processes

MDPI

Article

The Effect of Sugar Replacement with Different Proportions of Khalas Date Powder and Molasses on the Nutritional and Sensory Properties of Kleicha

Raya S. A. Almuziree and Raghad M. Alhomaid *

Department of Food Science and Human Nutation, College of Agriculture and Veterinary Medicine, Qassim University, Buraydah 51425, Saudi Arabia; 421200156@qu.edu.sa
* Correspondence: r.alhomaid@qu.edu.sa

Abstract: Evidence from the scientific community suggests that high levels of added sugar consumption contribute to the global epidemics of glucose intolerance, diabetes, and cardiovascular disease. The study aims to develop a local traditional food product (Kleicha) with healthy ingredients and to take advantage of the most productive crops in Saudi Arabia, namely dates, where Khalas date powder and molasses will be manufactured as an alternative to sugar in the Kleicha product. Six Kleicha samples with different fillings were manufactured as follows: Kleicha filled with sugar filling (KS), Kleicha with Khalas date powder filling (KD), Kleicha filled with Khalas date molasses filling (KM), Kleicha filled with sugar and Khalas date powder (1:1) filling (KSD), Kleicha filled with sugar and Khalas date molasses (1:1) filling (KSM), and Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling (KDM). In order to evaluate the prepared Kleicha samples, the proximate chemical composition, mineral content, phytochemical content and their antioxidant activities, sugar profiles using HPLC, in vitro glycemic index, glycemic load, and sensory evaluation were investigated. The results indicated that KM had the highest moisture content, while the KS sample had the lowest content. KD and KM had significantly higher ash contents compared with the other Kleicha samples. The protein and fat contents did not differ significantly. KD, KSD, and KDM demonstrated a significantly higher dietary fiber content than the other Kleicha samples. KS had the highest value of available carbohydrates. Regarding mineral content, the KDM sample had the highest K, Na, Ca, and P contents, while KD and KM had the highest Mg, Fe, and Mn contents. The Cu content indicated that KM had the highest content, representing a 25% increase compared with KS. Similarly, the Zn content in KM and KSD was significantly higher than in the other Kleicha samples. Replacing sucrose with Khalas date or molasses significantly changed the sucrose, glucose, and fructose contents. The phenolic content in KD, KM, and KDM was higher compared with KS, KSM, and KSD. Furthermore, the oxidative activity increased associatively with the addition of Khalas date powder and molasses. The percentage of sucrose decreased in KD and KDM. There was no significant difference in the general acceptance rate between the control sample and the other samples containing Khalas date powder, Khalas date molasses, and sugar or their mixture. In conclusion, it is possible to replace the sugar in the filling of the Kleicha with Khalas date powder and molasses or their mixture as it increases the health benefits; scaling up is recommended.

Keywords: Kleicha; dates; Khalas date powder; Khalas date molasses; sugar substitution; nutrition

check for updates

Citation: Almuziree, R.S.A.; Alhomaid, R.M. The Effect of Sugar Replacement with Different Proportions of Khalas Date Powder and Molasses on the Nutritional and Sensory Properties of Kleicha. *Processes* **2023**, *11*, 3077. https://doi.org/10.3390/pr11113077

Academic Editors: Elwira Sieniawska, Shengbao Cai, Yongliang Zhuang, Zhipeng Yu and Hu Hou

Received: 7 October 2023
Revised: 21 October 2023
Accepted: 24 October 2023
Published: 26 October 2023

Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Dates are rich in certain nutrients and are widely consumed in many countries, particularly in the Arab countries. Date palm is the highest fruit that contains sugars, and these ingredients vary according to the nature of the fruit, while dates are a concentrated source of sugar [1]. It is easily absorbed by the body and quickly reaches the blood and tissues. They are considered to have a lower glycemic load than other refined sugars. Dates are

a rich source of multiple vitamins, minerals, polyphenols [2], and fiber [3]. The date fruit industry in Saudi Arabia is the largest in the world.

Date fruit (*P. dactylifera*) is one of the most important crops. It has been cultivated primarily for cultural, nutritional, environmental, religious, and social development purposes [4,5]. Dates can be found in numerous varieties, which differ from each other based on shape and organoleptic properties [4,6–8]. Date sugar, a by-product of date fruit processing, has the potential to replace white sugar in some recipes. Nutritionally, 100 g of cane sugar has 387 kcal of energy, 0 g of fiber, 0.05 mg of iron, 2 mg of potassium, 0.01 mg of zinc, and 0.007 mg of copper. On the other hand, 100 g of dates contains 282 calories, 8 g of fiber, 1.02 mg of iron, 656 mg of potassium, 0.29 mg of zinc, and 0.206 mg of copper [1,9]. As an alternative to sugar cane, date sugar may be used as a sweetener and would supply more than simply calories because of its high nutrient content and possible health benefits. Date fruit mainly comprises carbohydrates, ranging from 40 to more than 80% based on dry weight, depending on the cultivated variety. The evaluated sugars in dates, such as glucose, fructose, and sucrose, were found to vary in amounts, ranging from 2 to 95%, depending on the dates' variety; the highest glucose content of 95.4% was found in the Khalas variety. Date fruit is considered to be a rich source of dietary fiber, ranging from 2 to 8%; the highest fiber content of 8% was found in the Deglet-Noor variety, mostly cultivated in Algerian and Tunisia. The well-known Moroccan date variety Medjool also contains a high amount of fiber, reaching 6.7%. In comparison, the lowest amount of 2.7% was found in the Lulu variety from the United Arab Emirates [10]. Median amounts of fiber of 4.35% were found in Sukkari dates cultivated from Saudi Arabia [11]. Dates' dietary fiber consists of good quality fiber fractions such as β-glucans, arabinoxylans, and cellulose, providing an excellent source of dietary fiber, even better than that of cereals [8]. Dates contain extremely low amounts of fat and protein [7,12,13]. Dates are considered a relatively good source of different vitamins, mainly B complex: thiamine, riboflavin, and niacin [10]. Other studies have reported a relatively high content of tocopherols based on fresh weight for α-, β-, and γ-tocopherol [14]. Some date varieties may also contain vitamin C in relative amounts but higher than that found in dried fruits such as apricots, figs, and raisins [7,13]. Minerals such as potassium, calcium, and magnesium are found in relatively high amounts in dates, ranging from 0.05–0.9%. The highest element found in dates is mostly potassium, followed by calcium, iron, phosphorus, sodium, and copper [5,12]. The high potassium and low sodium content in dates provide an excellent product for hypertensive individuals [15]. Several detected phenolic compounds were found in various date varieties [16], representing date fruits as rich sources of polyphenols. Such a high and wide variety of phenolic compounds can play a major role in elevating the antioxidant potential by inhibiting lipid peroxidation and evaluating antioxidant activities [17]. Dates also contain carotenoids and phytosterols, which are reported to have a strong antioxidant capacity [8]. Dates' bioactive components have been demonstrated to promote several health-beneficial effects. Incorporating other nutritive ingredients besides dates can provide intensive boosters to dates' functional properties [1,18].

Khalas dates are considered one of the best dates in the Al Qassim region and one of the excellent commercial varieties desired in the markets as they retain their good flavor when stored for a long time. It is a great source of carbohydrates, dietary fiber, and important minerals [19], and the high sources of antioxidants help protect the body against harm from harmful free radicals [20]. In addition, it is common in Middle Eastern cooking and can be eaten fresh or dried. Date powder is a raw product of dates that varies according to the type and quality of dates. Dates were dried and ground only and not separated from all their properties and nutritional benefits due to their soluble sugars, fiber, polyphenols, vitamins, and mineral content [1,18]. Today, it could provide a healthier substitute for white sugar and other artificial sweeteners [1]. It is also added to many products, foods, and sweets because of its benefits, as it is used as an alternative to sugar in many food industries [18,21,22]. Date powder helps lower blood cholesterol; prevent atherosclerosis, cancer of the large intestine, and hemorrhoids; reduce the formation of

gallstones; and facilitate pregnancy, childbirth, and puerperium because it contains good fiber and fast-digesting sugar [23–25]. Date molasses is a dark brown drink of thick texture, tastes very sweet, and is extracted from the fruits of dates. The methods of making molasses are as follows: The extraction process either occurs warmly or without heat, producing molasses. But, for each method, a different molasses quality in color grade is obtained; the cold method produces yellowish-red molasses (golden), and the hot method results in a dark brown color [26].

