

Advantages of Khalas Date Products (*Phoenix dactylifera* L.) as a Natural Substitute for Sugar and Sweeteners in Food Processing

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ABSTRACT

Advances in food science have led to the development of high-value food products, enhancing nutritional value by incorporating nutrient-rich ingredients. Adding high-nutritional plant materials, like dates, supports this trend. Dates, one of the oldest fruit crops, hold cultural and economic significance in the Middle East, especially in Saudi Arabia, the world's second-largest producer with over 300 varieties and an annual yield of 1.6 million tons. Saudi Arabia has advanced date production, leading to top-ranking global exports since 2021, with food industries comprising 24% of the Kingdom's exports. Dates are rich in sugars, fibre, minerals, vitamins, and antioxidants, providing numerous health benefits, including protection against diseases. Date paste, containing natural sugars, fibre, phenolic compounds, and essential vitamins, enhances health by promoting digestive health, regulating blood sugar, and supporting heart health. Using date paste as a natural sweetener reduces refined sugar intake and offers a flavorful, nutritious alternative suitable for various recipes, enhancing both taste and health.

Therefore, this study aims to support the using date paste as a natural sweetener and an alternative to sugar in different food products, to improve the nutritional value and sensory acceptability instead of those made of sugar and synthetic sweeteners.

Keywords: Date paste, Date syrup, Nutritional value, Sugar substitute, Low sugar foods.

INTRODUCTION

The date palm (*Phoenix dactylifera* L.) one of the oldest fruit trees in the world, long closely associated with human life in the Middle East, including Saudi Arabia. This is due to the geographical conditions of the desert region and the expertise of Saudi farmers. Dates are highly nutritious and rich in carbohydrates, Dietary fibre, minerals and multivitamins, such as vitamin B. interest in the health benefits of dates, is growing and there is a need to develop food products that use dates as a rich source of nutrients. It is estimated that 20-30% of dates are wasted each year because dates are not sold in previous years or are overproduced and therefore

their nutritional value is not utilized and applied in various nutritious diets. (Alhuzali, et al., 2023).

Saudi Arabia's Vision 2030 program is of great emphasis to the development and sustainability of the palm date sector. In 2021, the Kingdom of Saudi Arabia was the world's number one exporter of dates. (National Palm and Dates Center 2022). The availability of dates in the Kingdom in large quantities and the high proportion of sugars justifies their use in the manufacture of date candy which can be used as a partial alternative to similar imported candy products, so there is a good possibility to take advantage of surplus dates in the candy industry. The results of one study also showed the possibility of storing date candy at 25°C for up to eight weeks without affecting quality (Yousif & Alghamdi, 1999). The date palm is regarded one of the oldest cultivated plants in the world, and is planted mostly in dry and semi-arid parts of southern Europe, North Africa and southern Central Asia. (Alotaibi et al., 2023). Date palm cultivation has grown in the recent decade (Faostat. 2023). with global production of around 9.7 - 106 tons in 2021, where Egypt, Saudi Arabia, Iran, and Algeria are the biggest producers as shown in the Figure (1) . (Fig 1) (Alotaibi et al., 2023).

Eating large quantities of sugar and artificial sweeteners contributes to increasing calories without providing the necessary nutrients. This leads to weight gain and obesity, raising the chance of developing long-term conditions including heart disease and type 2 diabetes, as well as dental decay, weakened immune systems, and excessive exercise. The presence of sugar and sweeteners at high levels in food poses a risk to the health of consumers, especially children, and steps must be taken to reduce their consumption to promote public health and prevent diseases.

Illustrates, (Fig3/B).Date paste, a popular product made by grinding pitted dates, is rich in sugar, dietary fibre, and natural antioxidants, making it a valuable natural alternative to refined sugar. (AL-Farsi,2014). Widely

DOI: 10.21608/asejaiqsae.2024.391939

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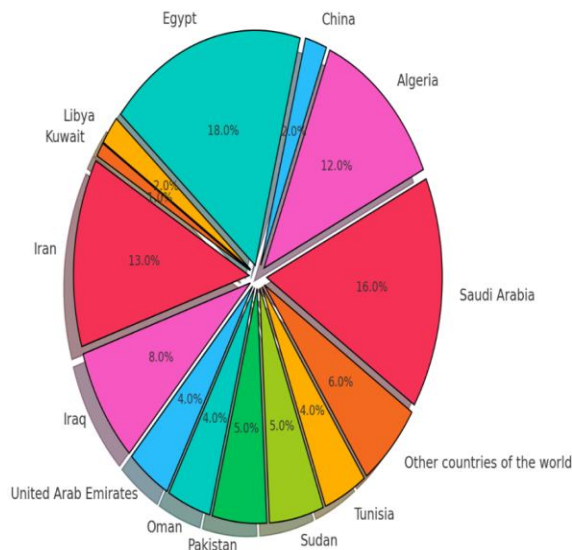
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Received, October 10, 2024, Accepted November 14, 2024.

used in the food industry, it enhances sweetness, texture, and flavor in products like sweets, baked goods, and beverages. Additionally, utilizing surplus or lower-quality dates for date paste reduces waste, improves production efficiency, and supports both environmental and economic sustainability. (Elleuch et al.,2008).

