Hindawi
Journal of Food Quality
Volume 2018, Article ID 9565931, 9 pages
https://doi.org/10.1155/2018/9565931

Research Article

Preparation of a Natural Candy from Date (*Phoenix dactylifera* L.), Olive (*Olea europaea* L.), and Carob (*Ceratonia siliqua* L.) Fruits

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Received 28 January 2018; Revised 28 April 2018; Accepted 22 May 2018; Published 26 June 2018

Academic Editor: Marina Carcea

Until the early 1960s, the traditional recipe "Arkouy" from the mixture of carob (*Ceratonia siliqua* L.) powder and olive (*Olea europaea* L.) oil represented a sought-after food product in some localities of the Kabylian region (Northeastern Algeria). The present work attempted to improve this traditional recipe to obtain a natural candy from date (*Phoenix dactylifera* L.), olive (*Olea europaea* L.), and carob (*Ceratonia siliqua* L.) fruits. For this, different formulations with various proportions of the date paste, olive paste, and carob powder were obtained using a constrained mixture design (proportion of date paste ≥ 0.7). The hardness and total color difference in the CIELab system were adopted as dependent variables. For comparison purpose, the local commercial candy "Caprice" was taken as reference. In addition, the two formulations containing the three basic ingredients were analyzed for the overall acceptability, reducing power, and thermal analysis. At first approximation, it can be said that the formulation containing 75% date paste, 20% carob powder, and 5% olive paste ensures a balance between the target values of texture and color. The obtained candy can be used as a dietary supplement for all categories of consumers, especially patients with swallowing difficulties.

1. Introduction

Consumer interest in natural products is now a global trend. This tendency manifests itself in new concepts of types "functional food," "Vitafood," and "nutraceuticals," formally expressing the relationship between diet and health.

From socioeconomic and cultural point of view, the date palm (*Phoenix dactylifera* L.) is for the Sahara people and the olive tree (*Olea europaea* L.) is for the Mediterranean, that is, nutritive trees. Thus, Al-Shahib and Marshall [1] wondered if, in many ways, date fruit does not deserve the status of an ideal food, considering its nutritional value and potential health benefits, whereas the olive tree has a long history of medicinal and nutritional values [2]. Furthermore, in Islamic faith, the three fruit species studied here figure significantly in *Quran* (case of date and olive fruits) [3] or in the traditions of Prophet Muhammad [4].

Candy is defined as preparations of sugar, honey, or other natural or artificial sweeteners in combination with chocolate, fruits, nuts, or other ingredients or flavorings in the form of bars, among others [4, 5]. It was established that one of the options for food security and the fight against poverty is a developing ready-to-consume foods, including compressed bars [6]. The bar itself is defined as a combination of ingredients which gives the food strength and low water content, providing a source of nutrients as opposed to candies that are consumed as sweetened products [7]. Quite recently, a formulation of date fruit-based bars was investigated [8]. In addition, energy bars for military were also studied [8, 9]. For their part, Garcêz de Carvalho et al. [10] have developed various formulations of cereal bars from three types of Brazil nuts. Tarar et al. [11] evaluated the biological value of food bars prepared from fermented chickpea. More recently, Mamatha and Prakash [12] investigated nutritional and sensory quality of iron fortified

sweet-sour tamarind fruit candies. However, it should be stressed that conventional food bars are usually added with purified ingredients. A palmyrah palm (*Borassus flabellifer* L.) or date palm (*Phoenix dactylifera* L.) sap-based sugar rich product "jaggery"was reported to be used for preparation of sweet confectionary items [13]. Today, the development of functional foods imposes the use of edible fats with no undesirable *trans*-fatty acids, instead of those such as obtained by common hydrogenation process [14].

In the Kabylian region (Northeastern Algeria), olive oil is still associated with almost all types of foods [15], making the latter more appetizing and more beneficial to health. Thus, it was revealed that an olive oil-enriched diet may be more efficacious for weight loss in breast cancer survivors than a standard lower-fat diet [16]. Until the early 1960s, the traditional recipe "Arkouy" from the mixture of carob (*Ceratonia siliqua* L.) powder and olive (*Olea europaea* L.) oil represented a sought-after food product in some localities of this region. In our view, the recipe has fallen into oblivion due to the change in the lifestyle of the population, availability of white sugar, semolina, industrial confectionery, and so on. However, as already underlined for arid foods, processing of traditionally important Saharan and mountain foods into more useful and convenient product can improve livelihood security of the people of concerned regions [17]. Reflecting this trend, the feasibility of a nutritional paste from the mixture of date powder and olive oil was experimented on [18].