Traditional foods in Saudi Arabia are integral to the country's culture and heritage. These foods have been passed down from generation to generation and reflect the region's unique history, geography, and climate. One is the traditional sweet (Kleicha), which contains flour dough with sugar and fat, and is filled with sugar. It is a local product high in calories and added sugar. According to the traditional method, a cup of wheat flour, white flour, two tablespoons of powdered milk, two tablespoons of sugar, half a cup of olive oil, and a cup of warm water re mixed to form a dough. The dough is filled with a cup of fine sugar; a tablespoon of ground black lemon; a pinch of salt; and a teaspoon of cardamom, cinnamon, and ginger. Then, the surface of the Kleicha is brushed with whipped eggs with milk mix. Khalas date powder and molasses could be used as a substitute for their great health benefits. The idea came to replace the processed sugar used in manufacturing Kleicha with natural sweeteners to protect the consumer and the national economy. The effect of the replacement process according to different proportions and its impact on nutritional and sensory specifications will be studied in this study.

2. Materials and Methods

2.1. Ingredients

Khalas date fruits, date molasses, brown wheat flour, white flour, olive oil, powdered milk, and sugar were obtained from the date market in Buriydah City, Qassim region, SA. Date fruits were dried with a multi-functional dryer (Didactaitalia, cod 947227, Torino, Italy) for 3 days at a temperature of 50 °C. Then, in the labs of the Food Science and Human Nutrition, College of Agriculture and Veterinary Medicine, Qassim University, dried dates were ground with a powerful grinder (Santos, VITA-MAX CORP-Light Industrial Food Preparing Machine Model, VM0122E, St Joseph, MO, USA) to obtain homogenous Khalas date powder.

2.2. Formulation of Different Fillings of Kleicha

The flavoring spices and condiments added to all of the samples were tested and fixed: ground black lemon, ground cinnamon, ginger, ground cardamom, and citric acids. These spices were mixed in the portion of 24.5, 24.5, 24.5, 24.5, and 2 g to create a 100 g mix, respectively. Then, 50 g was added to each 1 kg of the filling mix, and the Kleicha samples were prepared as follows: Kleicha filled with flavored sucrose (KS) with prepared flavoring spices and condiments (1 kg mixed with 50 g); Kleicha filled with flavored Khalas date (KD) at the same flavoring portion; Kleicha filled with flavored Khalas date molasses (KM); Kleicha filled with a mix of flavored sucrose and Khalas date (1:1, *w:w*) (KSD); Kleicha filled with a mix of flavored sucrose and Khalas date molasses (1:1, *w:w*) (KSM); and Kleicha filled with a mix of flavored Khalas dates and Khalas date molasses (1:1, *w:w*) (KDM).

2.3. Manufacturing of Kleicha

The Kleicha was manufactured in the College of Agriculture and Veterinary Medicine factories on Saturday, 21 January 2023. The ingredients were prepared, then the dry materials were kneaded (5 kg of white flour, 5 kg of wheat flour, 400 g of sugar, 400 g of powdered milk, 30 g of salt, 90 g of cardamoms, and 90 g of ginger) with the fatty substance (2.5 L of virgin olive oil) for 15 min, and then approximately 5 L of water was gradually added until the desired consistency and texture were reached. The kneading process was carried out in a spiral arm kneader (Gam 16—Kneading dough machine, Thermotechnika Crown Cool, Bratislava, Slovakia). The dough was left for half an hour

before shaping. The Kleicha samples were standardized at 50 g dough and then filled with 10 g of different filling mixtures. Then, the Kleicha ball dough was topically stamped with the traditional shape of the Kleicha. Then, the surface of the prepared Kleicha was brushed with approximately 5 g of whipped eggs with milk mix (8:2, *w:w*). The Kleicha was left for 10 min before baking; then, it was baked in a rotating oven at a temperature of 190 °C for 30 min. Then, the Kleicha was taken out and left to cool down before packaging.

2.4. Proximate Chemical Composition and Minerals of Kleicha

The formulated Kleicha were subjected to chemical analysis (moisture, ash, dietary fibers, and available carbohydrates) according to established methods [27]. The content of minerals, including sodium and potassium, was determined using flame photometry. In contrast, the calcium, magnesium, iron, copper, manganese, and zinc contents were analyzed using atomic absorption spectroscopy using the protocol of A.O.A.C. [27]. According to the description of Borah et al. [28], phosphorus was measured using a conventional colorimetric technique.

2.5. Phytochemicals Analysis of Kleicha

The TPC in the Kleicha samples was determined using the Folin–Ciocalteu reagent, according to Nsimba et al. [29], with slight modifications. Next, a microplate reader was used to determine the absorbance at 765 nm (BioTek, Winooski, VT, USA). Gallic acid (GA) solution was used to create a standard curve against which the results could be compared. Measurements of TPC were reported in terms of milligrams of gallic acid equivalents (GAE) per 100 g (mg of GAE 100 g^{-1} dw). The TFs content of Kleicha samples using the same extract was determined as Mohdaly et al. [30] described. By reacting the methanolic extract aliquots with sodium acetate (5%), the TFL concentrations in the Kleicha samples were calculated. Optical density (OD) was measured at 440 nm after 150 min with the addition of $AlCl_3$ (2%), as reported by Kumaran and Karunakaran [31]. The TF and TFL contents were then expressed as quercetin equivalents (QE mg) per 100 g dry matter (mg QE 100 g^{-1}). The total carotenoids (TCs) were determined by performing repeated extractions of 1 g of dried sample with a combination of acetone and petroleum ether (1:1, *v:v*), as described by Yuan et al. [32]. The top layer was gathered, rinsed thoroughly with water, and then mixed with the unfiltered extracts. The volume of the solution was calibrated by adding petroleum ether. The amount of TCs was calculated as mg 100 g^{-1} dry weight after the OD was spectrophotometrically measured at 450 nm.

2.6. Antioxidant Capacity Determination

For the purpose of determining the radical scavenging activity, Khalifa et al. [33] used a spectrophotometric method based on the bleaching of DPPH radicals in a purple solution with minor modifications. After that, a microplate reader (BioTek, Winooski, USA) detected absorbance at 517 nm. Trolox was utilized to create a standard curve and draw the Trolox calibration curve using the DPPH radical scavenging activity. The antiradical activity was assessed in µmol TE 100 g^{-1} of Trolox equivalents (TE) against ABTS radicals cation. The customized Lu et al. method of [34] was used to assess the Kleicha samples' radical scavenging ability (RSA). A Trolox calibration curve was plotted as a function of the percentage of the ABTS radical cation scavenging activity. The final results were expressed as micromoles of Trolox equivalents (TE) per 100 g (µmol of TE 100 g^{-1}).

2.7. Sugar Profile by HPLC

The Kleicha samples were prepared and homogenized to obtain homogeneous Kleicha powder, and then appropriately extracted. The sucrose, glucose, and fructose contents in the Kleicha samples were tested following the modified method of AOAC 982.14 using HPLC [35]. In brief, the appropriate crushed Kleicha samples were extracted three times with aqueous ethanolic solution (50%, *v:v*); the volume reached 100 mL, was centrifuged at 5000× *g* for 15 min, and filtered using 0.45 µm filter and injected into the HPLC. An HPLC

system (Agilent Technologies, Palo Alto, CA, USA) equipped with an autosampler and Refractive index detector (RID) was used. The solvent system contained acetonitrile/d.H_2O (80:20, *v*:*v*) as the mobile phase. Then, 20 µL of the prepared sample extract was automatically injected, the flow rate was adjusted at 2 mL min^{-1}, and separation was performed at 30 °C. The areas under the present peaks were calculated, and sugar profile data were presented as a g 100 g^{-1} Kleicha sample.

2.8. In Vitro Glycemic Index of Kleicha

The Kleicha samples were digested according to Englyst et al. [36]. For this, 100 mg of the material was weighed into 50 mL tubes with 10 glass beads (5 mm diameter). The tubes received 2 mL of HCl (0.05 M) with pepsin (5 mg mL^{-1}, The Curated Chemical Collection, Old Dutch Road Victor, NY, USA). The tubes were incubated for 30 min in a shaking water bath at 37 °C. Next, we added 4 mL of sodium acetate buffer (0.5 M, pH 5.2), 1 mL of enzyme solution with 0.104 g pancreatin (Sigma, Steinheim, Germany, P7545), and 14.45 U amyloglucosidase (260 U mL^{-1}, Sigma-Aldrich, Steinheim, Germany) to each tube. In a shaking water bath, the tubes were incubated horizontally at 37 °C. Eppendorf tubes were filled with 100 µL aliquots every 20 min at 0 to 160 min intervals and mixed with 1 mL of 100% ethanol. These solutions were centrifuged at 800× *g* for 10 min and analyzed for glucose content using Glucose liquicolor (GOD-POP) reagent (human, Wiesbaden, Germany) on a microplate reader (BioTek, Winooski, USA) at 510 nm. The hydrolysis index (HI) measured starch digestion, and the predicted glycemic index (GI) measured sample digestibility against white bread. The hydrolysis index (HI) is the ratio of the sample's hydrolysis curve area to the white bread sample's hydrolysis curve. HI was estimated as follows (Equation (1)):

$$\mathrm{HI} = \frac{\text{The area under the curve of the sample}}{\text{The area under the curve of white bread}} \quad (1)$$

The in vitro GI was determined using the following equation (Equation (2)) of Goñi et al. [37]

$$\mathrm{GI} = 39.71 + 0.549\mathrm{HI} \quad (2)$$

$$\text{Glycemic Load (GL)} = \frac{\text{GI} \times \text{Available carbohydrate (g)}}{100} \quad (3)$$

2.9. Sensory Evaluation of Kleicha

A sensory assessment of the samples was carried out by appointing 14 qualified and experienced arbitrators. The sensory assessment was carried out at room temperature of 25 °C, and an evaluation was carried out on numbered dishes containing the samples in terms of appearance, external color, internal color, texture, taste, aroma, and general acceptance using the 7-Hedonic scale method, where 7 indicates strong liking, 4 indicates neutrality, and 1 indicates a low level of liking. The results of the sensory assessment traits are reported according to the method described [38].

