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The Evaluation of Date Palm Pomace on the Physical Qualities and Acceptance of Yogurt

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ABSTRACT

Date fruit is a globally important commodity that plays a significant role in the economic and political lives of date-growing areas. The date palm has phases of ripening as hababauk, kimri, khalal, rutab, and tamer. Sugar, protein, fat, minerals, ash, pectin, crude fiber, polyphenols and water, the primary components of dates. Products made from date palms include semi-finished and ready-to-use date items as well as products made from date pomace, juice, syrup, spread, and pomace. In the processing of yogurt, date palm pomace powder with concentrations of 10, 20 and 30% was applied. Date palm pomace powder has been shown to improve the chemical properties of yogurt (mineral content, pH, titrable acidity, total solids, ash, fat, protein content, and vitamin C), viscosity and syneresis. Comparisons between sample yogurts supplemented with various amounts of date palm pomace yogurt and plain yogurt were performed (control). The yogurt's total sugar, protein, fiber, vitamin C, and mineral contents were improved by adding date palm pomace at varied quantities (10, 20 and 30%). Yogurt's pH and lipid content were significantly lower with the addition of date palm powder. Yogurt that had date palm pomace added to it had greater viscosity and less product syneresis than control yogurt. Additionally, so that we could effectively utilize the date palm byproduct, we produced enriched, one of which was dairy, which is high in dietary fiber, minerals and antioxidants, all of which serve to mitigate the harmful effects of dairy.

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Introduction

The date palm (*Phoenix dactylifera* L.) is the oldest cultivated tree with a history of consumption dating back more than 7,000 years; it is native to Arabian countries. It belongs to the family Palmae and Arecaceae [1]. Several regions grow date palms as their primary crop, including southern Africa, Australia, Mexico, North Africa, and southwest Asia [2]. The date palm tree is an invaluable source of nutritious food source and environmental protection for the people in those areas due to its strong tolerance for aridity and challenging climatic conditions [3]. In Egypt, the date palm is the principal fruit tree and is widely consumed. The local population's diet still depends heavily on dates. At every step of the fruit's development, dates are consumed.

Date fruit can be harvested from a female tree on average 5 years from seedling germination, producing 400–600 kg/tree yearly [4]. According to the cultivar, the date fruit is picked and sold at three different developmental phases Figure. (1): Khalal (mature firm), Rutab (soft brown) and Tamr (hard, raisin-like) [5].

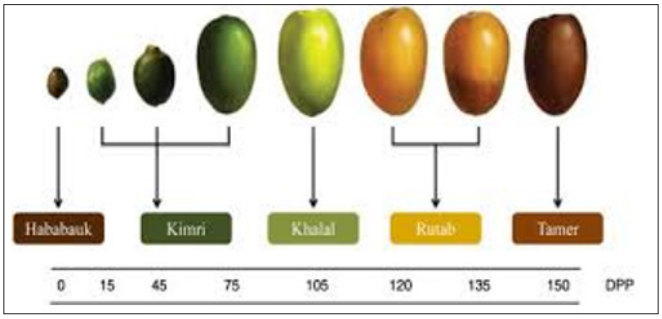

Figure 1: Different Stages of Maturation of Date Palm Fruits

The population of Arab countries almost exclusively eats dates, which are a staple food for millions of people worldwide. Dates provide rapid energy because of their high carbohydrate content, notably fructose and glucose, which are easily absorbed by the human body. Dates are also rich in several minerals. According to dates include a good amount of dietary fiber, ranging from 4.4 to 11.4%, and contain few proteins and fats. After the processing of date syrup, date fiber in by-products remaining provides 51.57% of the total fiber. The date fruit and its byproducts, such as its syrup and pomace, will boost the concentration of antioxidants in foods and likely reduce oxidative food deterioration. Additionally, they came to the conclusion that flavoring agents that may be employed in a variety of culinary products as well as innovative

natural antioxidants can be produced from date palm fruit [6-10].

Palm dates comprise the bulk of their carbohydrates in the form of simple sugars; a 100g serving of dates includes around 75 g of carbohydrates, or 18% of the recommended requirement for carbohydrates. Dates have 85% of their total carbohydrate content in the form of simple sugars. The cultivar, soil, climatic circumstances and fruit development stage can all have a considerable impact on the sugar content of a given variety of date fruit. The sugars from dates contain glucose, fructose, and sucrose, though most date types have little to no sucrose and the ratio of glucose to fructose is about equal. The date proteins were found to be rich in acidic amino acids and low in sulfur-containing amino acids like methionine and cysteine. The amino acid composition changes considerably within the same stage of maturation. Dried variants' enhanced amino acid content was mainly caused by the loss of water. Dates contain higher quantities of protein than the majority of other fruits, according to [11].The maximum level (5.5–6.4%) is seen in the Kimri phase, and it gradually declines to 2-2.5% in the Tamar stage. Dates also have oil in their flesh, 0.2-0.5% of it, while the seeds have 7.7-9.7% of it.

