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Effect of Blending Doum (*Hyphaene thebaica*) Powder with Wheat Flour on the Nutritional Value and Quality of Cake

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Abstract

Pastry is an essential part of food stuff people like, especially preferring those made of wheat flour: cakes, biscuits, pancakes, etc. The nutritive value of the products mentioned above is not high. Therefore, there is a need to increase it by adding something like doum fruit (*Hyphaene thebaica* L.), which is a widespread in Upper Egypt. Doum fruit is a rich source of fibers and antioxidants, also other valuable substances such as carbohydrates and minerals especially potassium (K for people suffering from blood pressure problems). This investigation was carried out to study the possibility of utilization doum fruit powder in cake production. Five levels of wheat flour substitution were used 0%, 5%, 10%, 15% and 20% to produce cake. Also, the effects of blends on farinograph parameters were studied. Results indicated that substitution of doum powder (D.P) led to increase the water absorption (%) and dough weakening (B.U), whereas dough stability (min) was decreased. The water holding capacity of blends increased with increasing the level of substitution. The chemical, physical and sensory characteristics of the prepared cakes were studied. Results showed that increasing the levels of substitution increased the total fat, crude fiber and ash contents in produced cake compared with control. Minerals of the produced cake showed an increment in K and Mg, while slightly increment in Ca, Fe and Zn with increasing the level of substitution. Total phenol and antioxidant activity (AO) increased in substituted cake. Physical attributes of the produced cakes were evaluated and results showed that volume of substituted cakes decreased with increasing the level of replacement except for 10% level it increased. Results of textural analysis showed that D.P fiber decreased all the parameters. Concerning cake color, as the percentage of D.P increased, the color of the cake became darker and had high a and b values. The sensory evaluation results showed an insignificantly decrease in the acceptability by increasing the doum powder substitution comparing with control.

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Keywords

Doum Fruit, Wheat Flour, Cake, Rheological, Physicochemical, Sensory Properties

1. Introduction

Doum fruit, (*Hyphaene thebaica*) is a desert palm growing wild throughout the drier regions in Egypt, (Sub-Saharan) Africa, and west India. It listed as one of the useful plants of the world [1]. It has been cultivated in Egypt since immemorial times. (Such plant is mentioned as garden tree under the name of MAMA which means it has forked stems with fan shaped leaves, with a flat surface of approximately 66 cm long).

The mesocarp of the fruit is usually eaten by children of primary and secondary school due to its delicious and sweet taste. To the people of the desert where doum palms are found, it is life sustaining and is listed as a famine food. Doum is one of commonly consumed beverages in traditional places in Egypt. The drink has been prepared from the fruits by infusing the dried ground fruit pulp in hot water. This drink is widely consumed as a health tonic as a remedy for hypertension [2].

Doum fruits are relatively rich in protein and in essential minerals. It contains high amount of essential minerals which in most instances exceed the recommended daily allowance (RDA), and thus may keep the balance and ratios between those in need [3]. Doum was reported to lower the blood pressure, when its biological activity was evaluated in rat feeding experiments [4] [5].

It has been reported that Na/K ratios less than one have a great importance in the body for the control of high blood pressure [6]. A food or feed source is considered good if the Ca/P ratio is above one and poor if the ratio is less than 0.50 [7].

The high fiber content of doum fruit is suggesting as a potential to be used in the formulation of bakery products such as bread, biscuits, cookies, cakes and pan cakes to satisfy consumer needs for increased fiber intake without sacrificing sensory attributes and enrich their texture, flavor and nutritional value [8] [9]. Besides, it is great contribution to the health and wellbeing of humankind by preventing the gastrointestinal problems such as constipation and therefore, it is regarded as a natural anti colon cancer [10]. Doum pulp contains 4.91% proteins, 5.26% fat, 4.50% ash and 85.33% total carbohydrate [11].

The current focus is toward natural antioxidant especially plant polyphenolics [12]-[14]. Doum is rich in polyphenolic compounds; its extract contains 1.20 µg/g dried plant extract as Gallic and 3.70 µg/g dried plant extract as quercetin which act to reduce the oxidative stress by scavenging free radicals [13] [15]-[17].

