yogurt sample

Viscosity

The apparent viscosity of yogurt samples was estimated at 10°C after 1, 7, 14,21 and 28 days of refrigerated storage using a Brookfield DVII viscometer equipped by (Brookfield Engineering Lab Inc., Stoughton, Mass.). The axial spindle No. 4 was used with a number of revolutions of 10 revolutions/min and a size 150 ml for the sample. Leave the spindle to rotate inside the sample for 60 seconds after it is done The gel was broken by moving it 10 times clockwise and 10 times counterclockwise, and the reading was taken three times and the average was calculated in centipoise units, according to [18.[

Water Holding Capacity

The water retention capacity was estimated by exposing 10 g of the milk sample to centrifugal force at a speed of 3000 rpm for 60 minutes at a temperature of 10°C, after which the filtrate was removed and the remaining wet sediment was weighed, and the water retention capacity was calculated as a ratio between the weight of the remaining sediment and the weight of the original sample, according to what mentioned. [42.[

Microbiological analysis

The microbiological analyzes of the prepared yogurt samples included estimating the total number of starter bacteria, the numbers of coliform bacteria, the numbers of Psychrophilic bacteria, and the numbers of yeasts and molds, by taking 10 grams of yogurt, mixed well using a blender with 90 ml of sterile peptone water to obtain a 10-1 dilution, and graduated dilutions were made from it. The other is to transfer 1 ml of it to several test tubes containing 9 One ml of sterile peptone water until the dilution is reached 10-7, according to what was stated in [7.[

Estimate the total number of starter bacteria

The total number of bacteria of the starter prepared for use in yogurt manufacturing was calculated 48 hours after the manufacturing process, as mentioned by [30], and the number of bacteria per cm3 was calculated by multiplying the colony rate for two plates × the reciprocal of the dilution for three replicates [52.[

Estimation of Streptococcus thermophilus

The total number of Streptococcus thermophilus bacteria was estimated according to the method described by [16]. Gradient dilutions of yogurt samples were prepared using a solution of 0.1% sterile peptone water. The pouring method was used on S. thermophiles isolation agar media, and the dishes were incubated under anaerobic conditions at a temperature of 37°C. For 48 hours, the numbers of growing colonies were calculated using Colony counting device.

Lactobacillus delbruecku ssp.bulgaricus

The total number of L. bulgaricus bacteria was estimated according to the method described by [20]. Gradient dilutions of yogurt samples were prepared using a solution of 0.1% sterile peptone water. The pouring method was used on MRS agar medium with a pH of 4.5 ± 0.1. The dishes were incubated under anaerobic conditions at a temperature 37°C for 72 hours, and the numbers of developing colonies were counted Using a colony counting device.

Total coliform

The total number of coliform bacteria was estimated using MacConkey agar medium. The plates were incubated at 37°C for 24-48

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hours, according to the method mentioned in [7.[

Estimating the number of Psychrophilic bacteria

The number of this group was estimated using Nutrient agar and incubation at 7°C for ten days, according to [7.[

Molds & Yeasts

The number of molds and yeasts was estimated using potato dextrose agar and incubated at 22°C for five days, according to [7.[

Sensory evaluation

Sensory evaluation of yogurt models were conducted in the Department of Food Science - College of Agriculture - University of Kufa by ten specialized professors and 10 students according to a sensory evaluation form that included the characteristics of flavour, texture, colour, appearance and acidity, developed by [39.[

Statistical analysis

Complete Random Design (CRD) and factorial experiments were used to study the interaction between different treatments in some characteristics of yogurt, and the significant differences between the means were compared with the least significant difference (LSD) test and the use of the statistical program Genstat (2012) in the statistical analysis of the studied data.

Results and Discussion

Chemical composition of milk used in making yogurt .

Table (1) shows the percentage rates of moisture, fat, protein, total solids and non-fat solids for whole raw cow's milk

amounting to 86.30, 3.59, 3.69, 14.12 and 10.53%, respectively, as for the pH and leachate acidity (calculated on the basis of lactic acid) and specific gravity are 6.63, 0.16, and 1.031, respectively. These percentages are within the normal limits for milk and are close to what [53] [5.[

Table (1): Chemical composition of raw, full-fat cow's milk

Whole milk	components
86.30	**%Moisture**
3.59	**%Fat**
3.69	**%Protein**
13.72	**%Total solid**
10.02	**% Non-fatty solids**
6.63	**pH**
0.16	**% Titritable Acidity**

Chemical composition and physical properties of yogurt fortified with moringa extract.

The following tables and figures show the chemical composition and physical properties of yogurt made from whole milk, control treatment C, and yogurt made from whole milk fortified with aqueous moringa extract at concentrations of 1% and 2%/liter, represented by treatments T1 and T2,

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respectively, immediately after manufacturing and during storage at temperature (5±1)°C for 28 days.