Epidemiological studies have repeatedly demonstrated that dietary fiber from dates may be beneficial for reducing the risk of chronic diseases like aging, cancer, inflammation and atherosclerosis [12,13]. As a result, plant-based fiber and protein products are important components of dietary systems for promoting human health. This may be due to the fact that dietary fiber includes a high concentration of phytochemicals such as polyphenols, carotenoids, natural antioxidants and other bioactive compounds.

It is well known that dates are nutrient-rich [14]. It is a good source of minerals, dietary fiber (mostly insoluble fiber), proteins, and carbs (about 70% of which are in the forms of fructose and glucose) [15]. Additionally, it contains a significant amount of flavonoids, procyanidins, carotenoids and sterols [16]. Additionally, dates include vital minerals like potassium, which is needed for muscle contractions and regulates blood pressure and heart rate [7]. 100 grams of dates contain the bone-building nutrients 696 mg of potassium, 90 mg of iron, 362 mg of copper, and 90 mg of magnesium. Red blood cell formation also depends on copper. One of the most significant bioactive materials is phenolic compounds, which are also known as strong antioxidants. They can also function as reducing agents and metal chelators [17]. Recently, phenolic acids and their use have grown due to prospective health advantages.

Studies on date fruit's health advantages, including cancer chemoprevention, diabetes prevention, and cardiovascular disease prevention, have been conducted [4]. Date fruit includes polyphenols that have anti-inflammatory and cholesterol-lowering effects [18]. It has antifungal, antiviral, antibacterial, anti-parasitic, heap-to-protective, anti-inflammatory, and anti-coccidial effects and is used in traditional medicine as an immune booster [19]. Low-quality date fruit can be utilized to create high value-added products like syrup or pomace and is a good source of sugars, phenolic compounds and dry matter Figure. (2) [20].

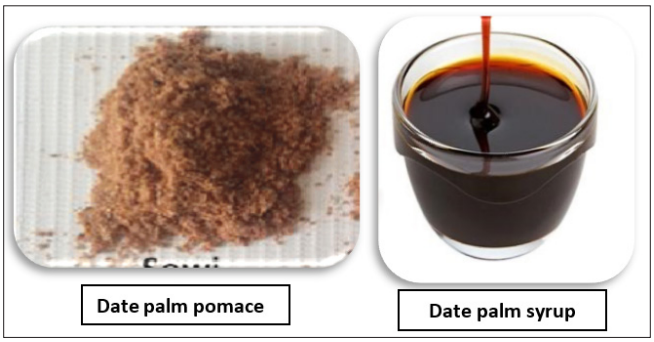

Figure 2: The Products of Date Palm Like Syrup or Pomace

The date has been touted as an antioxidant source. Antioxidants block the oxidative processes that cause degenerative diseases like arthritis, heart disease, and cognitive malfunction. According to reports, dates have anti-cancer and anti-mutagenic qualities that can reduce the incidence of malignancies, particularly pancreatic cancer, activate the immune system, and control how antibiotics are used [21].

The digestible sugars in dates, such as glucose (42.3-51.8%), fructose (22.5-47.5%), sucrose (3.2-7.4%), dietary fibers (2.2%), proteins (1.8-30.0%), lipids, pectin, vitamins and mineral salts, give dates their functioning and outstanding nutritional value [22]. As a result, date fruits are frequently used to make a variety of goods, including jelly, jam, confectionery and chutney. Fructose and glucose-containing date syrup is a natural sweetener that is used as a carbon source in a variety of food products [23]. According to the average annual production of date fruit was 8.53 million metric tons in 2018. Avoiding environmental issues requires using residue from date processing in food products as opposed to throwing it away. Furthermore, given the significance of dates and their byproducts in our life, the use of date syrup as an ingredient in probiotic dairy products such as milk cheese and yoghurt has expanded in recent years [24-27].

A crucial and nutritious dairy product is yogurt. Milk is fermented to make yogurt using bacterial cultures made up of a combination of Lactobacillus delbrueckii sub sp [28]. Neither milk nor dairy products contain any fiber. To improve structural and structural qualities, decrease fat retention, and boost water holding capacity, fiber from diverse sources is added to dairy products [29]. Yogurt's flavor, viscosity and texture were all enhanced by fortification with 1.5–4.5% of date fiber, which also improved color quality [9]. The viscosity of yogurt has been increased using dietary fiber as a stabilizer, to eliminate synergism, to improve compositional qualities, and as a powerful tool for cutting calories and fat [30]. Probiotic microorganisms found in fermented dairy products are regarded as healthful. Children, the elderly, and those with weakened immune systems, in particular, may benefit from probiotic bacteria's capacity to support the immune system [31]. Preserved fruit and other substances are sometimes used to flavor yogurt [32]. Fruit concentrates or flavorings are added to cultured milk before or after incubation to create flavored yogurt [33]. Compared to other fruits, dates have better nutritional content and don't require the addition of sugar, tastes or colors. investigated the qualities and acceptability of date palm-infused yogurt products. According to the findings, adding 10–20% of date paste with or without 5% date syrup did not change the acidity, protein or fat content of the yogurt but instead markedly increased the total solids. In addition, 5% date syrup and 15% date paste are added to give the yogurt the necessary sensory quality [34].