Bakery products constitute one of the most consumed foods in the world. Among them, cakes are popular and are associated in the consumer's mind with a delicious sponge product with desired organoleptic characteristics [18].

The objectives of this study were to use doum fruit powder as a rich source of fiber and as a functional ingredient in cake production and to evaluate the effect of substitution of wheat flour with doum powder on physical, rheological and sensory characteristics of cake.

2. Materials and Methods

2.1. Materials

Wheat flour (72% extraction rate) was obtained from South Cairo Company of milling. Sugar, baking powder, corn oil, salt, eggs, skim milk and vanilla were purchased from the super market. Doum fruit flakes (*Hyphaene thebaica*) were obtained from El Khateeb Company, Giza, Egypt. All chemicals were of the analytical reagent grade.

2.2. Methods

2.2.1. Preparation of Doum Powder (D.P)

Dry doum fruit flakes were ground electrically in laboratory mill (JKA-Labora technic, Janke and Kunkel Type: MFC, Germany) to pass through 80 mesh sieve, then packed and stored in a refrigerator (4˚C) until used.

2.2.2. Cake Preparation

Cakes were prepared from substitution blends containing 0%, 5%, 10%, 15% and 20% of Doum Powder (D.P). The formula included 100 g wheat flour, (72% extraction rate) and substituted blends as shown in **Table 1**. Dry ingredients, corn oil and half milk were mixed at low speed for 30 sec with a wire whip in a 4 - 7 l bowl of an electric mixer (Moulinex, France). After the bowl was scraped, mixing was continued half remain milk was added, and the batter was mixed 30 sec on low speed. The remaining milk was added, the butter was mixed for 20 sec on low speed, the bowl was scraped, and mixing was continued for 30 sec on low speed. The cake batter was immediately deposited into round cake pans. For each cake (82 g batter) was poured into a cake pan and baked at 180˚C for 25 min in preheated electric oven (Kumtel, Turkey). The cakes were allowed to cool for 1 h and were then removed from the pans. Each treatment contains eight replicates for all tests. The cooled cakes were sensory evaluate and packed in a polyethylene bags at room temperature before analysis [9].

2.2.3. Analytical Methods

The proximate chemical composition *i.e.* moisture, crude protein, total fat, ash and crude fiber of raw materials and cake samples were determined according to AOAC [19]. Total carbohydrate were calculated by difference.

2.2.4. Rheological Properties

Water absorption, dough development, stability and dough weakening of wheat flour and its blends were determined by using farinograph (Brabender Duisburg, Germany) according to the methods described in AACC [20].

2.2.5. Water Holding Capacity (WHC)

Water holding capacities (WHC) of doum powder (D.P), wheat flour (72% extraction) and substituted doum flour (blends) 5%, 10%, 15% and 20% were determined according to AACC [20].

2.2.6. Determination of Macro and Micro Elements for Doum Powder (D.P) and Substituted Doum Cake

Two grams of sample was weighed and heated at 550˚C. Then the ashes were dissolved with 100 ml 1 M HCl. Dissolved ash was analyzed for sodium, potassium, magnesium, calcium, iron and zinc content by using methods of AOAC [19]. Perkin Elmer (Model 3300, USA) atomic absorption spectrophotometer was used to determine these minerals. Phosphorus content was calorimetrically determined by spectrophotometer at 650 nm according to the method described in AOAC [19].

2.2.7. Total Phenol

The total phenol were estimated according to the Folin-Ciocalteu [21]. Gallic acid was chosen as a standard to

Table 1. Cakes formula prepared with doum fruit powder at different levels of substitutions.

Ingredients	Level (g)
Wheat flour	80 - 100
Sugar	75
Doum powder (D.P)	5 - 20
Corn oil	20
Whole eggs	60
Skim milk*	7.0
Water	45
Baking powder	3.0
Vanilla	0.3
Salt	0.2

*7 g solved in 45 ml water.

prepare the standard curve. Phenols were expressed as mg/100g sample on dry weight basis.

