Use of fat substitutes in yogurt manufacturing

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Abstract

This research included a study on the manufacture of healthy low-fat yogurt using skim milk and some types of fat substitutes such as (inulin - whey proteins - Arabic gum) in fixed proportions of (10 g) of each substitute and dissolving them in skim milk. This study was conducted in the laboratories of the Department of Food Health and Nutrition - College of Food Sciences - Al-Qasim Green University. A number of tests were conducted during two storage periods, on the first day and the fifteenth day of cold storage, which included testing moisture and ash, where it was found that the moisture level decreased after 15 days of cold storage of the samples, unlike what was found during the first test conducted on the first day after manufacturing. As for the ash, its percentage increased after 15 days of storage when compared to the first test. Carbohydrates and protein were also examined, where it was found that the percentage of protein in samples T2, T4, T1, T3, respectively, during the first test was lower than the second test, and this was in contrast to the carbohydrate test, which was higher in the first test compared to the second test. The acidity in the first test was higher for sample T1 and samples T2, T3, T4 were less acidic. In the second test, the readings changed and the acidity became higher in sample T2 with added inulin and T4 with added Arabic gum. The pH was higher during the first test, especially sample T2. In the second test, the pH level decreased and the lowest reading was for sample T1. Spontaneous Whey separation, water retention capacity and sensory evaluation tests were conducted to observe the effect on the physical, chemical and sensory properties of yogurt. The results of the study showed that adding these alternatives led to a reduction in the fat content of yogurt, as well as a reduction in the percentage of ash and moisture, and led to an increase in the level of total solids and an increase in acidity. These changes can be observed by comparing the samples to which fat alternatives were added and the samples to which no alternative was added during the two storage periods. Also, a good taste, texture and appearance were obtained when adding a whey protein alternative to skim milk compared to sample T2 to which inulin was added, which gave an unacceptable taste and an acceptable texture. As for the remaining alternatives, the evaluation results were acceptable.

Key word : Arabic gum, yogurt , sensory evaluation tests, Spontaneous Whey separation

Introduction

Milk components Milk is the distinctive liquid that God Almighty has given to all dairy animals, including humans, to be the food that is distinguished by its unique specifications, as it is the best natural food that meets the needs of young children in addition to the possibility of adults consuming it. Milk consists of a group of nutrients and elements that filter from the blood through the mammary vesicles to become the form in which it appears. The components of milk can be summarized as follows-:

•Water: Water constitutes the largest percentage of milk, reaching about 87.5% of the components of milk. It is the liquid that dissolves some components, while other components are in the form of a suspension, which gives the milk a white color.

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*Total solids: The rest of the percentage after subtracting the percentage of water from the total percentage. Total solids include the following materials:

A. Fat: It is subtracted from the percentage of total solids, and its percentage varies according to the breeds of cows and even within the same breed. The percentage of fat in cow's milk is approximately 3.7%.

B. Non-fat solids: constitute the remaining percentage of total solids and include:

*Protein: It comprises approximately less than half the percentage of non-fat solids and includes true protein and non-protein nitrogen. True protein includes milk protein (casein), albumin, and globulin. The percentage of protein in cow's milk is approximately 3.5%.

*Milk sugar (lactose): It constitutes the highest percentage of non-fat solids and is what gives the milk a sweet taste and is formed by the union of two sugars to form this disaccharide. The percentage of lactose in cow's milk is approximately 4.9%.