Fig. 1. Global changes in the area harvested from



date palms and the output of dates between 2010 and 2021. (FAOSTAT. 2023)

The dangers of sugar on human health and dental health:

Sugar, especially in its added forms, is considered one of the dietary components that can be harmful to health when consumed in large quantities. Studies indicate that excessive sugar consumption is linked to several health issues, including:

- 1) **Weight Gain and Obesity:** Sugary beverages and sugar-rich foods contribute to increased caloric intake, leading to weight gain and obesity, which are important contributing factors to a number of chronic illnesses, including heart disease and type 2 diabetes. (Malik et al., 2010).
- 2) **Heart Disease:** High sugar consumption can lead to increased blood pressure and elevated triglyceride levels, which heighten the risk of heart disease. (Yang et al., 2014).
- 3) **Dental Problems:** Sugar is one of the primary components responsible for tooth decay. When oral bacteria consume sugar, they create acid, which damages tooth enamel. (Petersen & Ogawa, 2016).

- 4) **Diabetes:** Excessive sugar intake is associated with elevated insulin resistance, which can cause type 2 diabetes to develop. (Hu et al., 2001).

The importance of replacing sugar with date paste in foods:

- 1) Date paste is considered a healthy alternative to added sugars. It contains natural sugars, along with vitamins, minerals, and fibres. The benefits of replacing sugar with date paste include:
- 2) **Improved Overall Health:** Date paste contains antioxidants and fibres, which help enhance overall health and improve digestion. (Alsarayrah et al., 2023).
- 3) **Reduced Risk of Cavities:** Using date paste instead of sugar may help reduce the risk of tooth decay, as it contains nutritious components that support oral health. (Al-Nabulsi et al., 2020).
- 4) **Sustained Energy:** Date paste's fibre component helps control blood sugar levels and avoid sharp increases in blood sugar, giving it long-lasting energy. (Sultan et al., 2022).
- 5) Based on the above, reducing sugar consumption and replacing it with natural sources such as date paste is an important step toward improving overall health and maintaining dental health.

STUDY'S PROBLEM:

The rising consumption of high-sugar products lacking nutritional value poses significant health risks, including obesity, diabetes, and tooth decay, as the body rapidly digests added sugars. To mitigate these issues, it is crucial to minimize added sugar intake. However, naturally sugars in fruits and vegetables, like dates, can be beneficial when consumed in moderation. These foods provide essential carbohydrates and other nutrients that contribute to overall health, making them valuable energy sources.

PREVIOUS STUDIES:

1. Global trends toward reducing sugar levels in foods:

Reducing sugar levels in food has become an important global topic in recent years as governments and health organizations make efforts to combat the marked increase in obesity and diseases associated with excessive sugar consumption. Research shows that several trends and initiatives are underway around the world to achieve this goal Government legislation: many countries are introducing taxes on sugar-sweetened beverages and foods high in sugar. These taxes aim to reduce consumption and incentivize companies to reduce the sugar content of their products . (Cawley et al., 2015).

Raising public awareness: Governments and health organizations conduct awareness-raising campaigns to inform the public about the risks associated with excessive sugar consumption. These campaigns emphasize the importance of reading food labels and choosing healthier alternatives. (World Health Organization, 2016).

Replacing sugar with natural alternatives: more and more manufacturers are turning to natural sweeteners such as stevia and beet sugar to reduce the amount of added sugar in their products. These alternatives address the problems associated with sugar while maintaining sweetness. (Bennett et al., 2018).

Improving product formulation: many companies are working to improve the formulation of their products to reduce the amount of added sugar without sacrificing quality and taste. This trend coincides with growing consumer demand for healthier food products. (Rogers et al., 2020).

Food innovation: reflecting the growing trend towards healthy lifestyles, new products with low or no sugar are being developed, including snacks and desserts made with wholesome ingredients. (Keller et al., 2018).

2. The nutritional value of dates and their impact on health:

Because they contain essential vitamins and minerals, including the 15 minerals included in dried dates, dates are a valuable nutritional supplement. Desert people have been using dates and goat and camel milk as a comprehensive nutritional supplement for thousands of years. The type of dried date determines how much of each mineral is present. Additionally, they contain high levels of pro-vitamin A and B1, B2, B3, B5, and C. (Siddiq & Greiby, 2013). Since vitamins are lost during the drying process, fresh dates have higher vitamin concentrations than dried dates. Vitamins riboflavin, pyridoxine, niacin, and folic acid are all found in typical amounts in dried date fruit. Dried dates have comparatively low levels of thiamine, ascorbic acid (vitamin C), and pro-vitamin A. (Chang, et al. 2016).

Dates are good for patients with hypertension because of their high potassium and low sodium content. Date fruit can be used as a supplement to help those who are iron deficient without having to deal with the negative effects of iron supplements, such as headaches, nausea, and appetite loss. (Hasnaoui et al., 2010).

Dates are rich in sugars including fructose, glucose, and sucrose. When athletes incorporate these sugars into their diet as extra ingredients, they provide them energy. Dates are considered a functional food because of their

high richness in carbohydrates, antioxidants, vitamins, minerals, and other essential components. Because of their texture, dates are simple to combine with cereals and other components when creating cuisine (Barrevel,1993). Therefore, Dates' nutritious content guarantees a complete, healthful meal for customers of all ages. Due to their strong antibacterial and antioxidant qualities, dates can help ward off illness and weariness (Vayalil,2002).

3. Chemical composition of date paste:

Date paste (Fig3/B) is a natural food product rich in various chemical compounds that enhance its nutritional value and health benefits. It primarily consists of simple sugars, containing high levels of glucose and fructose, making it an excellent source of energy (Al-Farsi et al., 2021). According to research, date paste also contains dietary fibres, which is crucial for enhancing digestive health and lowering the risk of heart disease (Abd El-Ghany et al., 2020).