2.2.8. Antioxidant Activity Assays

The DPPH (2.2-diphenyl-1-picrylhydrazydl) radical scavenging activity of methanolic extracts was determined following the method reported by Tepe *et al.* [22].

2.2.9. Physical Measurements of Cake

Cake weight (g) was recorded after cooling for1hr. Cake volume (cm^3) was determined by rapeseed displacement method as described by AACC [20]. Specific volume (cm^3/g) of cake was calculated by dividing volume by weight. Density (g/cm^3) was calculated by dividing weight by volume.

2.2.10. Texture Profile Analysis (TPA) of Cake

Cake texture was determined by universal testing machine (Conetech, B type, Taiwan) provided with software according to Bourne [23]. An aluminum 25 mm diameter cylindrical probe was used in a TPA double compression test to penetrate to 50% depth, at 1 mm/s speed test. Firmness (N), gumminess (N) chewiness (N), cohesiveness and springiness were calculated from TPA graphic.

2.2.11. Color Evaluation

The color of cake crumb was measured according to the method outlined by [24] crumb color was measured on opposite sides of cake by using a hand-held tristimulus reflectance Colorimeter Minolta chromammeter (model CR-400, Konica Minolta, Japan). The apparatus provided L (lightness with L = 100 for lightness, and L = zero for darkness), a [(chromaticity on green (−) to red (+)], b [(chromaticity on a blue (−) to yellow (+)], c (color saturation), h [(hue angle were 0˚ = red to purple, 90˚ = yellow, 180˚ = bluish to green and 270˚ = blue] scale.

2.2.12. Sensory Evaluation of Cake

Cake samples were organoleptically evaluated for its sensory characteristics. Slice of each cake sample was served for ten panelists on white, odorless and disposable plates. Samples were scored for shape, crust color, crust characteristics, crumb color, brightness, crumb texture, softness, taste, odor and total score. The evaluation was carried out according to Bennion and Bamford [25].

2.3. Statistical Analysis

For the analytical data, mean values and standard deviation are reported. The data obtained were subjected to one-way analysis of variance (ANOVA) at $P < 0.05$.

3. Results and Discussion

3.1. Farinograph Parameters

The effect of substitution wheat flour with different levels of doum fruit powder (5%, 10%, 15% and 20%) on farinograph parameters was cleared in **Table 2**. From **Table 2**, it could be observed that, water absorption of wheat flour dough and wheat flour blended with different levels of doum fruit powder increased from 62.8% to

Table 2. Farinograph parameters of wheat flour dough and doum fruit powder blends with different substitutions.

Samples \ Parameters	Water absorption (%)	Arrival time (min)	Dough development (min)	Stability (min)	Dough weakening (B.U)
100% W.F (72% extraction)	62.8	0.5	1.0	4.0	80
5% D.P	63.7	1.5	2.0	3.5	90
10% D.P	64.0	2.0	2.5	3.0	100
15% D.P	64.5	3.0	3.5	2.5	120
20% D.P	65.3	3.5	5.0	2.0	130

D.P = doum powder. W.F = wheat flour.

65.3% by increasing the levels to 20% compared with control dough (100% wheat flour). These results are in agreement with Holloway and Grieg [26] who mentioned that the doum fruit flour increases the water absorption, due to high fiber content. Also, the same trend was observed in the arrival time and dough development.

This increment may be due to high amount of crude fiber in doum fruit which effect on dough properties. It could be observed from that, 100% wheat flour dough (control) had the lowest development time (1 min), which increased upon replacing wheat flour with (D.P). Dough development time increased from 1.0 to 5.0 min. Dough stability, which is an indicator to dough strength decreased in dough samples from 4.0 to 2.0 min by increasing the level of substitution with (D.P), while weakening increased from 80 to 130 BU which is due to dilution of gluten protein from wheat flour with the increase fiber content from (D.P). This may also be due to the interaction between fibrous materials and gluten, which affects the dough mixing properties as reported by Shouk and Ramadan [27].

