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Alternative sweets from cooked pulses and date products: Nutritional and quality characteristics

Azza A. Omran*, Nadra S.Y. Hassan, Abd Elaziz M. Hanaa

Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

* e-mail: azzaa_omran@yahoo.com

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Abstract:
Nowadays, the worldwide market includes a wide variety of sweets with processed sugar. The food industry has been developing alternatives based on health products. This study aimed to formulate alternative, highly-nutritional date-based sweets filled with cooked pulses and sweetened with date products without using processed sugar. Different cooked pulses (red cowpea, soybean, and chickpea seeds) sweetened with date powder or date syrup (dips) were used to prepare alternative date sweets. They were exposed to physicochemical and microbiological analyses and sensory evaluation. Adding pulses to the pulse-date sweet samples significantly raised their contents of protein, fats, crude fibers, total sugars, calcium, iron, and zinc, as well as caloric values, lightness, and water activity. Compared to the control (date paste mixed with dark chocolate), the sweets with cooked pulses had lower contents of ash, carbohydrates, phenolics, and caffeine, as well as lower antioxidant activity and hardness values. Following storage for three months, the water activity and microbiological counts slightly declined. The date sweets filled with cooked pulses had high sensory acceptability. The samples containing cooked red cowpeas and chickpeas were the most acceptable, while those sweetened with date powder had maximum antioxidant activity. Our study revealed that enriching date sweets with cooked pulses increases their nutritional value without involving processed sugar in the final product.

Keywords: Date palm products, soybeans, chickpea, dark chocolate, alternative sweets, nutritional quality, sensory attributes

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INTRODUCTION

Legumes, or pulses, are a low-cost, natural source of protein and phenolic compounds such as tannins, phenolic acids, and flavonoids. In addition, they are rich in antioxidants and minerals, which could prevent mineral deficiencies [1, 2]. Cowpea seeds (*Vigna unguiculata* L.) are an important pulse crop grown in Africa and in some parts of America and Asia. They are widely consumed as an affordable source of protein, potassium, and polyphenols. Also, they have very low contents of lipids and sodium [3].

Soybeans (*Glycine max* L.) are a significant source of protein and lipids worldwide, with high nutritional and commercial value. They contain considerable amounts of folic acid, isoflavones, and saponins. Soybean products are gaining more attention due to their benefits for human health. In particular, they can reduce cholesterol and prevent multiple chronic diseases such as obesity, diabetes, and cardiovascular disease, as well as some types of cancer [4].

The chickpea (*Cicer arietinum* L.) is a major pulse crop cultivated and consumed all over the world. It has a high content of protein, crude fibers, and dietary fibers, as well as a lower content of carbohydrates than cereals. Chickpeas are rich in bioactive compounds such as saponins, carotenoid, tocopherol, and phenolic acids. Adding chickpeas to food products can increase their nutritional value. Additionally, the pulse nutrients' availability can be enhanced by different processing methods such as soaking and cooking [5, 6].

The date palm (*Phoenix dactylifera* L.) is one of the most significant cultivars worldwide. Its fruit has a high nutritional value and an abundance of minerals, dietary fibers, and other healthy metabolites [7]. Date fruit is also rich in antioxidants, proteins, carbohydrates, and a vitamin B complex (riboflavin, thiamine, pantothenic, niacin, folate, and pyridoxine). According to Aljaloud *et al.* [8], 70% of the date fruit is made up of carbohydrates, specifically fructose and glucose. The nutritional and sensory qualities of palm dates are enhanced by the pres-

ence of phytochemicals, such as flavonoids, carotenoids, and phenolic components.

Dates have found multiple applications in the food industry due to their enormous production worldwide [9]. According to the Bulletin of Food Balance Sheet [10], Egypt produced 523,000 tons of dried dates and date paste in 2021. Date fruits provide a wide range of potential health advantages. This has created a need for novel food products incorporating dates as a source of nutrients [8].

Candies and sweets may contain fruits, chocolate, nuts, honey, sugar, or other sweeteners. Chocolate is one of the most common and highly desired foods in the world market [11, 12]. Its consumption as a daily snack has increased among all age groups [11, 13]. Dark chocolate consumed for two weeks may boost microbiological activity in the gut and normalize the effects of stress on human metabolism [14]. Children most commonly favor chocolate biscuits, chocolate bars, chocolate cake, chocolate ice cream, and cocoa milk [15]. However, sweet products, particularly chocolates, have long been thought to be unhealthy because of their high sugar content (processed sugar). Consequently, food researchers have been working hard to modify recipes in the hope to improve the nutritional profile of sweet-based chocolate. This has included lowering the amount of sugar or adding ingredients without changing the texture or sensory aspects of the product [11].

The most significant changes in the food industry have been motivated by the consumers' rising demand for functional or health-promoting foods with bioactive components that positively modulate the immune system [16]. Since consumers are becoming increasingly concerned about their well-being and good health, they are changing their eating habits in favor of nutritious foods with functional components [1]. This drives the food industry and inspires the development of novel products [17]. In particular, the consumers' demand for healthier sweeteners has promoted a switch from sucrose, the most common sweetener used in chocolate, to other alternatives such as coconut- or palm-based sugar [18].

The core target of fortification is to enhance the nutritional value of products while also making them more self-sufficient and complementary to food products [16]. A strategy that is now being encouraged is the use of natural ingredients with an abundance of bioactive substances and beneficial nutritional contents. Fortifying food products with high-value-added seeds or plant-based materials may alter their nutritional qualities, overall consumer acceptance, and shelf life [16, 19].

Therefore, in this study, we aimed to produce alternative sweets from cooked pulses sweetened with date powder or date syrup (dips). The pulses were used as a filling in the sweets coated with date paste and dark chocolate. The sweet products were analyzed for their physicochemical, nutritional, microbiological, and sensory properties.