In addition, phenolic compounds are considered one of the main components of date paste. These compounds are attributed to their antioxidant properties, because they lower the risk of chronic illnesses and fight free radicals. (Hassan et al., 2022). A recent study has shown that the concentration of phenolic acids in date paste enhances its health benefits, making it an important component of the diet. (Khan et al., 2023).

Studies have shown criteria that reflect the differences in the chemical composition between the two types of date paste, indicating that black date paste contains a higher percentage of total solids and soluble solids compared to golden date paste. It was found that golden date paste contains 70.5% of total solids, while black date paste contains 83.5%. The soluble solids ($^{\circ}$ Brix) for the golden date paste were 60%, compared to 70% for the black date paste, measured using a digital refractometer. The pH was analysed using a pH meter, with the golden date paste showing a pH of 4.8 and the black date paste having a pH of 4.38. (Razavi & Karazhiyan., 2012).

In another study that examined the proximate composition of different types of date paste (Sukary and Wannanh), it was found that Sukary date paste contained 23.6% moisture, 1.73% crude protein, 1.35% crude fiber, 1.63% ash, 0.78% ether extract, and 0.02% acidity. Meanwhile, Wannanh date paste contained 25.5% moisture, 1.68% crude protein, 1.63% crude fiber, 1.71% ash, 0.75% ether extract, and 0.03% acidity. (Habiba & Mehaia., 2008).

Dates contain many phytochemicals that contribute to their beneficial properties as an abundant supply of antioxidants. The most well-known of these phytochemicals are carotenoids, which include lutein, zeaxanthin, beta-carotene, lycopene, and neoxanthin.

These compounds are known for their role in protecting cells from oxidative stress. In addition, there are several different types of phenolic chemicals in dates, the ferulic, syringic, vanillic, gallic, caffeic, protocatechuic, and coumaric acids are in particular cinnamic acids and their derivatives. Dactylifera acid is one of these acids' derivatives., further enhance the antioxidant properties of dates, making them a valuable component for promoting health and protecting against chronic diseases. (Aljaloud et al., 2022).

Carotenoids and phenolic chemicals, such as flavonoids and anthocyanins, are important sources of antioxidant and antimutagenic qualities. For example, ascorbic acid (vitamin C) is not as important as total phenolics medicine (oxidant activity) in dates. The ability of date fruits and date juice extracts to scavenge free radicals has been validated by several research. Most of the antioxidants in dates are soluble in water or hydrophilic. Because of their high concentration of active phenolic acids, they not only provide an unmatched supply of natural antioxidants but also enhance the flavor and color of culinary goods. (Aljaloud et al., 2022).

Dates, also known as the "fruit of the palm," are considered a nutritious food that offers numerous health benefits. Here are some key health benefits of dates based on scientific references such as the mentioned study:

1. High in minerals and vitamins: Vitamins like B6 and K, along with minerals like potassium and magnesium, are abundant in dates and help support general health.
2. Antioxidants: dates are rich in powerful antioxidants such as flavonoids, carotenoids and phenolic acids. These substances are crucial in combating free radicals and lowering the chance of contracting chronic illnesses.
3. Promoting heart health: By raising good cholesterol (HDL) and decreasing bad cholesterol (LDL), eating dates can help cardiovascular health.
4. Improving the digestive system: Constipation is avoided, and digestive function is enhanced by the high fibre content of dates. Additionally, fibre helps to improve the digestive system's general health.
5. Energy boost: Natural sugars like glucose, fructose, and sucrose, which are abundant in dates, provide a rapid energy boost.
6. Immune system support: the nutrients in dates support the immune system and increase disease resistance.
7. Support bone health: minerals such as calcium and phosphorus found in dates promote bone health and prevent osteoporosis.

These benefits are part of the results of the latest research on dates, making them a healthy and wholesome food. (Alsarayrah et al. 2023).

In conclusion, as illustrated in Figure 3 and table1, date paste's chemical composition (Fig3/B) represents a rich blend of sugars, fibre, vitamins, and minerals, making it a nutritionally significant ingredient with multiple health benefits. The steps for manufacturing figures3/B can also be referred to in figure 2, which is one of the best methods for manufacturing high-quality date paste.

Table 1. Date paste's chemical composition. (sánchez-zapata et al.,2011)

Component	Mean ± SD (g/100 g fresh weight)
Protein	2.12 ± 0.02
Fats	1.35 ± 0.25
Moisture	34.73 ± 1.16
Ash	1.75 ± 0.42
Total sugars	53.00 ± 1.03
Total dietary fibre	7.00 ± 0.15
Insoluble dietary fibre	4.04 ± 0.04
Total phenolic content	225 ± 22 (mg GAE/100 g fresh weight)

Table 2. A brief overview of the palm sweetener. Data retrieved from (Castro-Muñoz et al., 2022; Anwar, S et al., 2023). as well as the ancillary references in these works

Sweetener	Composition	Properties	Utilization
Palm sugar	Reduced sugars at 6% and sugar at 91%. notable levels of phenolics, minerals, and vitamins	Index of glycaemic: 70 Antioxidative agent-induced cytoprotective action against NIH3T3 fibroblast cells and cell proliferation	Additives for sweet soy sauce, sweets, and drinks

The study outlines several of the date palm's (*Phoenix dactylifera* L.) and its fruit's therapeutic advantages. Dates are rich in antioxidants, that lower inflammation and oxidative stress as mentioned in Table 2. They have anti-inflammatory, antimicrobial, and antitumor properties, supporting immune health and protecting against chronic diseases like cardiovascular problems and certain cancers. Furthermore, dates promote digestive health due to their high fibre content, which helps with constipation and overall gut health management (Mahomoodally et al. 2024).

