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Chemical Nutritional and Sensory Properties of Wheat Flour Balady Bread Fortified by the Mixture of Wheat Germ and Doum Fruit Powders

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Abstract: ***Equal quantity of doum fruit (DFP) and wheat germ (WGP) powders were mixed well and the mixture was replaced wheat flour (WF) (82% extraction rate) to produce balady bread with 2, 4 and 6% levels. Chemical composition, organoleptic characteristics and biological quality of the prepared balady bread were studied. WF, WGP, and DFP were found to contain 10.5%, 25.9% and 5.68% for protein and 1.2%, 3.2% and 24.3% for fiber, respectively. DFP was superior in calcium, iron and zinc. WGP was superior in magnesium while, WF was superior in manganese. DFP has high content of β-carotene and total dietary fiber, while WGP was the higher in the tocopherols. However, protein, fat, ash and fiber contents of fortified balady bread samples were increased with increasing the mixture levels of WGP and WEP, the total carbohydrates were decreased. WGP and DFP mixture could be fortified wheat flour balady bread to produce acceptable loaf and the level of fortification can be reach to 4%. The mean gain in body weight after four weeks averaged 16.05, 18.2, 15.4, 14.36 and 12.93 g upon the consumption of basal diet and balady bread containing mixture of WGP and DFP at levels 0.0%, 2 %, 4 % and 6 %, respectively. Significantly (p < 0.05) higher of food intake among rats groups consuming the balady bread fortified with mixture of WGP and DFP as compared to wheat flour balady bread (control). Triglyceride, glucose and total cholesterol were decreased, while protein and hemoglobin were increased in blood of rats groups consuming the bread fortified by the mixture of WGP and DFP up to level 6% compared with control group. Therefore, addition mixture of WGP and DFP to wheat flour could be used without any observed detrimental effect on balady bread sensory properties and improve the nutritional quality of balady bread especially in developing countries to avoid the malnutrition prevalent. Also, useful for those which suffering from high glucose, triglycerides and total cholesterol diseases.***

Keywords: Balady bread, nutritional, sensory properties, chemical composition

1. Introduction

Bread is one of the most widely consumed food product in the world. According to [1] bread making technology is probably one of the oldest technologies known. It is an important staple food for many countries. As a result of considered convenient foods [2]. The product is basically made from hard wheat flour, yeast, fat, sugar, salt and water [3]. Balady bread one of bread kinds characterized by acceptable and convenient produced from milled whole grains, which recognized as important nutritionally; moreover this grains contain photochemical whose promoted human health [4,5]. Furthermore, contain a high fiber which prevent and reduced risk in type 2- diabetes, obesity and cardiovascular diseases [6-9]. This encourages the fortified whole wheat flour with antioxidant materials from plant sources to produce nutritional and healthy baked product such as bread [10,11].

Doum fruit (*Hyphaene thebaica*) is a good source of potent antioxidants [12]. [13] Characterized the doum fruit color by a shimmy orange- brown to deep chestnut skin. [14] reported that doum fruit has a high quality protein varied between 2.86- 5.01%, high proportion of lysine and cystine of crude protein varied between 4.09- 4.16 % and 0.2- 1.62%, respectively, the limited amino acid threonine, crude fat varied between 1.2- 8.4%, crude fiber varied between 52.26- 66.5%, the most important carbohydrates component was mannose varied between 13- 75.9%, also presence of calcium, magnesium, potassium, iron sodium and negligible amount of nickel, cobalt and molybdenum. Phytochemical compounds of doum fruit such as tannins, saponin, steriods, glycosides, flavonoid, terpenes and terpinoids were found at low and moderate concentrations [15]. The phenols content of doum fruit were about 64.9 mg/g [16].

[17] Reported that wheat germ contains about 30% protein, 10% fat, 45% carbohydrates, high content of minerals, traces elements and vitamins complemented well together with wheat flour to produce nutritionally balanced high quality bread [18].

This ingredients not only nutrients but also therapeutic source useful in preventing and reduces diabetes, cardiovascular risks and inhibit LDL cholesterol [19-21]. Flavonoids, coumarins, hydroxycinamates and lignin components which act to prevent or reduce oxidative stress by scavenging free radicals [22-25].

The objectives of this research were to study the effects of wheat germ and doum fruit powders fortification on the chemical, sensory and nutritional properties of the produced balady breads.

2. Materials and Methods

1. Materials

1- Wheat flour (WF) extraction rate 82% and wheat germ were obtained from South Cairo Mills Co., Cairo, Egypt.
2- Activated compressed yeast was supplied by Starch and Yeast Co., Alexandria, Egypt.