Moisture percentage

Figure (1) shows the percentage of moisture for both yogurt in control treatment C and yogurt in treatments T1 and T2, as its value immediately after manufacturing for the control treatment was 85.63%, 85.55 and 85.46 and this result is close to what was found by [2]. The moisture percentage for the yogurt treatments enriched with water extract (T1) reached 85.64, 85.57 and 85.47% for the previous treatments, respectively. And (T2) 85.64, 85.63 and 85.56. It is noted from the results that there was a slight decrease in the percentage of moisture as the storage period progressed and for all yogurt treatments

After 21 days, the values for treatment C reached 85.40%. For treatments of yogurt added to moringa aqueous extract, the rates were 85.42 and 85.50% respectively.

. After 28 days, the values for treatment C reached 85.32%. For treatments of yogurt added to moringa aqueous extract, the rates were 85.34 and 85.45%respectively.

This result is consistent with what was found by [2], who observed a decrease in cheese fortified with moringa extract. The reason for this decrease may be due to the rate of evaporation from the moisture

content during storage. [11.[

The results of the statistical analysis shown in Figure (1) indicate that there are no significant differences (P>0.05) in the percentage of moisture between treatment C and the treatments to which the moringa aqueous extract was added immediately after manufacturing, as well as during the storage period of 28 days.

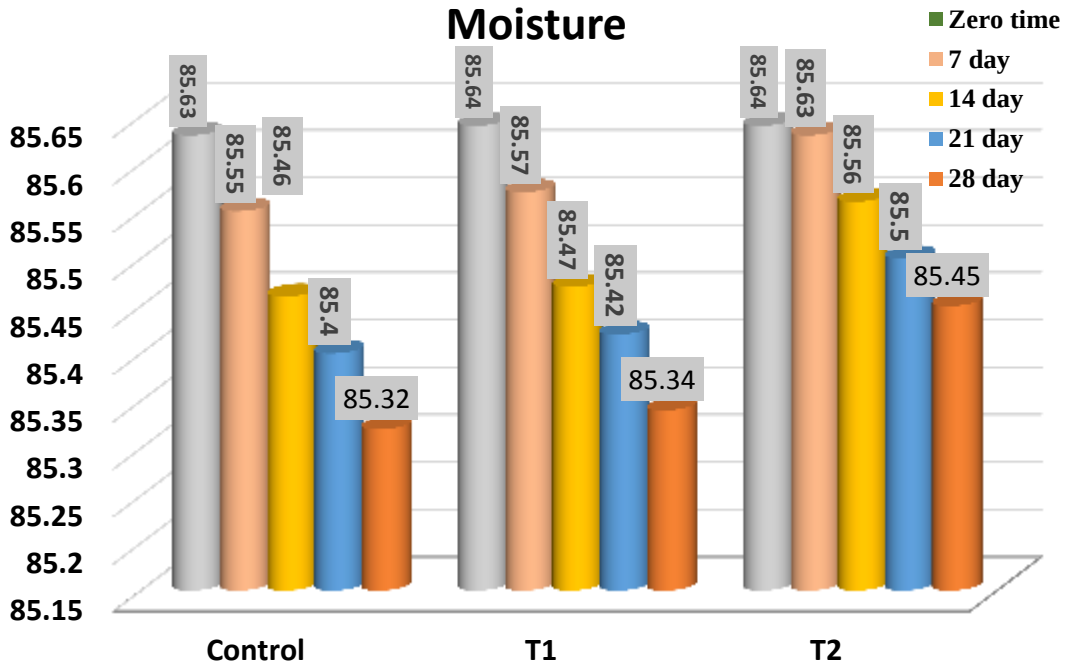

Figure (2) Percentage of total solids for yogurt in the control treatment and yogurt in the treatments supplemented with moringa aqueous extract.

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Percentage of total solids

Figure (2) shows the percentage of total solids for both yogurt in control treatment C and yogurt in treatments T1 and T2, as its value immediately after manufacturing for the control treatment was 14.36%.

The percentage of solids for the yogurt treatments supported with moringa extract reached 14.35 and 14.33% for the previous treatments, respectively. It is noted from the results that there was a slight increase in the percentage of total solids as the storage period progressed for all yogurt treatments, as the values after 28 days for treatment C reached 14.66%. For yogurt supplemented with moringa extract, the rates were 14.61 and 14.55%, respectively. The reason is due to the decrease in humidity, which led to an increase in the percentage of total solids.

The results of the statistical analysis shown in Figure (2) indicate that there are no significant differences (P>0.05) in the percentage of total solids between treatment C and the different treatments immediately after manufacturing as well as during the storage period of 28 days.

