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Evaluation of biscuits prepared from wheat flour and substituted by different levels of doum (*Hyphaene thebaica*) flour

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Abstract

Doum (*Hyphaene thebaica*) fruit flour (DFF) was studied in terms of chemical properties as well as technological processing to prepare wheat flour biscuits containing DFF. Chemical composition results showed that DFF possessed low contents of crude protein and it could be considered as a good source of minerals (Ca, P, Mg, Fe, Cu). The results also indicated that DFF had very good values in terms of crude fiber, total phenolic content, and flavonoid content. The edible portion of doum fruits (DFF) was used to formulate some functional foods. The organoleptic properties of biscuits containing DFF showed that all the biscuits samples were well accepted by the panelists. Generally, doum fruit flour could be used with wheat flour to prepare biscuit characterized with its good sensorial properties, higher nutritive value and healthy as a good source of fiber, minerals, polyphenolic, and flavonoids compounds.

Keywords: biscuits, wheat flour, doum, *Hyphaene thebaica*.

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1. Introduction

Doum (*Hyphaene thebaica*) is an African palm tree, common in Upper Egypt, originally native to the Nile Valley, bearing an edible fruit which is glubose-quandrangular, about 6 x 5 cm with a shiny orange-brown to deep chestnut skin (epicarp). The rind (mesocarp) in some palm is inedible but of other it is very palatable, highly aromatic and sweet with a taste like gingerbread hence the English name. When eaten it serves as vermifuges and parasite expellant. The chloroform extract of the fruits improves spermatic count of male rats at low concentration, but decrease it at high concentration (Hetta *et al*., 2005; Hetta and Yassin, 2006). Doum fruit has nutritional and pharmacologic properties. Doum extracts are being used in the treatment of bilharziasis, haematuria, bleeding especially after childbirth, and as hypolipidemic and hematinic suspension. The tea of doum is popular in Egypt and believed to be good for diabetes. It has been used by Egyptian people as a folk medicine for treatment of hypertension (Hetta *et al*., 2005; Kamis *et al*., 2003). Roots of doum were used in treatment of Bilharziasis, while the resin of the tree has demonstrated, diuretic, diaphoretic properties and recommended for tap worm as well as against animal bites. The use of some plants as medicinal plant is due to the presence of flavonoids and saponins. Doum was reported to contain important substances including saponins, tannins, and flavonoids; hence the use of doum, which is rich in flavonoids and saponins, in folk medicine is not surprising (Dosumu *et al*., 2006; Waterhouse, 2003). Biscuits are the most popular bakery items consumed nearly by all sections of the society in Egypt. Some of the reasons for such wide popularity are low cost in compared with other processed foods (affordable cost), good nutritional quality and availability in different forms, varied taste and longer shelf-life. Bakery products are sometimes used as a vehicle for incorporation of different nutritionally rich ingredients (Sudha *et al*., 2007). The objective of this study was to use doum fruit pulp powder as a rich source of fiber and as a functional ingredient in biscuit production, evaluate the effect of substitution of wheat flour or yellow maize flower (free gluten) with doum powder on physical, chemical and sensory characteristics of biscuit.

2. Materials and methods

2.1 Materials

Dry doum fruit flakes were brought from the Agricultural Research Station, Aswan governorate, Egypt and the biscuit ingredients were brought from local supermarket.

2.2.1 Preparation of raw materials

Dry doum fruit flakes were milled in a laboratory mill to obtain the whole flour.

2.2 Methods

2.2.1 Proximate composition analysis

Proximate analysis was carried out using the standard procedures of the Association of Official Analytical

Chemists (AOAC, 2000). Moisture content was obtained by heating the fresh samples to a constant weight in a thermostatically controlled oven at 60°C. Ash content was determined (2 g) by a muffle furnace at 550°C. Nitrogen content was determined using the Kjeldhal method and crude protein was calculated by multiplying the percentage nitrogen by 6.25. The crude fat content was determined by soxhlet apparatus using petroleum ether (40-60°C). The crude fiber content was estimated by consecutive acid and alkali digestion of sample followed by washing, drying, ashing at 600°C and calculating the weight of ash free fiber. Total carbohydrate was calculated by difference according to Pellet and Sossy (1970). The caloric value (Kcal/100g) was determined according to Wilson *et al.* (1974) and Seleet (1990).