3- Other baking ingredients margarine, table salt granulated and sugar were purchased from local markets of 6 October City, Giza governorate.
4- Dry doum fruits were obtained from hyper market (6 October city, Egypt) in a form of small pieces.

2. Methods

1. Preparation of raw materials:
Wheat germ and dry doum fruit were ground using an electric mill to fine powders then used for subsequent analysis.

2. Preparation of balady bread:
Equal quantity of doum fruit (DFP) and wheat germ (WGP) powders were mixed well and the mixture was replaced wheat flour to produce blends with 2, 4 and 6% levels. Balady bread was prepared as formula presented in Table (1) by mixing the formula components with other ingredients which are 1% dry yeast, 2% sodium chloride, 6% sugar, 1% fat and water as determined from a farinograph absorption test. The mixture was mixed in mixer (250 rpm) for 20 min. The dough was left for fermentation at 30- 32°C and 85-90% relative humidity for 60 min. After fermentation, the dough was divided into 130 g pieces. Each piece was molded on a wooden board previously covered with a fine layer of bran and left to ferment about 15 min at the same mentioned temperature and relative humidity. The fermented dough pieces were flattened to about 20 Cm diameter. After flatting, the dough was left to final fermentation about 15 min until suitable properties. The flat dough was baked in oven at 380- 400°C for 3- 4.5 min. The loaves were allowed to cool at room temperature before sensory evaluation (Yaseen, 1985) [26].

3. Analytical Methods

a. Chemical composition:
Chemical composition of wheat flour, doum fruit and wheat germ granules as well as balady bread was determined using the following AOAC (2000) [27] methods: moisture, total ash, crude fiber, total fat, and total nitrogen (micro-Kjeldahl). Protein was calculated as N × 5.7. Total carbohydrates were calculated by difference.

b. Minerals analysis:
Magnesium, manganese, calcium, Iron and zinc, were determined using a Pye Unicom SP 19000 Atomic Absorption Spectroscopy in Food Technology Research Institute, Agriculture Research Center, Giza, Egypt as described by AOAC (2000) [27].

c. β-Carotene analysis
The procedure followed to determine β-Carotene in materials was the same as described by (Rogers et al., 1993) [28].

d. Dietary fiber analysis
The raw materials and final products samples were analyzed by Prosky et al. method (1985) and (AOAC, 2000) [27, 29].

e. Tocopherol analysis
Tocopherol was quantitatively determined by method based on a gas- liquid chromatographic separation of their trimethyl silyl ether derivatives (Slover et al., 1969) [30].

4. Feeding Experiments
a. Animals and treatment
Twenty four male albino rats weighing (140- 160g) of Sprague Dawley strain were obtained from Research Institute of Ophthalmology, Medical Analysis Department, Giza, Egypt. Rats (n = 25 rats) were housed in wire cages in a room maintained at 25± 2°C and kept under normal healthy conditions. All rats were feed on basal diet for one week before starting the experiment for acclimatization. After one-week period, the rats were divided into 5 groups (4 rats each), all groups were fed for 28 days. First group was fed on the standard balady bread diet only as a control negative. One of the other groups was fed as a positive control group on a basal diet. The other groups were fed on balady bread containing 2 %, 4 % and 6% levels from the mixture of wheat germ powder (WGP) and doum fruit powder (DFP) diets. All rats were fed thrice daily, morning, afternoon and evening for a period of 7 days before they were sacrificed.

b. Basal diet:
The basal diet and vitamin mixtures preparing carried out according to methods described by Cohn et al. (1975); Cuthbertson et al. (1967) and Caster et al. (1975) [31-33].

c. Collection of serum
The rats were anaesthetized with chloroform and then sacrificed. The blood was carefully collected into a test tube after sacrifice. The blood was allowed to clot for a period of about 15- 20 min. The specimen was centrifuged at 3000 rpm for 10 min. The serum was separated from the red cells to avoid interference.

d. Determination of total protein
The total protein was determined using Tietz (1995) [34] method.

e. Determination of glucose
Glucose were determined using Barham and Trinder (1972) [35] method.

f. Determination of cholesterol
Cholesterol was determined using Allain Photovoltaic (1974) [36] method.

g. Determination of triacyglycerol
Triglyceride was determined using enzymatic test glycerol-phosphate oxide method of Jacob et al. (1960) [37].

h. Determination of hemoglobin
Fresh blood was diluted 1: 200 with 0.4% ammonium hydroxide and the hemoglobin absorbance was measured at 450 nm according to the method of Caster and Marie (1967) [38].