Date syrup was also employed by to flavor and sweeten yogurt. From date syrup and low-fat milk created date juice yogurt with a long shelf life. Given the aforementioned details, it has been intended for the current study to make functional probiotic fermented yogurt utilizing date palm pomace as a sweetening and flavoring agent in order to enhance the health and nutritional quality of the finished product [35,36].

There have been few studies exploring whether Sewi-type date palm pomace is suitable for use as a prebiotic in yogurt recipes, despite the enormous importance of date goods. The current study evaluated the influence of date palm pomace added to yogurt at various concentrations as a prebiotic. It also looked into the effect of date pomace on the chemical properties of yogurt (total sugar, pH, acidity, fiber, total solids, fat, vitamin C, protein and minerals content) and the acceptability of yogurt.

Material and Methods

This study was conducted from 2022 to 2023 in *Central Lab of Date Palm Researches and Development, Agricultural Research Center, Giza, Egypt*. The dried date palm fruit was bought from Giza Governorate's local markets. Before analysis, all dates were kept in a refrigerator at 5°C. The dates that are mature and homogeneous in size, devoid of physical damage and insect and fungal illness. Were chosen and utilized in the experiment.

Date palm by-product preparation (pomace powder)

From Sewi dates, date pomace was produced. To get free of dust and other external pollutants, date fruits were carefully washed. To extract the seeds from the fruit, manual splitting was used. The dried date fruits (500 g) were mechanically powdered (to increase surface area), to increase the amount of resources extracted, then transferred into a glass beaker and thoroughly mixed with water (1:4), the mixture was heated at 90 °C for 3 h with stirred until softened and allowed in a cold place overnight to completely extract. The recovered materials were then separated using a centrifuge operating at 7000 revolutions per minute for 15 minutes, then filtered by filter paper Whatman No. 1. The date product (pomace) was collected and placed in the dryer to remove the majority of the water. The pomace was subsequently dried by a fan in the chamber before being milled into 5 mm fine flour by a coffee miller. The date palm flour was dried in a laboratory oven to a moisture content of 5 to 8%, after which it was cooled and stored in a glass jar with a tight seal in the refrigerator. In the making of yogurt, date pomace extract functions as a prebiotic [37].

Chemical analysis of plain yogurt and yogurt with date palm pomace

The moisture (Percentages of moisture by vacuum oven), total sugar was estimated following method. The percentage of crude protein was estimated by kjeldahl nitrogen direct analysis were determined according to the Association of Official Analytical Chemists methods. Ash and fiber were estimated according to while total fat estimated using [38-40].

Total solid (TS) determination

By placing 0.5 g of syrup on the lens of a digital refractometer and measuring the sample for temperature correction, the total solids (TS) in yogurt added with dried palm pomace (DPP) was determined, Kjeldal performed the Brix test [40].

PH and acidity determination

Using a digital PH meter with yogurt as the measuring medium, the pH of the samples was determined in accordance with [41]. By combining 10 g of yogurt with 20 ml of distilled water, and titrating the mixture with 0.5 NaOH and 0.5 ml of phenolphthalein as an indicator to an end-point of faint pink color, the titrable acidity (TA) percentage expressed as a percentage of lactic acid—was determined. A duplicate set of measurements was taken.

Determination of Vitamins (Vit. C and Folic Acid)

According to vitamin C and folic acid content in yogurt were measured for both the control (yogurt made from milk) and the yogurt flavored with date palm pomace. This method is based on the oxidation of ascorbic acid, which is extracted from the product and converted to dehydroascorbic acid by oxalic acid in an acidic medium, and titration using the dye 2,6-dichlorophenolin [42].

Viscosity was measured using a Rotational Viscometer Type Lab. Line Model 5437 in accordance with the method of [43]. At a temperature of 30 °C, measurements were taken for 15 seconds, and the findings were expressed in centipoise.

Syneresis and pH of yoghurts

Using the drainage method, the syneresis of the examined yoghurt was determined [44]. The analysis was done using a Whatman filter no 2 placed on top of a funnel. Following that, samples totaling around 25 g were spread out on the paper. The drainage period lasted 20 minutes, and the temperature was 21°C. The formula used to determine the percentage syneresis was (liquid weight/initial sample weight) x 100.

Determination of Mineral Content

According to the method given by the mineral content of both the yogurt and the yogurt with the addition of date palm pomace was assessed. Samples were heated to a temperature of 450 °C in an oven for six hours, cooled, and then dissolved in concentrated HNO_3 for analysis and dilution twice. The macro- and micro-elements were identified using the flame atomic absorption with variation spectrophotometer (JENWAY PFP7). Each element being examined has a different atomic absorption as determined by the hollow cathode lamp (UNICAM 929 AA Spectrometer) [45].