2.10. Statistical Analysis

One-way analysis of variance (ANOVA) was used for the statistical analysis, and SPSS version 25 was used to compile the results (IBM Corp., Armonk, NY, USA, Released 2013). Tukey's test was used for multiple comparisons, and the significance threshold was set at 0.05. The data were interpreted as though they came from a fully randomized study. Numbers were shown as means and standard deviations, according to Steel et al. [39].

3. Results

3.1. Proximate Composition of Kleicha

The proximate chemical composition of the manufactured Kleicha samples with different filling mixtures is presented in Table 1. Based on the table, the KM sample had the highest moisture content, measuring 14.18 g 100 g^{-1}, while the KS sample had the lowest moisture content at 8.23 g 100 g^{-1}. The KD and KM samples had significantly higher ash contents, measuring 1.45 g 100 g^{-1} each, compared with the other Kleicha samples filled with sugar/date powder, sugar/date molasses, or a mixture of date powder and date molasses, which had ash contents of 1.3, 1.17, and 1.32 g 100 g^{-1}, respectively. These results indicate that filling Kleicha with Khalas dried dates increased the ash content, as Khalas dried dates contain ash content. Only the KS sample was significantly lower in crud fat than all of the Kleicha samples, with 17.66 g 100 g^{-1}, whereas no significant difference was found among the other samples. The Kleicha sample containing different fillings did not present a significant protein content difference. The findings showed that Kleicha filled with Khalas dried dates, Khalas date molasses, or their mixture presented slightly higher protein content. Furthermore, the KD, KSD, and KDM samples demonstrated a significantly higher dietary fiber content than the other Kleicha samples, with values of 6.22, 6.07, and 6.09 g 100 g^{-1}, respectively. Regarding the available carbohydrate content, the KS sample had the highest value of 57.72 g 100 g^{-1}.

Table 1. Proximate composition of Kleicha filled with different filling mixtures (mean ± SE), n = 3.

Treatment *	Chemical Composition g 100 g^{-1} fw					
	Moisture	Ash	Curd Fat	Crude Protein	Dietary Fiber	Available Carbohydrates
KS	8.23 ± 0.02 ^{e}	1.15 ± 0.01 ^{c}	17.66 ± 0.08 ^{b}	15.25 ± 0.23 ^{ab}	4.97 ± 0.12 ^{bc}	57.72 ± 0.28 ^{a}
KD	9.95 ± 0.14 ^{d}	1.45 ± 0.01 ^{a}	18.24 ± 0.14 ^{a}	15.65 ± 0.15 ^{a}	6.22 ± 0.14 ^{a}	54.72 ± 0.31 ^{b}
KM	14.18 ± 0.25 ^{a}	1.45 ± 0.01 ^{a}	18.27 ± 0.08 ^{a}	14.76 ± 0.23 ^{b}	4.87 ± 0.11 ^{c}	51.36 ± 0.12 ^{d}
KSD	9.51 ± 0.11 ^{d}	1.3 ± 0.02 ^{b}	18.65 ± 0.07 ^{a}	15.24 ± 0.15 ^{ab}	6.07 ± 0.14 ^{a}	55.30 ± 0.20 ^{b}
KSM	11.02 ± 0.06 ^{c}	1.17 ± 0.01 ^{c}	18.66 ± 0.12 ^{a}	15.59 ± 0.11 ^{a}	5.47 ± 0.13 ^{b}	53.56 ± 0.16 ^{c}
KDM	11.6325 ± 0.08 ^{b}	1.32 ± 0.03 ^{b}	18.43 ± 0.20 ^{a}	15.33 ± 0.16 ^{ab}	6.09 ± 0.14 ^{a}	53.29 ± 0.32 ^{c}

* Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling, $^{a–e}$: No significant difference ($p > 0.05$) between any two means within the same column have the same superscripted letters.

3.2. Minerals Content in Kleicha

The mineral content of the manufactured Kleicha samples with different filling mixtures is presented in Table 2. Among the Kleicha samples, the KDM sample had the highest K, Na, Ca, and P contents, measuring 1696.44, 1136.06, 209.24, and 28.78 mg 100 g^{-1}, respectively. Regarding the Mg, Fe, and Mn content, the KD and KM samples had the highest values, measuring 450.81 mg 100 g^{-1} and 450.58 mg 100 g^{-1} for Mg, 12.94 mg 100 g^{-1} and 12.37 mg 100 g^{-1} for Fe, and 10.29 mg 100 g^{-1} and 10.16 mg 100 g^{-1} for Mn. The copper content exhibited significant differences among the samples, with the KM sample having the highest content at 131.97 mg 100 g^{-1}, representing a 25% increase compared with KS (control sample). This confirms that the copper content of Khalas molasses was higher than that of the dates and sugar. Similarly, the Zn content of the KM and KSD samples was significantly higher than that of the other samples, measuring 54.85 mg 100 g^{-1} and 51.14 mg 100 g^{-1}, respectively.

Table 2. The mineral contents of Kleicha filled with different filling mixtures (mean ± SE), $n = 3$.

Treatments *	Minerals Content mg 100 g^{-1}								
	K	**Na**	**Ca**	**P**	**Mg**	**Fe**	**Mn**	**Cu**	**Zn**
KS	1151.33 ± 7.77 ^{d}	905.04 ± 23.45 ^{b}	163.92 ± 3.27 ^{c}	25.61 ± 0.48 ^{bc}	402.87 ± 4.75 ^{c}	9.83 ± 0.22 ^{bc}	8.88 ± 0.27 ^{c}	98.26 ± 0.77 ^{c}	34.31 ± 0.68 ^{b}
KD	1578.37 ± 30.31 ^{b}	948.85 ± 8.33 ^{b}	190.08 ± 4.19 ^{ab}	24.01 ± 0.41 ^{c}	450.81 ± 2.64 ^{a}	12.94 ± 0.9 ^{a}	10.29 ± 0.08 ^{a}	67.91 ± 2.19 ^{e}	33.55 ± 1.12 ^{b}
KM	1598.37 ± 25.89 ^{b}	1014.82 ± 20.95 ^{b}	177.42 ± 5.93 ^{bc}	25.29 ± 1.14 ^{bc}	450.58 ± 8.68 ^{a}	12.37 ± 0.12 ^{a}	10.16 ± 0.1 ^{a}	131.97 ± 1.31 ^{a}	54.85 ± 0.76 ^{a}
KSD	1450.42 ± 12.27 ^{c}	963.88 ± 20.87 ^{ab}	182.43 ± 4.28 ^{bc}	26.06 ± 0.48 ^{abc}	415.64 ± 6.34 ^{bc}	11.49 ± 0.31 ^{ab}	10.04 ± 0.2 ^{ab}	114.87 ± 0.92 ^{b}	51.14 ± 2.76 ^{a}
KSM	1463.58 ± 2.21 ^{c}	1024.86 ± 15.59 ^{ab}	187.59 ± 7.45 ^{ab}	27.6 ± 0.33 ^{ab}	421 ± 4.55 ^{bc}	9.45 ± 0.26 ^{c}	9.49 ± 0.06 ^{bc}	75.22 ± 2.08 ^{d}	36.56 ± 3.52 ^{b}
KDM	1696.44 ± 6.38 ^{a}	1136.06 ± 83.3 ^{a}	209.24 ± 5.85 ^{a}	28.78 ± 1.01 ^{a}	433.47 ± 3.08 ^{ab}	10.24 ± 0.22 ^{bc}	9.85 ± 0.1 ^{ab}	42.67 ± 1.68 ^{f}	21.42 ± 2.4 ^{c}

* Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling, $^{a–f}$: No significant difference ($p > 0.05$) between any two means within the same column have the same superscripted letters.