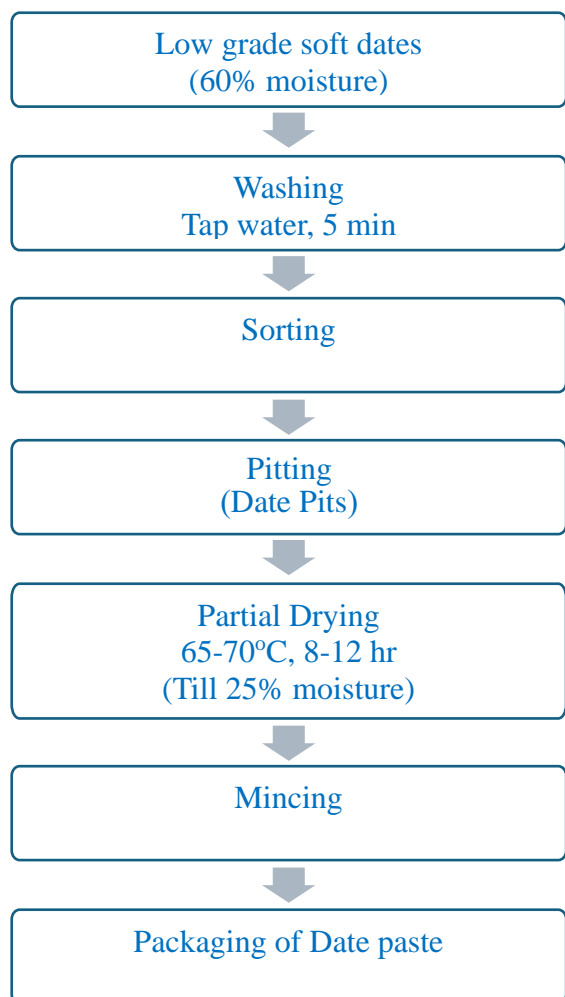


Fig. 2. Figure 2 illustrates date paste manufacturing steps. (Rabie et al.,2021)

4. Use date paste as an alternative to sugar in different food products

The amount of added sugars in processed meals nowadays has a detrimental effect on tooth health and is a contributing factor to chronic illnesses. For example, cardiovascular disease, type 2 diabetes, metabolic syndrome, and obesity. This underscores the potential of replacing added sugars with dates, which offer a natural, nutritious alternative to artificial sweeteners. Because they are high in macro- and micronutrients, especially bioactive ones like fibre, polyphenols, and minerals, dates are positioned to promote health and fend off disease. Utilizing dates that are damaged or unmarketable can also reduce waste and improve the sustainability of date palm farming. This study demonstrates that secondary and second-quality date products can serve as effective alternatives to sugar in creating sweet and healthy foods. (Sayas-Barberá et al., 2024). Ripe, pitted, and skinless dates that have been

steamed or boiled in boiling water are ground to create this product. (Oladzad, et al., 2021).







Date products	Name	Symbol
	Khalas date	A
	Date paste	B
	Date fiber	C
	Date sugar	D
	Date syrup	E
	Date powder	F

Fig. 3. Appearance of Dates and date products used in food manufacturing

4-1 Use date as a date syrup:

The primary product made from dates is date syrup as illustrated (Fig3/E), which is one of the first methods used to make sweeteners. It is used in chocolate, ice cream, honey, jams, marmalades, concentrated drinks, and other culinary items in the food business. Because of their high phenolic component concentration, date palm syrups have good antioxidant qualities and are rich in sugar, minerals (potassium, iron, magnesium, and calcium), and vitamins (thiamine B1, riboflavin B2,

nicotinic acid, pro-vitamin A, and C). Furthermore, date syrup contains a lot of unsaturated fatty acids, such as linolenic, palmitoleic, oleic, and linoleic acids. (Castro-Muñoz et al., 2022).

Date syrup: this by-product of dates is made by extracting the date juice hot (60 °C) in water and then vacuum-evaporating the resulting extract. Date syrup is a component of many baked goods, ice creams, jams, drinks, and other foods. [39]. When making different sweets, this substance is also used as a sweetener in place of sugar. (Manickvasagan, et al., 2018; Lajnef, et al., 2021) and beer without alcohol (Ghafari, 2013). Additionally, it is added to yogurt and prebiotic milk to enhance their organoleptic qualities. (Kazemalilou, et al., 2017; El-Nagga, et al., 2012). Additionally, date syrup may be utilized as a source of carbon for bacteria in a variety of fermentation processes that result in the production of unicellular proteins, alcohol, date wine, antibiotics, organic acids, and baking yeast. (Oladzad, et al., 2021).

4-2 Use date paste as a sugar substitute in dairy products:

(Amerinasab et al. 2015) using date palm liquid sugar as a sugar replacement in dairy products at varying amounts (1–9%). According to the findings, yogurts with a 6% content had the ideal pH, color, and total titratable acidity. In addition, these yogurts had a high viscosity and hardness, decreased syneresis, and received the top ratings for texture, taste, scent, and general acceptance. These yogurts also shown notable increases in phenolic content and antioxidant activity.