•Vitamins and minerals: It includes the main vitamins, which are vitamins (A, D, E, K) that dissolve in fats in addition to vitamins C and B. As for minerals and mineral salts, milk contains calcium and phosphorus in addition to other minerals necessary to maintain the body's normal growth and protect against diseases. The percentage of minerals in cow's milk is approximately 0.7% (1.(

Yogurt A healthy diet has become prevalent in modern lifestyles, and thus there is an increasing market demand for functional foods with beneficial effects on human health. Functional foods have become of particular interest due to their health-promoting benefits; they maintain the normal intestinal flora, protect against intestinal pathogens, and lower blood cholesterol and blood pressure (2). Fermented dairy products are considered healthy and nutritious foods that people around the world consume as part of their diet. The consumption of fermented dairy products has increased significantly compared to liquid milk consumption over the past few decades (3). Yogurt is one of the most widely consumed fermented dairy products in the world and is often viewed as a nutritious food (4). Yogurt contains viable, beneficial microorganisms that compete with pathogenic bacteria for nutrients and space (5,6). The technology of making yogurt is an ancient technique dating back thousands of years. Yogurt is often included in lists of healthy foods due to its high nutritional value. It is an excellent source of proteins, vitamins, and minerals. Yogurt can be specially prepared to meet specific nutritional requirements for people whose normal metabolic processes change or those who want a specific effect by controlling the intake of foods or certain nutrients (7). The main ingredient in yogurt is milk, and the type of yogurt depends on the type of milk. The most important health functions of yogurt can be summarized as follows:

•Yogurt has many ways to aid healthy digestion.

•Reducing the risk of type 2 diabetes.

•Protection against colon, rectal and stomach cancer.

•Prevention of osteoporosis.

•Improving the immune system.

•Reducing high blood pressure and harmful cholesterol levels in plasma (8.(

Fats :It is one of the main macronutrients in the human diet. Different forms of fats are found in different types of foods, including dairy products, and although fats from different sources have distinct compositions and properties, they usually share a similar chemical structure, which is often classified as

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triacylglycerol (TAG) and a hyster derived from glycerol and three fatty acids. A fatty acid is a long-chain hydrocarbon with a terminal carboxyl group that is classified as either saturated or unsaturated fatty acids (SFA or USFA). The variety and composition of fatty acids varies among foods.

Dietary fat, which is consumed excessively in developed countries, is one of the most important contributors to a number of chronic diseases, such as cardiovascular disease, type 2 diabetes, obesity, and cancer (9). Recently, the relationship between fat consumption and heart disease has been accepted, and nutritionists have recommended reducing animal fats in the diet (10). Since fat is a major component of dairy products, the consumption of low-fat or fat-free dairy products has increased in recognition of their health benefits and the health problems faced by consumers (11,10). The effects of excessive consumption of total fat, trans fat, and saturated fat on the risk of chronic diseases have attracted widespread attention. (12,13) Although consumers are aware of the benefits of low-fat foods, it remains difficult to keep total fat consumption below recommended levels (14). In addition, low-fat foods are considered more beneficial and desirable in the context of appropriate types of fats, and given the adverse health effects and economic consequences associated with excessive consumption of dietary fat, low-fat foods are a reasonable option. However, because fat contributes to texture and mouthfeel as well as energy, simply removing fat from the original foods may cause loss of quality and/or desirability and thus reduce food acceptance among consumers. (15) To address this general problem, fat substitutes are used to compensate for the loss of fat-related properties and improve acceptance of low-fat diets. (16) Fat substitutes also need to have a low energy density so that the total caloric content of the product is reduced. Isolated fats from biological sources are considered the most suitable fat substitutes because they are generally safe in food applications and have a lower energy density (0–4 kcal/g) compared to fat (17). Compared to protein-based fat substitutes, carbohydrate-based fat substitutes are generally more cost-effective. Milk fat plays an important role in the development of texture, flavor, and color of dairy products. Fat reduction can cause some disadvantages in nonfat yogurt such as poor flavor, poor body, and poor texture (18,11). Although the manufacture of low-fat or fat-free dairy products has been possible for many years, the use of fat substitutes in dairy product manufacturing is still new. Fat substitutes, which reduce the calorific value of food, can be used to solve some of the physical and organic problems arising from low fat levels in the final products.