3.3. Sugar Profile by HPLC

The sucrose content in the Kleicha samples varied (Figure 1), with KS having the highest content at 17.69 g 100 g^{-1}, while the KM, KD, and KDM samples had the lowest. Consequently, the samples containing Khalas date powder and molasses had a lower percentage of sucrose. Regarding the glucose content, the KS, KD, KM, KSD, KSM, and KDM samples contained 1.52, 5.67, 3.62, 3.25, 3.17, and 5.22 g 100 g^{-1}, respectively. Similarly, the fructose content in these samples was 1.7, 6.35, 3.96, 3.57, 3.56, and 5.92 g 100 g^{-1}, respectively. Kleicha filled with Khalas date powder or a mixture of Khalas date powder and molasses showed slightly higher glucose and fructose contents than the other samples. Conversely, the KS sample had the lowest glucose and fructose content.

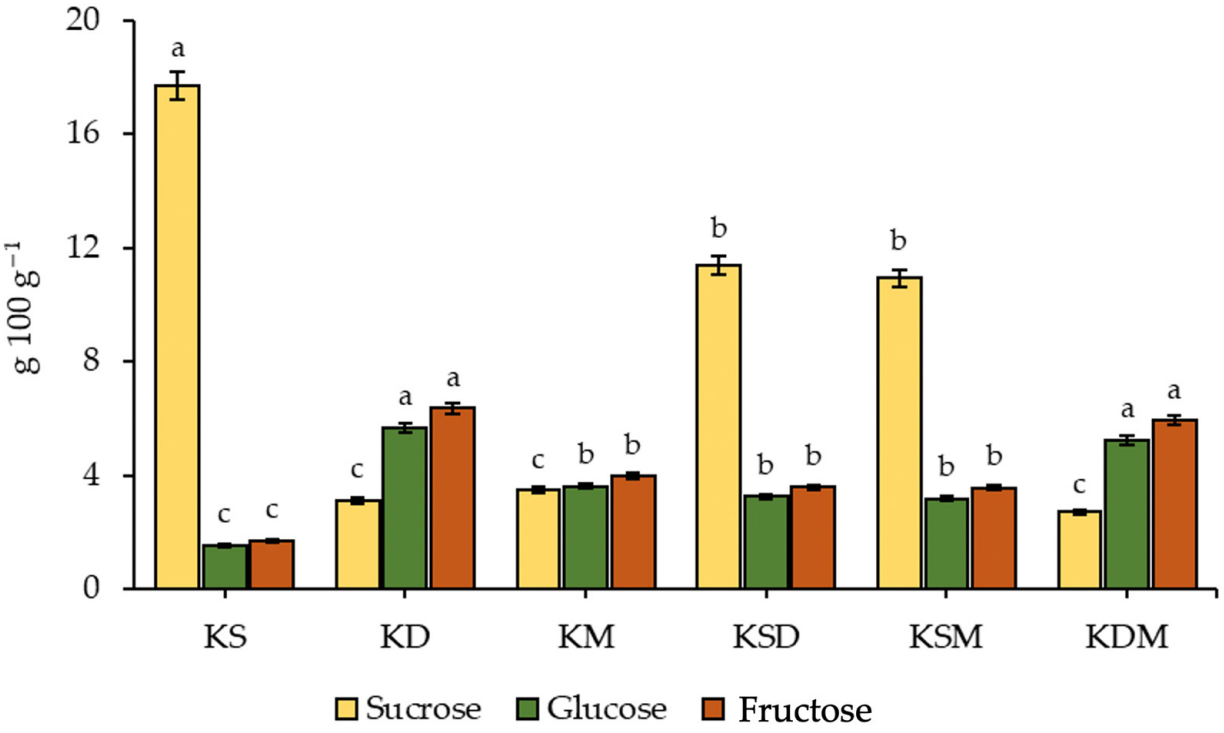

Figure 1. The sugar profile using HPLC of Kleicha filled with different filling mixtures. Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling (mean ± SE), $n = 3$. $^{a–c}$: Bars of each sugar kind that do not share similar letters differ significantly ($p > 0.05$).

3.4. In Vitro Glycemic Index

The results of the in vitro glycemic index (GI) for Kleicha samples are presented in Table 3. The Kleicha sample filled with Khalas date molasses had the highest GI, significantly differing from the other samples, with a value of 40.30. On the other hand, the Kleicha samples filled with a mixture of Khalas date powder and molasses had the lowest GI at 40.15. According to the classification of foods based on GI values, the glycemic index in this study is considered low, as it is less than 55. Furthermore, the glycemic load (GL) was evaluated, and the KS sample had the highest GL at 21.21, while the KM sample had the lowest at 18.73. Foods are classified based on their glycemic load as low (GL $\leq$ 10), medium (GL 11–19), and high (GL $\geq$ 20).

Table 3. Glycemic index and glycemic load of Kleicha filled with different filling mixtures (mean ± SE), *n* = 3.

Treatment *	Glycemic Index	Glycemic Load
KS	40.21 ± 0.01 ^{bc}	21.21 ± 0.01 ^{a}
KD	40.18 ± 0.01 ^{cd}	19.49 ± 0.02 ^{c}
KM	40.30 ± 0.01 ^{a}	18.73 ± 0.01 ^{f}
KSD	40.19 ± 0.01 ^{bc}	19.78 ± 0.01 ^{b}
KSM	40.21 ± 0.02 ^{b}	19.34 ± 0.03 ^{d}
KDM	40.15 ± 0.02 ^{d}	18.95 ± 0.01 ^{e}

* Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling, $^{a–f}$: No significant difference ($p > 0.05$) between any two means within the same column have the same superscripted letters.

3.5. Phytochemicals Analysis of Kleicha

The results of the quantitative analysis of phytochemicals, including the total phenolic compounds (TPC), total flavonoids (TF), total flavonols (TFL), and total catechins (TC), in the Kleicha filled with different filling mixtures are presented in Table 4. Among the samples, the KD sample exhibited the highest concentration of TPC, measuring 1498.66 mg GAE 100 g^{-1}. In contrast, the Kleicha sugar-filled sample showed a significantly lower TPC content. The KD sample exhibited the most significant increase in total flavonoid (TF) content, measuring 340.67 mg QE 100 g^{-1}. Conversely, the KS sample showed a significant decrease in TF, with a 228.28 mg QE 100 g^{-1} content. Regarding the total flavanols (TFL), the KD sample demonstrated a significant increase, reaching 148.05 mg QE 100 g^{-1}, higher than the other samples, except for KDM, which had a TFL content of 134.18 mg QE 100 g^{-1}. In contrast, the KS sample had a significantly lower TFL content of 108.68 mg QE 100 g^{-1}. Similarly, the TC content of Kleicha filled with different mixtures was analyzed, and the KD and KDM samples showed the highest TC levels, measuring 425.66 mg 100 g^{-1} and 405.75 mg 100 g^{-1}, respectively. In contrast, the KS sample had the lowest TC content, with 334.46 mg 100 g^{-1}. Interestingly, there was a significant increase in TPC, TF, TFL, and TC in the KD and KDM samples compared with the Kleicha filled with sugar. Conversely, the Kleicha filled with sugar exhibited the most significant decrease in these phytochemical contents.

Table 4. The phytochemicals analysis of Kleicha filled with different filling mixtures (mean ± SE), n = 3.

Treatment *	Phytochemicals Analysis			
	TPC mg GAE 100 g^{-1}	TF mg QE 100 g^{-1}	TFL mg QE 100 g^{-1}	Carotenoids mg 100 g^{-1}
KS	701.16 ± 29.92 ^{d}	228.28 ± 9.24 $_{e}$	108.68 ± 8.16 ^{c}	334.46 ± 26.64 ^{c}
KD	1498.66 ± 22.52 ^{a}	340.67 ± 3.92 ^{a}	148.05 ± 6.15 ^{a}	425.66 ± 8.77 ^{a}
KM	1252.07 ± 33.27 ^{b}	299.19 ± 7.45 ^{bc}	115.67 ± 3.04 ^{bc}	365.31 ± 11.92 ^{bc}
KSD	1076.2 ± 32.20 ^{c}	267.74 ± 10.13 ^{cd}	120.01 ± 2.70 ^{bc}	359.24 ± 11.62 ^{bc}
KSM	971.63 ± 21.16 ^{c}	259.99 ± 11.18 ^{de}	120.94 ± 2.60 ^{bc}	366.56 ± 7.05 ^{bc}
KDM	1398.5 ± 39.71 ^{a}	310.45 ± 4.64 ^{ab}	134.18 ± 4.96 ^{ab}	405.75 ± 5.35 ^{ab}

* Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling, $^{a–e}$: No significant difference ($p > 0.05$) between any two means within the same column have the same superscripted letters.