The present work was an attempt for improving the traditional recipe "Arkouy" with a view to obtain a natural dietary candy from date (*Phoenix dactylifera* L.), olive (*Olea europaea* L.), and carob (*Ceratonia siliqua* L.) fruits. As far as we know, such formulation has never been investigated, apart from the feasibility aspect [19]. As noticed above, the three used Mediterranean raw materials are well recognized for their functional and nutritional properties.

2. Experimental

2.1. Olive Paste (OP), Date Paste (DP), and Carob Powder (CP). Olive paste is obtained from pitted olives, preliminary open-air dried in the traditional way, as that is still applied in the locality of Barbacha in the region of Bejaia (200 km east of Algiers). The water content of the olive flesh is about 0.25 gm·gm^{-1} of fresh material (fm).

To our knowledge, date paste has never been studied even if multinutritional blocks for animal feed have already been described in the literature [20–22]. Presently, date fruits are first washed, pitted, and then ground to obtain a homogeneous date paste.

In addition to fiber and sugars, the carob powder contains a substantial amount of proteins with a concentration of 0.06 gm·gm^{-1}, in the case of Egyptian species [24]. In this work, the carob powder was obtained by drying carob pods (at 40°C, until constant weight), crushing, and sieving (380 μm) in order to obtain a uniform particle size powder.

2.2. Natural Dietary Candy Preparation. The procedure to obtain the various natural dietary candy is shown schematically in Figure 1, while the applied constrained mixture design (date paste proportion ≥ 0.70) is shown in Table 1. The dependent variables (responses) are as follows: (1) the hardness, as indicator of texture, determined by means of a Shore-A durometer with a scale graduated from 0 (softer) to 100 (harder), and (2) the total color difference ΔE^* measured in the CIELab system using a CM chromameter 2500d Minolta(Japan): L^* = whiteness (0: completely black; 100: completely transparent), a^* (−60: green; 60: red), and b^* (−60: blue; 60: yellow). ΔE^* indicates the difference between L^*, a^*, and b^* values of prepared candies and those of commercial (reference) "Caprice" (local caramel candy):

$$\Delta E^* = \left[\left(\Delta L^*\right)^2 + \left(\Delta a^*\right)^2 + \left(\Delta b^*\right)^2\right]^{(1/2)}. \quad (1)$$

Surface responses and contour curves were constructed using Minitab 17 software (trial version).

It is pertinent to recall that the color and texture are key factors affecting sensory perception and consumer acceptance of foods [25].

Hardness covers many food attributes such as elasticity, plasticity, brittleness, and toughness [26]. Shore-A durometer is particularly recommended for especially surveying "soft-diet" species [27].

The total color difference (ΔE^*) was intended to be a single number metric for Pass/Fail tolerance decisions

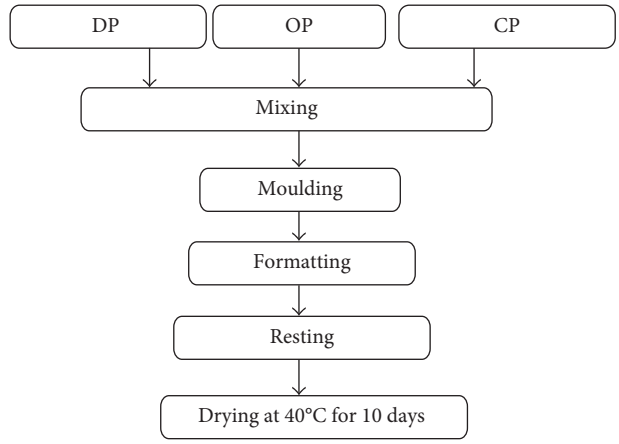

Figure 1: Diagram of preparation of candies. DP: date fruit paste; OP: olive fruit paste; CP: carob fruit powder.

Table 1: Design matrix.