STUDY OBJECTS AND METHODS

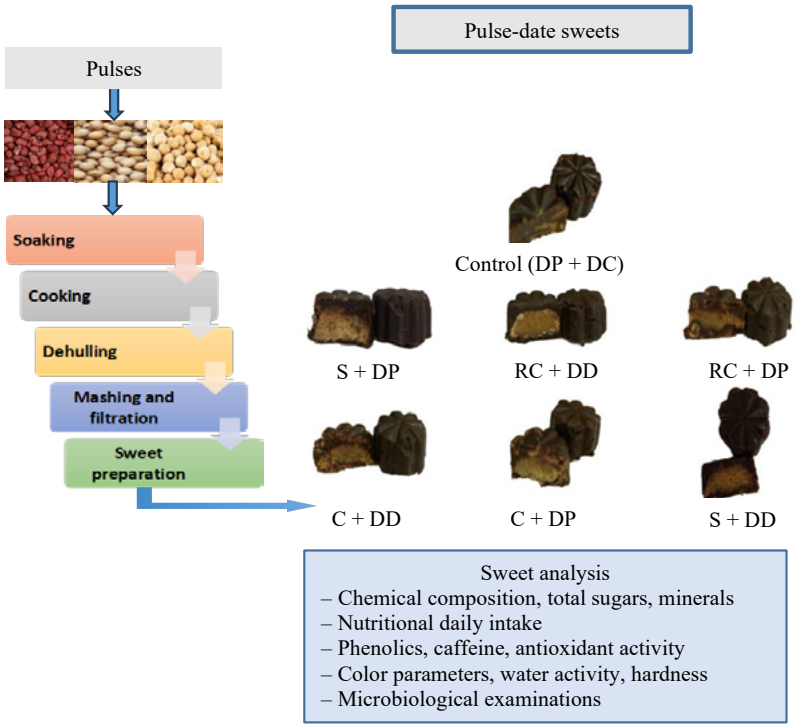
Materials. Soya bean seeds (*Glycine max* L., Giza 111 variety) were provided by the Field Crops Research Institute, Agricultural Research Center, Egypt. Red cowpea seeds (*Vigna unguiculate* L. Walp, *Leguminasae* family) were purchased from the markets in Cairo and then botanically recognized and authenticated by the Flora and Phytotaxonomy Research Department, Horticulture Research Institute, Agricultural Research Center, Egypt. Chickpea (*Cicer arietinum* L.), date powder, date dips (68% TSS) and dark chocolate were purchased from markets in Cairo and all of the other chemicals were analytical grade.

Pulses processing. Different pulse seeds were exposed to certain technological treatments. They had been thoroughly cleaned and freed of any extraneous materials and broken seeds before being soaked in water (1:2, w/v) for 12 h (the soaking water was changed twice). The soaked seeds were then cooked in water (1:3, w/v) for 60–70 min, drained, and hulled. Then, the cotyledons were mashed, filtrated through a cloth to remove excessive water, packed in polyethylene bags, and frozen for further use.

Pulse-date sweet preparation. The cooked pulses were heated for 10 min until the appropriate consistency was achieved. Then, 120 g of date paste was mixed with 80 g of dark chocolate and filled with 100 g of the cooked pulses sweetened with 20 g of date powder or date dips (based on preliminary experiments). The weight of each sweet sample was 12 g (8 g of date paste mixed with dark chocolate and 4 g of cooked pulses). Then, the samples were shaped, stored in polypropylene metalized bags, and refrigerated at 4 ± 1°C for 90 days until further investigation (Fig. 1).

Proximate analysis. The moisture, protein, fat, crude fibers, and ash contents of raw materials, cooked pulses, and pulse-date sweet samples were estimated using the methods of the Association of Official Analytical Chemists (AOAC) [20]. Carbohydrates were determined as follows: [carbohydrates = 100 – (ash + fats + crude fibers + protein)]. The calcium, iron, and zinc contents were measured by Model-4210 MP-AES Microwave Plasma Atomic Emission Spectrometers (Agilent Technologies, USA) using the method established by the AOAC [20]. Total calories in the pulse-date chocolate samples were calculated by multiplying the fat, protein, and carbs values on the basis of 9, 4, and 4 kcal/g, respectively [20]. The total sugar content was measured by the Somogyi-Nelson method, as described by the AOAC [20]. The pH of the samples was measured with a pH meter. The daily intakes, %, of protein, calories, calcium, iron, and zinc in the pulse-date sweets were calculated using the Dietary Reference Intakes (DRI) [21] and the Recommended Dietary Allowances (RDA) [22] using the Eq. 1:

$$\text{The calculated daily intake} = \frac{\text{Value of the nutrient in each sample}}{\text{DRI or RDA for each age group for the same nutrient}} \quad (1)$$



Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips

Figure 1 The pulse-date sweet preparation

Determination of total phenolics. The total phenolic content in the pulse-date sweet samples was extracted and evaluated based on the Folin-Ciocalteu phenol method [23]. The samples' absorbance was measured at 725 nm by a Jenway spectrophotometer Model-6715-UV/Vis (Cole-Parmer Ltd, UK), and the data was presented as mg/100 g of gallic acid equivalent.

Caffeine determination. To determine the caffeine content, 2 g of a sample and 20 mL of H_2O were boiled in a water bath for 10 min, then 2 g of sodium carbonate was added to the mix (to precipitate tannins), and filtered. The samples were concentrated by heating and added to 5 mL of chloroform in the separator funnel. The bottom layer was separated and 0.10 mL of each sample was diluted with 10 mL of chloroform [24]. The absorbance of the samples was measured at 274 nm against the blank, and the results were expressed as mg/100 g of caffeine equivalent.

Free radical scavenging by DPPH. The antioxidant activity of the phenolic sample extract was measured by mixing 0.10 mL of the extract with 3.90 mL of DPPH methanol solution (2.40 mg of DPPH dissolved in 100.0 mL of methanol) [25]. The mixture was left in the dark for 30 min and then measured at 515 nm, and the radical scavenging, %, as DPPH was calculated using the Eq. (2):

$$\text{Radical scavenging} = \left[\frac{A_0 - A_1}{A_0}\right] \times 100 \qquad (2)$$

where A_0 is the absorbance of the control reaction and A_1 is the absorbance of the tested sample after 30 min.

Sensory evaluation. The pulse-date sweet samples and the control (DP + DC) were cooled to room temperature (23 ± 2°C) before a sensory evaluation by ten panelists from the Food Technology Research Institute. The samples were assessed for color, sweetness, mouthfeel, odor, taste, aftertaste, and overall acceptability. The panelists were informed about the study and the products to be tasted before they gave their consent. We used the nine-point hedonic test (9 – extremely like; 5 – neither like nor dislike; 1 – extremely dislike) [26].

Color measurement. The color characteristics of the sweet samples (for outer and inner color) were determined with a hand-held Tristimulus reflectance colorimeter Minolta Chroma Meter CR-400 (Konica Minolta, Japan). The color parameters were recorded as L^* [lightness = (100 for lightness and zero for darkness)]; a^* [redness = red (+) to green (–)]; and b^* [yellowness = yellow (+) to blue (–)], by means of three replicate measurements.