3.6. Antioxidant Capacity Determination

The antioxidant activities of the manufactured Kleicha samples with different filling mixtures were evaluated using the DPPH and ABTS assays, as shown in Figure 2. The

DPPH radical scavenging activity revealed that the KS sample had the lowest antioxidant capacity, measuring 273.19 μmol 100 g^{-1}. On the other hand, the KD sample exhibited the highest antioxidant capacity, with a value of 1507.15 μmol 100 g^{-1}. Similarly, the ABTS radical scavenging activity was measured and showed values of 685.05, 1447.08, 1098.01, 921.1, 909.65, and 1345.14 for KS, KD, KM, KSD, KSM, and KDM, respectively. Notably, the KD and KDM samples demonstrated the highest antioxidant capacities compared with the other samples, while the KS sample had the lowest capacity.

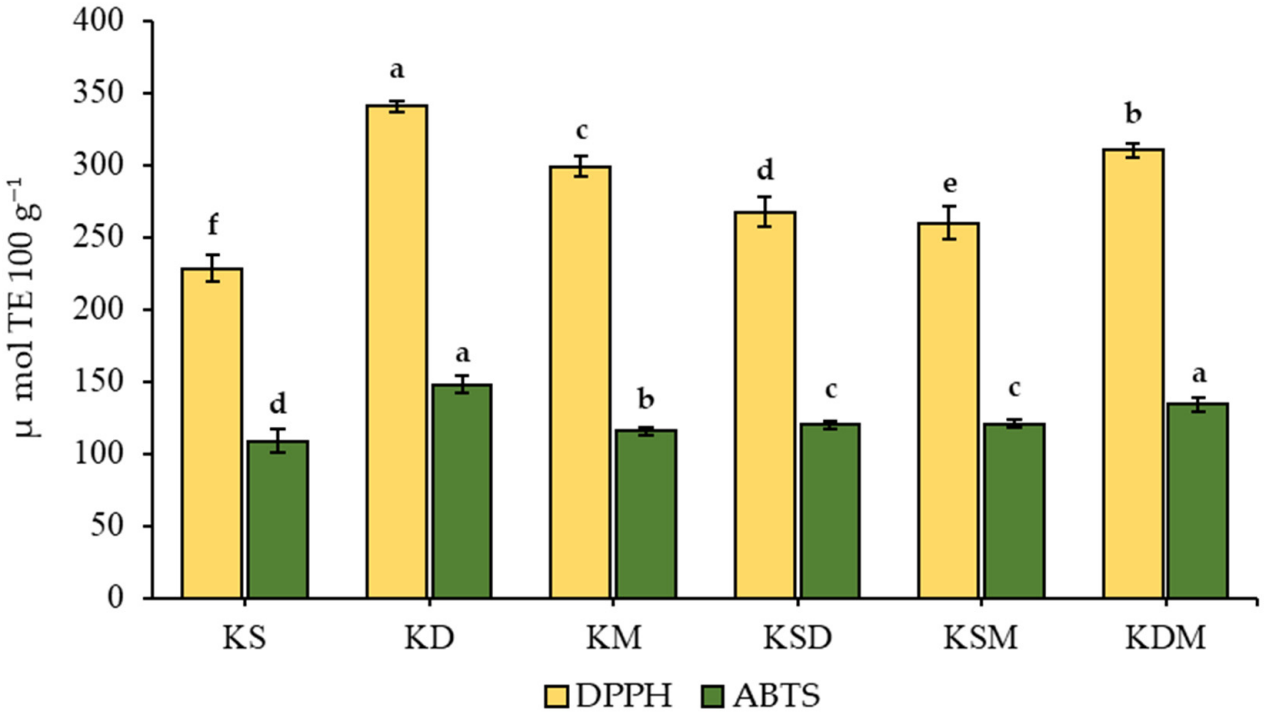

Figure 2. The DPPH and ABTS content of Kleicha filled with different filling mixtures. Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling (mean ± SE), $n = 3$. $^{a–f}$: Bars not sharing similar letters differed significantly ($p > 0.05$).

3.7. Sensory Evaluation

The sensory evaluation of the Kleicha samples filled with different filling mixtures was conducted, assessing six aspects, namely: appearance, external color, internal color, taste, texture, and aroma. The results of these characteristics were used to determine the general acceptance rate. The general acceptance rates for the Kleicha samples were 94.43%, 81.64%, 76.07%, 87.21%, 87.93%, and 80.29% for KS, KD, KM, KSD, KSM, and KDM, respectively (Figure 3).

Interestingly, filling the Kleicha with either Khalas date powder or Khalas date molasses alone did not indicate the highest general acceptance. However, incorporating a sugar mixture with date powder or molasses did not significantly impact the general acceptance. This suggests that incorporating Khalas date powder or molasses can improve the nutritional value of Kleicha compared with adding sugar alone.

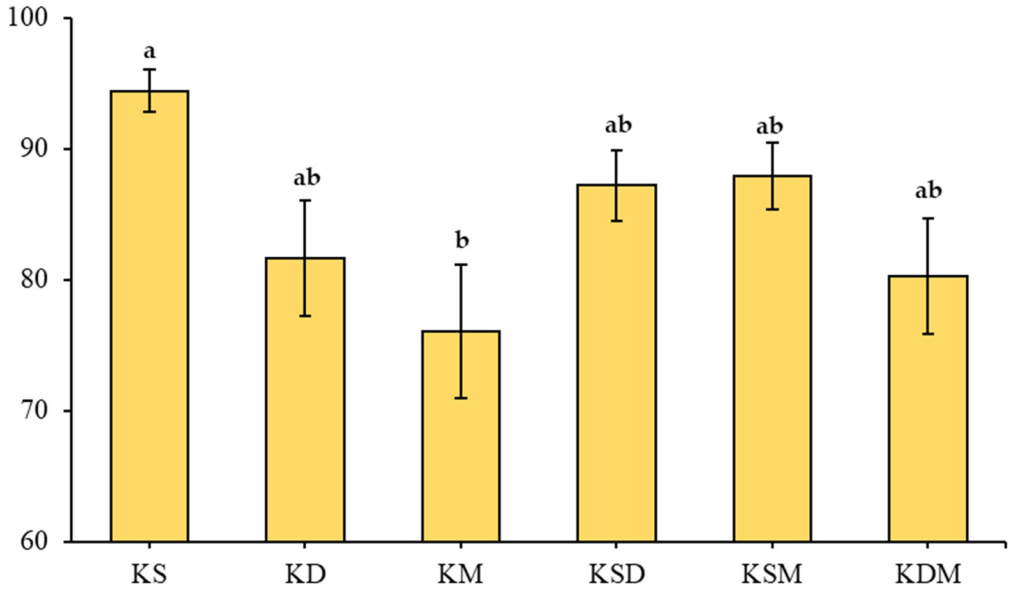

Figure 3. The general acceptance of Kleicha filled with different filling mixtures. Treatments: KS: Kleicha filled with sugar filling; KD: Kleicha with Khalas date powder filling; KM: Kleicha filled with Khalas date molasses filling; KSD: Kleicha filled with sugar and Khalas date powder (1:1) filling; KSM: Kleicha filled with sugar and Khalas date molasses (1:1) filling; KDM: Kleicha filled with Khalas date powder and Khalas date molasses (1:1) filling (mean ± SE), $n = 3$. ^{a,b}: Bars not sharing similar letters differed significantly ($p > 0.05$).

4. Discussion

The traditional cuisine of the Kingdom of Saudi Arabia plays a significant role in the history and identity of the country. These recipes have been passed down through the generations and accurately reflect the history, geography, and climate of their respective regions. Kleicha is a popular example of a traditional sweet; it is made of whole flour that has been sweetened with sucrose and flavored by a special spice mix. It is considered a sweet and calorie-dense local product. Date palm and its products, including date molasses and date powder, have been used to achieve this goal of using unhealthy ingredients like shortening and added sugars. The impact of the substitution process in varying proportions on nutritional and sensory qualities was studied. For instance, Khalas dates are highly prized as a commercial variety and are among the best in the Al Qassim area. Carbohydrates, fiber, and several essential minerals can all be found in abundant quantities [40]. It is also a high source of antioxidants that help protect the body against harm from harmful free radicals [41]. Date powder and molasses are used as an alternative to sugar in many food industries [42]. With some functional components, such as its pectin content, it aids in reducing blood cholesterol and warding off atherosclerosis. It also protects against developing colon cancer, stops hemorrhoids, lessens the chances of gallstones, and causes the nine months of pregnancy and the postpartum period to be easier [26].