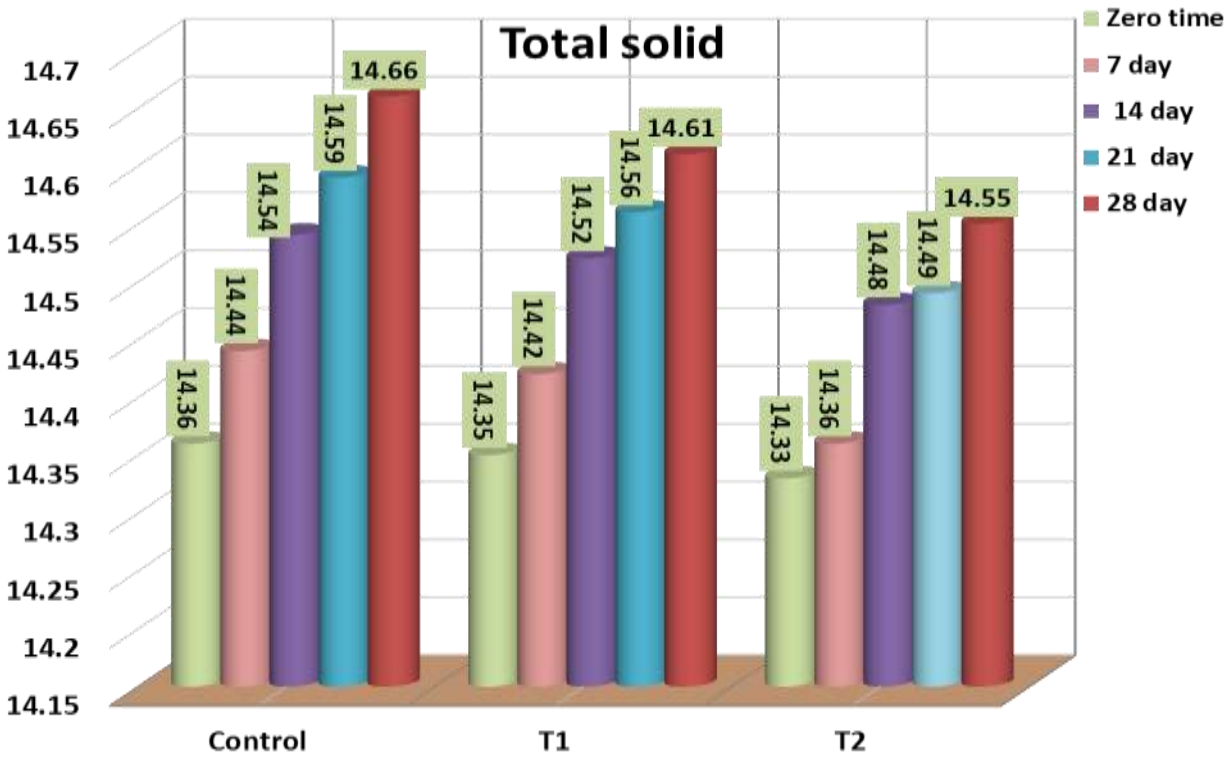

Figure (2) Percentage of total solids for yogurt in the control treatment and yogurt in the treatments supplemented with moringa aqueous extract.

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Titritable Acidity (TA (

The results shown in Figure (3) show the values of leachate acidity for the yogurt of the different treatments, as it was 0.98% immediately after manufacturing for the C treatment, and this result does not agree with what [38] found for the yogurt, which was 0.80% As for the total leachate acidity of the yogurt treatments fortified with aqueous extract, it was 0.98%, respectively. It is noted that there is no effect of fortification with aqueous extract of moringa on the pH values of the treatments fortified with the aqueous extract compared to the control treatment on the first day of manufacturing.

The results of the statistical analysis of the normal acidity values for all storage treatments show that there is no significant difference. The values after 28 days for yogurt treated with C were 1.25%, and for yogurt treatments fortified with aqueous extract of moringa, they were 1.24 and 1.23%, respectively.

The results of the statistical analysis indicate that there are no significant differences in the acidity percentage between the control treatment and the yogurt treatments supplemented with aqueous extract immediately after manufacturing. However, during the storage period of 28 days, we notice slight significant differences.