Water activity. The water activity (a_w) of the sweet samples (before and after storage for three months) was measured at 18 ± 2°C using a Rotronic HygroLab 3 analyzer (CH-8303, Switzerland) [27].

Hardness. The hardness of the sweet samples was assessed at 23 ± 2°C using a Universal Testing Machine (Cometech, B type, Taiwan) equipped with software [28]. Three replicates of each pulse-date sweet sample were cut with a flat-ended probe (2.50 mm thick) at a cross-head speed of 1 mm/s and 20% compression. The hardness values were expressed in Newton.

Microbiological analysis. The total plate, as well as yeasts and molds in the sweet samples were counted before and after storage using a method developed by the American Public Health Association [29]. The microbiological analysis results were presented as log CFU/g.

Statistical analysis. The data was statistically analyzed for means and standard deviations using CoStat statistical software [30]. The data was analyzed by one-way analysis of variance (ANOVA, $p > 0.05$) and then by Duncan's new multiple range tests to evaluate variations of the means.

RESULTS AND DISCUSSION

Proximate composition of ingredients. Table 1 displays the proximate composition of the ingredients used in the study, namely red cowpea, soy bean, chickpea, dark chocolate, date paste, date powder, and date dips.

As can be seen, soybeans had a higher content of protein, ash, fats, and crude fibers than the other pulses. Date dips, how-ever, had a higher content of carbohydrates and a lower content of protein, ash, fats, and crude fibers.

The results of our study were partially close to those reported by Ferweez *et al.* [31], Rabie *et al.* [32], USDA [33], Xiao *et al.* [34] and Zewudie & Gemede [35], who analyzed dried dates, date syrup, black-eyed peas, chickpeas and soybeans.

Table 1 also shows that the soaking, cooking, and dehulling of pulses (red cowpea, soy bean, and chickpea) led to a slight increase in protein and carbohydrates and a decrease in fats, ash, and crude fibers. Different processing methods indicated a high moisture content in all the cooked pulses compared to the raw seeds.

Sensory acceptability of pulse-date sweets. Table 2 exhibits the sensory acceptability scores of the cooked pulse-date sweet samples and the control. The samples were evaluated for their overall acceptability based on their color, sweetness, odor, taste, mouthfeel, and aftertaste scores.

There were no significant differences between the control and the cooked pulse samples in terms of color, sweetness, odor, mouthfeel, aftertaste, and overall acceptability. The taste scores, however, were higher for the pulse-date sweets compared to the control, except for the soybean-date samples, which had the lowest scores. The chickpea-date powder sample and the red cowpea-date dips sample recorded the highest scores (8.60 and 8.55). They were followed by the red cowpeadate powder sweet, the chickpea-date dips sweet, the control, and the soybean-date powder sample, respectively.

Table 1 Proximate composition of sweet ingredients and cooked pulses

Constituents / Samples	Moisture	Protein	Fats	Ash	Crude fibers	Carbohydrates
Raw materials						
Red cowpea	7.38 ± 0.14^{d}	21.71 ± 0.99^{b}	2.77 ± 0.09^{d}	3.96 ± 0.37^{b}	6.09 ± 0.70^{b}	65.47 ± 2.10^{e}
Soybean	5.78 ± 0.44^{e}	33.63 ± 0.40^{a}	21.95 ± 0.59^{a}	4.85 ± 0.74^{a}	9.41 ± 0.17^{a}	30.16 ± 1.86^{f}
Chickpea	10.37 ± 0.57^{c}	20.61 ± 0.33^{c}	5.53 ± 0.16^{c}	1.98 ± 0.02^{d}	3.28 ± 0.19^{c}	68.60 ± 0.69^{d}
Dark chocolate	1.20 ± 0.04^{g}	6.69 ± 0.13^{d}	19.21 ± 2.49^{b}	2.81 ± 0.02^{c}	0 ± 0^{e}	71.29 ± 2.63^{c}
Date paste	14.92 ± 0.47^{b}	2.79 ± 0.16^{f}	0.75 ± 0.03^{e}	1.66 ± 0.01^{de}	2.05 ± 0.18^{d}	92.75 ± 0.37^{b}
Date powder	3.18 ± 0.10^{f}	3.64 ± 0.12^{e}	1.32 ± 0.08^{de}	2.03 ± 0.12^{d}	1.88 ± 0.09^{d}	91.13 ± 0.72^{b}
Date dips	26.24 ± 0.08^{a}	0.82 ± 0.06^{g}	0 ± 0^{e}	1.18 ± 0.34^{e}	0.02 ± 0.01^{e}	97.98 ± 0.41^{a}
Hulled cooked pulses						
Cooked red cowpea	53.50 ± 1.09^{b}	23.09 ± 0.18^{b}	1.91 ± 0.11^{c}	1.43 ± 0.01^{b}	2.38 ± 0.55^{b}	71.19 ± 0.83^{a}
Cooked soybean	55.52 ± 0.11^{a}	34.22 ± 0.70^{a}	21.12 ± 0.15^{a}	3.66 ± 0.05^{a}	4.04 ± 0.10^{a}	36.96 ± 0.99^{b}
Cooked chickpea	50.95 ± 0.20^{c}	21.05 ± 0.17^{c}	4.77 ± 0.57^{b}	1.06 ± 0.03^{c}	1.42 ± 0.72^{b}	71.70 ± 1.44^{a}

Moisture content and caloric value were calculated as fresh weight. Means of three replicates ± SD, the number in the same column followed by a different letter is significantly different at 0.05 level