In the current research, the proximate chemical composition of the manufactured Kleicha samples with different filling mixtures was determined. The increase in moisture content in the KM sample can be attributed to the formation of hydrogen bonds with water molecules, which is associated with the higher hydroxyl group content in date molasses than sugar. This results in reduced free water movement and an increase in the moisture content of prepared Kleicha. A study by Nadeem et al. [21] focused on replacing sugar with date powder in muffins showed similar results. Its samples, which had the highest percentage of date substitution, exhibited an increased moisture content. The KD and KM samples had significantly higher ash contents compared with the other Kleicha samples filled with sugar/date powder, sugar/date molasses, or a mixture of date powder and date molasses. These results indicate that filling Kleicha with Khalas dried dates increases the

ash content, as Khalas dried dates have an ash content of 1.8 g 100 g^{-1} [20]. This finding aligns with the study by [21], where the sample with the highest ash content had the highest date content. Comparing the curd fat content with the Kleicha samples, the KS sample had significantly lower crude fat content compared with the other Kleicha samples. However, there were no significant differences observed among the remaining samples. It is worth noting that dates generally have a low fat content, with dried dates containing only 0.38 g of fat per 100 g [41]. Regarding the protein content, there was no clear significant difference observed among the Kleicha samples with different fillings. However, Kleicha filled with Khalas dried dates, Khalas date molasses, or a mixture of both showed a slightly higher protein content. Dates contain proteins in small amounts, with an average protein content of 2.14 g 100 g^{-1} in dried dates. The study conducted by Nadeem et al. [21] also confirmed that the sample with the highest protein content was T4 (100% date powder), which is consistent with the results of this study. Furthermore, the KD, KSD, and KDM samples demonstrated a significantly higher dietary fiber content than the other Kleicha samples. This increase in dietary fiber content can be attributed to incorporating Khalas date powder, as dried Khalas dates have a dietary fiber content of 8.0 g 100 g^{-1} [20]. This finding is consistent with the previous study by Nadeem et al. [21], which also showed increased dietary fiber content by incorporating date powder. The remarkable changes in filled Kleich with the date or its by-products might be related to the high nutritional values regarding the macro- and micro-nutrients, as previously indicated [1,9].

The mineral content in the KDM sample had the highest K, Na, Ca, and P contents. This can be attributed to the high mineral content in Khalas dates, which contain 742 mg 100 g^{-1}, 82 mg 100 g^{-1}, 85 mg 100 g^{-1}, and 74 mg 100 g^{-1} of dry weight for K, Na, Ca, and P, respectively [20,40]. Date molasses also contributes to the mineral content, with Ca and P present at a rate of 21.8 mg 100 g^{-1} and 48.2 mg 100 g^{-1}, respectively [40]. These findings align with a study by Gamal et al. [41], which demonstrated increased potassium, sodium, calcium, and phosphorus contents with the fortification of biscuits with wheat bran and date fruit. Regarding the Mg, Fe, and Mn content, the KD and KM samples had the highest values. Khalas dates contain 62 mg 100 g^{-1} of magnesium and 0.6 mg 100 g^{-1} of iron in their dry weight [20,42], while date molasses contains 52.5 mg 100 g^{-1} of magnesium and 0.4 mg 100 g^{-1} of iron [40]. These results are consistent with the study by Gamal et al. [41], which also showed an increased Mg content with the fortification of biscuits with dates. The copper content exhibited significant differences among the samples, with the KM sample having the highest content. This confirms that the Cu content of Khalas molasses is higher than that of dates and sugar. Similarly, the Zn content of the KM and KSD samples was significantly higher than that of the other samples. Date molasses contributes to the copper and zinc content, with Cu present at a rate of 0.08 mg 100 g^{-1} and Zn at 0.2 mg 100 g^{-1} [40]. These findings align with the study by Gamal et al. [41], which demonstrated an increased zinc content and the percentage of dates in biscuits. The obtained results agree with the reviewed data by Barakat and Alfheeaid [1]. Also, adding dates and their by-products enriched the minerals content as relatively expected from previous literature [5,12]. Interestingly, the newly formulated Kleisha could be a functional product for diabetes and hypertensive individuals [15].

The sucrose content in the Kleicha samples varied, with KS having the highest content while the KM, KD, and KDM samples had the lowest. This can be attributed to the low sucrose content in Khalas date powder and molasses, approximately 0.2 g per 100 g [40]. Consequently, the samples containing Khalas date powder and molasses had a lower percentage of sucrose. Kleicha filled with Khalas date powder or a mixture of Khalas date powder and molasses showed slightly higher glucose and fructose contents than the other samples. Conversely, the KS sample had the lowest glucose and fructose content. This can be attributed to the predominance of monosaccharides (glucose and fructose) in Khalas dates, with approximately 26.6 g 100 g^{-1} and 22.8 g 100 g^{-1} of glucose and fructose, respectively [43].

The Kleicha sample filled with Khalas date molasses had the highest GI, significantly differing from the other samples. On the other hand, the Kleicha samples filled with a mixture of Khalas date powder and molasses had the lowest GI. According to the classification of foods based on GI values, the glycemic index in this study is considered low, as it was less than 55. This can be attributed to Khalas dates having a low glycemic index of 35.5 [44]. A low-glycemic-index diet has been associated with protection against obesity, colon cancer, and breast cancer. A study by Sameen et al. [45] found that date molasses reduced the GI when used to replace sugar in ice cream. Furthermore, GL was evaluated, and the KS sample had the highest GL, while the KM sample had the lowest one. Foods are classified based on their GL as low (GL $\leq$ 10), medium (GL 11–19), and high (GL $\geq$ 20). Date molasses is classified as having a low glycemic load with a value of 11.29 [46], and dates, in general, are considered to have a medium glycemic load of 13.58 [47]. A high glycemic load is associated with the rapid release of triglycerides into the bloodstream [48].

The results of phytochemicals analysis in the prepared Kleicha filled with different filling mixtures indicated the KD sample exhibited the highest concentration of TPC. In contrast, the Kleicha sugar-filled sample showed a significantly lower TPC content. These findings align with a study by Mohamed et al. [49], which investigated the phytochemical composition of 16 commercial date cultivars, including Khalas, grown in Saudi Arabia. The study reported that Khalas dates contain approximately 149 mg GAE 100 g^{-1} DW of TPC. Additionally, the results of this study support the findings of a study by Manickavasagan et al. [50]. The study demonstrated that incorporating dates and molasses into IDLI led to an increase in TPC content. Specifically, the IDLI sample supplemented with chopped dates contained 75.1 mg 100 g^{-1} of TPC. Supplemented samples with date syrup contained 82.1 mg 100 g^{-1}, compared with the control sample, which had only 4.5 mg 100 g^{-1} TPC. These results are consistent with the findings of Al-Farsi and Lee [51], who emphasized the potential of dates and date molasses to enhance the phytochemical content of food products. The KD sample exhibited the most significant increase in TF content. Conversely, the KS sample showed a significant decrease in TF. Regarding TFL, the KD sample demonstrated a significant increase higher than the other samples, except for KDM, which had a valuable TFL content. The KS sample had a significantly lower TFL content. It is worth noting that Khalas dates had a TF content of 27 mg QE 100 g^{-1} DW [49]. Similarly, the TC content of the KD and KDM samples showed the highest TC levels. In contrast, the KS sample had the lowest TC content. This difference can be attributed to the high carotene content in dried Khalas dates, which contain approximately 2900 μg 100 g^{-1} [20]. Notably, the major carotenoids found in dates are lutein, β-carotene, and neoxanthin [19]. Interestingly, there was a significant increase in TPC, TF, TFL, and TC in the KD and KDM samples compared with the Kleicha filled with sugar. Conversely, the Kleicha filled with sugar exhibited the most significant decrease in these phytochemical contents. The antioxidant activities, such as DPPH and ABTS radical scavenging activity, revealed that the KS sample had the lowest antioxidant capacity. The KD sample exhibited the highest antioxidant capacity. Notably, the KD and KDM samples demonstrated the highest antioxidant capacities compared with the other samples, while the KS sample had the lowest capacity. This can be attributed to the fact that Khalas dates contain significant levels of oxidative activity, with 8.25 mg GAE of DPPH radical scavenging and 1.53 mg GAE of ABTS radical scavenging [49].

The sensory evaluation of Kleicha samples filled with different filling mixtures was conducted, assessing six aspects. The KS sample scored the highest acceptance, followed by KSM and KSD. Interestingly, filling the Kleicha with either Khalas date powder or Khalas date molasses alone did not indicate the highest acceptance score. This suggests that incorporating Khalas date powder or molasses can improve the nutritional value of Kleicha compared with adding sugar alone. This finding aligns with a study by Assirey [12], where the control sample with 100% sugar had a high general acceptance. There was no significant difference between the control and cookie samples where sugar was replaced with 25% and 50% date powder or 75% date molasses. In another study by Gamal et al. [41], the

results indicated that the control sample had the highest general acceptance. There was no significant difference between the control and biscuit samples fortified with 10% and 20% date powder, while the sample fortified with 40% had the lowest acceptance score.