Formula	Proportion of			Responses	
	DP	OP	CP	Hardness	ΔE^*
A	1	0	0	58.14	14.12
B	0.7	0.3	0	63.23	13.18
C	0.7	0	0.3	85.90	8.98
D	0.85	0.15	0	58.57	6.48
E	0.85	0	0.15	68.20	31.56
F	0.7	0.15	0.15	65.56	13.80
G	0.8	0.10	0.10	61.66	5.63
Reference[1]	—	—	—	85.55	—

[1]Commercial candy "Caprice"; DP: date fruit paste; OP: olive fruit paste; CP: carob fruit powder; ΔE^*: total color difference.

since a ΔE^* tolerance value defines an acceptance sphere around the target color [28]: the lower the ΔE^* value is, the closer the sample is to the standard.

Each mixture sample, formed into bar shape (4 cm × 1 cm × 1 cm) is subjected to drying in an oven (40°C) to give the product of a desired texture: the finished product must be firm and should not stick to the hand. It should be noted that the shape and dimensions of the examined bars are adjustable as desired.

2.3. Thermogravimetry (TG) and Differential Scanning Calorimetry (DSC). The calorimetric information from DSC can be used to characterize the structure and properties of food systems before and after processing and storage conditions and to understand the thermal transitions that the food system may undergo during processing or storage [29]. In fact, taking into account the nature of employed ingredients, the investigated natural dietary candy itself may be used as ingredient in other baked confectionaries. Thus, the effect of replacing cocoa powder by carob flour in gluten-free cakes baked at 200°C was evaluated [30], whereas the use of date paste as date syrups as sweetening agent was widely described in the literature [31, 32]. Spanish multinational Natra raised the profile of Spanish chocolate by combining it with, among others, olive oil to trade on consumer perceptions of a healthy Mediterranean lifestyle [33].

The two formulas F and G and their three basic components were analyzed by thermogravimetry (TG) and differential scanning calorimetry (DSC). The TG and DSC curves were obtained using a calorimeter of type STA 409 PC LUXX. A heating rate of 5°C/min and a scanning range between 20 and 200°C were used throughout the study.

2.4. Reducing Power (RP). The RP (in mg of ascorbic acid equivalents (AAE) per gram of candy) indicates the ability of antioxidant substances to reduce Fe^{3+} to Fe^{2+}. It was determined according to Oyaizu [34].

2.5. Acceptability Test. The general acceptability test is conducted by a panel of 35 untrained panelists (students and teachers of the University of Boumerdes) using a 9-point hedonic scale: 1, extremely disagreeable (ED); 2, very disagreeable (VD); 3, disagreeable (D); 4, quite disagreeable (QD); 5, neither disagreeable nor agreeable (NDNA); 6, quite agreeable (QA); 7, agreeable (A); 8, very agreeable (VA); and 9, extremely agreeable (EA).

3. Results and Discussion

3.1. General Aspect of Natural Dietary Candy. By general aspect, we believe the following summary characteristics of natural dietary candy: (1) visual observations (color and shape) and (2) perception of texture (firmness). However, it is important to note that the visual assessment of the objects is also influenced by several other factors such as socio-cultural conditions of the observer [35]. The specific structure of the used components (fluidity of olive paste and the powdery nature of carob powder) has led us to impose a constraint on the date paste proportion (≥70%) (Table 1); otherwise, the bars are nonfeasible.

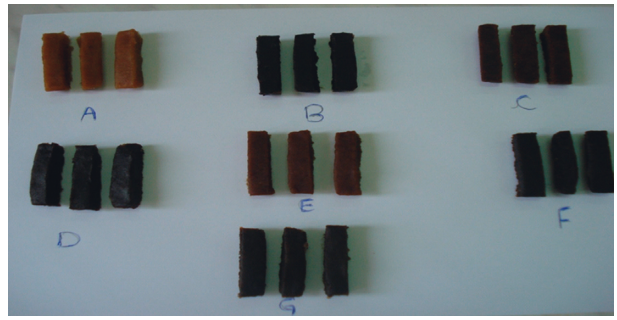

Figure 2: Physical aspect of obtained candy samples. See Table 1 for composition of samples.

Photos in Figure 2 represent the final product samples obtained when the two previous criteria were judged satisfactory. As can be seen, the samples appear firm and uniform, whereas the color seems to be strongly influenced by the composition of natural dietary candy samples.