Table 2 Sensory acceptability of pulse-date sweets

Samples	Color	Sweet-ness	Odor	Taste	Mouth-feel	After-taste	Overall acceptability
Control (DP + DC)	8.65 ± 0.41^{a}	7.85 ± 0.62^{a}	8.80 ± 0.42^{a}	7.90 ± 0.74^{ab}	8.45 ± 0.59^{a}	8.15 ± 0.74^{a}	7.95 ± 0.68^{a}
RC + DP	8.40 ± 0.52^{a}	8.45 ± 0.68^{a}	8.60 ± 0.70^{a}	8.35 ± 0.53^{ab}	8.50 ± 0.97^{a}	8.40 ± 0.65^{a}	8.20 ± 0.58^{a}
RC + DD	8.40 ± 0.52^{a}	8.20 ± 0.79^{a}	8.70 ± 0.67^{a}	8.55 ± 0.49^{a}	8.60 ± 0.69^{a}	8.60 ± 0.46^{a}	8.45 ± 0.49^{a}
S + DP	8.15 ± 0.81^{a}	8.20 ± 0.67^{a}	8.60 ± 0.69^{a}	7.85 ± 1.03^{ab}	8.50 ± 0.70^{a}	8.25 ± 1.03^{a}	7.90 ± 0.94^{a}
S + DD	8.35 ± 0.58^{a}	8.00 ± 0.94^{a}	8.50 ± 0.84^{a}	7.55 ± 0.80^{b}	8.50 ± 0.71^{a}	8.30 ± 0.78^{a}	8.10 ± 0.87^{a}
C + DP	8.40 ± 0.66^{a}	8.45 ± 0.68^{a}	8.70 ± 0.48^{a}	8.60 ± 0.52^{a}	8.60 ± 0.51^{a}	8.40 ± 0.52^{a}	8.60 ± 0.53^{a}
C + DD	8.30 ± 0.78^{a}	8.40 ± 0.70^{a}	8.70 ± 0.48^{a}	8.10 ± 0.73^{ab}	8.20 ± 0.78^{a}	8.30 ± 0.67^{a}	8.35 ± 0.63^{a}

Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips. Moisture content and caloric value were calculated as fresh weight. Means of ten replicates ± SD, the number in the same column followed by a different letter is significantly different at 0.05 level

After three months of storage, there were no variations in any of the attributes between the values at the start of manufacturing and at the end of storage. It is generally acknowledged that adding cooked pulses to sweets has no substantial influence on their qualities. Incorporating various seeds into chocolate products is regarded as acceptable. In some studies, different chocolate formulations with plant-based sources had a noticeable variation in texture and flavor [36, 37]. According to Radia *et al.* [38] and Erukainure *et al.* [39], date paste can be utilized as a natural flavoring ingredient to improve consumer perceptions (flavor and taste) of the final product.

Proximate composition, phenolics, antioxidant activity, and pH of pulse-date sweets. Table 3 and Fig. 2 exhibit the proximate chemical composition of seven pulse-date sweet samples, including the control. We found that the addition of pulses significantly increased the contents of protein, fats, and crude fibers, as well as the caloric value of the samples relative to the control. The highest protein content was observed in the soybean-date powder sample followed by the soybean-date dips sample, which included cooked soybeans sweetened with date powder and syrup, respectively. Adding cooked pulses also led to a decrease in ash and carbohydrates compared to the control with a higher carbohydrate content in date paste.

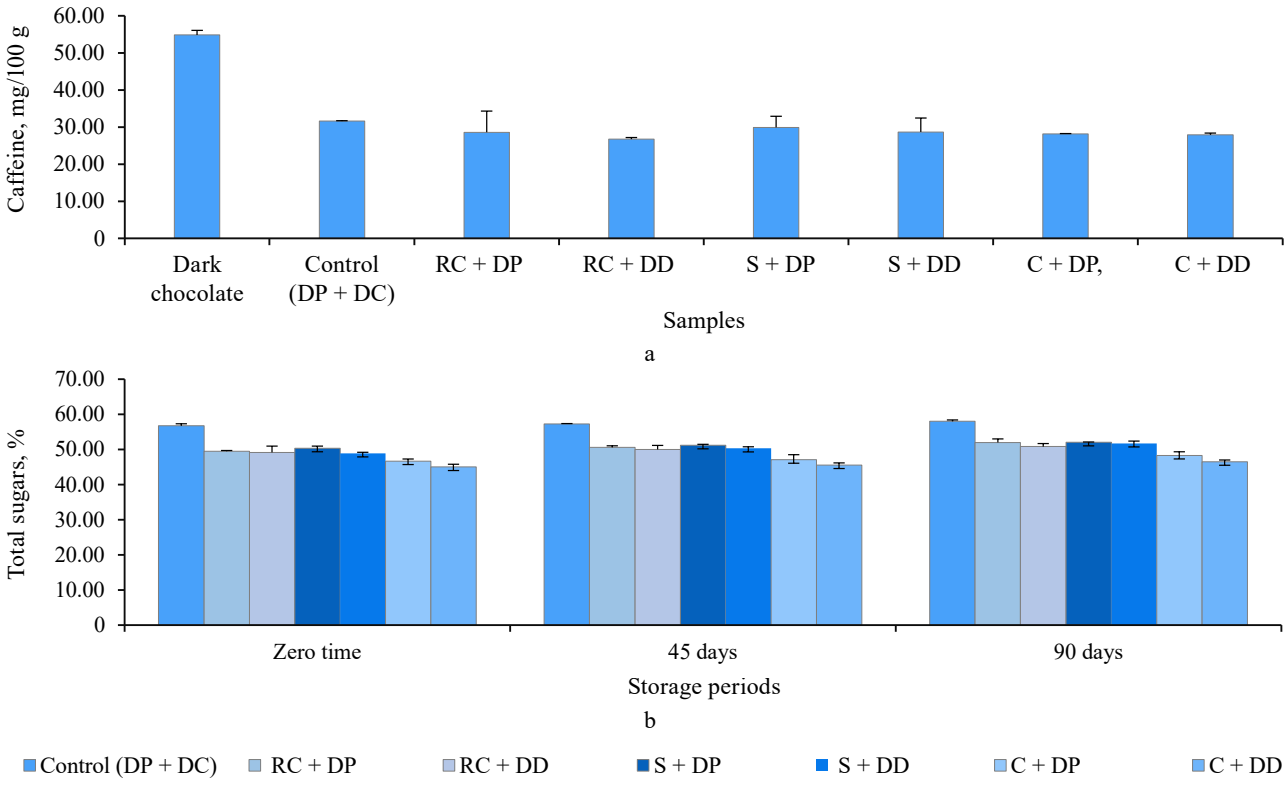
The results of Ibrahim *et al.* [40] were close to those reported by us. In addition, dried fruits are a great material for chocolate formation and have strong nutritional qualities and health benefits [41]. Ripnar *et al.* [42] found that their cluster bean-chocolate products were similar in protein contents, higher in fats and energy, and lower in carbohydrates. They also contained sufficient amounts of nutrients compared to other common chocolate products on the market.