3.2. Water Holding Capacity

Water holding capacity of doum fruit powder, wheat flour (72% ext.) and their blends (5%, 10%, 15% and 20%) illustrated in **Figure 1**. From data in **Figure 1** it could be observed that the doum fruit powder has the highest water holding capacity (3.32 g/g), whereas wheat flour has the lowest value (1.99 g/g). This means that the doum powder absorbed more water than wheat flour. By increasing the level of doum fruits powder, the water holding capacity increased. This may be attributes to the high fiber content of the doum fruit powder. This result is in agreement with Holloway and Grieg [26] who found that the high fiber content of doum fruit led to high water holding capacity.

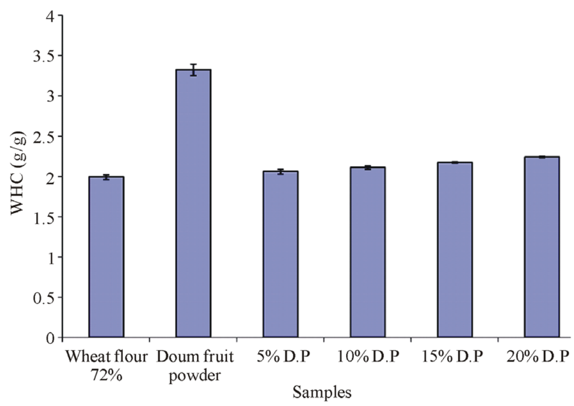

Figure 1. Water holding capacity of wheat flour, doum powder and substituted blends.

3.3. Chemical Composition

Chemical composition of wheat flour and doum fruit powder was given in **Table 3**. Data showed that wheat flour had higher levels of protein and carbohydrate content (11.63% and 85.63%) than doum powder (7.05% and 62.72%), respectively. While doum powder had higher levels of fat, crude fiber and ash content (2.57%, 20.88% and 6.60%) than wheat flour 72% extraction (1.50%, 0.73% and 0.52%), respectively. From the above mentioned

Table 3. Chemical composition of raw materials (% dry weight).

Components (%)	Wheat flour (72% extraction rate)	Doum fruit powder
Protein	11.63 ± 0.11[a]	7.05 ± 0.21[b]
Total fat	1.50 ± 0.12[b]	2.57 ± 0.10[a]
Crude fiber	0.73 ± 0.10[b]	20.88 ± 0.30[a]
Ash	0.52 ± 0.09[b]	6.60 ± 0.20[a]
Total carbohydrate	85.63 ± 0.39[a]	62.72 ± 0.9[b]

Values are mean of three replicates ± SD, number in the same row followed by the same letter are not significantly different at 0.05 leve1.

data, it was cleared that wheat flour was rich in protein and carbohydrates while poor in fat, fiber and ash content. Whereas, doum powder was rich in the last three components. These results are in agreement with those obtained by Hashem [2] and Abd El-Latteef *et al.* [28].

Table 4 showed chemical composition of the produced cake substitutes with 5%, 10%, 15% and 20% of doum fruit powder. Cake substitutes with doum powder at different levels showed significant differences for total fat, crude fiber and ash content relative to control cake and this may be due to the higher content of total fats, crude fiber and ash in doum fruit powder. Total carbohydrates of substituted cake decreased significantly compared with control cake. This may be due to low amount of carbohydrates in doum fruit powder compared with wheat flour. At the same time, there were significant differences in total carbohydrates content between doum cake at 5% and 10% levels.

Table 4. Chemical composition of produced cake with different substitutions (% on dry weight basis).

Samples	Protein	Total fats	Crude fiber	Ash	Total carbohydrates
Control (100% W.F)	13.97 ± 0.20^{a}	16.41 ± 0.10^{e}	0.75 ± 0.05^{d}	0.85 ± 0.03^{e}	68.02 ± 0.18^{a}
5% D.P	13.82 ± 0.20^{a}	16.81 ± 0.20^{d}	2.37 ± 0.04^{c}	0.93 ± 0.05^{d}	66.04 ± 0.44^{b}
10% D.P	13.35 ± 0.10^{b}	17.21 ± 0.10^{c}	3.62 ± 0.05^{b}	1.45 ± 0.01^{c}	64.37 ± 0.36^{c}
15% D.P	13.12 ± 0.90^{bc}	17.61 ± 0.30^{b}	3.93 ± 0.10^{a}	1.91 ± 0.05^{b}	63.43 ± 0.65^{d}
20% D.P	12.90 ± 0.11^{c}	18.00 ± 0.20^{a}	4.02 ± 0.03^{a}	2.04 ± 0.04^{a}	63.03 ± 0.37^{d}

D.P = doum powder. W.F = wheat flour. Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 leve1.