3.2. Hardness. Natural dietary candies are supposed to present a mechanical behavior consistent with consumer expectations. We recall that the textural properties were evaluated through hardness, taking as reference the local commercial candy "Caprice." The response surface and contour curves (Figures 3(a) and 3(b)) clearly indicate that the values of hardness increase strongly with increase in the proportion of the carob powder and that the hardness values which are close to the reference candy are localized between light green and intense dark green areas of the response surface corresponding to the following average composition (Figure 3(b)): DP: 75%, CP: 20%, and OP: 5%.

Therefore, in addition to the food value, the carob powder can be regarded as thickening and plasticizing ingredient, while the date paste and olive paste seem to be softeners and fluidizing agents. We believe that the hardening phenomenon can be attributed to two independent physicochemical mechanisms, by analogy with that has already been described for cakes [36]: (1) the removal of the water from the food product and (2) the firming process, in relation to the intra- and intermolecular various changes, including the water and oil holding power of the carob powder [19]. Moreover, it was reported that the sugar/water mixtures [37] and mixtures of vegetable oils [38] show plastic properties.

3.3. Color. The color determines to a large extent (40% in average) the food acceptability by consumers [39]. The response surface showed the contribution of each component in the formation of the final color of the natural dietary candies. The desired low values of ΔE^* are achieved when the fraction of the olive paste is minimum (Figures 4(a) and 4(b)). As it can be observed, only a small region of the experimental field gives values of ΔE^* quite low (≤6). Only

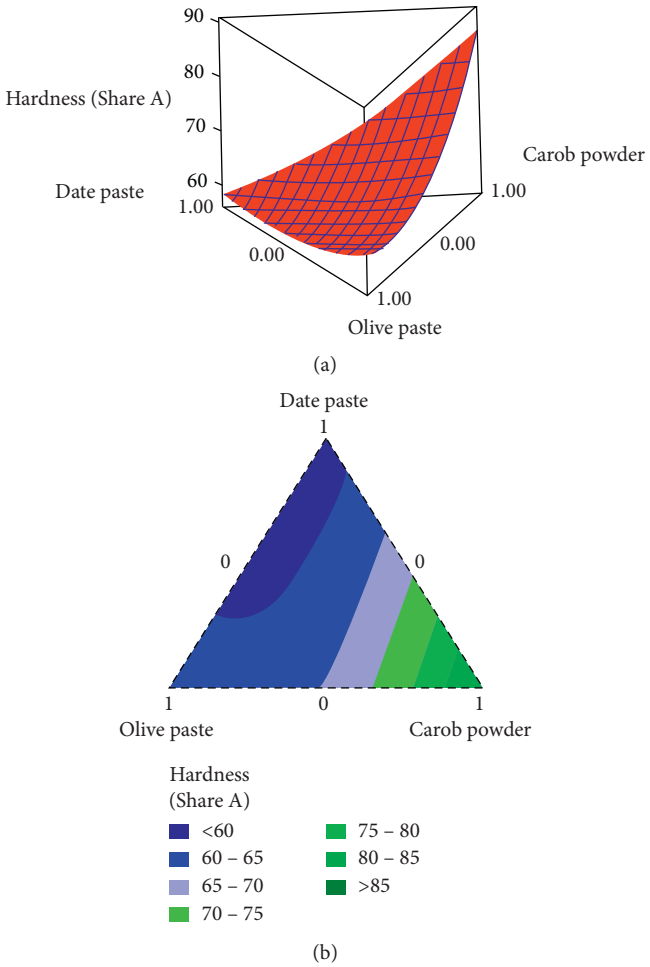

Figure 3: Response surface (a) and contour curve (b) related to the variation of candy hardness on function of proportions of basic components.