Bio-yogurt preparation

The highest levels of date products to be added were determined by preliminary tests that involved making yogurt flavored with date pomace. According to the findings, pomace can be added to yogurt for up to 30%. The yogurt with date palm pomace was made using commercial yogurt and made by supplementation 10, 20 and 30% date palm pomace, respectively. The plain yogurt (control) and yogurt containing date palm pomace were compared.

Results and Discussion

Chemical Analysis

The physicochemical composition of date palm pomace powder, which is employed in supplemented yogurt production, is shown in Table (1). All data is the average of triplicated samples. Date palm pomace was discovered to be rich in sugar, protein ash and fiber. The total solids content of date palm pomace is 84.6%, the moisture content is 1.1%, the total sugar content is 25.8 g/100g, the total protein content is 3.83%, the total fat content is 0.38% and the ash content is 2.2%, fiber content of 6.9%, vitamin C. content of 3.15 mg/100g and total acidity of 0.13%.

The majority of the carbohydrates in palm dates are in the form of simple sugars. Approximately 75 g of carbohydrates, or 18% of the daily requirement for carbohydrates, are included in a 100 g serving of dates. Dates contain 85% of their total carbohydrate content as simple sugars. Date fruit of a specific variety may have a significantly different sugar content depending on the cultivar,

soil, environmental conditions, and fruit maturity stage. The sugars from dates contain glucose, fructose, and sucrose, though most date types have little to no sucrose and the ratio of glucose to fructose is about equal.

Table 1: Estimation of nutritional values of date palm pomace

Components	Value
Total solids on dry weight (%)	84.6
Moisture content (%)	1.1
Total sugars (g/100g)	25.8
Total proteins (g/100g)	3.83
Fat (%)	0.38
Ash content (%)	2.2
Fiber (%)	6.9
Vitamin C. content (mg/100 g)	3.15
Total acidity (%)	0.13

According to glucose and fructose are the two main sugars found in date syrup. The sucrose is separated into smaller units before being absorbed by cells in culture [46,47]. As an alternative, date syrup contains macro and micronutrients in addition to sugar, which may help it improve the nutritional content of yogurt. These sugars have a higher level of sweetness, are natural, and have more health advantages than sucrose. In a previous study, hot water (80–85 °C) was used to extract 96% of the sugar from date pulp by cooking it for 20 minutes [48]. The digestible sugars in dates, like as glucose (42.3-51.8%), fructose (22.5-47.5%), sucrose (3.2-7.4%), proteins (1.8-30.0%), dietary fibers (2.2%), pectin, lipids, vitamins and mineral salts, give dates their distinctive functioning and exceptional nutritional value [22]. The total amount of sugar in Sewi pomace was also determined to be 25.8 g/100 g Table (1), which can be used in a variety of industrial applications. The amount of date palm pomace in this study was greater than the amount of carbohydrates in some plant residues, such as olive pomace 18.4 g/100 g and less than apple pomace 48 g/100 g on the basis of dry weight. This was primarily caused by the treatments used in the dates pomace industry [49,50].

Results showed that zahdi pomace had a total carbohydrate content of 20.8g/100g, which was less than matured zahdi dates by 86.5%. [51]. According to nutritional analysis, dates and their products are rich sources of minerals like calcium, potassium, and iron. They also include between 70 and 80 (%) of carbohydrates in the form of sugars that are simple for the body to absorb [6]. The relevance of eating functional foods for their participation in preventing many chronic diseases, such as heart diseases and cancer, the recently raised the interest of researchers in the fields of health and food [52]. The date type and water-to-date ratio are unquestionably crucial factors in solid extraction. Rapid and thorough extraction will be facilitated by a high ratio. The results of the chemical analysis, the moisture percentage in Sewi pomace powder decreased to 1.1% Table (1), which was less than the finding of who examined the structural and functional characteristics of some Omani dates cultivars and their residues and found that the average moisture level was 9.5% stated that the moisture content in Iraqi zahdi dates was 12.6 at the mature stage based on fresh weight discovered that the moisture content of zahdi residues was 9.36%, which is greater than the findings of the present study [53,54].

Ash content in Sewi date pomace was 2.2%, which is in line with and in close proximity to conducted on olive pomace, which found roughly 3-4% of ash. According to the percentage of ash in grape pomace was 8.26%, and the percentage of ash in residues varied depending on the type of treatment. Numerous variables, including plant cultivar, its biological characteristics, and ecological conditions, have an impact on the amount of ash and other chemical components of plant residues that are left over from the food industries of fruits and vegetables [55-57].

The amount of total fats in Sewi pomace powder in the current study was 0.38%; nevertheless, found 1.58, 1.40 and 2.2 g/100 g, respectively in Aum sala, Almubls and Omani Sahal dates, respectively [6]. While, noted an increase in the percentage of fat in the pomace of zahdi dates, which was 8.56g/100g. Date cultivar and processing technique both affect the quantity of fat in date pomace conducted research on the date syrup's chemical composition and recorded 2.40 g/100 g of total fats based on fresh weight [54,58].