(Abdollahzadeh et al. 2018) used various combinations of date extracts at concentrations of 4%, 8%, and 12% to improve the nutritional makeup of a probiotic fermented milk product with a date taste. Antioxidant activity increased proportionately, according to the research. Furthermore, for the course of the product's shelf life, the probiotic content—specifically, *Lactobacillus acidophilus*—consistently surpassed 6 log₁₀ units. Date palm extract is a promising option for enhancing the nutritional profile of probiotic dairy products, according to the authors' conclusion.

Date syrup has been used into yogurt by several writers as a natural and nourishing addition illustrated in (Fig3/E). (Moustafa, et al., 2016; Jafarpour et al., 2017; Abdel-Ghany et al., 2018), Additionally, a fermented milk beverage . (Tawfek, et al., 2021), to create flavoured milk beverages that are healthier and more nutrient-dense while reducing the amount of added sugar (Djaoud et al., 2020). It was determined that using date by-products (energy dates or syrup) in place of sugar may be a novel way to replace dairy products. The findings indicated that date syrup-based dairy products

had the highest reducing power, DPPH inhibition, and overall phenolic content, followed by mixed dairy products.

4-3 Use date paste as a sugar substitute in chocolate:

In order to replace sugar in chocolate goods, dates were investigated as a natural sweetener. To enhance the flavor, fragrance, health, and physicochemical qualities of chocolate goods, the authors substituted date syrup or powder for sugar, either by itself or in conjunction with other sweeteners. (Ibrahim, et al., 2020; Munoz-Tebar, et al., 2023; Erukainure et al., 2010). Date syrup, a natural sweetener, and inulin, a prebiotic, were used to transform sweet prebiotic chocolate milk (unfermented dairy milk) into optimum prebiotic chocolate milk. (Kazemalilou et al., 2017). Furthermore, chocolate made with 4% date palm powder had far better flavor, fragrance, texture, and bioactive ingredients (dietary fibre and phenolic content). Date palm can also be utilized as a healthier alternative to cocoa powder in chocolate manufacture. (Tlay et al., 2023).

4-4 Use date paste as auger substitute in Biscuits production:

Research has focused on reformulation techniques meant to lower or substitute the amount of sugar in baked goods with low moisture content, including biscuits. (Aljutaily et al., 2022). showed figure 3/C that in obese albino rats, biscuits supplemented with 5%, 10%, and 15% date fibre (Fig3/C) indicated effective anti-obesity effects. This implies that the fruit of the date palm may have a biological impact on the regulation of body weight in this specific animal group. Date syrup's thermal characteristics have been reported to be comparable to those of sucrose. (Woodbury et al., 2021).

Other research has concentrated on adding flour and date powder illustrated in (Fig3/F). (Amin, et al., 2019; Agu et al., 2020; Panhwar et al., 2022; Dhankhar et al., 2019). in the manufacturing of biscuits, leading to improved nutritional value. There is a restriction, though, since a replacement threshold of 10% to 20% is advised to prevent negative impacts on physical attributes and sensory analysis. To provide a new culinary use for these fruits, other palm types, such *P. canariensis*, have also been researched in the biscuit industry. By substituting date powders for wheat flour or sugar, these authors were able to create innovative biscuits with increased fibre and polyphenolic content. (Turki et al., 2020).

4-5 Use date paste as a sugar substitute in cookies:

One of the most well-known fast snack items is cookies (Farheena et al. 2015). (Olaoye et al.; 2007). characterized cookies as healthy treats made from

unappetizing dough that is heated in an oven to create a delicious outcome. Baked goods have many attractive characteristics such as high consumption, long and convenient shelf life, and serving as carriers of important nutrients (Ajibola et al.; 2015). While milk, salt, aerating agent, emulsifier, taste, and color can be added, the primary components of cookies are wheat flour, oil (margarine), sugar, and water. To satisfy certain dietary or medicinal requirements of customers, they can also be enhanced or fortified with additional components. (Ajibola et al.; 2015).

Date fruits are high-energy foods because they contain over 70% sugar, namely glucose and fructose (Dada et al.;2012), date fruit is rich in fibre (Hamza et al.; 2014), rich in lutein, zeaxanthin, and beta-carotene, which are antioxidant flavonoids. Along with being a moderate amount of vitamins A and B2, they are also a great source of iron, calcium, copper, magnesium, and potassium (Dada et al.; 2012; Farheena et al.; 2015).

Therefore, cookies made with date palm fruit as a sugar substitute would be a great functional food with high nutritional content in addition to being the perfect snack or meal for diabetics and other patients with metabolic conditions. (Hamza et al.; 2014).

The study's findings (Farheena et al., 2020). Table 3 lists the average results for each sample. Since dates are foods with intermediate moisture content, the proximate chemical analysis of the fortified date cookies from the table indicates that the rise in moisture content in the cookies may be caused by an increase in date paste. The percentage of fat increases somewhat from 5.06% in T0 to 6.27% in T3 (80:20). Due to the inclusion of shortening, milk powder, and more date paste, the fat level has increased. Protein levels in T3 (80:20) rise somewhat from 8.68% in T0 (control) to 9.62%. The rise in crude fiber and ash content from the table indicates that dates are high in fiber and minerals. The crude fibre increases from 1.23% in T0 to 2.27% in T3 and the ash content increases from 0.34% in T0 to

0.74% in T3. However, it is concluded from the table that carbohydrate content decreases with increase in date paste. The calorific value also decreases from 384.85kcal/100g in T0 to 377.86 kcal/100g in T3.