Fat substitutes :Fat substitutes consist of a mixture of fat substitutes of fatty origin, or fat mimics of protein or carbohydrate origin, or their combinations (18). The loss of quality due to fat reduction is due to the decrease in the relative volume of fat, the interactions between lipids, lipoproteins and lipopolysaccharides are reduced, which changes the flow resistance of food products. The complex differences in sensory qualities in low-fat foods have been studied extensively, the main oral sensory properties related to fat (thickness, softness, oiliness and fatness) are positively correlated with fat content (19,20,21). Therefore, the quality of food can be seriously deteriorated by fat reduction. In addition, color, Water retention capacity, microstructural properties and particle size are also related to fat content. In

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some cases, reducing fat in a product may indirectly alter the eating quality of other foods. The loss of quality associated with fat reduction may also be due to changes in the perception of taste, flavor, and aroma. Many flavor and aroma compounds are lipophilic and have low solubility in the aqueous phase; therefore, fat reduction can result in the loss of characteristic flavors and aromas (22,23). Previous studies have shown that removing fat significantly affected the kinetics of lipophilic flavor and aroma release. As fat is reduced, the maximum overall flavor and aroma intensity is reduced, making the product less appealing than full-fat foods (24,25). In addition to affecting perceived intensity, fat content also affects flavor and aroma release. Reducing fat to reduce the caloric content of a food typically results in a loss of quality or significantly alters the sensory properties compared to those of the original full-fat food (15). To address these issues, researchers use fat substitutes to retain or mimic fat-related sensory qualities (17,26.(

In recent years, new and redesigned ingredients have been introduced as fat substitutes and alternatives. A fat substitute is an ingredient that replaces some or all of the functions of a fat and may or may not provide nutritional value. A fat substitute is an ingredient that replaces all of the functions of a fat without contributing any energy. Currently available fat substitutes are fat mimics or fat analogues. Fat substitutes are based on carbohydrate and/or protein and/or fat and have energy values ranging from 0 to 38 kJ/g (0-9 kcal/g). Since no single ingredient replaces all of the functions of a fat, most low-fat foods are manufactured with a combination of ingredients and processes that affect the fat and energy content. Fat substitutes are classified into fat-based fat substitutes, carbohydrate-based fat substitutes and protein-based fat substitutes.

-1 Carbohydrate-based fat substitutes

Starch and starch derivatives Starches can be isolated from plant organs, such as the root, leaf, tuber, and seed. The main components of starch are amylose (AM) and amylopectin (AP). Starch is digestible in the human gastrointestinal tract and provides approximately 4 kcal/g of energy on average. Isolated native starches generally have the same granular structure but differ in their shape, particle size, and AM:AP ratios. Starches with granular sizes similar to those in fat emulsions have been suggested as potential fat substitutes (27,28). Starch granules can be individually distributed in a droplet-like pattern in an emulsion, providing distinct textural and sensory properties. Researchers have also attempted to use cross-linked starches instead of native starches in fat replacement applications (29). The advantage of using cross-linked starches is their lower digestibility, which generates fewer calories than regular starch. To better mimic the behavior of fats in food systems (e.g., interfacial and hydrophobic interactions), the results of starch addition include increased product yield, Water retention capacity, and gel stiffness; altered flow behaviors (e.g., viscosity); and modified sensory attributes (e.g., creaminess). In addition to the widely observed effects on textural properties, some studies have reported unique attributes such as melt-in-the-mouth properties.

-2Fat-based substitutes

They are made to contribute fewer or no calories. Fat-based fat substitutes are made in two ways:

(1The structure is modified so that fat is not absorbed as well

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(2The length of the fatty acid on the glycerol is shorter. Because these substitutes are made from fat, they provide the same physical properties as fat, including taste, texture, and mouthfeel. (30(

-3Protein-based fat substitutes

They are found in cheese, butter, mayonnaise, salad dressings, frozen dairy desserts, sour cream, and baked goods. They are made from whey or egg whites and are primarily used in frozen dairy desserts. Because basic protein-based fat substitutes break down when heated, they can only be used in uncooked foods. Protein-based ingredients provide between 1 and 4 calories per gram.(31(