Dates contain more protein than the majority of other fruits, according to a study by [11]. Kimri phase has the highest content (5.5–6.4%), which subsequently reduces to 2.0-2.5% during the Tamar stage. The majority of date proteins were water-soluble albumins, as revealed by the sequential extraction of date pulp. Green dates initially had relatively little protein, but as they matured, this content grew quickly [8]. Typically, the average of protein is regarded to be higher due to its concentration of various amino acids, and the total protein in Sewi date pomace of this study was enhanced and amounted to 3.83 g/100g in comparison with zahdi date pomace which amounted to 2.989 g/100g [53]. Date fruit extract possessed potent anti-oxidant and anti-mutagenic effects [59].

Dates are a fruit noted for being nutrient-rich. It provides healthy amounts of dietary fiber (mostly insoluble fiber), proteins, minerals and carbohydrates (about 70% of which come from fructose and glucose). Additionally, it contains a lot of flavonoids, procyanidins, carotenoids, phenolic acids, and sterols [14-16,60].

Some food products, including ice cream, beverages, baked goods, jam, and butter, can contain date syrup as an ingredient [61]. Date syrup and date powder can be used to sweeten desserts, increase viscosity, and stimulate spontaneous exudation because of their high fiber and sugar levels [62]. It also serves as a natural flavoring and coloring component.

Table 2: Determination of minerals in date palm pomace (DPP)

Minerals	Concentration (mg/100 g)
Iron Fe	4.8
Mg	1.06
Manganese Mn	0.15
Cadmium Cd	0.7
Potassium K	660
Calcium	58.3
Phosphorus P	73.12
Zinc Zn	0.28
Sodium	0.75

It was determined that the Mg, K, Ca and P contents of date palm pomace were highly high at 1.06, 660, 58.3 and 73.12 ppm, respectively. Fe, Mn, Cd and Zn concentrations were low and within the safe range, at 4.8, 0.15, 0.7 and 0.28 ppm, respectively, as shown in Table (2). Therefore, compared to plain yogurt, date palm pomace-supplemented yogurt is a great source of important nutrients due to the high concentration of minerals found in the current study. The 100 grams of dates contain the bone-building nutrients 696 mg of potassium, 90 mg of iron, 362 mg of copper and 90 mg of magnesium. Additionally, copper is necessary for the synthesis of red blood cells. Dates are ideal for those with hypertension due to their high potassium and low sodium concentrations [63]. It is thought that dates are a good supplier of these minerals. In terms of selenium, copper, potassium, magnesium, and moderate amounts of manganese, iron, phosphorus, and calcium, 100 g of dates supply more than 15% of the daily Recommended Dietary Allowance (RDA) to Adequate Intakes (AI) [8]. Iron, calcium, cobalt, copper, fluorine, magnesium, manganese, potassium, phosphorus, sodium, copper, sulfur, boron, selenium and zinc are all prevalent in pulps.

Potassium concentrations in various date varieties range from 0.9% in the flesh to 0.5% in some of the pits and seeds. Boron, calcium, cobalt, manganese, phosphorus, zinc and other minerals and salts are also present in varying amounts [64]. According to, the date fruit contains fluorine, which has been found to prevent tooth decay [65]. Furthermore, selenium has a number of functions in the body, improve the immune system including the capacity to prevent cancer. Dates are high in iron and may help alleviate anemia and iron deficiency. Dates include a variety of phytochemicals, including sterols, phenolics, anthocyanins, carotenoids, procyanidins and flavonoids, as well as dietary fiber, carbohydrates and numerous essential vitamins and minerals. The dates' nutritional and sensory qualities are influenced by phytochemicals in addition to their pharmacological effects. The considerable antioxidant properties of phytochemicals found in fruits have been demonstrated, and these properties may be related to lower incidence and mortality rates of degenerative diseases in humans [66,67]. The dates include vital minerals, such as potassium, which is necessary for muscle contractions and lowers blood pressure and pulse rate [7]. The date fruit extract is added to dairy products to improve their functional qualities. Date fruit is a rich source of carbohydrates, dietary fiber, and a few key vitamins and minerals.

Table 3: The chemical composition of fresh plain yoghurt

Components	Value
pH	4.5
Moisture%	86.81
Protein%	3.2
TS%	12.85
Ash	0.4
Acidity%	0.87
Fiber	0.0
Fat	3.95
Vitamin C (mg)	25.0
Folic acid	1.15
Total sugar g/100g	5.4
Viscosity	32
Syneresis	3.11

It is important to note that a variety of factors, such as the animal's health, the time of lactation, hereditary characteristics, and environmental conditions, are to blame for the wide range of milk compositions from which yogurt is made. Some common dairy products with various chemical components are fermented products [68]. According to Table (3), the yogurt has a pH of 4.5, a moisture content of 86.81%, a total protein content of 3.2%, a total solids content of 12.85%, ash content of 0.4%, an acidity of 0.96%, the fiber of 0.0%, a total fat content of 3.95%, a total sugar content of 5.4%, a vitamin C content of 12.0 mg, the folic acid content of 1.15, a viscosity of 32% and Syneresis of 3.11%.