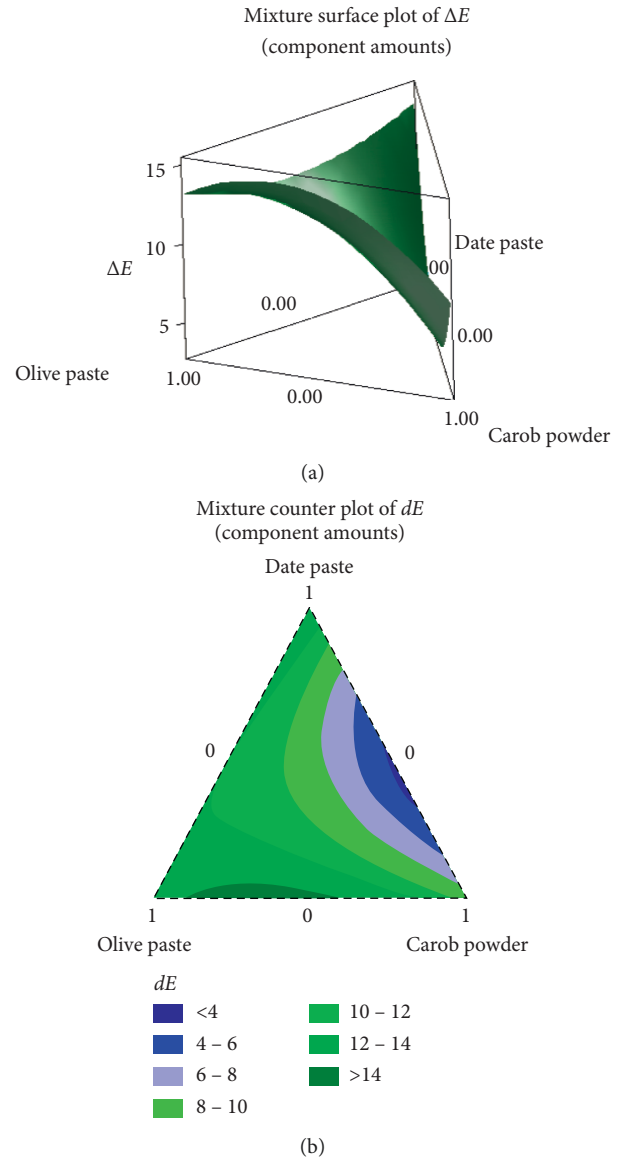

Figure 4: Response surface (a) and contour curve (b) related to the variation of candy total color difference hardness (ΔE^*) on function of proportions of basic components.

by chance, this region included the optimum value of hardness (see the blue area of Figure 4(b) and medium green area of Figure 3(b)). In this connection, Sun-Waterhouse et al. [40] obtained ΔE^* values ranged between 0.96 and 7.82 for fruit bars. Among all tested formulations, F and G appear to be closer to the aforementioned optimal composition (see also Table 1). So, they will be the subject of some further analyses described below.

3.4. DTA and DSC. Figure 5 shows curves of DSC and TGA for initial employed components. The results revealed that there were more or less pronounced endothermic and exothermic peaks for the three samples. These thermal effects were accompanied by a distinct and fairly uniform weight drop. This finding could be attributed principally to the release of free and bound water. It is well known that the presence of moisture in material gives a broad endothermic peak due to evaporation of water [41].

However, the highest loss of samples weight occurred at about 50°C for all samples. At this temperature, the DSC curve became slightly concave in the case of date paste (Figure 5(a)), compared to olive paste (Figure 5(b)) and carob powder (Figure 5(c)). This difference in behavior may be due to the difference in basic chemical composition between the three products: presence of water and sugar (case of date paste), water and oil (case of olive paste), and sugar and protein (case of carob powder). The second endothermic peak appeared at higher temperatures (120–125°C) for date paste and olive paste and may be attributed to the onset of the evaporation of bound water as that was observed for chitosan and carboxymethyl chitosan [42]. An exothermic peak was observed for date paste at about 168°C, indicating very probably a crystallization of sucrose [43]. Regarding the carob powder, the second endothermic peak was observed at 180°C. According to the literature data about melting behavior of D-sucrose, D-glucose, and D-fructose [44], we think that this peak reflects the melting point of sucrose.