5. Sensory Evaluation

Balady bread was evaluated for their sensory characteristics by ten panelists from the staff of Quality Control Department, Bakery Product Company, 6 October city, Giza, Egypt, according to Hegazy and Faheid (1990) [39]. Balady bread was evaluated by using the following scores 20 for appearance and taste, 10 for crust color, rounder and distribution of crumb, while score 15 for odor and separation of layers. Panelists evaluated balady bread samples without special lighting and at ambient temperature (25°C). Water was provided for rinsing purposes.

6. Statistical Analysis

Results are expressed as the mean value ± standard deviation (SD) of three separate determinations. The data were statistically analyzed using analysis of variance and least significant difference according to Gomez and Gomez (1984) [40] by using SPSS software program. Significant differences were determined at the $P<0.05$ level.

3. Results and Discussion

Table (1) reveal the difference of the raw materials in their contents of protein, fat, ash, crude fiber, total carbohydrates on dry basis and moisture content. Wheat flour (WF), wheat germ powder (WGP), and doum fruit powder (DFP) were found to contain 10.5%, 25.9% and 5.68% for protein and 1.5, 10.4 and 6.8% for fat and 1.1%, 4.2 and 5.1% for ash, 1.2%, 3.2% and 24.3% for fiber and 71.88%, 44% and 46.2% for carbohydrates and 13.8%, 12.3% and 11.7% for moisture, respectively. These results are in agreement with those reported by [41], who reported that wheat germ powder contained 30% protein and 10% fat. While, [10] noticed that doum fruit powder contained 52.26%- 66.5% crude fiber. WGP contained the highest values of protein (25.9%) and fat (10.4%), while, DFP contained the highest values of crude fiber (24.3%) and ash (5.1%).

Table 1: Chemical composition of wheat flour (WF), wheat germ powder (WGP) and doum fruit powder (DFP) (On dry weight basis)

Components (%)	*Samples*		
	Wheat flour (WF)	*Wheat germ powder (WGP)*	*Doum fruit powder (DFP)*
Moisture	13.8	12.3	11.7
Protein	10.5	25.9	5.68
Fat	1.5	10.4	6.8
Ash	1.1	4.2	5.1
Fiber	1.2	3.2	24.3
Total carbohydrate*	71.88	44	46.2

* Calculated by difference.

Table (2) represents the minerals contents of wheat flour (WF), wheat germ powder (WGP) and doum fruit powder (DFP). DFP was superior in calcium, iron and zinc. WGP was superior in magnesium while, WF was superior in manganese. These results for WF are in agreement with those reported by [15, 42]**.** Therefore, fortification of WF with WGP and DFP give a rise to high levels of minerals.

Table 2: Mineral contents of wheat flour (WF), wheat germ powder (WGP) and doum fruit powder (DFP) (mg/100 g) (On dry weight basis)

Minerals	*Samples*		
	Wheat flour (WF)	*Wheat germ powder (WGP)*	*Doum fruit powder (DFP)*
Mg	17.1	12.1	14.3
Mn	2.2	4.1	3.8
Zn	4.9	2.8	5.1
Fe	2.1	3.5	4.6
Ca	16.7	20.5	23.1

Table (3) indicated that wheat germ powder (WGP) and doum fruit powder (DFP) contains some phytochemical (β-carotene, tocopherols and total dietary fiber), whose promote human health. DFP has high content of β-carotene (11.3 mg/ 100 g) and total dietary fiber (29.9%). These results agreements with those reported by [16] of doum fruit powder. WGP was the higher in the tocopherols (21.5 mg/100 g), same results obtained by [43]. So, the addition of WGP and DFP to wheat flour improve produced balady bread potent antioxidants.

Table 3: β-Carotene, tocopherols and total dietary fiber (TDF) content of wheat germ powder (WGP) and doum fruit powder (DFP)

Materials	*β-Carotene Mg/100g*	*Tocopherols Mg/ 100g*	*Total dietary fiber (TDF) %*
Wheat germ powder (WGP)	Traces	21.5	8.6
Doum fruit powder (WFP)	11.3	0.5	29.9

Table (4) showed the chemical composition of wheat flour (WF) balady bread fortified with mixture of wheat germ powder (WGP) and doum fruit powder (WFP) at different levels. There were difference between the 100% WF bread and those fortified with WGP and WEP mixture levels. However, protein, fat, ash and fiber contents of fortified balady bread samples were increased with increasing the mixture levels of WGP and WEP, the total carbohydrates were decreased. The increase in protein, fat, ash, and fibers of fortified balady bread can be attributed to the high content of (DFP) and (WGP). This clearly indicates that can be produced nutritionally balanced high quality balady bread [20], and an alternative source of dietary fiber in balady bread making. On the other hand, carbohydrate content was reduced as a result of increase fortified ingredient levels. These results were in agreement with that obtained by [14].