Probiotic microorganisms found in fermented dairy products are beneficial to health. Children, the elderly, and others with weakened immune systems may benefit from probiotic bacteria's immune system-supporting properties [31]. Fruit preserves and other ingredients are the most popular flavors for yogurt, according to [32].

Table 4: Evaluation the Nutritional Values of Yogurt with added 10, 20 and 30% of Date palm pomace (DPP) compared with Plain Yogurt

Treatment	Total sugar g/100g	Ash %	TS %	Fat %	Protein%	PH	Acidity %	Moisture%	Fiber	Vitamin C (mg)
Plain	5.4 d	0.4	12.85	3.95a	3.2a	4.5	0.87 d	86.81	----	12.0b
10% DPP	8.3 bc	0.7	18.9	3.9a	3.1a	4.0	1.14 c	80.0	0.8	12.3ab
20% DPP	11.0 b	0.9	21.0	3.84ab	2.8ab	3.8	1.5 b	76.5	1.5	12.4ab
30% DPP	14.1 a	1.1	22.3	3.8b	2.5b	3.6	1.9 a	72.3	2.0	12.6a

Fruit concentrates or flavors are added to cultured milk before or after incubation to create flavor-infused yogurt [33]. Compared to other fruits, dates have better nutritional content and don't require the addition of sugar, flavors or colors. Due to the complexity of its nature and composition, yogurt is a complicated viscous dietary substance. Yogurt's rheological behavior is affected by carbohydrates, fat and water [69].

The total sugar content (g/100 g) of yogurt containing DPP powder varied significantly depending on the supplementation level. As demonstrated in Table (4), the sugar content increased as the concentration of DPP increased to 8.3, 11.0, and 14.1 g/100 g, respectively, from plain yogurt's 5.4 g/100 g. When date palm pomace was added to yogurt at concentrations of 10, 20 and 30%, the ash content of the resulting product dramatically increased 0.7, 0.9, and 1.1 (%), respectively, while, the plain yogurt have 0.4% ash content. The yogurt with supplied date palm pomace had a greater total solids content (18.9, 21.0 and 22.3%), this was not the case for plain yogurt (12.85%). However, there were no appreciable variations in the fat percentage of the yogurt supplemented with date palm pomace powder at any concentration.

In the current study, as indicated in Table (4), the protein level in yogurt was gradually decreased with added varying concentrations of date palm pomace to (3.1, 2.8 and 2.5%), respectively, compared to plain yogurt (3.2%). The pH levels and total acidity (%) of bio-yogurt samples containing 10, 20, and 30% date palm pomace are shown in Table (4). Additionally, the pH value decreased gradually, and there was an increase in acidity than that of the control sample. This variation may be explained by yogurt's impact on the development of microbes, which in turn has an impact on pH levels. The starter culture type, lactic acid conversion to lactose, storage time, and temperature of fermentation could all contribute to pH drop during storage.

The presence of antimicrobial components in date palm pomace powder that inhibited yogurt activity may be to blame for the slow development of acidity despite the addition of an adequate quantity of active yogurt. However, there were noticeable variations in the yogurt's acidity. Acidity as a proportion of lactic acid ranged from 0.87 to 1.9%.

Table (4) shows the moisture content of plain yogurt and yogurt with added 10, 20 and 30% date palm pomace. In comparison to plain yogurt's 86.81% moisture, the addition of date palm pomace reduced moisture to 80.0, 76.5 and 72.3%, respectively. The findings demonstrated that adding more date palm pomace considerably enhanced the fiber content of the yogurt prepared. When compared to plain yogurt, which did not include fiber, the fiber content in yogurt with supplied date palm pomace at 10, 20 and 30% were 0.8, 1.5 and 2.0%, respectively.

For the simultaneous measurement of water-soluble vitamins in yogurt, a quick, easy, and reliable liquid chromatographic technique had been established. The results showed no discernible variation in the amount of vitamin C present in yogurts that had been made either plain or with various amounts of date palm pomace added Table (4).

The percentages of protein, fat, ash and total solids in the milk were 11.42%, 3.26%, 3.18%, and 0.72%, respectively. The amount of protein, fat, ash and total solids in the date syrup were, respectively, 80.42%, 1.67%, 0.98% and 2.08%. It is obviously true that when date syrup is added to milk in low quantities, the levels of specific ingredients in the resulting fermented milk noticeably increase. Date syrup considerably raised the TS and ash levels of the finished syn-biotic product. This rise was related to the quantity of date syrup added. However, Protein and fat composition did not change significantly [70].