2.2.2 Determination of total polyphenols

The total polyphenols content of samples was determined using modified Folin-Ciocâlteu colorimetric method (Singleton *et al*., 1999). The samples' extracts (25 µg each) were dissolved in 80% methanol and further dilution were performed to obtain readings within the standard curve made with gallic acid. The extracts were oxidized by Folin-Ciocâlteu reagent (120 µl) and after 5 minutes, 340 µl of Na_2CO_3 was added for neutralization. The samples were kept for 90 min in the dark followed by the reading of the absorbance at 750 nm. The results were expressed as milligram of gallic acid equivalents /100 g sample (mg GAE / 100 g sample).

2.2.3 Determination of total flavonoids

The aluminium chloride colorimetric assay was used for flavonoids determination, as described by Marinova *et al*. (2005). Extraction of flavonoids in the samples (n=3) was achieved by homogenizing 2.0 g of the sample in 50 mL distilled water. The mixture was transferred into a rotary shaker for 12 h to ensure full extraction. Thereafter, the mixture was filtered, and the filtrate (extract) made up to 50 mL. Precisely, 1 ml of extracts or standard solution of catechin (20, 40, 60, 80 and 100 mg/L) was added to test tubes containing 4 ml of redistilled water. To this mixture 0.3 ml of 5% $NaNO_2$ was added. After 5 min, 0.3 ml 10% $AlCl_3$ was added. Immediately, 2 ml 1M NaOH was added, and the total volume was made up to 10 ml with redistilled water. The solution was mixed thoroughly and the absorbance of both blank and standard was read at 510 nm using UV–Visible spectrophotometer Model UV 1601 version 2.40 (Shimadzu). Total flavonoids content was expressed as mg catechin equivalents (mg catechin /100 g sample D.W).

2.2.4 Determination of minerals content

Contents of Ca, Mg, Fe and Cu in the studied samples were determined by iCAP6200 (ICP-OES) Inductively Coupled Plasma Emission Spectrometry (Isaac and Johnson, 1985). However, P content was determined by spectrophotometer (Jackson, 1967) after wet ashing by method described in AOAC (2000).

2.2.5 Processing of biscuit

Control biscuit dough was prepared according to the formula presented in Table (1). The other biscuit sample were prepared using the same formula except for replacing the wheat flour with 5, 10, 15 and 20% of whole doum flour. Powdered sugar and corn oil were creamed in Braun Mixer with a flat beater for 2 minutes. Water containing sodium chloride, ammonium bicarbonate and rose oil was added to the cream and mixed for 5 minutes to obtain a homogenous cream. Thereafter flour was added slowly to the above cream and was mixed for 2 minutes to obtain biscuit dough. The biscuit dough was sheeted to a thickness of 3.5 mm, cut using a circular mould (51 mm dia.), and baked at 205°C for 9-10 minutes. After baking, biscuits cooled to room temperature, packed in polypropylene pouches and sealed (Saba, 1997).

2.2.6 Sensory evaluation of biscuit

Biscuit samples in pouches coded with different numbers were presented to the judges from the staff of Food Science and Technology Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.

Table (1): Ingredient contents of biscuit formulas.

Ingredients (g)	Biscuit formula				
	Control	5%	10%	15%	20%
Wheat flour	100.00	95.00	90.00	85.00	80.00
Doum flour (whole)	--	5.00	10.00	15.00	20.00
Powdered sugar	25.00	25.00	25.00	25.00	25.00
Corn oil	15.00	15.00	15.00	15.00	15.00
Salt	1.00	1.00	1.00	1.00	1.00
Ammonium carbonate	1.00	1.00	1.00	1.00	1.00
Rose oil	0.01	0.01	0.01	0.01	0.01
Water	20.00	20.00	20.00	20.00	20.00

They were asked to rate each sensory attribute by assigning a score for surface colour (10), surface characteristics (10), crumb colour (10), taste (20), texture (20) and mouth feel (10) as described by Sudha *et al*. (2007).

2.2.7 Statistical analysis

The experimental data were subjected to an analysis of variance (ANOVA) for a completely randomized design using a statistical analysis system (SAS, 2000).