3.4. Minerals Content of Doum Powder and Substituted Cake

Doum fruit powder, wheat flour cake and substituted doum cake were analyzed for phosphorus, calcium, iron, potassium, sodium, magnesium and zinc as presented in **Table 5**. Results show that minerals content were varied according to the raw materials and the levels of substitution. Minerals content of doum fruit powder showed the highest contents of calcium (Ca), magnesium (Mg), potassium (K), iron (Fe) and zinc (Zn) except for phosphorus (P) and sodium (Na) compared with wheat flour cake. P content of control and cake substituted with doum powder was decreased from 190.01 to 182.95 mg/100g, while Na content of cakes increased from 579.14 to 634.06 mg/100g. Replacing wheat flour by doum powder increased the macro minerals concentration in produced cake relative to the control sample.

The greatest increasing rate observed in magnesium (95.38%) followed by K (57.18%) in 20% substituted cake sample. While, sodium concentration increased in the same sample (9.48%).

Phosphorus content slightly decreased in all samples with increasing substitution. While calcium (Ca) content slightly increased compared with control. Doum fruit contains higher amounts of essential minerals which in most instances exceed the recommended daily allowance (RDA), thus may keep the balances and ratios between those in need. These results are due to the doum powder is good source of these minerals. The Na/K ratio less

Table 5. Minerals of doum fruit powder and produced cake with different substitutions.

Samples	Minerals (mg/100g sample)								
	P	Ca	Fe	K	Na	Mg	Zn	Ca/P	Na/K
Doum powder	150.00	30.0	5.55	1451.69	274.65	217.16	0.48	0.20	0.19
Control cake (100% W.F.)	190.01	17.40	4.80	507.70	579.14	42.01	0.43	0.09	1.14
5% D.P	188.10	18.90	4.83	580.28	592.87	53.89	0.44	0.10	1.02
10% D.P	186.50	20.40	4.86	652.86	606.60	63.99	0.48	0.10	0.93
15% D.P	184.25	21.90	5.00	725.44	620.33	71.22	0.50	0.12	0.86
20% D.P	182.95	23.87	5.03	798.02	634.06	82.08	0.52	0.13	0.79

D.P = doum powder. W.F. = wheat flour.

than one with increasing the levels of substitution (10%, 15% and 20%). The Ca/P ratio is poor because it is less than one (ranged from 0.09 to 0.13 for control cake and substituted cake at 20%, respectively). These results are in agreement with Aremu *et al.* [6] and Nieman *et al.* [7].

Concerning to micro minerals concentrations, data showed slight increase in iron (Fe) and zinc (Zn) levels for substituted cake. This may be due to the concentration of zinc and iron in wheat flour and doum powder are nearly equal.

From the above mentioned data, the produced cakes have good amount of K, so they are considered an advantage for people suffering from blood pressure problems.

3.5. Total Phenol and Antioxidant Activity (AO) in Doum Fruit Powder, Wheat Flour Cake and Substituted Cake with Doum Fruit Powder at Different Levels

Doum fruit powder, wheat flour cake (control) and substituted doum cake were analyzed for total phenol and antioxidant activity (AO) (**Table 6**, **Figure 2**). Data given in **Table 6** indicated that doum fruit powder has higher total phenol content (122.55 mg/100g) than wheat flour cake (22.96 mg/100g). Substitution of wheat flour with doum fruit powder caused a significant increase in total phenol content proportionally with increasing the substitution level. The highest value was noticed at 20% (66.92 mg/100g) compared with control (22.96 mg/100g) and the other cake samples.