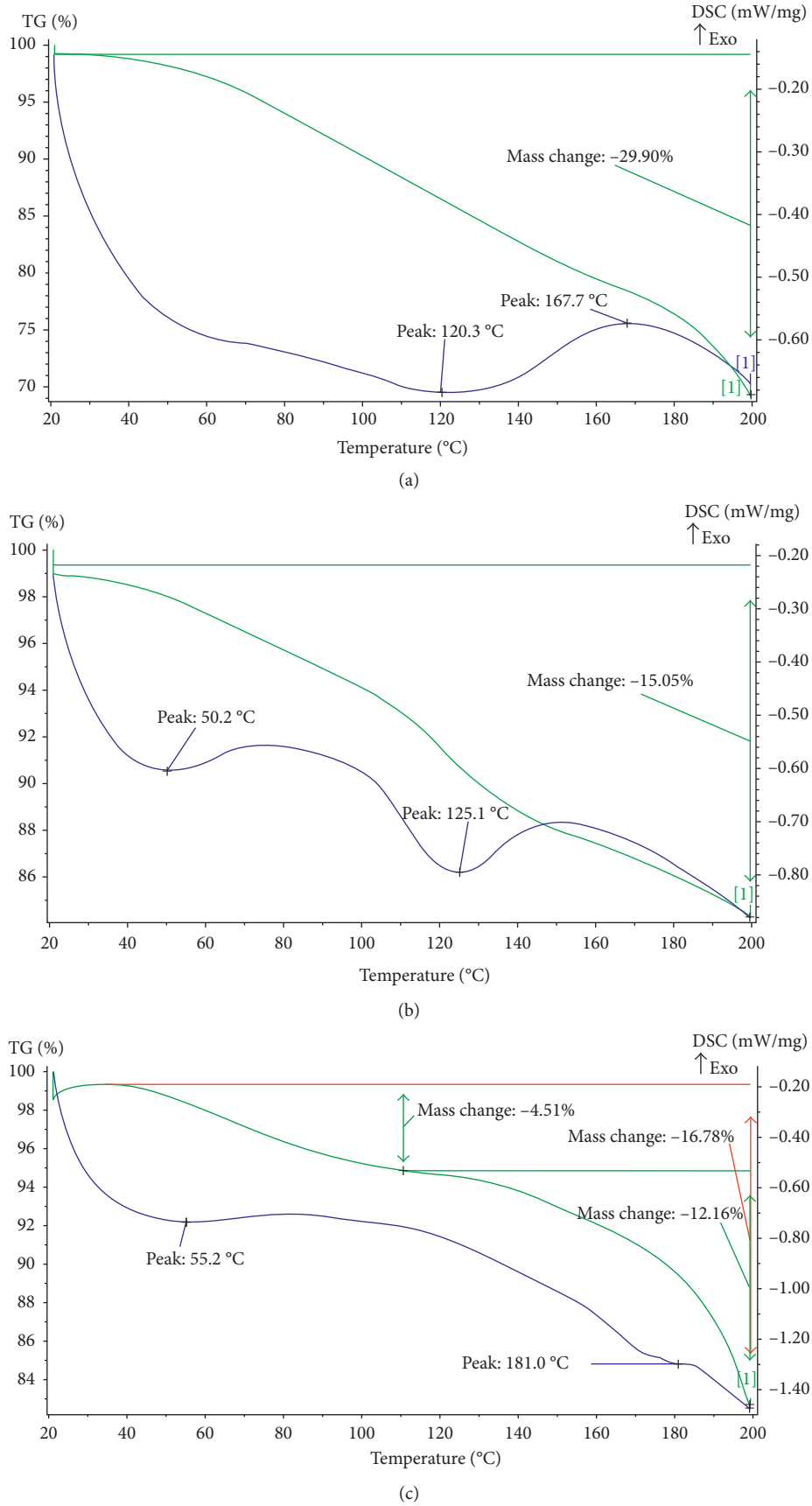

Figure 5: Thermograms of DP (a), OP (b), and CP (c). DP: date fruit paste; OP: olive fruit paste; CP: carob fruit powder.