5.1Types of alternatives used in research

-1Whey proteins: It is one of the most important ingredients due to its nutritional value and technological functions, as it contains many biologically active peptides, which have biological effects such as anti-inflammatory, antihypertensive, antioxidant, and antibacterial properties. The development of functional foods uses these peptides as active ingredients (31). The main components of whey protein fractions are:

Lactoglobulin (Lg), lactalbumin (La), immunoglobulins (IGs), bovine serum albumin (BSA), lactoferrin (LF), lactoperoxidase (LP). Whey protein concentrate (WPC) has been found to stimulate the growth of bifidobacteria (32)(33.(

-2Arabic gum: Gum can be successfully used as a fat substitute in the manufacture of low-fat yogurt with additional nutritional benefits without affecting the physical and chemical properties of yogurt. It is a natural gum used as an antioxidant, antimicrobial, anticoagulant and anti-inflammatory. It is also used to improve the shelf life of food products (34). Gum is a hydrocolloid plant, a polymer of monosaccharides or mixed sugars. Sugars are soluble and dispersible in water due to their ability to interact with water. Thus, gum can be used as one of the food additives, to modify the quality of food in terms of nutritional stability and texture and appearance properties as emulsifiers, thickeners, gelling agents or texture modifiers (35.(

-3-Inulin: Inulin, a substitute for fats or carbohydrate-derived dietary fibers, has the ability to gel with water and is a functional food additive due to its prebiotic properties (36). It is not digested in the small intestine, but is fermented in the colon by lactic acid bacteria such as yogurt starter cultures. Thus, inulin promotes the growth of healthy bacteria, enhances calcium and magnesium absorption and immune functions, and reduces blood cholesterol and lipid levels (37,38,39). Moreover, inulin fermentation may stimulate the formation of short-chain fatty acids such as acetate, propionate and butyrate, the latter being the preferred energy substrate for colon cells (40). Inulin, found in water-based foods like dairy products, when used as a fat substitute, gives a fat-like texture and feel in the mouth (41,42.(

Materials and methods

Preparation method

.1 Prepare the containers for storing the samples and give each alternative its own code

.2 Prepare 4 liters of milk for all types of alternatives. Dissolve the equivalent of one liter of water(

.3 Put the mixture on the fire (pasteurization process is carried out with measuring the temperature during pasteurization until the temperature reaches (90°C) then remove from the fire

.4 Divide the quantity into four equal parts of (1) liter) of milk before its temperature reaches 45°C

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.5 With the withdrawal of (200) (ml) from each liter to dissolve (10) g) of each alternative used in it, then mix this quantity with the rest of the milk gradually

.6 Add the starter at an amount of 30 grams per liter

.7 Pour equal amounts of the final mixture into the containers designated for them

.8 And place in the incubator for (3-4) hours

.9 After removing the samples from the incubator, they are transferred to cooling and storage in the refrigerator at a temperature below 5°C

Sample preparation method

Sample codes are as follows: Note that

T1= Skim milk

T2= Inulin

T3= Whey proteins

T4= Arabic gum

Figure No. (1(

2-2Tests

1.2.2Chemical tests

-1Estimation of moisture content

The percentage of moisture in curdled milk was measured by placing 2 gr of the sample in a weighed ceramic bowl and inserting it into the drying oven at a temperature of 105°C

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The percentage of moisture was calculated according to the following equation-:

Moisture% = Weight of the lid with the sample before drying – Weight of the lid with the sample after drying * 100

Sample weight

-Estimation of Ash Percentage

The ash percentage was measured by direct burning method by taking 2 gr of the sample and placing it in a dry ceramic bowl of known weight, which was inserted into the incineration furnace for 6 hours at a temperature of 550°C or until white ash was obtained. Then it was transferred to the desiccator for cooling, then the bowl was reweighed

The ash percentage was calculated according to the following equation-:

Ash% = (weight of the lid with Ash – weight of the lid empty) / weight of the original sample * 1003- Estimation of carbohydrates in yogurt

Their percentage was measured mathematically by the difference method:

%Carbohydrates = 100 _ (Protein + Fat + Moisture + Ash% (

-4Estimation of pH

The pH was measured by placing the pH meter sensor directly in the yogurt sample. The pH will be estimated.