4-6 Use date as a sugar substitute in sweet bread production:

In order to increase the bread's nutritional content, a number of studies have examined the benefits of using date products in place of sugar. (Nwanekezi et al., 2015; Shinde, et al., 2019). According to these research, using date flour or paste in bread making can improve the flavor and color of the crust by approaching the functional qualities of sugar. Additionally, this change improves the bread's nutritional profile by increasing its mineral and dietary fibre content. The use of dates' fibre and bioactive substances improves nutritional qualities by reducing losses during baking. (Shinde, et al., 2019).

4-7 Use date as a sugar substitute in jelly candy:

Gelatin is one of the most common food ingredients and is widely used in the food industry and gelatin gel candies. Jelly candies made from fruits and vegetables have a higher nutritional value than commercial products made solely from chemical additives: Color, flavor, aroma and texture for five different types (lemon jelly candy, mint, Hindi dates, hibiscus and chocolate covered dates), The results of sensory evaluation of jelly candies in terms of qualities such as overall acceptability showed, that all jelly candies had significant mean values for color and flavor, texture and acceptability when stored at room temperature for three months, except dates and chocolate jelly candies which showed significant differences in texture compared to other types. No significant differences were found. The overall flavor rating by the arbitrator ranged from very palatable to very palatable in all species. (Mona, et al.,2022).

Table 3. Proximate composition of cookies fortified with dates paste (%), (Iftikhar et al.,2020)

Treatment level (WF:DP)	Moisture	Fat	Protein	Crude Fibre	Ash	Carbohydrates	Calorific value (Kcal/100g)
Control (T0)	8.32±0.15	5.06±0.20	8.66±0.15	1.23±0.09	0.34±0.12	75.92±0.18	384.85±0.12
90:10 (T1)	9.79±0.05	6.11±0.21	9.11±0.10	2.02±0.10	0.35±0.10	72.53±0.15	382.31±0.18
85:15 (T2)	9.78±0.23	6.20±0.14	9.31±0.14	2.14±0.13	0.69±0.20	71.61±0.17	381.31±0.11
80:20 (T3)	10.34±0.12	6.27±0.10	9.62±0.12	2.27±0.11	0.74±0.09	70.77±0.12	377.86±0.16

Values are means ± (SD), n = 3, WF: wheat flour, DP: Date paste

The use of date paste as a sugar substitute in a range of foods, such as jellies and other confections, has been the subject of several investigations. Date paste's high dietary fibre, natural sugar, vitamin, and mineral content makes it a nutritious substitute for refined sugar. In particular, its use in jellies and other confections can lower the glycaemic index while increasing nutritional value. For example, studies have shown that replacing sugar with date paste in jelly-type products maintains the desired texture and sensory properties. The paste not only adds sweetness, but also provides natural antioxidants and bioactive compounds that improve the nutritional quality of confectionery products. (Sayas-Barberá et al., 2024).

Juice can be extracted from the wet date paste, which can be successfully used in the jelly industry. The sensory evaluation's findings demonstrated that the arbitration panel approved and was pleased with the date items' excellent quality. The recognition of these products by the arbitration panel opened up a wide range of opportunities for the utilization of surplus dates. In particular, the introduction of dates in the production of new products will contribute to solving the problem of avoiding the consumption of dates and restoring the prestigious status of dates (Yousif, et al., 1987).

Studies have shown that replacing sugar with a natural sweetener such as date paste in jelly formulations can reduce calories while maintaining the desired texture and flavor. Experiments with fruit-based jellies have also shown that the addition of date paste maintains product stability during storage (Rivero et al., 2023) (Sayas-Barberá et al., 2024).

4-8 Use date as a sugar substitute in jam product:

Making jam using date paste is a great approach to improve the finished product's nutritional value and usefulness. Dates are a perfect food addition since they are high in vitamins, minerals including potassium and magnesium, dietary fibre, and carbs. Studies show that date paste can act as a natural sweetener instead of sugar in jam making, increasing the nutritional value of the product and improving its sensory properties such as flavor and texture. (Habiba & Mehaia 2008).

This application not only increases the nutritional value of the jam, but also reduces the loss of excess dates during harvesting and storage. (Bhople et al. 2019).

The study showed that jams that combine dates with apples and oranges produce a nutritious and edible safe product. This finding lessens the post-harvest waste of excess fruit and opens the door for the usage of dates in the creation of a variety of culinary items. (Makanjuola, & Alokun, 2019).

The study concentrated on turning a number of significant date varieties cultivated in the United Arab

Emirates into jams and sauces. The goal of the study was to increase the nutritional content of various goods by substituting date paste for sugar. The findings demonstrated that adding date paste to jams enhanced their flavor and nutritional content while maintaining product quality over time. (Al-Hooti et al. 1997).

This study aimed to increase the nutritional content of jam by utilizing firm dates. The findings demonstrated that using date paste in place of sugar enhanced the jam's flavor and texture as well as its nutritional value because of its high dietary fibre and mineral content. The study concluded that date jam is a healthy alternative to conventional sugar-sweetened jams. (Besbes et al. 2009).

Another study showed that the use of date paste as a sweetener in jam production increases the nutritional value of jam and improves its stability and quality during storage. (Kulkarni et al. 2010).

In this study, replacing sugar with date paste was investigated to improve the properties of carrot jam. The results showed that date paste was an ideal substitute for sugar in jam production and contributed to the improvement of sensory properties such as color and flavor. In addition, due to its natural composition rich in vitamins and minerals, the nutritional value of the product was improved. (Habiba & Mehaia 2008).