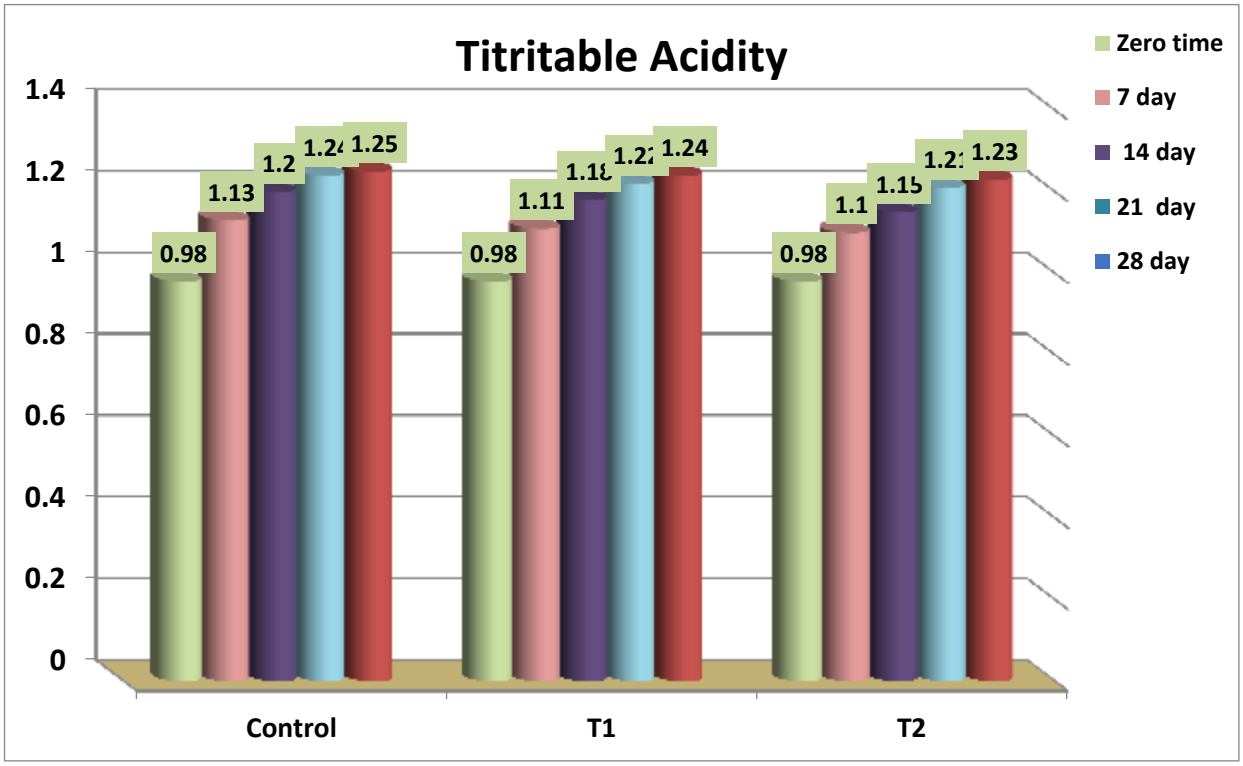

Figure (3) Percentage of titritable acidity of yogurt treated with control and yogurt in the treatments supplemented with moringa aqueous extract.

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pH

The results in Figure (4) show the pH values for the different yogurt treatments mentioned above. These values, immediately after manufacturing for the C treatment, were 4.86, and this agrees with what [5] found for yogurt, which was 4.63. It also agreed with what [47]found. (For yogurt of 4.60, as for pH values for yogurt supplemented with moringa aqueous extract, the coefficients were 4.95 and 4.96, respectively. It is noted from the results of the statistical analysis that there are no significant differences (P<0.05) in the pH values immediately after manufacturing between C and the other treatments

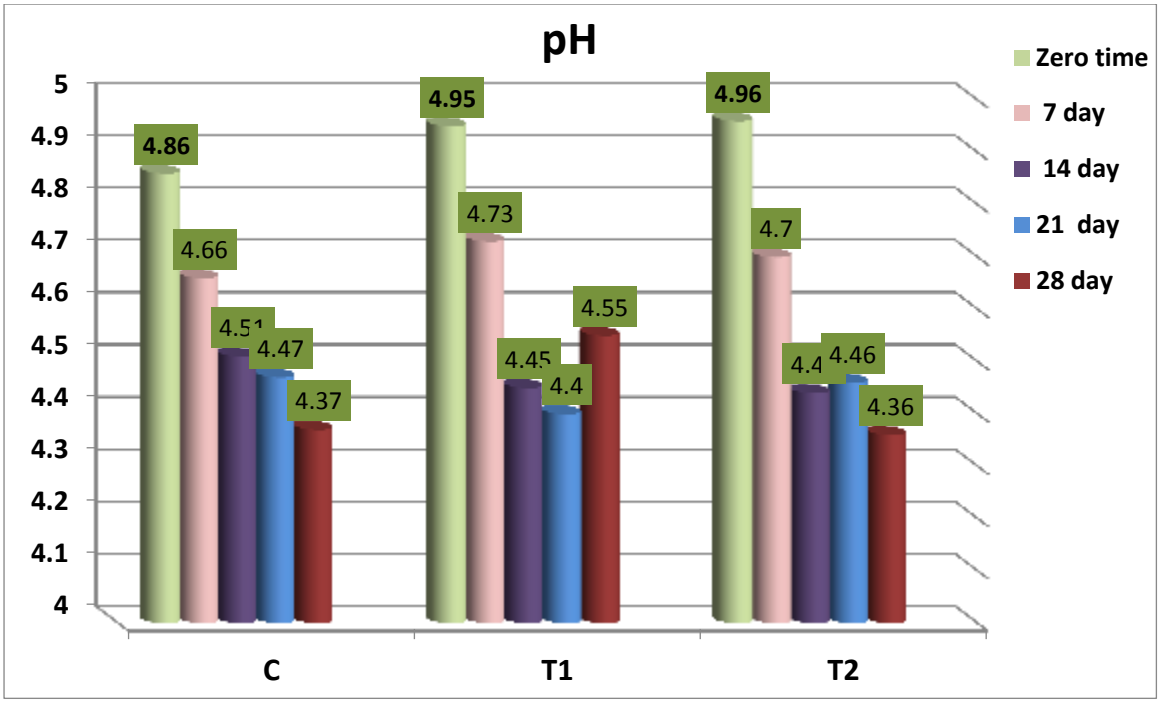

Figure (4) pH values of yogurt in the control treatment and yogurt in the treatments supplemented with moringa.