-5Estimation of total acidity

The total acidity was measured by weighing 9 gr of the sample in a beaker and adding a few drops of phenophthalein indicator, then sieved with NaoH of 0.1 standard until the pink color appeared.

The percentage of total acidity was calculated and estimated on the basis of lactic acid according to the following equation-:

Percentage % = Volume of base consumed (ml) * Standard of base * Gram equivalent weight of

Rheological tests

-1Spontaneous Whey separation

The Whey permeability was estimated by placing 50 ml of yogurt in a cup at an angle of 45º for two hours at a temperature of 5°C. The oozing whey was withdrawn from the surface using a syringe, then the cup was weighed again and the process was carried out in 10 seconds to avoid over-oozing.

-2Water retention capacity

The Water retention capacity was estimated by exposing 10 gr of the yogurt sample to a centrifugal force at a speed of 3000 g for 60 minutes at a temperature of 10 °C. Then 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 original weight of the sample

It was calculated in the following equation-:

Water retention capacity % = W2*100/W1

-3Texture determination

The automated tests related to yogurt samples include hardness, elasticity and adhesion which were measured using a texture analyzer (CT3.4500 Brookfield engineering lab) equipped with a 5 kg load cell where the product was exposed to a compressive force by means of a bulb from above at a distance of 30 mm. The measuring conditions of the device were set as follows: initial test speed 1 mm/sec and final test speed 1 mm/sec. The probe pressure force (Trigger

)force10.0gr. And the time used for each test is 5 seconds, and the sample size is (3x3x2.5) cm3.

3.2.2Sensory evaluation

The sensory evaluation of yogurt with three types of fat substitutes added to it in addition to regular yogurt without addition was conducted after 1 and 14 days of storage, i.e. on the 15th day, the samples were presented in

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small cups with a capacity of (125 gr) and were evaluated by a number of professors specialized in the College of Food Sciences / Al-Qasim Green University. The samples were evaluated in terms of flavor, texture, consistency, appearance and acidity according to the sensory evaluation form.

Results and Discussion

Table (1) shows the physicochemical and rheological properties

spontaneous whey separation	Water retention capacity	Acidity	ph	Storage period	sample
0.82	2.5	0.80	4.82	1	**T1**
0.62	1.7	0.88	4.32	15	
0.73	9.7	0.77	4.83	1	**T2**
0.52	4.2	0.94	4.37	15	
0.92	1.57	0.68	4.76	1	**T3**
0.65	0.11	0.85	4.39	15	
0.74	1.6	0.74	4.73	1	**T4**
0.57	0.13	0.91	4.32	15	

.1pH

The results of the pH test for the treatments showed that the pH values for treatment T1 were (4.82), treatment T2 (4.83), treatment T3 (4.76), and treatment T4 (4.73). The highest percentage was for sample T4 (4.73) and the lowest percentage was for sample T2 (4.83).After 15 days of refrigerated storage, treatment T1 was (4.32), treatment T2 (4.37), treatment T3 (4.39), and treatment T4 (4.32). The highest percentage was for sample T1

(4.32) and the lowest percentage was for sample T3 (4.39) compared to the rest of the samples.

-2Acidity

The results of Table No. 1 show the values of the acidity correction for the treatments T1 (0.80), T2 (0.77), T3 (0.68), and T4 (0.74). The highest percentage was for sample T1 (0.80) and the lowest percentage was for sample T3 (0.68). After 15 days of refrigerated storage, the values were for treatment T1 (0.88), treatment T2 (0.94), treatment T3 (0.85), and treatment T4 (0.91). The highest percentage was for sample T2 (0.94) and the lowest percentage was for sample T3 (0.85) compared to the rest of the samples.