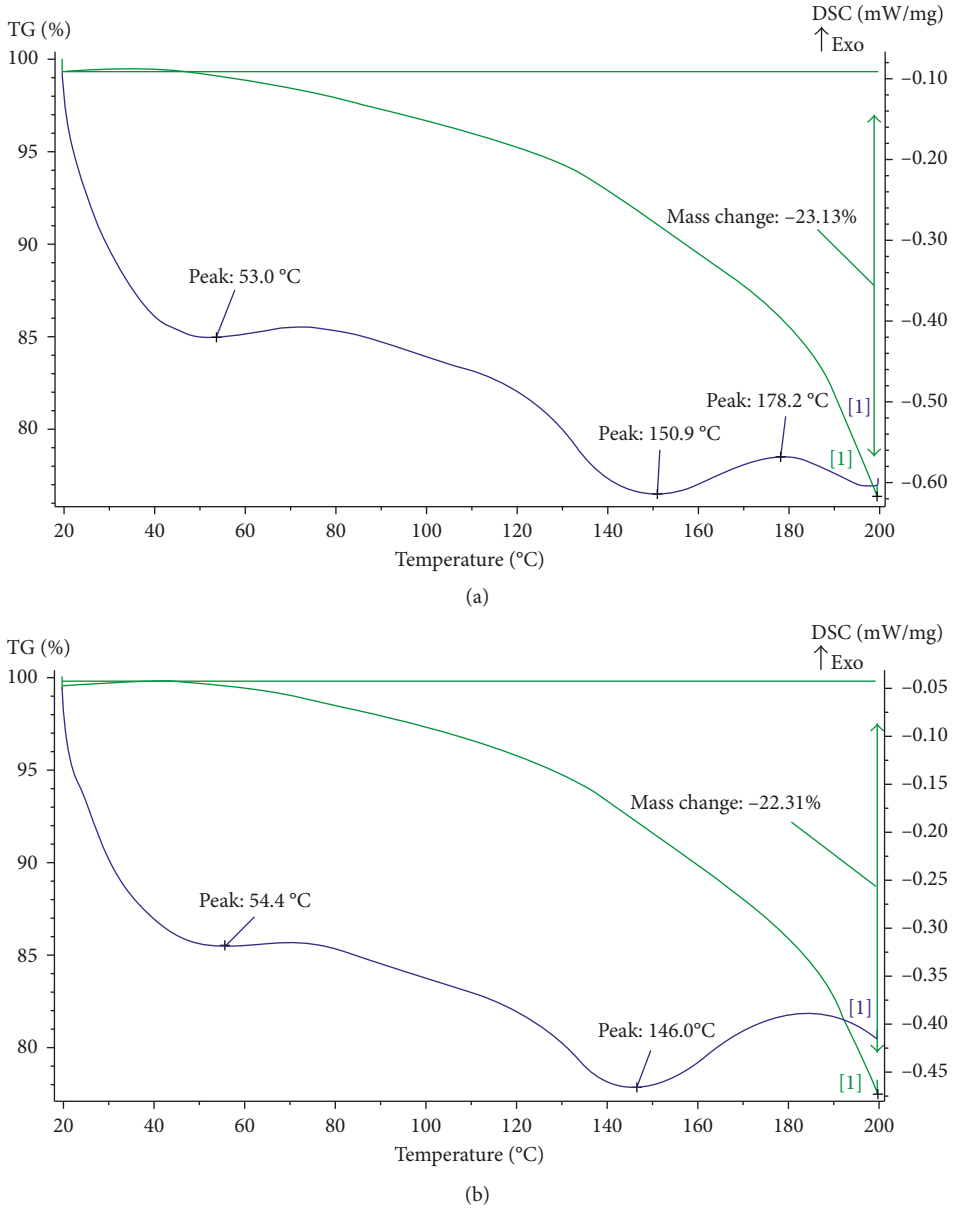

Figure 6: Thermograms of F (a) and G (b) candy samples. See Table 1 for F and G composition.

From Figure 6, the DSC and TG curves of the two candies (F and G) show a similar general shape. Like for the two basic components date paste and olive paste, the two endothermic peaks related to water removal, were reveled with a slight shift to slightly higher temperatures of 53/151°C (for F formula) (Figure 6(a)) and 54/146°C (for G formula) (Figure 6(b)). At the same time, the exotherm related to sucrose crystallization (Figure 5(c)) shifted to a higher temperature (178°C) in the case of F formula (Figure 6(a)) which is richer in carob powder (15%) than G formula (10%) (Table 1). This shift of peaks may be due to the water removal from candies during drying and water and oil holding capacity of carob powder, implicating a decrease in the thermal conductivity of samples. In fact, it is well documented that the thermal conductivity of dry samples is lower than that of wet samples.

It should be noted that no degradation of the olive oil is detected from DSC curves which is perfectly normal, considering that the smoke point of the extra virgin oil is about 195°C [45]. Furthermore, the raw olive oil present in olive paste must start to degrade in heat later than refined oil because the natural antioxidants present in oil are eliminated during the refining process [46].

3.5. Reducing Power (RP). The results obtained are summarized in Table 2. The RP of Carob Powder is approximately 1.5 and 2 times higher than that of date paste and olive paste, respectively. This result is consistent with that reported by some authors who postulated that the RP of carob fruit extract is approximately four times greater than that of red wine and catechins [47]. In addition, The RP of F

Table 2: Reducing power (RP) of F and G candy samples and their basic components.