As for storage, a decrease in the pH values of all treatments was observed. The values after 28 days for the C treatment were 4.37, and for the treatments supported with water extract, they were 4.55 and 4.36%, respectively. The reason for this is attributed to the continued activity of the starter bacteria during storage, but slowly. This result is consistent with what was found by [27], who indicated a decrease in the pH values of fortified cheese after... After two months, the value was 4.54 compared to the values on the first day of manufacturing, which was 4.71.

The results of the statistical analysis indicate that there are no significant differences (P<0.05) in the pH values between the control treatment and the rest of the treatments supplemented with aqueous moringa extract during the storage period of 28 days.

Viscosity

Viscosity is one of the important factors for determining the quality indicators of

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yogurt, which is related to both the stability of the product and the oral taste of the fermented milk. The stability of the viscosity of the product is also very important for its quality characteristics, and according to what [45] mentioned, the bacteria Streptococcus thermophilus it plays a major role in the production of tissue-giving factors that are exogenous cell products called exopolysaccharides, which may interfere with the protein content of milk, increase its viscosity, and improve its quality characteristics.

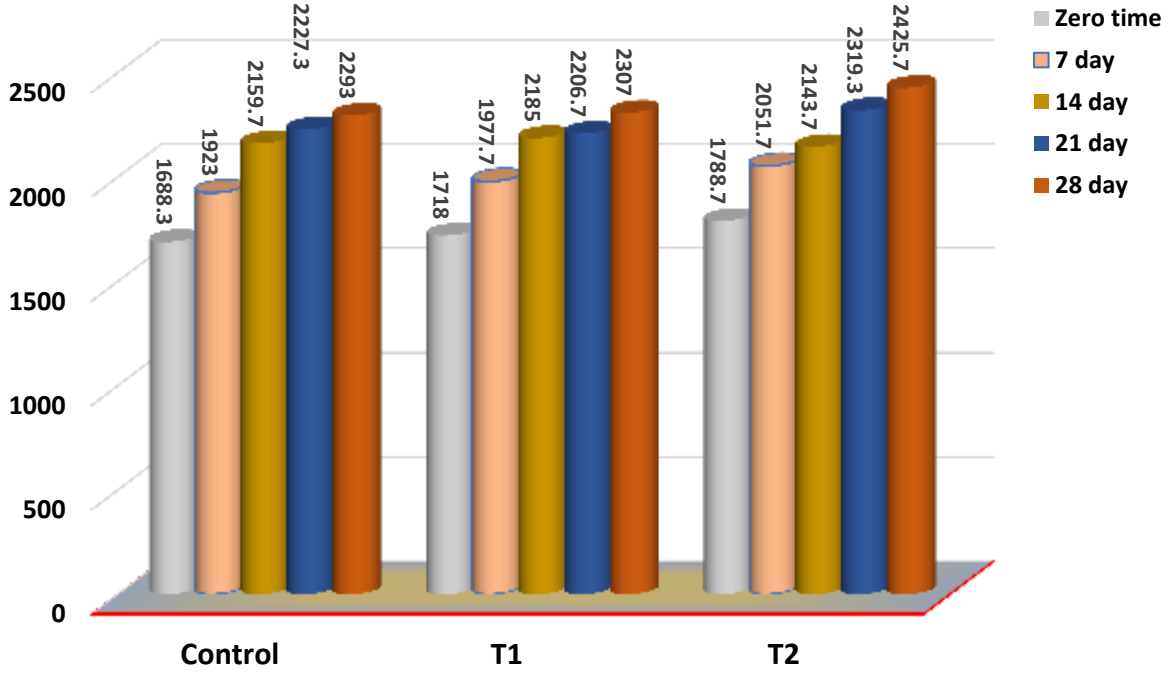

Figure (5): Viscosity values for the yogurt of the control treatment and the yogurt of the treatments supplemented with aqueous extract of moringa

The results shown in Figure (5) show that the viscosity values for the C treatment immediately after manufacturing were 1688.3 centipoise, while the viscosity values for the treatments supported with the water extract reached 1718.0 and 1788.1 centipoise, respectively. A slight decrease in the viscosity values is observed immediately after manufacturing for the treatment Controlling the transactions of fortified yogurt fortified with aqueous extract of moringa, During storage, an increase in the viscosity values was observed in the control treatment, as after 28 days it reached 2293.0 centipoise for the control treatment, and this is consistent with what was found by [47], who indicated an increase in the viscosity of the yogurt treatment from 2123 centipoise immediately after manufacturing to 2307 centipoise. The reason for this is due to the lower pH of yogurt, which leads to an increase in its hardness and thus an increase in viscosity [51]. The results also indicate an increase in the viscosity of yogurt supplemented with moringa extract upon storage.