Same trend was observed in antioxidant activity (AO) of the produced cake. Data revealed that doum fruit powder had high DPPH scavenging activity (86.00%) compared with wheat flour cake (6.84%). Increasing the level of replacement, the high value of antioxidant activity (AO) of cake was observed and there were significant differences between cake samples. The antioxidant activity of cakes ranged from 6.84% for control and 56.71% for 20% substitution level. The high value of antioxidant activity for substituted cake samples could be attributed to the high total phenol content of doum fruit powder (**Figure 2** and **Table 6**). These results are in agreement with Abou-Elalla [16] who mentioned that the aqueous extract of doum fruits showed an antioxidant activity, this is due to the substantial amount of their water soluble phenolic content.

Table 6. Total phenol of doum fruit powder and produced cake with different substitutions.

Samples \ Parameter	Total phenol (mg/100g)
Doum fruit powder	122.55 ± 1.77[a]
Control cake	22.96 ± 0.79[f]
5% D.P	34.86 ± 0.01[e]
10% D.P	41.65 ± 1.19[d]
15% D.P	50.32 ± 2.32[c]
20% D.P	66.92 ± 3.08[b]

D.P = doum powder. Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 leve1.

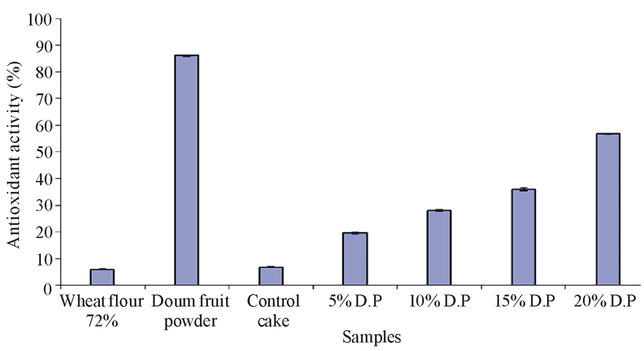

Figure 2. Antioxidant activity (AO) of wheat flour, doum powder and produced cake with different substitutions.

3.6. Physical Properties of Cake

Physical attributes (weight, volume, specific volume and density) of wheat flour cake and substituted cakes are given in **Table 7**. According to weight data showed no significant difference between control cake and 10% substituted cake, also between 15% and 20%. Substituted cake at level 10% has the highest volume (130.50 cm^3), while the volume began to decrease with increasing the level of substitution to reach 107.0 cm^3 Concerning to specific volume (cm^3/g), the results indicated that substituted cake at 10% level had the highest specific volume (3.46 cm^3/g) relative to other samples. On the other hand, density of the same cake sample decreased to 0.29 g/cm^3 compared with control cake (0.33 g/cm^3) and other substituted cakes.

3.7. Texture Analysis of Cake Produced from Wheat Flour Substituted with Different Levels of Doum Fruit Powder

The texture parameters assessed from Texture Profile Analysis (TPA) curves are presented in **Table 8**. A slight decrease in firmness from 1.80 to 1.39 N was found. On the other hand, the cake became softer with increasing doum powder levels.

Results showed a decrease in cakes cohesiveness and springiness relative to control, whereas there were no significant differences between substituted cake samples with increasing the levels of doum powder in the same parameters. Furthermore, the gumminess parameter was decreased with increasing level of doum powder.

The same trend was observed in chewiness parameter. Overall, doum fruit powder decreased all the TPA parameters, this is connected with the fiber ability in doum powder to detain moisture in wheat flour products. These results are in agreement with Fondroy *et al.* [9] and Gedrovica and Karklina [29] who mentioned that as the amount of cellulose was increased in the formation, the cake become softer. Coimbra and Jorge [10] found that high fiber content of doum fruit is enriching bakery products texture.

3.8. Color Measurements of Cake Samples

Color values (L, a, b, c and h) were showed in **Table 9**. Color values lightness and redness (L and a) are vary with control cake, also yellowness (b) was vary with the control, but there is no significant difference between 10% and 15% substituted cake. However, as the level of substitution was increased, the cake crumb become

Table 7. Physical properties of produced cake with different substitutions.