This study was not in agreement with who studied chemical components of yogurt products supplemented with date products like, pH, acidity, moisture, protein, fat and total solids. Date paste and depis yogurt shared the same acidity and pH levels as plain yogurt. The addition of date products had no impact on the yogurt's fat or protein content, but it did result in a drop in moisture and an increase in total solids evaluated the quality and acceptability of yogurt with date palm ingredients [34]. According to the findings, adding 10 to 20% date paste, with or without % date syrup, did not significantly modify the acidity, protein, or fat content of yogurt, but it significantly increased the total solids. Furthermore, the inclusion of 15% date paste and 5% date syrup provided the appropriate sensory quality to the yogurt. Date palm pomace's increased ash and total solids content are probably to blame for the increase in TS and ash of fermented yoghurt following its inclusion [71]. These findings are in line with those made public by, who claimed that adding date palm pomace to skim milk enhanced the amount of TS, protein, and ash in the fermented milk [72]. In addition, revealed comparable findings for their investigation into the creation of functional yogurt enhanced with date palm pomace. When date syrup was added to milkshakes, also noted comparable results [35].

It was shown that lactose content was responsible for the development of coagulum and the decrease in PH brought on by the creation of lactic acid [9]. This investigation confirms that there were substantial variations in acidity with increasing the concentration of DPP addition, as indicated in table 4. As a result, lactic acid bacteria use the sugar (glucose and fructose) in date palm pomace as a food source. This also shows that adding date palm pomace to yogurt samples while they are being stored activates pro-biotic bacteria. These findings concur with those of [73]. Date depis supplements to fermented milk increased its acidity levels from 1, 2.5 and 5% to those of the control. According to a different study, adding 10 and 15% (w/w) rutub pieces of dates to cow's milk to generate bio-yogurt increased the acidity and decreased the pH [74].

The dry weight 6.4 to 11.5% of the date fruit is thought to be constituted of dietary fibers like pectin, hemicellulose, lignin, resistant starch, and soluble fiber. According to Al-, 100 g of dates, or seven to nine fruits, provide 25 to 30 g of dietary fiber [75]. Dates have a dietary fiber content that ranges from 4.4 to 11.4% [7]. Date fiber, a by-product of the production of date syrup, contains 51.57% of the daily recommended amount of fiber [9]. The antioxidant content of food will rise when date fruit and its byproducts, such as syrup and pomace, are added. This will likely stop food from oxidatively deteriorating. They also determined that date palm fruit can be used to create innovative natural antioxidants that can be employed in a variety of culinary products. examined the affected of the addition of date fiber on yogurt quality [10]. Although the pH of fresh yogurt was raised, adding 1.5%, 3.0% and 4.5% date fiber did not significantly alter the acidity. Date fiber-fortified yogurt had a firmer texture (higher hardness ratings) and a deeper shade. When the percentage of date fibers in yogurt reached 4.5%, both the sensory evaluations and acceptability considerably dropped. Yogurt that had been fortified with 3% date fibers was palatable and had positive health effects found that date syrup greatly increased the vitamin C content of functional yogurt [72]. According to a research on the effects of date syrup and date powder in a dairy dessert, the physicochemical, phytochemical, microbiological, rheological, and microstructural features of the date-added goods differed from those of the commercial sample studied [76]. According to reports, date syrup can take the place of sugar in some classic Iranian and Indian delicacies [77]. After date syrup was added to goods such prebiotic chocolate milk and yogurt, it was noticed that the chemical composition and organoleptic qualities had improved [78].

Table 5: Evaluation of viscosity and syneresis of yogurt with added date palm pomace compared to plain yogurt

Treatment	Viscosity	Syneresis
Plain yogurt	32	3.11
10% DPP	61	1.69
20% DPP	69	1.4
30% DPP	75	1.25

Table (5) illustrates how the addition of date palm pomace affected the viscosity parameters of yogurt. Data showed that the

viscosity of the resulting syn-biotic yogurt significantly increased when date palm pomace was added to yogurt. Additionally, the concentration of additional date palm pomace was linked to this outcome. The bio-yogurt containing 10, 20, and 30% date palm pomace had syneresis values of 1.69, 1.4 and 1.25, respectively, while the syneresis of the control sample (without date palm pomace) was 3.11%. Date palm pomace concentration increased water-holding capacity while decreasing syneresis. The date palm pomace's higher water-holding capacity and high concentration of compounds that can bond with water, such as fiber, may explain why date palm pomace-based bio-yogurt syneresis rates are so low.

Date palm pomace appears to have increased the amount of fiber in the cultured yogurt, which modifies its structure and increases viscosity by binding to water molecules [79]. These findings support those made by, who found that adding date syrup considerably raised the acidity and viscosity of yogurt and probiotic dairy products [36,80]. Although the apparent viscosity of yogurt reduced with an increase in the quantity of date fruit extract, the yogurt containing 10% date syrup had a satisfactory consistency, especially when it wasn't stabilized. Due to the high sugar content, which effectively binds moisture and prevents bacterial growth, the fruit is kept fresh [75].

In contrast, it was discovered that increasing the concentration of DPP addition caused viscosity values to rise in comparison to the control group. These findings concur with those of [9] [69], who came to the conclusion that a larger water-holding capacity of date fiber may be associated with a higher absorption of moisture when viscosity is increased.