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It is noted from the results of the statistical analysis that there are significant differences (P<0.05) in the viscosity values immediately after manufacturing, as well as during the storage period, between
treatment C and the treatments supplemented with aqueous moringa
extract. Likewise, significant differences were found in the viscosity values between the different time periods within one treatment.

Water Holding Capacity

Factors affecting the ability to retain water in food protein include the type of amino acids included in its composition, the nature of the protein conformation, and the amount of polarity and hydrophobic force [29.[

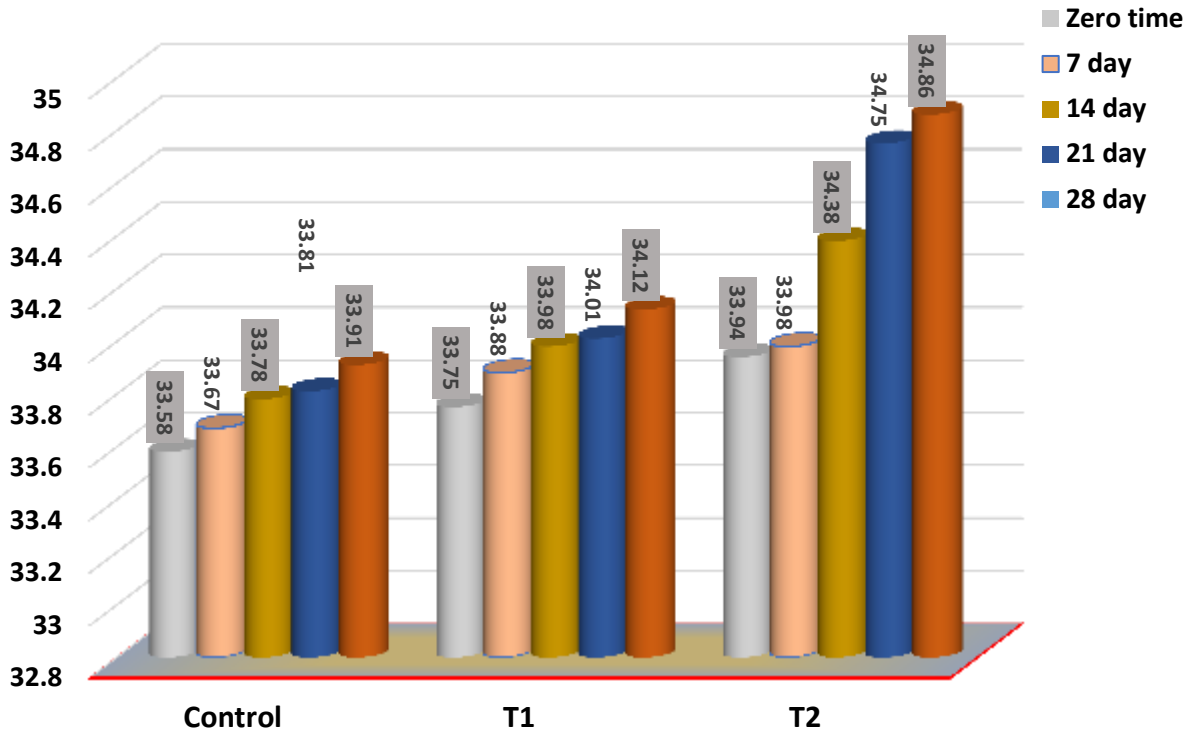

Figure (6): Water holding values for yogurt in the control treatment and yogurt in the treatments supplemented with aqueous moringa extract.

It is noted from the results shown in Figure (6) the percentage of water retention capacity for the different yogurt treatments mentioned above, and it is clear from them that the water retention capacity for the C treatment immediately after manufacturing is 33.58%, and this result is consistent with what [2] indicated that The water retention capacity of the yogurt treatment immediately after manufacturing reached 35.05%, while the water retention capacity of the treatments supported with aqueous moringa extract reached 35.05%. 33.75 and 33.94%, respectively.

It is higher than its value for treatment C and increased with increasing concentration of the added extract. We also find that water retention capacity is affected by the duration of storage, as it is observed to increase for all treatments as storage periods progress. This is consistent with what was found by [2], who indicated an increase in water retention

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capacity for yogurt treatment from 35.05% directly after manufacturing to 35.5%.

On the 28th day of storage, the reason for this may be due to the effect of the decrease in moisture content of the yogurt treatments. As for the values after 28 days, the C treatment was 33.91% and the extract-fortified yogurt treatments were 34.12 and 34.86%, respectively. The results of the statistical analysis also indicate There are significant differences ($P<0.05$) between the control treatment and all treatments supplemented with moringa extract immediately after manufacturing as well as during storage. It is also noted that there are significant differences between the different storage periods within one treatment.