The prepared Barhi date jam (as a reference sample) and the substitution of 25, 50, and 75% of Barhi dates with pureed carrot or pumpkin were examined for sensory assessment, color parameters, rheological characteristics, and nutritional value. Jam samples with 25% Barhi dates: and 75% carrots had the lowest brightness (34.86) and maximum yellowness (51.71). Additionally, the panelists' findings indicated that the jam made with 25% Barhi date and 75% carrot had the highest overall acceptance (35.7), followed by jam made with 50% Barhi date and 50% pumpkin (33.9). The calorie counts of the Barhi date jam samples with pureed carrot and pumpkin ranged from 379.17 kcal for the control jam sample to 398.87 kcal for the jam sample with 50% Barhi date and 50% pumpkin. Barhi date 25%: pumpkin 75% and Barhi date 50%: carrot 25%: pumpkin 25%, respectively, showed a substantial ($P \leq 0.05$) increase in potassium content (101.36 ppm) in the control sample, followed by 95.00 and 86.98 ppm. The jam sample made with Barhi date 50%: carrot 25%: pumpkin 25% had a substantial ($P \leq 0.05$) increase in calcium content (14.25 ppm), followed by 11.68 ppm from Barhi date 50%: carrot 50%. The flow behavior index of all produced date jams was less than unity, suggesting a non-Newtonian behavior of the samples with a pseudo-plastic type. Additionally, the relationship between shear stress (τ) and shear rate ($\dot{\gamma}$) for all date jam samples was nonlinear. The plastic viscosity value of the jam made from Barhi date

25%:carrot 75% was greater at 58.43 (Pa.s.) than the jam made from Barhi date 50%:carrot 50% at 20°C. This was followed by 49.04 (Pa.s.). When compared to control date jam and other treatments, the jam sample made from Barhi date 25%:carrot 75% had the greatest apparent viscosity, followed by Barhi date 50%:carrot 50%. Lastly, our findings showed that the best sample in terms of color, texture, viscosity, and sensory acceptability was jam made from Barhi dates 25%:carrots 75%. This was followed by jam made from Barhi dates 50%:pumpkin 50%. (Gadallah et al., 2015).

4-9 Use date as a sugar substitute in different products:

By creating goods like date paste, date syrup, honey, jams, and vinegars that satisfy customer demands, date processors have established a solid reputation. Dates' pectin, fiber, and syrup are used as gelling agents and food thickeners in processed foods such yogurt, jams, table jellies, confections, and soft cheese. Numerous investigations on the extraction of date juice and the processing of date syrup have been carried out due to the notable advantages of this unique fruit.

The general process of making date paste involves steaming, cleaning and macerating dates to produce a semi-solid paste having a water activity of less than 0.6 and a moisture content of around 20–23%. Date paste is frequently used as a component in confections and as a sugar replacement in various culinary compositions. (Aljaloud et al., 2020).

Adding fresh date paste to some meat products can reduce oxidation of fats and coloring during storage. Date paste may also be used to make value-added goods like date jam and date candy because of its high sugar content. Date paste enhances the dough's rheological qualities in baked goods, extending their shelf life and lowering spoilage. (Najjar et al., 2020).

Along with minerals like potassium and magnesium, date paste also includes important vitamins and minerals including vitamin A and B vitamins. (Almuhanna et al., 2021).

Recent studies have shown the possibility of using date paste as a sugar substitute in muffins, fruit bars, jams, bread and yogurts. (Tassoult et al., 2021).

Table 4. a collection of research on the primary findings of using date products as sweeteners in food processing

Products	Concentration Used	Main Results	References
Yoghurt	6.0, 8.0 and 10%	Increased ash, solids, and acidity reduced overall bacterial count, pH, lipid, and lactobacilli; 8% was the ideal additive level.	(Mustafa et al., 2016)
Flavored drinking yoghurt	5 and 10%	Increased acidity Enhanced viscosity Acceptable sensory attributes.	(Jafarpour et al., 2017)
Dairy dessert	14% of date syrup and 2% of date powder	increased the antioxidant activity, lipids, dry matter, and total phenolic.	(Djaoud et al., 2020)
Chocolate	17.94, 19.86 and 25.16%	enhanced the product's flavor and taste	(Erukainure et al, 2010)
Biscuits	10, 20, 30, 40, 50, and 60%	Reduce the hardness, Reduced fracturability Cookies that are darker.	(Woodbury et al.,2021)
Fortified bread	15, 25, 35%	enhanced bread's nutritional makeup, stability in storage, and physical and sensory qualities.	(Shinde et al., 2019)
Original beer (nonalcohol)	25, 50, 75 and 100%	The 50% date syrup sample is still deemed acceptable since its physical properties have improved.	(Ghafari et al., 2013)
Biscuits and Dough	Sucrose was replaced at 0, 20, 40, 60, 80 and 100%	Dough with higher pH, cohesiveness, and lower softness and adhesiveness Higher ash, moisture, density, antioxidant, mineral content, texture, and deeper color in biscuits, together with a lower pH	(Majzoobi et al.,2019)

5. The role and function of sugar in improving the characteristics and quality of food:

Scientific studies on the role of sucrose in enhancing the sensory properties of foods have primarily focused on its importance in flavor enhancement, texture, and overall palatability. Sucrose significantly contributes to flavor development and odor stabilization in various products, particularly confectionery and chocolate.