Regarding minerals, the contents of calcium, iron, and zinc in the pulse-date sweets (121.54–137.13, 5.45–6.69, and 1.31–1.54 mg/100 g, respectively) were higher than in the control, except for the lower zinc content in the soybean-date samples. Likewise, the samples containing cooked chickpea had the highest iron content compared to the sweets with red cowpea and soybean. In general, adding cooked pulses to the date products raised their contents of the above minerals. Kumari *et al.* [36] mentioned that the chocolate product made from different ingredients had a good overall nutritional quality.

Table 3 Proximate composition, phenolics, antioxidant activity, and pH of pulse-date sweets

Samples / Constituents	Control (DP + DC)	RC + DP	RC + DD	S + DP	S + DD	C + DP	C + DD
Moisture, %	11.86 ± 0.55^{e}	20.75 ± 0.04^{b}	20.70 ± 0.05^{b}	19.00 ± 0.11^{d}	21.34 ± 0.12^{a}	19.32 ± 0.25^{cd}	19.50^{c}±0.33
Protein, % on dry weight basis	4.01 ± 0.16^{f}	6.77 ± 0.14^{d}	6.38 ± 0.27^{e}	7.79 ± 0.08^{a}	7.53 ± 0.29^{ab}	7.30 ± 0.18^{bc}	7.12^{c}±0.12
Fats, % on dry weight basis	3.85 ± 0.03^{c}	9.11 ± 0.17^{b}	9.07 ± 0.17^{b}	11.90 ± 0.28^{a}	11.50 ± 0.05^{a}	8.85 ± 0.17^{b}	8.73^{b}±0.69
Ash, % on dry weight basis	2.11 ± 0.03^{a}	1.79 ± 0.03^{a}	1.68 ± 0.20^{a}	1.76 ± 0.05^{a}	1.67 ± 0.04^{a}	1.80 ± 0.30^{a}	1.6688 ± 0.50^{a}
Crude fibers, % on dry weight basis	3.61 ± 0.27^{b}	4.13 ± 0.15^{a}	3.91 ± 0.27^{ab}	4.17 ± 0.05^{a}	4.03 ± 0.12^{a}	4.05 ± 0.10^{a}	3.88 ± 0.08^{ab}
Carbohydrates, % on dry weight basis	86.42 ± 0.50^{a}	78.20 ± 0.61^{a}	78.96 ± 0.94^{c}	74.38 ± 0.45^{b}	75.27 ± 0.48^{c}	77.99 ± 0.74^{c}	78.61 ± 0.96^{c}
Caloric value, kcal/100 g	396.39 ± 1.06^{b}	431.60 ± 8.63^{b}	422.9 ± 1.19^{a}	437.91 ± 0.89^{b}	441.43 ± 8.37^{a}	419.90 ± 1.17^{a}	419.61 ± 4.97^{a}
Calcium, mg/100 g	116.67 ± 1.61^{d}	126.92 ± 3.49^{b}	121.54 ± 2.31^{c}	137.10 ± 2.31^{a}	133.90 ± 1.85^{a}	134.82 ± 4.38^{a}	134.02 ± 2.29^{a}
Iron, mg/100 g	5.18 ± 0.75^{b}	5.74 ± 0.84^{ab}	5.54 ± 0.14^{b}	5.80 ± 1.02^{ab}	5.45 ± 0.19^{b}	6.69 ± 0.10^{a}	6.61 ± 0.06^{a}
Zinc, mg/100 g	1.50 ± 0.05^{ab}	1.54 ± 0.41^{a}	1.51 ± 0.08^{a}	1.35 ± 0.15^{a}	1.31 ± 0.38^{a}	1.45 ± 0.09^{a}	1.39 ± 0.04^{a}
Total phenolics, mg/100 g, as gallic acid	135.66 ± 0.78^{a}	108.86 ± 1.37^{b}	96.40 ± 0.72^{de}	104.70 ± 0.72^{c}	98.35 ± 0.29^{d}	94.56 ± 1.09^{e}	86.29 ± 4.26^{f}
Antioxidant activity, %, as DPPH	73.38 ± 0.35^{a}	73.21 ± 0.26^{a}	67.35 ± 0.26^{c}	71.85 ± 0.18^{b}	62.39 ± 0.05^{d}	57.54 ± 0.05^{e}	49.20 ± 1.38^{f}
pH	7.36 ± 0.38^{a}	6.78 ± 0.10^{b}	6.83 ± 0.05^{b}	6.68 ± 0.07^{b}	6.64 ± 0.05^{b}	6.72 ± 0.07^{b}	6.66 ± 0.03^{b}

Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips. Means of three replicates ± SD, the number in the same row followed by a different letter is significantly different at 0.05 level



Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips. Values are means of three replicates ± SD

Figure 2 Caffeine (a) and total sugars (b) in pulse-date sweet samples

As for phenolics, their contents varied between 86.29 and 108.86 mg/100 g sample. The control sample, which contained only date paste and dark chocolate, had a higher content of phenolics (135.66 mg/100 g) than the other samples. The highest antioxidant activity was in both the control and the red cowpea-date powder sample (73.38 and 73.21%, respectively). This might be due to the type of phytochemicals in those samples [12]. It was clear that the samples sweetened with date powder had higher antioxidant activity than those sweetened with date dips.

Figure 2a shows the caffeine content in dark chocolate and the date sweets prepared from cooked pulses. Dark chocolate, which was used for comparison, contained 54.82 mg caffeine/100 g, which was significantly ($p < 0.05$) higher than in the other sweet samples (26.76–29.92 mg/100 g). This variation in caffeine contents may be due to the differences in the pulse and date types, as well as moisture content. Since the control sample contained only dark chocolate and date paste, its caffeine level was higher (31.62 mg/100 g) than in the other samples. The lowest caffeine level was found in the red cowpea-date dips sweet. Overall, the sweet samples had lower caffeine contents than the maximum allowed concentrations. According to Vuletić *et al.* [26], food labels have to specify the exact amount of caffeine in the product (beverages and chocolate) to avoid overdose health risks. The Food and Drug Administration limits the maximum amount of caffeine to 45 mg/day for children aged 4–6 years, 62.50 mg/day for children aged 7–9, and 85 mg/day for those aged 10–12 [43]. Caffeine intoxication and an overstimulated central nervous system may result from an acute caffeine overdose, often exceeding 250 mg per day [44].

Regarding pH values, the control sample (date paste mixed with dark chocolate) had a significantly ($p < 0.05$) higher pH value (7.36) than the other samples. The sweets had varying pH values depending on their ingredients and processing methods. The measurement of pH in food products ensures consumer health and acceptability since it affects two key aspects of food safety: consistency and quality [45].