Microbiological tests for yogurt

Figure 7 shows the results of estimating the numbers of microorganisms for the total number of starter bacteria and the numbers and number of coliform bacteria, Psychrophilic bacteria, yeasts and molds for the yoghurt treatment C and the yoghurt treatment immediately after manufacturing and during storage at a temperature of (5±1)°C for 21 days. It is clear from the results that the total number of starter bacteria immediately after manufacturing for treatment C was 69 x107 CFU/g. This result is close to what [5] found for full-fat yogurt, which was 60 x107 CFU/g, which is less than what [16] found for full-fat yogurt, which was 107 x 99.1 CFU/g, but it Within the limits set by international standards (FAO, 1997 / WHO 1994 FIL, \ IDF) which requires that the number of live cells of the starter bacteria not be less than 107 cfu/g, 69 ^{x} 107 CFU / g this result is close to what [5] found for full-fat yogurt, which was 60 x107 CFU/g, which is less than what [16] found for full-fat yogurt, which was 107 x 99.1 CFU/g, but it is within the limits set by international standards. (FAO,1997 /;WHO 1994 FIL,\IDF) which It is required that the number of live cells of the starter bacteria not be less than 107 cfu/g.

The total number of bacteria for yogurt treatments fortified with moringa extract was 107x76 and 107x83 mm/g, respectively. It is clear from the results that the values of the numbers of these bacteria were higher in the treatments to which the water extract was added compared to the C treatment. The reason for this may be due to the nutrients that the added extract provides to the bacteria, including amino acids, such as which are considered among the nutrients that encourage the growth of starter bacteria [33. [

As for refrigerated storage, the results shown in table (7) indicate a gradual decrease in the numbers of starter bacteria, starting from the seventh day and for all storage stages, as they reached after 28 days of storage at a temperature of (5 ± 1) C for the control treatment. 5.1x106 Wm/g, for coefficients T1 and T2 It of yogurt starter bacteria decreased from 107 was 4.8x106 This is consistent with what was found by [16], who indicated that the number

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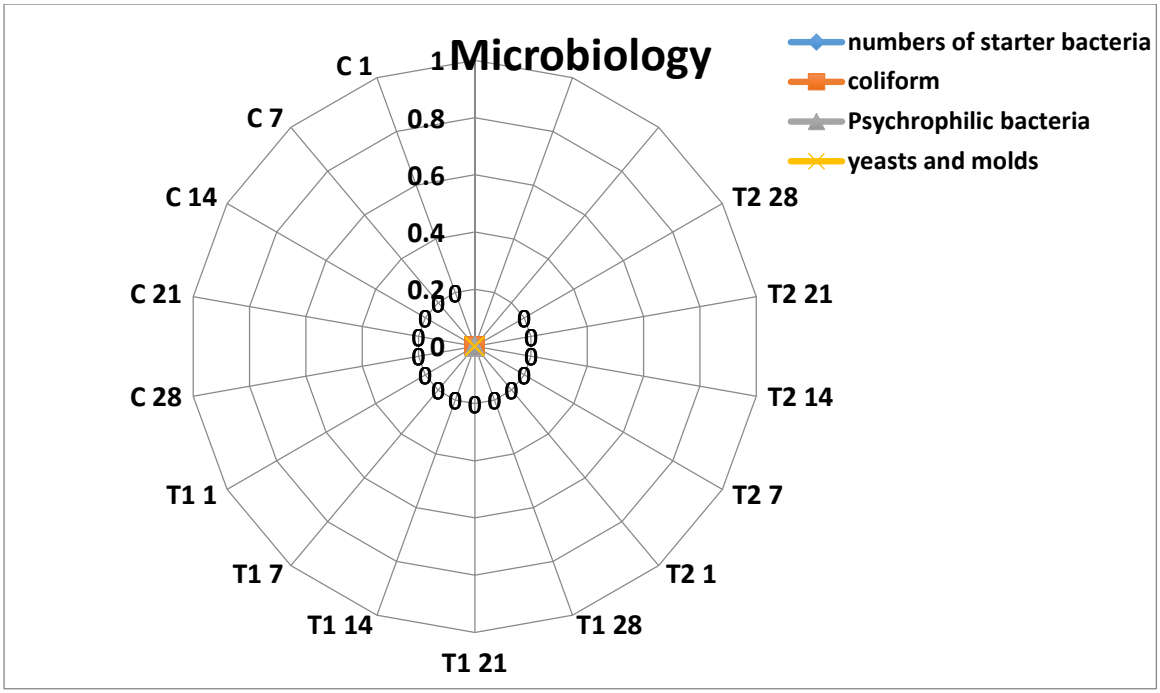

Figure (7) Microbiological analysis of the control yogurt treatment and the yogurt treatment supplemented with aqueous moringa extract during the storage period at (5±1)°C for 28 days.

No growth was observed in the numbers of bacteria, coliform bacteria, Psychrophilic bacteria, yeasts and molds during the storage period of 28 days. The reason may be that the aqueous extract of moringa enhances the inhibitory effect of lactic acid bacteria Lactobacillus acidophilus, Lactobacillus rhamnosus and Streptococcus thermophilus in reducing the growth of pathological bacteria. Such as coliform bacteria and other contaminated microorganisms such as molds and yeasts.