For instance, it aids in odor retention and flavor enhancement by balancing sweetness. When combined with acids like citric acid, sucrose notably enhances sensory responses by creating a balance between sweet and sour flavors. (Risch,1991), (Higginbotham,1991).

Moreover, sucrose improves the texture of products such as chocolate and desserts, providing the desired sweetness, cohesiveness, and overall sensory quality of the final product. (Mao et al.,2022).

Sucrose also contributes a characteristic brown color to foods through reactions like the Maillard reaction during cooking, which significantly influences the color and flavor of baked goods and desserts. This reaction is crucial during the thermal processing of foods. Glucose and fructose, derived from the hydrolysis of sucrose, are key carbohydrate components involved in the sugar-amine reaction that defines the aroma and flavor of heat-treated products. The compounds generated during Maillard reactions are responsible for the unique aroma and flavor profiles in foods of plant, animal, and microbial origin. Various conditions—such as the presence of sugars, amino acids, and different pH levels—favor these Maillard processes. Additionally, different thermal treatments like baking, frying, boiling, and drying induce these reactions with varying intensities. (özelcik & yilmaz, 2023).

CONCLUSION

With the prevalence of high-sugar food products that lack nutritional value, the idea of using Khalas paste as a natural alternative to refined sugars is increasingly relevant. Incorporating Khalas paste into food products represents an important step toward enhancing dietary quality. This date paste is highly nutritious, containing essential vitamins and minerals that support overall health. Additionally, It is a great option for diabetics and others trying to control their weight because of its high fiber content, which also supports digestive health and aids in blood sugar regulation.

Khalas paste provides natural sweetness and a delightful flavor, making it suitable for a variety of recipes, including candies, beverages, and main dishes. Furthermore, dates are rich in antioxidants that bolster public health and aid in fighting infections.

By reducing reliance on refined sugars, Khalas paste can promote healthier dietary habits. Encouraging its use in the food industry could improve public health outcomes and lower the risk of chronic diseases linked to excessive sugar consumption. In summary, Khalas paste is a sustainable and nutritious option that supports health and encourages healthy eating.

RECOMMENDATIONS

- 1) Development of nutrition techniques and production of new types of food supported by dates.
- 2) Study the impact of using date paste on public health, such as its effect on blood sugar levels and the nutritional content of the final products.
- 3) To increase the use of date paste in the food sector and bolster the local economy, cooperation with regional date growers is encouraged.
- 4) Supporting manufacturing sustainability by using dates as an alternative to sugar can support sustainable manufacturing practices. Because dates are often regarded as a local and natural source in many areas, date paste can be used to reduce the environmental impact associated with sugar production and refining.
- 5) We recommend encouraging investment in the production and processing of date paste locally, especially in countries that produce dates in large quantities. This will enhance the economic value of dates and reduce dependence on imported sugar
- 6) More research and innovation in the food industry should be directed to Date paste is used in a variety of goods, including sweets, bread, and beverages. Dates paste can be used to improve the characteristics of sensory products, such as flavor and texture, especially in food destined for children and health-conscious consumers.
- 7) Despite the apparent advantages, more extensive clinical research is still required to evaluate the long-term health effects of date-paste use in comparison to refined sugar, especially concerning glucose and weight control.

Conflicts of interest

The authors declare no conflicts of interest.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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الملخص العربي

فوائد منتجات تمر الخلاص (*Phoenix dactylifera* L.) كبديل طبيعي للسكر والمحليات في تصنيع الأغذية

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معجون التمر، الذي يحتوي على السكريات الطبيعية والألياف والمركبات الفينولية والفيتامينات الأساسية، داعماً لصحة الجهاز الهضمي، وتنظيم مستويات السكر في الدم، وصحة القلب. كما أن استخدام معجون التمر كمحلي طبيعي يقلل من استهلاك السكر المكرر ويقدم بديلاً مغذياً ولذيذاً مناسباً لمجموعة متنوعة من الوصفات، مما يعزز النكهة والقيمة الغذائية معاً.

لذا تهدف هذه الدراسة إلى دعم استخدام معجون التمر كمحلٍ طبيعي وبديل للسكر في مختلف المنتجات الغذائية، بهدف تحسين القيمة الغذائية وقبول المستهلك مقارنة بالمنتجات المصنوعة من السكر والمحليات الاصطناعية.

الكلمات المفتاحية: معجون التمر، دبس التمر، القيمة الغذائية، بديل السكر، الأغذية منخفضة السكر

أدى التقدم في علوم الأغذية إلى تطوير منتجات غذائية عالية القيمة عبر تعزيز القيمة الغذائية بإضافة مكونات غنية بالعناصر المغذية، مما يدعم توجه إضافة المواد النباتية ذات القيمة الغذائية العالية، مثل التمور. تعد التمور من أقدم المحاصيل وتكتسب أهمية ثقافية واقتصادية كبيرة في الشرق الأوسط، خاصة في المملكة العربية السعودية، التي تحتل المرتبة الثانية عالمياً في إنتاج التمور بأكثر من 300 نوع وحصاد سنوي يبلغ 1.6 مليون طن. وقد حققت المملكة تقدماً ملحوظاً في إنتاج التمور، مما جعلها تصدر قائمة الدول المصدرة منذ عام 2021، حيث تشكل الصناعات الغذائية 24% من صادرات المملكة.

تحتوي التمور على نسبة عالية من السكريات، والألياف، والمعادن، والفيتامينات، ومضادات الأكسدة، مما يمنحها فوائد صحية متعددة، بما في ذلك الحماية من الأمراض. ويعد