As for total sugars, the findings revealed a significant ($p < 0.05$) decrease in total sugars across all the samples compared to the control (Fig. 2b). Likewise, the pulse-date samples containing chickpeas and sweetened with date powder or syrup had the lowest amount of sugars compared to the other pulses. Conversely, as storage times extended, the overall sugar content somewhat increased.

Daily intake of some nutrients in pulse-date sweets. The daily intakes of protein, calories, calcium, iron, and zinc were calculated for females and males aged 4–18 years (schoolchildren) based on the proximate chemical composition (Table 2) for the control and pulse-date sweets (Table 4). According to the results,

Table 4 The daily intake of some nutrients in pulse-date sweets (100 g) for different age groups

Children age group	Nutrients	DRI	Control (DP + DC)	RC + DP	RC + DD	S + DP	S + DD	C + DP	C + DD
From 4–8 y. o.	Protein, g/day	19	21.11	35.63	33.58	41.00	39.63	38.42	37.47
	Calories, kcal/day,								
	Female	1200	33.03	35.97	35.25	36.49	36.79	34.99	34.97
	Male	1500	26.43	28.78	28.20	29.19	29.43	27.99	27.97
	Calcium, mg/day	1000	11.67	12.70	12.15	13.71	13.39	13.48	13.40
	Iron, mg/day	10	51.80	57.40	55.40	58.00	54.50	66.90	66.10
	Zinc, mg/day	5	30.00	30.80	30.20	27.00	26.20	29.00	27.80
From 9–13 y. o.	Protein, g/day	34	13.63	19.91	18.74	22.91	22.15	21.47	20.94
	Calories, kcal/day								
	Female	1600	24.77	26.98	26.43	27.37	27.59	26.24	26.23
	Male	1800	22.02	23.98	23.50	24.33	24.52	23.32	23.31
	Calcium, mg/day	1300	8.97	9.76	9.35	10.55	10.30	10.37	10.31
	Iron, mg/day	8	64.75	71.75	69.25	72.25	68.12	83.62	82.62
	Zinc, mg/day	8	18.75	19.25	18.89	16.87	16.37	18.12	17.37
From 14–18 y. o.	Protein, g/day								
	Female	46	8.72	14.72	13.87	16.93	16.37	15.87	15.48
	Male	52	7.71	13.02	12.27	14.98	14.48	14.04	13.69
	Calories, kcal/day								
	Female	1800	22.02	23.98	23.50	24.33	24.52	23.32	23.31
	Male	2800	14.16	15.52	15.11	15.64	15.77	14.99	14.99
	Calcium, mg/day	1300	8.97	9.76	9.35	10.55	10.30	10.37	10.31
	Iron, mg/day								
	Female	15	34.53	39.27	36.93	38.67	36.33	44.60	44.07
	Male	11	47.09	52.18	50.36	52.72	49.54	60.81	60.09
	Zinc, mg/day								
	Female	9	16.67	17.11	16.78	15.00	14.55	16.11	15.44
	Male	11	13.64	14.00	13.73	12.27	11.91	13.18	12.63

DRI – Dietary Reference Intake [21], calories were calculated based on RDA – Recommended Dietary Allowance [22], Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips

Table 5 Color values of pulse-date sweet samples

Parameters / Samples	Outer color			Inner color		
	*L**	*a**	*b**	*L**	*a**	*b**
Control (DP + DC)	43.70 ± 0.15^{e}	2.67 ± 0.16^{abc}	1.62 ± 0.08^{bc}	46.31 ± 0.05^{d}	3.72 ± 0.04^{f}	3.64 ± 0.40^{g}
RC + DP	46.36 ± 0.33^{a}	1.92 ± 0.08^{d}	1.00 ± 0.02^{e}	57.86 ± 1.56^{a}	4.30 ± 0.035^{e}	16.74 ± 0.13^{c}
RC + DD	45.79 ± 0.31^{b}	1.97 ± 0.04^{d}	1.22 ± 0.02^{de}	51.03 ± 1.01^{b}	5.78 ± 0.05^{a}	9.00 ± 0.29^{f}
S + DP	44.76 ± 0.11^{c}	$3.06 \pm 0.3.06^{ab}$	2.10 ± 0.42^{a}	58.06 ± 0.85^{a}	5.21 ± 0.06^{c}	21.69 ± 0.24^{a}
S + DD	44.10 ± 0.34^{de}	3.26 ± 0.56^{a}	1.88 ± 0.22^{ab}	49.00 ± 0.07^{c}	5.43 ± 0.18^{b}	14.44 ± 0.23^{d}
C + DP	45.35 ± 0.29^{b}	2.11 ± 0.02^{cd}	1.52 ± 0.09^{cd}	59.45 ± 0.13^{a}	5.01 ± 0.04^{d}	18.40 ± 0.09^{b}
C + DD	44.26 ± 0.11^{d}	2.51 ± 0.02^{bcd}	1.78 ± 0.06^{abc}	50.81 ± 0.12^{b}	5.35 ± 0.02^{b}	12.86 ± 0.56^{e}

Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips, *L** – lightness, *a** – redness, and *b** – yellowness. Means of three replicates ± SD, the number in the same column followed by a different letter is significantly different at 0.05 level

schoolchildren aged 4–18 years can eat about 3 sweets per day as a snack to cover some part of their daily requirements in protein, calories, calcium, iron, and zinc. The sweets prepared from cooked pulses were higher in these minerals, especially iron, which was consistent with [46]. As for zinc, the pulse-date sweets can provide 4–8-year-olds (both females and males) with 26.20 to 30.80% of their daily requirement, the highest zinc content compared to the other age groups. Abedini *et al.* [19] found that high-value plant-based constitutes could be added to chocolate-based products to enhance their nutritional value. The qualitative characteristics of date-based products enhance their potential as nutritious snacks [47].