The results of the statistical analysis indicate that there are significant differences in the numbers of starter bacteria between the control treatment and the treatments supplemented with moringa aqueous extract.

Sensory evaluation

Figure (8) shows the results of the sensory evaluation of the yogurt of the various treatments mentioned above. It is clear from the results that the scores given to the flavor, texture, colour, appearance and acidity were superior to the yogurt of the treatments supplemented with water extract compared to the yogurt of the control treatment. This superiority was significant after 1, 7, 14, 21 and 28 days of storage. This superiority was attributed to the effect of the aqueous extract, which improved the sensory properties of the product, The T1 treatment supplemented with aqueous extract obtained the highest total score of 99.00, 99.00, and 99.00 out of 100 on the first, third, and fifth days, compared to the control treatment, which obtained a total score of 92.00, 97.00, and 99.00, while the T1 treatment supplemented with the aqueous extract obtained a total score of Scores 93.00,98.00,99.00 notes from The table shows

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the parameters of yogurt fortified with aqueous extract the T1 treatment supplemented with aqueous extract obtained the highest total score of 99.00, 99.00, and 99.00 out of 100 on the first, third, and fifth days, compared to the control treatment, which obtained a total score of 92.00, 97.00, and 99.00, while the T1 treatment supplemented with the aqueous extract obtained a total score of Scores 93.00, 98.00, 99.00. It is noted from the table that the coefficients of yogurt fortified with water extract it obtained the highest degree of sensory evaluation. This may be attributed to the stimulating effect of moringa on the growth of starter bacteria and the production of acidity and desired flavoring substances, which helped to give a product with a good and cohesive texture and the desired hardness, reduced whey exudation, and increased the ability to retain water. This result is consistent with what he found. [27], who indicated that cheese fortified with aqueous extract obtained the highest sensory evaluation scores for texture, texture, appearance, and smell compared to control cheese. [3.[

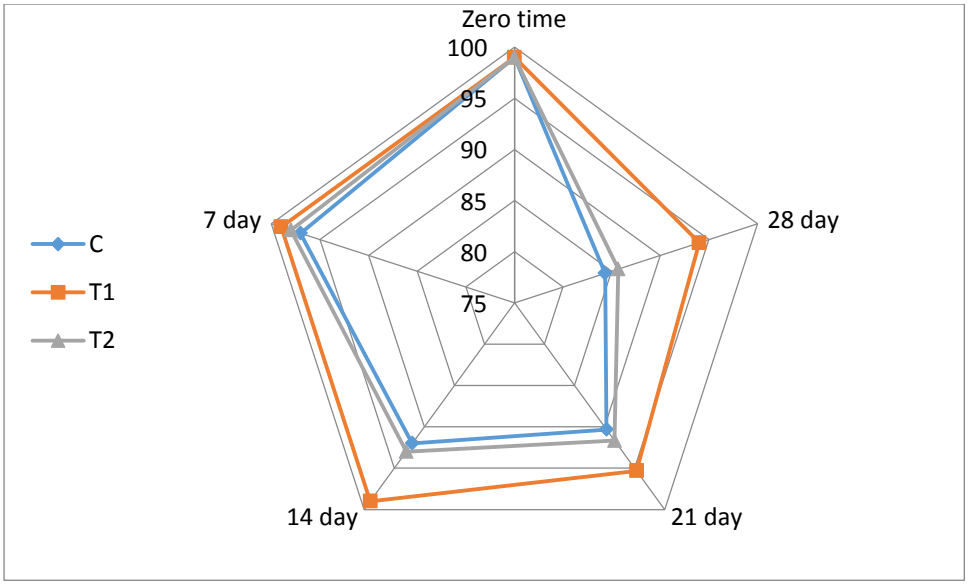

Figure (8) Sensory evaluation of yogurt treated with control and yogurt treated with water extract at different concentrations during storage at a temperature of (5±1)°C for a period of 28 days.

It is noted that during storage, treatment T1 outperformed all treatments, as it obtained the highest sensory evaluation score awarded, so the total score at the end of the storage period reached 94.00. As for treatment T2, the sensory evaluation score given to it reached 85.67, compared to treatment C, which was close to it throughout the storage period. It was the degrees of sensory evaluation the amount granted to her is 84.33 at the end of the storage period. The results of the statistical analysis indicate that there are significant differences (P<0.05) between the control

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treatment and the yogurt treatments supplemented with water extract. It is also noted that there are significant differences in the degrees of sensory evaluation between the different time periods within one treatment.

Conclusion

Fortification with moringa extract succeeded in maintaining the chemical composition of the manufactured yogurt and also played a role in prolonging the shelf life of the product.

Improved reinforcement with moringa extract is one of the rheological properties of manufactured yogurt represented by increased viscosity.

The results of the sensory evaluation showed that the consumer accepted the yogurt fortified with moringa extract, and no negative effect was observed on the taste, flavour, texture and texture. The treatment of the yogurt fortified with moringa extract at a concentration of 1% was superior in all sensory characteristics to all other treatments.

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