-3Water retention capacity

The results for T1(2.5), T2(9.7), T3(1.57) and T4(1.6) were shown, and the highest percentage was for sample T2(9.7) and the lowest percentage was for sample T4(1.6).After 15 days of cold storage, the results for T1(1.7), T2(4.2), T3(0.11) and T4(0.13) were shown, and the highest percentage was for sample T2(4.2) and the lowest percentage was for sample T1(1.7) compared to the rest of the samples.

-4Spontaneous Whey separation

The results for T1 (0.82), T2 (0.73), T3 (0.92), and T4 (0.74) were shown, with the highest percentage for sample T3 (0.92) and the lowest percentage for sample T2 (0.73).After 15 days of refrigerated storage, the results for T1 (0.62), T2 (0.52), T3 (0.65), and T4 (0.57) were the highest percentage for sample T3 (0.65) and the lowest percentage for sample T2 (0.52) compared to the rest of the samples.

Table (2) Tissue tests

Flexibility	cohesion	Strength	Storage period	sample
3.8	0.54	60.5	1	T1
3.8	0.57	70.8	15	
3.1	0.60	32.8	1	T2
3.9	0.87	18.3	15	
4.2	0.59	61.5	1	T3
3.9	0.57	62.0	15	
4.2	0.65	55.4	1	T4
3.4	0.47	66.9	15	

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-1Hardness

The hardness percentage increases as the percentage of solid materials increases and was for T1 (60.5), T2 (32.8), T3 (61.5), and T4 (55.4). The highest percentage was for sample T3 (61.5) and the lowest percentage was for sample T2 (32.8.(

After 15 days of cold storage, the results were for T1 (70.8), T2 (18.3), T3 (62.0), and T4 (66.9). The highest percentage was for sample T1 (70.8) and the lowest percentage was for sample T2 (18.3) compared to the rest of the samples.

-2Cohesion

The cohesion ratio increases as the cohesion strength ratio increases. The treatment T1 (0.54), T2 (0.60), T3 (0.59), and T4 (0.65) were the highest ratio for sample T4 (0.65) and the lowest ratio for sample T1 (0.54.(

After 15 days of refrigerated storage, the results for T1 (0.57), T2 (0.87), T3 (0.57), and T4 (0.47) were the highest ratio for sample T2 (0.87) and the lowest ratio for sample T4 (0.47) compared to the rest of the samples.

-3Elasticity

The elasticity ratio increases as the elasticity ratio increases and was for T1 (3.8), T2 (3.1), T3 (4.2), and T4 (4.2). The highest ratio was for sample T2 (4.2) and the lowest ratio was for sample T2 (4.2.(

After 15 days of cold storage, the results of T1 (3.8), T2 (3.9), T3 (3.9), and T4 (3.4). The highest ratio was for sample T2 (3.9) and the lowest ratio was for sample T4 (3.4) compared to the rest of the samples

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Table 3: Chemical tests

Protein	Carbohydrates	Ash	Moisture	Storage period	sample
4.31	4.56	0.66	87.12	1	T1
4.38	4.51	0.69	86.97	15	
4.65	4.70	0.70	88.15	1	T2
4.68	4.65	0.74	87.90	15	
4.26	4.62	0.65	87.13	1	T3
4.30	4.60	0.68	86.98	15	
4.62	4.66	0.66	88.36	1	T4
4.69	4.60	0.71	87.98	15	

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-Humidity

The results of T1 treatment (87.12), T2 treatment (88.15), T3 treatment (87.13), and T4 treatment (88.36) were shown. The highest percentage was for sample T4 (88.36) and the lowest percentage was for sample T1 (87.12).After 15 days of cold storage, the results of T1 treatment (86.97), T2 treatment (87.90), T3 treatment (86.98), and T4 treatment (87.98). The highest percentage was for sample T4 (87.98) and the lowest percentage was for sample T1 (86.97) compared to the rest of the samples.