3. Results and Discussion

3.1 Raw materials

Gross chemical composition of wheat flour (72% extraction) and doum flour (g/100g D.W) are shown in Table (2). Wheat flour (WF) and doum fruit flour (DFF) contained 12.85and 2.99% crude protein, 1.57 and 2.69 crude fat, 0.63 and 8.97% ash, 0.82 and 15.22% crude fiber, 84.13and 70.13% carbohydrates, 12.12 and 8.85% moisture, respectively.

Wheat flour had higher levels of protein and carbohydrate content than doum powder. While DFF had higher levels of crude fat, crude fiber and ash content than WF. From the above-mentioned data, it was clear 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 nearly in agreement with those obtained by Abd El-Latteef *et al*. (2001).

Table (2): Gross chemical composition* of wheat flour and doum flour (g/100g D.W except moisture).

Samples	Moisture	Ash	Crude oil	Crude protein	Crude fiber	Total carbohydrates	Energy (Kcal/ 100 g D.W.)
Wheat flour (72% extraction)	12.12	0.63	1.57	12.85	0.82	84.13	402.05
Doum flour (whole)	8.85	8.97	2.69	2.99	15.22	70.13	316.69
L.S.D 0.05	0.1319	0.0956	0.0378	0.0632	0.0857	0.0354	0.0995

*Mean of triplicates.

Table (3) indicated that doum fruit powder has higher in total phenolics and total flavonoids content (4539.97 mg GAE/100 g and 2143.62 mg catechin/100 g D.W) than wheat flour (1518.49 mg GAE/100 g D.W and 711.69 mg catechin/100 g D.W respectively). These results agree with Abou-Elalla (2009), 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 and flavonoids content. Table (4) showed that minerals contents were found in reasonable content as result of differentiation between materials. Doum fruit powder contained the highest levels of Ca, P, Mg, Fe and Cu comparing wheat flour.

Table (3): Phenolics and flavonoids content of wheat flour and doum flour.

Samples	Total phenolics (mg GAE/100 g D.W)	Total flavonoids (mg catechin/100 g D.W)
Wheat flour (72% extraction)	1518.49	711.69
Doum flour (whole)	4539.97	2143.62
L.S.D 0.05	0.2182	0.9438

Table (4): Mineral content of wheat flour and doum flour (mg/100g D.W).

Samples	Ca	P	Mg	Fe	Cu
Wheat flour (72% extraction)	20.39	130.73	119.70	0.81	0.33
Doum flour (whole)	265.44	139.21	134.25	7.78	1.62
L.S.D 0.05	0.0513	0.0441	0.1205	0.02	0.0262

3.2 Biscuit samples

Table (5) showed the chemical composition of wheat flour (WF) biscuits replaced with different levels of doum fruit flour. Data revealed that moisture, ash and crude fiber content of biscuit samples were increased with increasing the DFF replacement levels. However total carbohydrates content was decreased. The increase in ash and crude fiber content of biscuits can be attributed to their high content in the replaced doum flour. This clearly indicates that high-quality, nutritionally balanced biscuits can be produced by partial replacement of wheat flour with DFF as a good source of dietary fiber and minerals elements. On the other hand, carbohydrate content was reduced as result of DFF replacement level increasing. These results were in agreement with that obtained by Lokurua (2007).

Table (5): Gross chemical composition* of biscuits made from wheat flour (100%) replaced with different levels of whole doum flour (g/100g D.W except moisture).

Samples	Moisture	Ash	Crude oil	Crude protein	Crude fiber	Total carbohydrates	Energy (Kcal/100 g D.W.)
Control WFB	13.37	0.71	14.45	8.02	2.01	74.81	461.37
5% DFB	13.29	0.82	14.16	7.46	2.34	75.22	458.16
10% DFB	16.65	1.43	14.48	7.86	2.87	73.06	454.00
15% DFB	15.17	1.88	14.20	7.48	3.06	73.38	451.24
20% DFB	15.83	2.12	14.83	7.81	3.28	71.96	452.55
LSD 0.05	0.0932	0.065	0.0535	0.0603	0.0481	0.0726	0.1559

*Mean of triplicates. WFB= Wheat flour biscuit. DFB= Doum flour biscuit.