The activity of the yogurt starter culture, which turned lactose into lactic acid, as well as the presence of simple sugars (glucose and fructose) and other nutrients in date palm pomace, may have stimulated the bacterial activity, according to one theory [81,82]. Furthermore, date palm pomace could include certain oligosaccharides that raise the viscosity of the finished products.

Syneresis is the measurement of serum release from bio-yogurt gel under centrifugal force. It is used to assess the quality of the yogurt and the gel's ability to retain water. Table (5) demonstrates that by increasing the concentration of date palm pomace addition in comparison to control, the syneresis values fell dramatically. Stabilizers including pectin, gelatin, and starch are used in yogurt processing to prevent syneresis. Another strategy for reducing syneresis is to add more total solids to yogurt milk, particularly more protein and fiber. As can be seen, the control yogurt had a greater index of syneresis than the other treatments. These results are consistent with those of, who stated that adding carbohydrate components reduced product syneresis while improving the texture and rheological properties of the yogurt supplement [83].

Numerous studies have found that adding date juice reduces the amount of yogurt syneresis that occurs. Yogurt syneresis increased when 1-9% of date liquid sugar was added, increasing its capacity to store water while decreasing whey syneresis values. Evident viscosity differences and the presence of syneresis are the most prevalent yogurt texture flaws that could cause consumer rejection, according to [84-87].

Table 6: The comparative among chemical content of plain yogurt and with added different concentrations of date palm pomace on it, all data is the average of triplicated samples

Yoghurt	K	Ca	P	Mg	Fe	Zn	Mn
Control (mg/100 gm)	148 mg	322 mg	260 mg	156	0.7 mg	4.8	0.04
10% DPY	350	490	550	170.1	6.9	6.5	0.08
20% DPY	420	544	608	179.0	8.7	7.2	1.2
30% DPY	510	608	660	188.4	11.4	8.8	1.2

The average concentration of K, Ca, P, Mg, Fe, Zn and Mn in plain yogurt were found to be 148, 322, 260, 156, 0.7, 4.8, and 0.04 mg/100 g, while the average content of Fe, Mg, Mn, Cd, K, Ca, P, Zn, and sodium in date palm pomace was found to be 4.8, 1.06, 0.15, 0.7, 660, 58.3, 73.0. As can be shown in Table (6), adding date palm pomace to yogurt significantly increased the products' general mineral content.

These findings support us findings, and suggest that these findings may be related to the increased concentrations of these minerals in date palm pomace [82,88]. The levels of K, Ca, P, Mg, Fe, Zn, and Mn in all samples of fermented yogurt considerably improved as the storage period progressed. According to and the addition of date syrup enhanced the Na, K, and Fe content of the resulting yogurt [36,72]. When date palm pomace was added to yogurt at 10, 20 and 30%, it had a higher minerals content than plain yogurt. The body needs vitamins and minerals every day, which are grouped as micronutrients. The new product of yogurt contained a lot of calcium, which supports stronger bones and is especially advantageous for young children in preventing rickets as well as brittle and weak bones in adults. It has also been shown that consuming enough calcium and other nutrients from dairy can lower the chance of developing high blood pressure [89]. Additionally, this yogurt was high in potassium, which controls the body's water balance and gives bodily fluids the proper alkaloidal properties. Additionally to encouraging the kidneys to eliminate harmful biological toxins [90]. Since the body cannot store potassium and a significant amount is lost through perspiration, it must constantly be refilled. Yogurt made with date palm pomace has a significant amount of iron, which regulates the production of hemoglobin in red blood cells and maintains a healthy level of red blood cells in the blood [91]. Additionally, new yogurt included more zinc than plain yogurt. The healing process, blood stability, cognitive abilities and maintaining a healthy alkaline balance in the body are all thought to benefit from zinc [92].

The high mineral concentrations found in the current study enhanced the concentration of the date palm pomace yogurt samples that were supplemented, confirming the importance of yogurt as a source of crucial nutrients. Yogurt might be a great substitute for milk for those who cannot consume dairy products. Additionally, date palm pomace powder, which is rich in many critical minerals, including iron, manganese, magnesium, potassium, calcium, and phosphorus, provides milk and yogurt, which are low in iron content compared to other foods, with a variety of nutritional benefits. These findings concur with earlier research [93]. Additionally, yogurt fortified with date palm extract offers more of the soluble minerals we require to maintain human health, according to a study by [72]. While discovered that the potassium, sodium, and iron contents of date syrup were 771, 14.4 and 4.36 mg/100 g, respectively [88]. Observed that the Na, K and Fe content of milk ranged from 217.9-488, 1106-19, 895 and 0.42-3.46 mg/100 g. According to, milk contained 8.4 0.44 mg/dl of vitamin C [94-96].

Conclusion

Yogurt with date palm powder has been consumed because it is an excellent source of dietary fiber, sugar, minerals and antioxidants, but it can also be employed as a functional food. Children enjoy it more because of its excellent flavor and bright color.

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