-2Ash

The results for T1 (0.66), T2 (0.70), T3 (0.65), and T4 (0.66) were shown, with the highest percentage for sample T2 (0.70) and the lowest percentage for sample T3 (0.65.(

After 15 days of cold storage, the results for T1 (0.69), T2 (0.74), T3 (0.68), and T4 (0.71) were shown, with the highest percentage for sample T2 (0.71) and the lowest percentage for sample T3 (0.68.(

-3Carbohydrates

The results of T1 treatment (4.56), T2 treatment (4.70), T3 treatment (4.62), and T4 treatment (4.66) were shown, and the highest percentage was for sample T2 (4.70) and the lowest percentage was for sample T1 (4.56).After 15 days of cold storage, the results of T1 treatment (4.51), T2 treatment (4.65), T3 treatment (4.60), and T4 treatment (4.60), and the highest percentage was for sample T2 (4.65) and the lowest percentage was for sample T1 (4.51) compared to the rest of the samples.

-4Protein

The results of T1 treatment (4.31), T2 treatment (4.65), T3 treatment (4.26), and T4 treatment (4.62) were shown, and the highest percentage was for sample T2 (4.65) and the lowest percentage was for sample T3 (4.26).After 15 days of refrigerated storage, the results of T1 treatment (4.38), T2 treatment (4.68), T3 treatment (4.30), and T4 treatment (4.69), and the highest percentage was for sample T4 (4.69) and the lowest percentage was for sample T3 (4.30) compared to the rest of the samples.

Table (4) Sensory evaluation results for yogurt treatment on the first day and the fifteenth day of refrigerated storage

T4	T3	T2	T1	traits	day
27	**35**	**15**	**30**	**Taste and Flavor 45 %**	**On the first day of manufacturing and cold storage**
34	**27**	**30**	**33**	**Texture 35%**	
2	**4**	**3**	**2**	**Acidity 10 %**	
8	**8**	**7**	**8**	**Appearance 10 %**	
71%	**74%**	**55%**	**73%**	**total 100 %**	

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30	**40**	**14**	**40**	**Taste and Flavor 45 %**	**On the 15th day of cold storage**
30	**33**	**32**	**29**	**Texture 35 %**	
10	**9**	**8**	**9**	**Acidity 10 %**	
9	**9**	**7**	**8**	**Appearance 10 %**	
79%	**91%**	**61%**	**86%**	**total 100 %**	

From Table (4) above, the following results were obtained for the sensory evaluation on the first day: The highest percentage was on the first day for sample T3, which reached 74% in terms of taste, flavor, texture, texture, acidity and external appearance, and the lowest percentage was for sample T2, which reached 55%, followed by samples T1, which reached 73%, and T4, which reached 71%. For the sensory evaluation on the fifteenth day of cold storage, the highest percentage was on the first day for sample T3, which reached 91% in terms of taste, flavor, texture, texture, acidity and external appearance, and the lowest percentage was for sample T2, which reached 61%, followed by samples T1, which reached 86%, and T4, which reached 79%.

Conclusions and Recommendations

Conclusions:

-1Adding these alternatives eliminated the presence of fat in the product, and also led to improving the qualitative properties and maintaining consumer acceptance and producing low-energy yogurt.

-2The results showed that adding fat alternatives represented by inulin, whey proteins and Arabic gum and storing them for 15 days gave satisfactory results, especially when adding the whey proteins alternative, which was given the highest percentage of sensory evaluation in terms of taste, texture and acidity level, which was acceptable after refrigerated storage for 15 days.

-3Adding the inulin alternative gave an undesirable taste and the acidity of the sample was somewhat high, which is considered one of the reasons for the appearance of the undesirable taste.

-4As for the Arabic gum alternative, it gave average results when compared with the standard sample T1 in terms of taste and texture, while the acidity was higher when compared to the rest of the types of alternatives.

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