5. Conclusions

In conclusion, our research intended to create a less unhealthy version of the traditional food product Kleicha by substituting Khalas date powder and molasses for sugar. Six samples of Kleicha were analyzed, all of which had different fillings such as sugar, Khalas date powder, Khalas date molasses, and a few different mixes of these. Samples supplemented with Khalas date powder or molasses showed an elevated phenolic content, a marker of greater health benefits. Furthermore, the oxidative activity increased when Khalas date powder was added, whereas the sucrose content dropped when Khalas date powder and molasses were used. More importantly, there was no discernible difference in acceptance rates between the control group and the group that had fillings based on dates. Based on these results, replacing sugar with Khalas date powder, molasses, or a combination of the two in Kleicha can have positive health effects while maintaining the original flavor.

Author Contributions: Conceptualization, R.M.A. and R.S.A.A.; methodology, R.S.A.A.; investigation, R.M.A. and R.S.A.A.; data curation, R.M.A.; writing—original draft preparation, R.S.A.A.; writing—review and editing, R.M.A.; visualization, R.S.A.A.; supervision, R.M.A.; project administration, R.M.A. All authors have read and agreed to the published version of the manuscript.

Funding: The project was funded by the Deanship of Scientific Research in Qassim University (CAVM-2022-1-1-J-27842).

Data Availability Statement: Data are contained within the article.

Acknowledgments: The authors gratefully acknowledge Qassim University, represented by the Deanship of "Scientific Research, on the financial support for this research under the number (CAVM-2022-1-1-J-27842) during the academic year 1444 AH/2022 AD". The authors also thank Qassim University for its technical support.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Barakat, H.; Alfheeaid, H.A. Date Palm Fruit (*Phoenix dactylifera*) and Its Promising Potential in Developing Functional Energy Bars: Review of Chemical, Nutritional, Functional, and Sensory Attributes. *Nutrients* **2023**, *15*, 2134. [CrossRef] [PubMed]
2. Nadeem, M.; Qureshi, T.M.; Ugulu, I.; Riaz, M.N.; An, Q.; Khan, Z.I.; Ahmad, K.; Ashfaq, A.; Bashir, H.; Dogan, Y. Mineral, Vitamin and Phenolic Contents and Sugar Profiles of Some Prominent Date Palm (*Phoenix dactylifera*) Varieties of Pakistan. *Pak. J. Bot.* **2019**, *51*, 171–178. [CrossRef] [PubMed]
3. Elleuch, M.; Besbes, S.; Roiseux, O.; Blecker, C.; Deroanne, C.; Drira, N.-E.; Attia, H. Date Flesh: Chemical Composition and Characteristics of the Dietary Fibre. *Food Chem.* **2008**, *111*, 676–682. [CrossRef]
4. Ibrahim, S.A.; Ayad, A.A.; Williams, L.L.; Ayivi, R.D.; Gyawali, R.; Krastanov, A.; Aljaloud, S.O. Date Fruit: A Review of the Chemical and Nutritional Compounds, Functional Effects and Food Application in Nutrition Bars for Athletes. *Int. J. Food Sci.* **2021**, *56*, 1503–1513. [CrossRef]
5. Siddeeg, A.; Zeng, X.-A.; Ammar, A.-F.; Han, Z. Sugar Profile, Volatile Compounds, Composition and Antioxidant Activity of Sukkari Date Palm Fruit. *J. Food Sci. Technol.* **2019**, *56*, 754–762. [CrossRef] [PubMed]
6. Echegaray, N.; Pateiro, M.; Gullon, B.; Amarowicz, R.; Misihairabgwi, J.M.; Lorenzo, J.M. *Phoenix dactylifera* Products in Human Health—A Review. *Trends Food Sci. Technol.* **2020**, *105*, 238–250. [CrossRef]
7. Siddiq, M.; Greiby, I. Overview of Date Fruit Production, Postharvest Handling, Processing, and Nutrition. In *Dates: Postharvest Science, Processing Technology and Health Benefits*; John Wiley & Sons: Hoboken, NJ, USA, 2013; pp. 1–28.
8. Hussain, M.I.; Farooq, M.; Syed, Q.A. Nutritional and Biological Characteristics of the Date Palm Fruit (*Phoenix dactylifera* L.)—A Review. *Food Biosci.* **2020**, *34*, 100509. [CrossRef]
9. United States Department of Agriculture (USDA). 2020. Available online: https://fdc.nal.usda.gov/fdc-app.html (accessed on 22 May 2023).
10. Amadou, I. Date Fruits: Nutritional Composition of Dates (Balanites Aegyptiaca Delile and *Phoenix dactylifera* L.). In *Nutritional Composition of Fruit Cultivars*; Elsevier: Amsterdam, The Netherlands, 2016; pp. 215–233.