Table 4: Chemical composition of wheat flour (WF) balady bread fortified with mixture of wheat germ powder (WGP) and doum fruit powder (DFP) at different levels.*

Composition (%)	*Balady bread samples*			
	Control (100% WF)	*2% (1% WGP + 1% DFP)*	*4% (2% WGP + 2% DFP)*	*6% (3% WGP + 3% DFP)*
Protein	10.5	14.1	14.5	15.3
Fat	1.5	1.6	1.8	2.01
Ash	1.1	1.19	1.27	1.38
Fiber	1.2	1.46	1.7	2.01
Total carbohydrate	84.5	81.65	80.73	79.3

* Equal quantity of DFP and WGP powders were mixed well and the mixture was replaced wheat flour to produce blends with 2, 4 and 6% levels.

Table (5) shows the sensory evaluation of balady bread produced from wheat flour (WF) fortified with a mixture of wheat germ powder (WGP) and doum fruit powder (DFP) at different levels ratio 2, 4 and 6%. The sensory evaluation included the general appearance, taste, crust color, separation of layers, roundness, distribution of crumb and odor. No significant ($P > 0.05$) differences observed between the wheat flour balady bread comparing to balady bread fortified with mixture of WGP and DFP at all levels (2, 4 and 6%) in their separation of layers, roundness, distribution of crumb and odor. No significant ($P > 0.05$) differences between wheat flour balady bread and balady bread fortified with mixture of WGP and DFP at 2 and 4% levels in their appearance, taste and crust color. The scores of appearance, taste and crust color were significantly ($P < 0.05$) decreased in balady bread fortified with mixture of WGP and DFP at 6% level. Thus, WGP and DFP mixture could be fortified wheat flour balady bread to produce acceptable loaf and the level of fortification can be reach to 4%.

Table 5: Sensory properties of wheat flour (WF) balady bread fortified with mixture of wheat germ powder (WGP) and doum fruit powder (DFP) at different levels.*

Balady bread samples	*Appearance*	*Taste*	*Crust color*	*Separation of layers*	*Rounder*	*Distribution of crumb*	*Odor*
Control (100% WF)	19.5 ± 0.50^{a}	19.5 ± 0.27^{a}	9.5 ± 0.37^{a}	14.5 ± 0.39^{a}	9.5 ± 0.35^{a}	9.5 ± 0.39^{a}	14.5 ± 0.39^{a}
2% (1 WGP + 1 DFP)	19.4 ± 0.59^{ab}	19.3 ± 0.28^{ab}	9.4 ± 0.37^{a}	14.3 ± 0.39^{a}	9.4 ± 0.39^{a}	9.4 ± 0.40^{a}	14.5 ± 0.39^{a}
4% (2 WGP + 2 DFP)	19.1 ± 0.58^{ab}	19.3 ± 0.29^{ab}	9.3 ± 0.38^{a}	14.2 ± 0.39^{a}	9.3 ± 0.39^{a}	9.3 ± 0.41^{a}	14.3 ± 0.39^{a}
6% (3 WGP + 3 DFP)	18.7 ± 0.58^{b}	19.1 ± 0.28^{b}	8.9 ± 0.38^{b}	14.2 ± 0.41^{a}	9.2 ± 0.39^{a}	9.2 ± 0.34^{a}	14.2 ± 0.41^{a}

*Equal quantity of DFP and WGP powders were mixed well and the mixture was replaced wheat flour to produce blends with 2, 4 and 6% levels.
Means ± standard deviation of means of three determinations.
Means in the same row with different letters are significantly different ($P < 0.05$).