Parameters \ Samples	Control cake (100% wheat flour)	5% D.P	10% D.P	15% D.P	20% D.P
Weight (g)	38.28 ± 0.52[a]	37.57 ± 0.08[b]	37.70 ± 0.34[ab]	36.56 ± 0.03[c]	36.86 ± 0.36[c]
Volume (cm^3)	116.70 ± 3.05[b]	109.30 ± 3.06[c]	130.50 ± 0.5[a]	108.50 ± 0.51[c]	107.0 ± 3.00[c]
Specific volume (cm^3/g)	3.04 ± 0.09[b]	2.91 ± 0.08[b]	3.46 ± 0.03[b]	2.94 ± 0.05[b]	2.89 ± 0.14[b]
Density (g/cm^3)	0.33 ± 0.01[b]	0.34 ± 0.01[a]	0.29 ± 0.01[c]	0.34 ± 0.01[a]	0.34 ± 0.01[a]

D.P = doum powder. Values are mean of three replicates ± SD, number in the same row followed by the same letter are not significantly different at 0.05 leve1.

Table 8. Texture analysis of produced cake with different substitutions.

Samples \ Parameters	Firmness (N)	Cohesiveness	Gumminess (N)	Chewiness (N)	Springiness
Control cake	1.80 ± 0.03[a]	0.68 ± 0.01[a]	1.21 ± 0.02[a]	0.77 ± 0.02[a]	0.65 ± 0.01[a]
5% D.P	1.62 ± 0.01[a]	0.48 ± 0.01[b]	0.79 ± 0.01[b]	0.40 ± 0.01[b]	0.50 ± 0.01[b]
10% D.P	1.59 ± 0.03[b]	0.46 ± 0.01[b]	0.72 ± 0.01[bc]	0.37 ± 0.01[b]	0.52 ± 0.01[b]
15% D.P	1.47 ± 0.14[bc]	0.46 ± 0.04[b]	0.69 ± 0.06[cd]	0.36 ± 0.03[b]	0.49 ± 0.04[b]
20% D.P	1.39 ± 0.03[c]	0.43 ± 0.01[b]	0.61 ± 0.01[d]	0.30 ± 0.01[c]	0.47 ± 0.01[b]

D.P = doum powder. Values are mean of three replicates ± SD, number in the same column followed by the same letter are not significantly different at 0.05 leve1.

darker (lower L values), slightly more yellow (b values) specially for 20% levels of substitution, and more redness (a values) increased with increasing the levels of substitution comparing with control (lower negative a value −0.39).

The b values were only slightly affected by levels of substitution. On the other hand, c (color saturation) increased with increasing the level of substitution, from yellow to orange yellow. The hue angle (h) decreased significantly in substituted cake comparing with control, then the color of the cake gradually change from yellow to orange yellow for 10% to 20% level of substitution.

3.9. Sensory Evaluation

Sensory evaluation score for the cakes substituted with different level of doum powder are illustrated in **Table 10**. The results showed that there are no significant differences between substituted samples in shape and crust color. Also, there are no significant differences in crust characteristics, and odor between samples and control. On the other hand, there are significant differences in crumb color and brightness between samples and control, also brightness decreased significantly with increasing the level of substitution. Crumb texture slightly decreased with increasing the level of substitution, while there are no significant differences in softness between samples and control. Taste slightly decreased in substituted cake sample at 20% level compared with control, but there were no significant differences between substituted cake (5%, 10% and 15%) and control cake.

Results in **Table 10** clearly indicated that using doum fruit powder in cake at levels 5%, 10%, 15% and 20%

Table 9. Color measurements of produced cake with different substitutions.