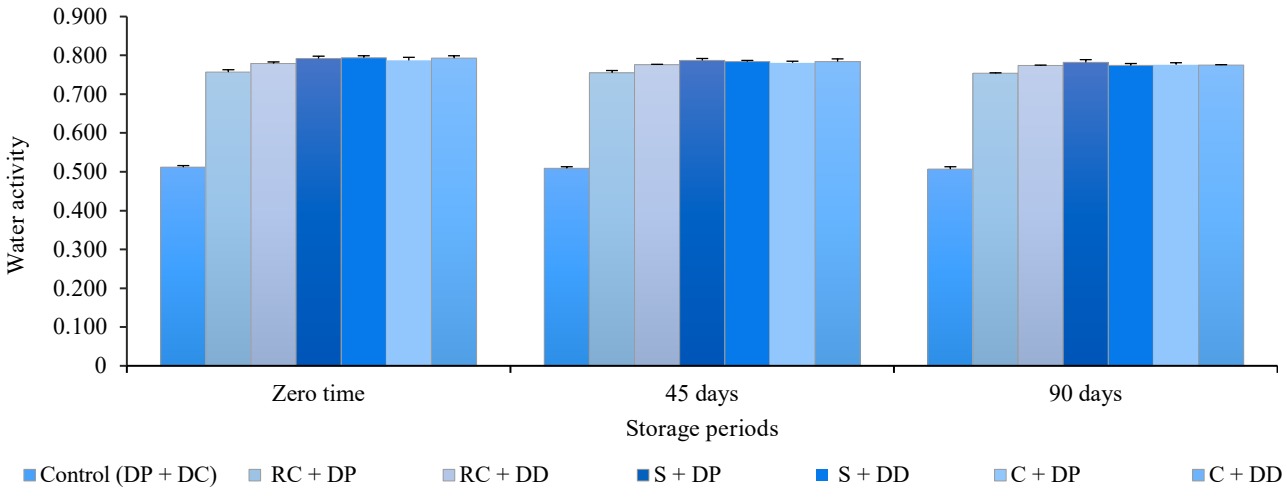
Color of pulse-date sweets. Various optical phenomena, such as scattering and the shape of the food surface, can influence the color of the food being consumed [48]. Table 5 displays the color measurements for the pulse-date sweet samples. As can be seen, adding cooked pulses considerably raised the lightness (*L**)

values of the inner and outer colors in all the sweet samples compared to the control. This might be attributed to the light color of cooked pulses in comparison with dark chocolate. Furthermore, the inner color of the sweets had higher brightness values than the outer color. Similarly, addingdate dips lowered the lightness. In terms of redness (a^*) and yellowness (b^*), adding date dips increased the redness values across all the samples while decreasing their yellowness. Additionally, the yellowness values of the soybean samples were higher than those of the other pulse samples and the control, which might be due to the yellow color of soybean seeds. The color of food products is affected by many factors, such as processing methods, the presence of pigments, variety type, as well as packaging and storage conditions. Consequently, the food's quality can be managed by examining its color parameters and assessing the changes in its chemical composition [49].

Water activity of pulse-date sweets. Water is an essential component in food. It is crucial for the industry to monitor free water since it can be used for microbiological growth and chemical reactions. The measurement of water activity (a_w) can have a significant impact on the product's quality and is highly useful in food preservation [50]. Figure 3 presents the a_w values of the pulse-date sweet samples during storage. The data demonstrated that using cooked pulses in sweets had a significant ($p < 0.05$) effect on the water activity before storage (at zero time) compared to the control. In particular, the water activity varied between 0.757 and 0.793, which might be due to the moisture content in the cooked pulses. These results were close to those reported by Ibrahim *et al.* [51]. The water activity slightly decreased in all the samples after storage for three months, ranging within 0.755–0.787 and 0.754–0.782 during 45 and 90 days, respectively. The control sample recorded the lowest water activity (0.512, 0.509, and 0.507 after storage for 0, 45, and 90 days, respectively). The relationship between the level of water activity and the sample's humidity levels should be considered as these two parameters are highly proportional [52]. Preetha & Narayanan [53] found that chocolate candies, dried fruit (e.g., dates and figs), nuts, rolled oats, and malt extract had water activity values ranging between 0.650 and 0.750.

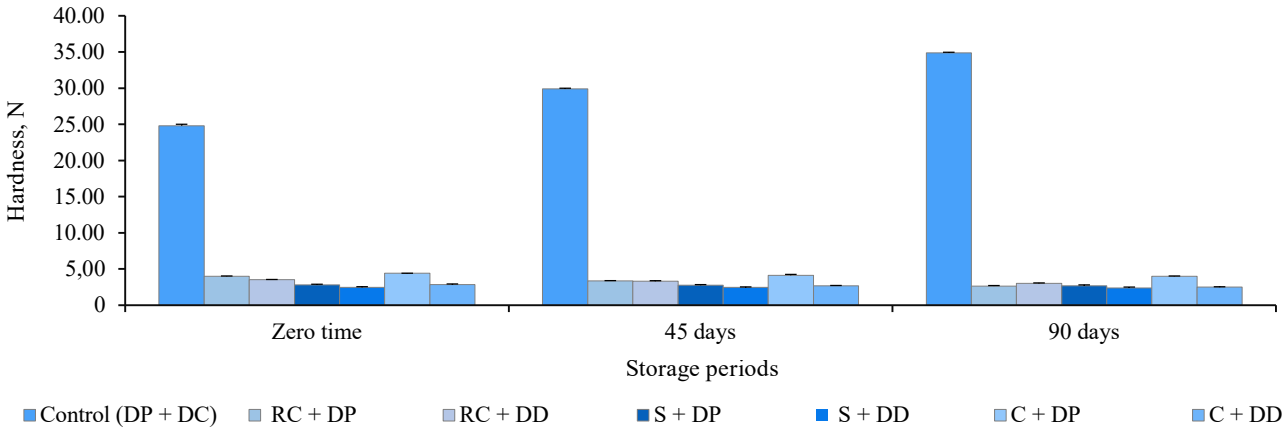
Hardness. Figure 4 illustrates a side view of the pulse-date sweets' texture during a three-month storage period. We found that the hardness of the sweets was significantly reduced when part of the dates and dark chocolate mixture was replaced with cooked pulses. In particular, the hardness values reached 4.02, 3.53, 2.82, 2.48, 4.41, and 2.84 N at zero time for the red cowpea samples sweetened with date powder and date dips, the soybean samples sweetened with date powder and date dips, and the chickpea samples sweetened with date powder and date dips, respectively. The control sample recorded the highest hardness value of 24.81 N. After storage for 90 days, the results showed an increase in hardness in the control and a further slight decrease in the samples [54]. Additionally, the samples that contained date dips were softer than those containing date powder. This could be due to different moisture contents in both the ingredients and the pulses affecting the texture of the final product, which aligned with the findings of Sayas-Barberá *et al.* [55].