The obtained calorific value of doum biscuits with different substitution levels (varied from 451.24 to 458.16 kcal/100g) was significantly ($P<0.05$) differ and less than control biscuits (461.37 k cal/100 g D.W). It is clear that the doum biscuit contain a high of fiber and low energy, so it is good and healthy. Wheat flour biscuits (control) and substituted doum biscuits were analyzed for total phenolics and flavonoids. Data given in Table (6) indicated that substitution of wheat flour with doum fruit flour caused a significant increase in total phenolics content proportionally with increasing the substitution level. The highest value was noticed at 20% DF substation (1892.50 mg GAE/100g D.W) compared with the control (1117.76 mg GAE/100g D.W) and the other biscuits samples. Same trend was observed in flavonoids of the produced biscuits. Data revealed that 20% DF substitution had the highest value (1344.84 mg) compared with wheat flour biscuit (495.30 mg catechin /100 g D.W) and the other biscuit samples.

Table (6): Total phenolics, total flavonoids and mineral composition of biscuit samples.

Samples	Total phenolics (mg GAE/100 g D.W)	Total flavonoids (mg catechin/100 g D.W)	Ca	P	Mg	Fe	Cu
Control WFB	1117.76	495.30	33.64	162.32	127.91	12.91	0.16
5% DFB	1294.08	556.74	41.75	151.30	138.24	16.81	0.44
10% DFB	1382.24	821.22	45.37	186.01	145.43	20.95	0.30
15% DFB	1676.11	1125.78	46.37	187.29	146.55	20.97	0.36
20% DFB	1892.50	1344.84	47.64	196.10	148.78	21.64	0.38
LSD 0.05	0.4778	0.0902	0.049	0.095	0.1123	0.0271	0.1142

The results Table (6) showed that minerals Ca content in the control biscuit was 33.64 mg/100 g, this value increased by increasing DFF substitution (from 5 to 20 %), which were found to be from 41.75 to 47.64% mg/100g, respectively. Data presented in Table (6), also showed that the concentration of P in control sample (162.32 mg/100 g) was lower than that found in the biscuits' samples contain 10 to 20 % DF (varied from 186.01 to 196.10 mg/100 g, respectively). Besides, the level and of Mg and Fe was slightly increased in biscuit samples with the replacement of DF up to 20% of wheat flour. There were significant differences (P<0.05) between all biscuits' samples compared with the control in their Fe and Mg concentration. Moreover, wheat biscuit (control) recorded significant (P<0.05) lower concentration of Cu than that found in the biscuit sample with DFF addition from 5 to 20% of wheat flour (Table 6).

3.3 Sensory evaluation of biscuits samples

Sensory characteristics of the studied biscuits as influenced by the replacing doum flour of wheat flour are outlined in Table (7).

Table (7): Sensory evaluation of biscuits samples.

Sample	Colour (10)	Surface character (10)	Crumb colour (10)	Taste (20)	Texture (20)	Mouth feel (10)	Total score (80)
Control WF	8.75	8.59	8.50	17.40	17.37	8.59	69.21
WF + DF 5%	7.98	8.01	8.08	17.30	16.98	8.36	67.35
WF + DF 10%	8.61	8.37	7.75	17.46	17.68	8.15	68.05
WF + DF 15%	8.43	7.78	7.56	16.70	17.25	7.75	65.48
WF + DF 20%	7.93	7.09	7.87	16.28	16.62	7.24	61.98
LSD 0.05	0.0708	0.0577	0.1081	0.1098	0.0833	0.0614	0.09

WF= wheat flour, DF= doum flour.

Data reveled that all sensory attributes of biscuit sample (contained 5-20% DF of Wheat flour) were lower than that of WF biscuit (control). However, the studied biscuit samples recorded total sensory score (total acceptability) varied from about 90% (of 20% DF) to 98% (of 10% DF) comparing with that of the control (0% DF). As above-mentioned results, wheat flour could be replaced up to 15% using doum flour without drastically affecting biscuits quality.

4. Conclusion

From the obtained results, it could be concluded that the wheat flour can be replaced by doum flour as a good source of fiber, minerals, and antioxidants up to 15% at least to produce a good acceptable, sensorial, nutritive, and healthy biscuit.

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