Product	RP (mg vitamin C/100 gm)
DP	373
OP	201
CP	522
F	1017
G	701

DP: date fruit paste; OP: olive fruit paste; CP: carob fruit powder.

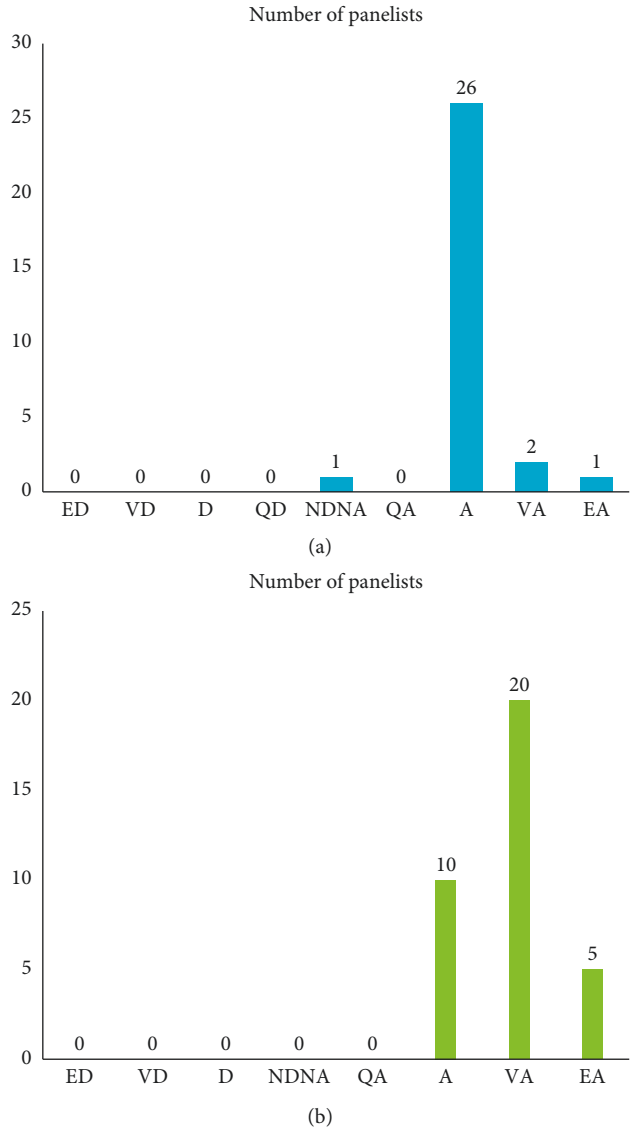

Figure 7: General acceptability concerning F (a) and G (b) formulations. ED: extremely disagreeable; VD: very disagreeable; D: disagreeable; QD: quite disagreeable; NDNA: neither disagreeable nor agreeable; QA: quite agreeable; A: agreeable; VA: very agreeable; EA: extremely agreeable.

and G samples are respectively 1.5 and 2 times higher than that of the carob powder, highlighting the synergistic effect between the three components in terms of antioxidant activity. Moreover, the RP of F and G are close to the result (1050 mg AAE/100 g, ms) found concerning the Sisam carob fruit variety [48].

3.6. Acceptability Test. The results of the test of general acceptability indicate that the increase in the proportion of the date paste promotes a better evaluation of the final product by consumers (Figure 7) since, compared to F, the G formula was incontestably more appreciated by consumers. Apart from texturizing properties which imposed a minimum fraction of 70% in the final product, the date paste can be considered as a natural flavoring agent.

The first results concerning the dissolution of natural dietary candy (not presented here) in a pH 6.8 buffer solution (simulating the human saliva) confirm the appreciable melt-in-the mouth texture of the final product as noted by tasters.

4. Conclusion

The results proved the feasibility of natural dietary candy from date paste, olive paste, and carob powder. At first approximation, it can be said that the formulation containing 75% date paste, 20% carob powder, and 5 % olive paste ensures a balance between the target values of texture and color.

The natural dietary candy, as food ready for consumption, can be used as dietary supplement for all categories of consumers, especially patients with swallowing difficulties.

Thermal analysis showed that the natural dietary candy tolerated high temperatures (up to 200°C), which makes them appropriate as food improvement agents for other types of baked confectioneries.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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