Parameters \ Treatments	Control	5% D.P	10% D.P	15% D.P	20% D.P
L	62.58 ± 1.05[a]	56.21 ± 0.21[b]	48.29 ± 0.26[c]	47.65 ± 0.05[c]	46.27 ± 0.31[d]
a	−0.39 ± 0.04[e]	3.39 ± 0.02[d]	5.41 ± 0.17[c]	6.33 ± 0.28[b]	7.47 ± 0.41[a]
b	28.36 ± 0.02[d]	28.91 ± 0.07[c]	29.62 ± 0.19[b]	29.78 ± 0.16[b]	30.94 ± 0.09[a]
c	28.36 ± 0.28[e]	28.91 ± 0.07[d]	29.38 ± 0.24[c]	30.28 ± 0.25[b]	31.67 ± 0.15[a]
h	90.76 ± 0.07[a]	83.13 ± 0.05[b]	79.72 ± 0.29[c]	78.60 ± 0.29[d]	77.60 ± 0.25[e]
Color	Yellow	Yellow	Orange yellow	Orange yellow	Orange yellow

D.P = doum powder. Values are mean of three replicates ± SD, number in the same row followed by the same letter are not significantly different at 0.05 leve1. L (lightness with L = 100 for lightness, and L = zero for darkness), a [(chromaticity on green (−) to red (+)], b [(chromaticity on a blue (−) to yellow (+)], c (color saturation), h [(hue angle were 0˚ = red to purple, 90˚ = yellow, 180˚ = bluish to green and 270˚ = blue] scale.

Table 10. Sensory evaluation of produced cake with different substitutions.

Attributes \ Samples	Control	5% D.P	10% D.P	15% D.P	20% D.P
Shape (10)	9.78 ± 0.42[a]	8.89 ± 0.78[b]	8.78 ± 0.83[b]	8.72 ± 0.90[b]	8.56 ± 1.33[b]
Crust color (10)	9.5 ± 0.50[a]	8.06 ± 0.88[b]	8.06 ± 1.18[b]	8.17 ± 1.22[b]	7.61 ± 1.32[b]
Crust characteristics (10)	9.56 ± 0.53[a]	9.06 ± 1.07[a]	8.72 ± 0.94[a]	8.67 ± 1.30[a]	8.50 ± 1.27[a]
Crumb color (10)	9.78 ± 0.44[a]	8.67 ± 0.71[b]	8.39 ± 0.49[bc]	7.72 ± 1.03[cd]	7.56 ± 1.13[d]
Brightness (10)	9.72 ± 0.44[a]	8.89 ± 0.93[ab]	8.50 ± 1.27[bc]	8.11 ± 1.27[bc]	7.78 ± 1.09[c]
Crumb texture (10)	9.78 ± 0.41[a]	9.22 ± 0.62[ab]	8.89 ± 0.96[ab]	8.72 ± 1.35[b]	8.67 ± 1.09[b]
Softness (10)	9.78 ± 0.43[a]	9.17 ± 0.71[a]	9.24 ± 0.88[a]	9.25 ± 1.20[a]	9.30 ± 1.27[a]
Taste (15)	14.56 ± 0.73[a]	13.67 ± 0.90[ab]	13.56 ± 1.10[ab]	13.44 ± 1.17[ab]	13.11 ± 1.54[b]
Odor (15)	14.11 ± 0.93[a]	14.06 ± 0.88[a]	13.78 ± 1.06[a]	13.33 ± 1.66[a]	13.06 ± 1.55[a]
Total score (100)	96.27 ± 2.74[a]	89.66 ± 5.66[b]	87.92 ± 6.20[b]	86.13 ± 8.17[b]	84.15 ± 8.75[b]

D.P = doum powder. Values are mean of ten replicates ± SD, number in the same row followed by the same letter are not significantly different at 0.05 leve1.

did not affected on same characteristics of cake compared with control. Meanwhile, it showed an increasing the acceptability in 5% followed by 10% levels of substituted cake.

4. Conclusion

From this study, it could be concluded that odor and general acceptability of cakes prepared with 5% and 10% doum powder were more acceptable and had no adverse effect on quality compared with the control cakes. Textural analysis indicated that firmness of the cakes was decreased and it became moisty due to the effect of doum fruit fiber. Generally, as the amount of doum powder was increased from zero to 20% of the flour weight in substituted cake, sensory and physicochemical characteristics were altered. Increasing the levels of substitution increased the total fats, crude fiber and ash contents in produced cake. Physical characteristics indicated a reduction in cake volume except for 10% level of substitution and increased the orange yellow color of the cake crumb.

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