Microbiological examination. The microbiological quality of food is essential for consumers' health and safety. Figure 5 shows changes in the microbial counts (total plate count, yeasts and molds) of the pulse-date sweet samples before and after storage periods (90 days). There was a decrease in molds and yeasts after storage in all the samples. This reduction could be attributed to the decrease in water activity and the content of total sugars, as well as to the presence of phytochemicals with antioxidant properties acting as antimicrobial agents [56].



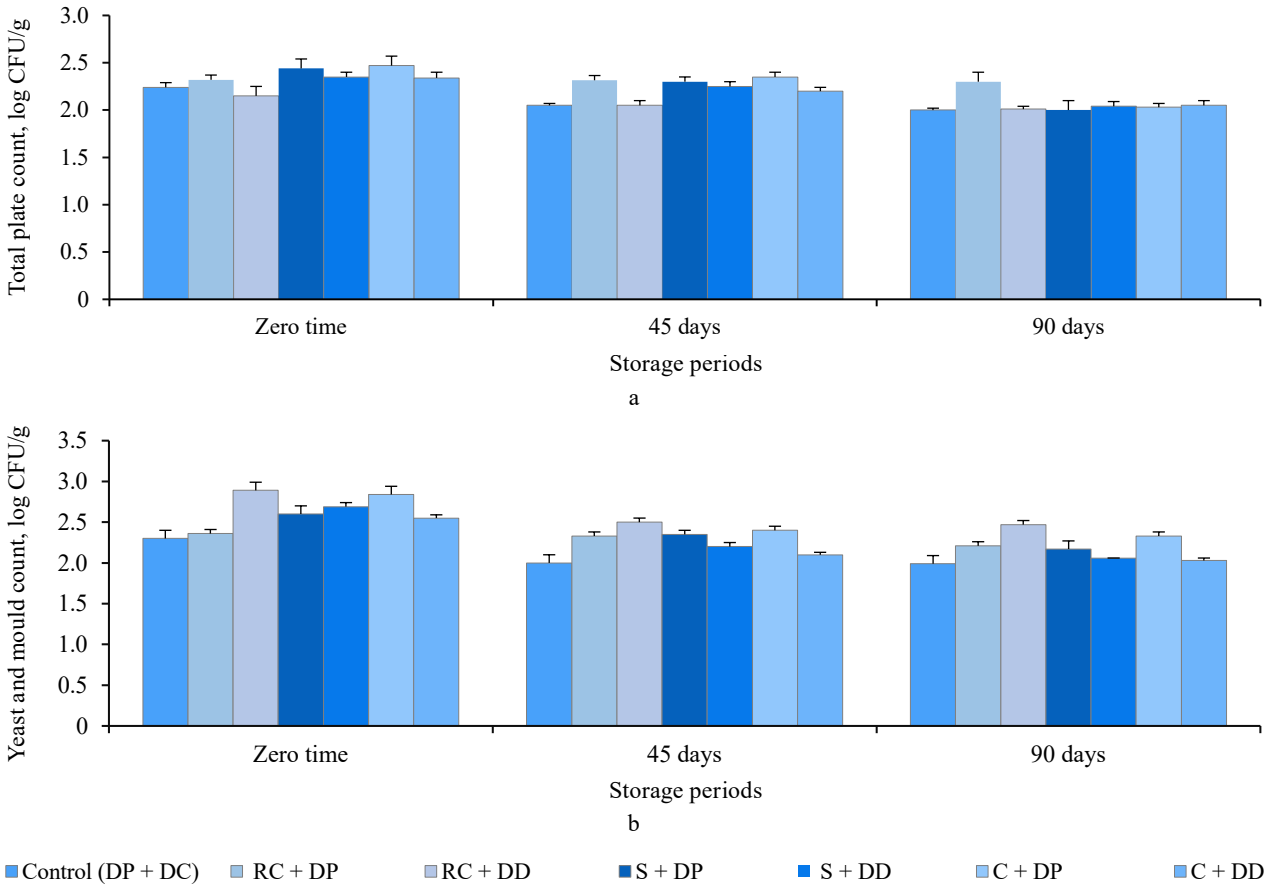
Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips. Values are means of three replicates ± SD

Figure 3 Water activity of pulse-date sweet samples



Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips. Values are means of three replicates ± SD

Figure 4 Hardness of pulse-date sweet samples during storage



Control (DP + DC) – date paste mixed with dark chocolate, RC + DP – red cowpea with date powder, RC + DD – red cowpea with date dips, S + DP – soybean with date powder, S + DD – soybean with date dips, C + DP – chickpea with date powder, and C + DD – chickpea with date dips. Values are means of three replicates ± SD

Figure 5 Total plate (a) and yeast and mold (b) counts of pulse-date sweets during storage

Agamy *et al.* [47], who studied dates and date-based products, reported values of below 10^4 CFU/g for yeasts and molds and 10^5 CFU/g for the total plate count. According to Snyder *et al.* [57], microorganism growth could occur in food products with water activity up to 0.850. Abedini *et al.* [19] reported that the shelf life of chocolate-based products could be extended by fortifying them with some plant-based ingredients. Foods high in carbs are susceptible to spoilage by microbes that ferment carbohydrates, such as yeasts and molds [55].

CONCLUSION

There is a growing demand for highly-nutritious healthy products, including alternatives to sweets without processed sugar. In response to this demand, we formulated date-based sweets filled with cooked pulses, such as red cowpeas, soybeans, and chickpeas, using date powder or date dips as alternative sweeteners. The pulses improved the nutritional characteristics and flavor of the samples and proved a reasonable source of protein, bioactive components, calcium, iron, and zinc. The sweet products also had high sensory acceptability, especially the samples containing red cowpeas and chickpeas.

Thus, these constituents can be effectively applied to prepare pulse-date sweets with functional properties. Overall, our study revealed an efficient technique for mixing different cooked pulses with dates to create new nutritious food products in a variety of shapes and textures for all consumer categories.

CONTRIBUTION

All the authors contributed to the design and concept of this study and were equally involved in the data collection and analysis, investigation, preparation, writing, and revision of the manuscript. All the authors have read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS APPROVAL AND CONSENT TO PARTICIPATION

The sensory evaluation was conducted following the rules and criteria of the Food Technology Research Institute, Agricultural Research Center. The participants were provided with full information about the study and the products to be tasted before they gave their consent to participate in the research

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ORCID IDs
Azza A. Omran https://orcid.org/0000-0002-9328-8087
Nadra S.Y. Hassan https://orcid.org/0009-0007-8370-4028
Abd Elaziz M. Hanaa https://orcid.org/0009-0005-3733-990X