11. Aljutaily, T.; Barakat, H.; Moustafa, M.M.; Rehan, M. Incorporation of Sukkari Date in Probiotic-Enriched Fermented Camel Milk Improves the Nutritional, Physicochemical, and Organoleptical Characteristics. *Fermentation* **2021**, *8*, 5. [CrossRef]
12. Assirey, E.A.R. Nutritional Composition of Fruit of 10 Date Palm (*Phoenix dactylifera* L.) Cultivars Grown in Saudi Arabia. *J. Taibah Univ. Sci.* **2015**, *9*, 75–79. [CrossRef]
13. Ayad, A.A.; Williams, L.L.; Gad El-Rab, D.A.; Ayivi, R.; Colleran, H.L.; Aljaloud, S.; Ibrahim, S.A. A Review of the Chemical Composition, Nutritional and Health Benefits of Dates for Their Potential Use in Energy Nutrition Bars for Athletes. *Cogent Food Agric.* **2020**, *6*, 1809309. [CrossRef]
14. Hamad, I.; AbdElgawad, H.; Al Jaouni, S.; Zinta, G.; Asard, H.; Hassan, S.; Hegab, M.; Hagagy, N.; Selim, S. Metabolic Analysis of Various Date Palm Fruit (*Phoenix dactylifera* L.) Cultivars from Saudi Arabia to Assess Their Nutritional Quality. *Molecules* **2015**, *20*, 13620–13641. [CrossRef] [PubMed]
15. Ralston, R.; Lee, J.; Truby, H.; Palermo, C.; Walker, K. A Systematic Review and Meta-Analysis of Elevated Blood Pressure and Consumption of Dairy Foods. *J. Hum. Hypertens.* **2012**, *26*, 3–13. [CrossRef] [PubMed]
16. Eid, N.M.; Al-Awadi, B.; Vauzour, D.; Oruna-Concha, M.J.; Spencer, J.P. Effect of Cultivar Type and Ripening on the Polyphenol Content of Date Palm Fruit. *J. Agric. Food Chem.* **2013**, *61*, 2453–2460. [PubMed]
17. Razali, N.S.M.; Wenyin, B.; Arjunan, R.D.; Hashim, H.; Abdullah, A. Total Phenolic Content and Antioxidant Activities of Date Fruit Extracts. *Malays. Appl. Biol.* **2019**, *48*, 103–108.
18. Alfheeaid, H.A.; Barakat, H.; Althwab, S.A.; Musa, K.H.; Malkova, D. Nutritional and Physicochemical Characteristics of Innovative High Energy and Protein Fruit- and Date-Based Bars. *Foods* **2023**, *12*, 2777. [CrossRef]
19. Al-Farsi, M.A.; Lee, C.Y. Nutritional and Functional Properties of Dates: A Review. *Crit. Rev. Food Sci. Nutr.* **2008**, *48*, 877–887. [CrossRef] [PubMed]
20. Al-Farsi, M.; Alasalvar, C.; Morris, A.; Baron, M.; Shahidi, F. Comparison of Antioxidant Activity, Anthocyanins, Carotenoids, and Phenolics of Three Native Fresh and Sun-Dried Date (*Phoenix dactylifera* L.) Varieties Grown in Oman. *J. Agric. Food Chem.* **2005**, *53*, 7592–7599. [CrossRef] [PubMed]
21. Nadeem, M.; Qureshi, T.M.; Ahmad, M.M.; Riaz, M.N.; Ameer, A. Development of Free Flowing Date Powder and Its Utilization in Muffins to Enhance Nutritional Value. *J. Agric. Res.* **2017**, *55*, 03681157.
22. Abd El-Hady, E.S.A.; Alfheeaid, H.A.; Abd El-Razik, M.M.; Althwab, S.A.; Barakat, H. Nutritional, Physicochemical, and Organoleptic Properties of Camel Meat Burger Incorporating Unpollinated Barhi Date Fruit Pulp. *Int. J. Food Sci.* **2022**, *2022*, 4581821. [CrossRef]
23. Vayalil, P.K. Date Fruits (*Phoenix dactylifera* L.): An Emerging Medicinal Food. *Crit. Rev. Food Sci. Nutr.* **2012**, *52*, 249–271. [CrossRef]
24. Al-Dashti, Y.A.; Holt, R.R.; Keen, C.L.; Hackman, R.M. Date Palm Fruit (*Phoenix dactylifera*): Effects on Vascular Health and Future Research Directions. *Int. J. Mol. Sci.* **2021**, *22*, 4665. [CrossRef]
25. Ali, Z.; Li, J.; Zhang, Y.; Naeem, N.; Younas, S.; Javeed, F. Dates (*Phoenix dactylifera*) and Date Vinegar: Preventive Role against Various Diseases and Related in Vivo Mechanisms. *Food Rev. Int.* **2022**, *38*, 480–507. [CrossRef]
26. Al-Mudhaffar, A.W. *Dates and Sugar Technology*; Aldar Al-Jameaeh for Printing, Publishing and Translation; University of Kufa Iraq: Kufa, Iraq, 2019; p. 450.
27. A.O.A.C. *Official Methods of Analysis of the Association of Official Analytical Chemists*; Association of Official Analytical Chemists: Washington, DC, USA, 2000.
28. Borah, S.; Baruah, A.M.; Das, A.K.; Borah, J. Determination of Mineral Content in Commonly Consumed Leafy Vegetables. *Food Anal. Methods* **2009**, *2*, 226–230. [CrossRef]
29. Nsimba, R.Y.; Kikuzaki, H.; Konishi, Y. Antioxidant Activity of Various Extracts and Fractions of *Chenopodium Quinoa* and *Amaranthus* Spp. Seeds. *Food Chem.* **2008**, *106*, 760–766. [CrossRef]
30. Mohdaly, A.A.A.; Hassanien, M.F.R.; Mahmoud, A.; Sarhan, M.A.; Smetanska, I. Phenolics Extracted from Potato, Sugar Beet, and Sesame Processing by-Products. *Int. J. Food Prop.* **2013**, *16*, 1148–1168. [CrossRef]
31. Kumaran, A.; Karunakaran, R.J. In Vitro Antioxidant Activities of Methanol Extracts of Five Phyllanthus Species from India. *LWT Food Sci. Technol.* **2007**, *40*, 344–352. [CrossRef]
32. Yuan, G.-f.; Sun, B.; Yuan, J.; Wang, Q.-m. Effects of Different Cooking Methods on Health-Promoting Compounds of Broccoli. *J. Zhejiang Univ. Sci. B* **2009**, *10*, 580–588. [CrossRef] [PubMed]
33. Khalifa, I.; Barakat, H.; El-Mansy, H.A.; Soliman, S.A. Optimizing Bioactive Substances Extraction Procedures from Guava, Olive and Potato Processing Wastes and Evaluating Their Antioxidant Capacity. *J. Food Chem. Nanotechnol.* **2016**, *2*, 170–177. [CrossRef]
34. Lu, J.; Zhao, H.; Chen, J.; Fan, W.; Dong, J.; Kong, W.; Sun, J.; Cao, Y.; Cai, G. Evolution of Phenolic Compounds and Antioxidant Activity During Malting. *J. Agric. Food Chem.* **2007**, *55*, 10994–11001. [CrossRef]
35. Association of Official Analytical Chemists. *Aoac Official Method 982.14.: Glucose, Fructose, Sucrose, and Maltose in Presweetened Cereals—Liquid Chromatographic Method*; Association of Official Analytical Chemists: Washington, DC, USA, 2007.
36. Englyst, H.N.; Veenstra, J.; Hudson, G.J. Measurement of Rapidly Available Glucose (Rag) in Plant Foods: A Potential In Vitro Predictor of the Glycaemic Response. *Br. J. Nutr.* **1996**, *75*, 327–337. [CrossRef]
37. Goñi, I.; Garcia-Alonso, A.; Saura-Calixto, F. A Starch Hydrolysis Procedure to Estimate Glycemic Index. *Nutr. Res.* **1997**, *17*, 427–437. [CrossRef]

38. Peter Ikechukwu, A.; Okafor, D.; Kabuo, N.; Ibeabuchi, J.; Odimegwu, E.; Alagbaoso, S.; Njideka, N.; Mbah, R. Production and Evaluation of Cookies from Whole Wheat and Date Palm Fruit Pulp as Sugar Substitute. *Int. J. Eng. Technol. Manag. Appl. Sci.* **2017**, *4*, 1–31.
39. Steel, R.G. *Pinciples and Procedures of Statistics a Biometrical Approach*, 3rd ed.; McGraw-Hill: Boston, MA, USA, 1997.
40. Aleid, S.M.; Haddadin, J.S. Valorization and Chemical Constituents Assessments of Khalas Dates Fruit, Syrup and Pits. *Curr. Res. Nutr. Food Sci.* **2023**, *11*, 77–87. [CrossRef]
41. El-Sharnouby, G.A.; Aleid, S.M.; Al-Otaibi, M.M. Nutritional Quality of Biscuit Supplemented with Wheat Bran and Date Palm Fruits (*Phoenix dactylifera* L.). *Food Nutr. Sci.* **2012**, *3*, 322–328.
42. Ahmed, J.; Al-Jasass, F.M.; Siddiq, M. Date Fruit Composition and Nutrition. In *Dates*; John Wiley & Sons: Hoboken, NJ, USA, 2013; pp. 261–283.
43. Al-Saikhan, M.S.; Sallam, A. Impact of Chemical and Non-Chemical Thinning Treatments on Yield and Fruit Quality of Date Palm. *J. Food Res.* **2015**, *4*, 18–29. [CrossRef]
44. Brand-Miller, J.C. Glycemic Load and Chronic Disease. *Nutr. Rev.* **2003**, *61*, S49–S55. [CrossRef] [PubMed]
45. Sameen, A.; Manzoor, M.F.; Khan, M.I.; Sahar, A.; Saddique, A. Quality Evaluation of Ice Cream Prepared with *Phoenix dactylifera* Syrup as a Substitute of Sugar. *Pak. J. Food Sci.* **2016**, *26*, 226–233.
46. Julai, K.; Sridonpai, P.; Ngampeerapong, C.; Tongdonpo, K.; Suttisansanee, U.; Kriengsinyos, W.; On-Nom, N.; Tangsuphoom, N. Effects of Extraction and Evaporation Methods on Physico-Chemical, Functional, and Nutritional Properties of Syrups from Barhi Dates (*Phoenix dactylifera* L.). *Foods* **2023**, *12*, 1268. [CrossRef]
47. Jarrar, A.H.; Kamal-Eldin, A.; Bataineh, M.a.; Al Dhaheri, A.S. Glycemic Index (Gi) and Glycemic Load (Gl) Values for Dried Bisr and Tamr Dates. *Emir. J. Food Agric.* **2019**, *31*, 88–94. [CrossRef]
48. Liu, S.; Manson, J.E.; Stampfer, M.J.; Holmes, M.D.; Hu, F.B.; Hankinson, S.E.; Willett, W.C. Dietary Glycemic Load Assessed by Food-Frequency Questionnaire in Relation to Plasma High-Density-Lipoprotein Cholesterol and Fasting Plasma Triacylglycerols in Postmenopausal Women. *Am. J. Clin. Nutr.* **2001**, *73*, 560–566. [CrossRef]
49. Mohamed, S.A.; Awad, M.A.; El-Dengawy, E.-R.F.; Abdel-Mageed, H.M.; El-Badry, M.O.; Salah, H.A.; Abdel-Aty, A.M.; Fahmy, A.S. Total Phenolic and Flavonoid Contents and Antioxidant Activities of Sixteen Commercial Date Cultivars Grown in Saudi Arabia. *RSC Adv.* **2016**, *6*, 44814–44819. [CrossRef]
50. Manickavasagan, A.; Mathew, T.; Al-Attabi, Z.; Al-Zakwani, I. Dates as a Substitute for Added Sugar in Traditional Foods? A Case Study with Idli. *Emir. J. Food Agric.* **2013**, *25*, 899–906. [CrossRef]
51. Al-Farsi, M.A.; Lee, C.Y. 25 the Functional Values of Dates. In *Dates: Production, Processing, Food, and Medicinal Values*; CRC Press: Boca Raton, FL, USA, 2012; p. 351.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.