Table (6) presents the mean changes in body weight, feed intake and feed efficiency ratio (FER). Significantly ($p < 0.05$) higher of food intake among rats groups consuming the balady bread fortified with mixture of WGP and DFP at 2, 4 and 6% levels as compared to wheat flour balady bread (control). This finding suggests that fortified balady bread levels were more palatable to the rats than the control one. The mean gain in body weight after four weeks averaged 16.05, 18.2, 15.4, 14.36 and 12.93 g upon the consumption of basal diet and balady bread containing mixture of WGP and DFP at levels 0.0%, 2 %, 4 % and 6 %, respectively. The lowest ($p < 0.05$) mean value was found among rats groups consuming diets containing 6 % mixture of WGP and DFP. These changes in body weight could be as a result of a decrease in their blood level during the administration of the tested feed which could also lead to sluggishness in movement [44]. Also, weight gain decrease could be attributable to a reduced metabolizable energy of the diets containing WGP and DFP, due to its high fiber content, resulting in lower mean values of FER [45]. Also, the water holding capacity of dietary fiber is thought to be an important determinant of fecal bulking and intestinal transit times with influence on gastrointestinal disease [10]-[46].

Table 6: Body weight gain, feed intake and feed efficiency ratio of rat feed on balady bread fortified with mixture of wheat germ powder (WGP) and doum fruit powder (DFP) at different levels.*

Animal group	*Initial body weight (gm)*	*Final body weight (gm)*	*Body weight gain (gm)*	*Feed intake (gm)*	*Feed efficiency ratio*
Control (basal diet)	27.3 ± 2.70[a]	45.3 ± 3.10[a]	16.05±1.62 [b]	164.09± 11.95[b]	0.079± 0.004[b]
Control (100% WF)	27.3 ± 2.70[a]	31.40±3.49[b]	18.20±1.42[a]	170.5 ±18.89[b]	0.106±0.012[a]
2% (1 WGP + 1 DFP)	28 ± 2.30[a]	45.5 ± 4.50[a]	15.40±1.84[bc]	176.11 ±19.66[b]	0.071±0.007[c]
4% (2 WGP + 2 DFP)	28.3 ± 2.20[a]	45.6 ± 4.20[a]	14.36±1.49[c]	178.87±10.56a[b]	0.064±0.006[cd]
6% (3 WGP + 3 DFP)	28.4 ± 2.10[a]	45.6 ± 3.10[a]	12.93±1.62d	185.53 ±13.84[a]	0.055±0.005[d]

* Equal quantity of DFP and WGP powders were mixed well and the mixture was replaced wheat flour to produce blends with 2, 4 and 6% levels.
Means ± standard deviation of means of three determinations.
Means in the same row with different letters are significantly different (P<0.05).

Data in table (7) reveals that serum concentrations of hemoglobin and total protein in the test groups were significantly (P < 0.05) higher than the control. The exact reason for this increase in level of total protein and hemoglobin is obscure but could indicate the high presence of iron and protein contents (Tables 2, 3) in the replacement ingredients. According to [13], analyze the tested doum fruit had high quality contain from protein varied between 2.86- 5.01%. While [16] found wheat germ contains 30% protein and high content in minerals. The result shows that the level of both protein and hemoglobin are higher in bread fortified by 6% level mixture of both WGP and DFP than other levels. This result suggests that the level of protein increases with an increase in the concentration of the fortification. Significant (P < 0.05) decreased in triglyceride, glucose and total cholesterol obtained from balady bread diet fortified with the mixture of WGP and DFP at levels 4 and 6% compared with control group. Dietary fibers of balady bread fortified at levels 4% and 6% by the mixture of WGP and DFP have gained immense importance because of their constructive role in releasing sugars and the absorption of these sugars slowly in the intestinal tract; consequently, they reduce the severity of diabetes mellitus and are helpful in reducing blood glucose from 7.60 to 6.85 Mm/ l and cholesterol from 174.22 to 158.08 mg/ dl, respectively. This result was in the same trend with [46]-[47,48]. While the significant (P<0.05) decreased in triglyceride and cholesterol may be attributed to effects of high fiber content [49] and to high-dose β-carotene and tocopherols in both WGP and DFP. The obtained results of serum lipids and cholesterol are in the same trend with [12]-[21].

Table 7: Glucose, hemoglobin, total protein, triglycerides and total cholesterol of rat feed on balady bread fortified with mixture of wheat germ powder (WGP) and doum fruit powder (WFP) at different levels.*

Animal group	*Glucose (Mm/l)*	*Hemoglobin (mg/dl)*	*Total protein (g/dl)*	*Triglycerides (mg/dl)*	*Total cholesterol (mg/dl)*
Control (purified diet)	7.60±0.92[a]	15.42±1.88[a]	5.93±0.72[b]	101.70±19.64[a]	174.22±21.23[a]
Control (100% WF)	6.90 ±0.71[ab]	14.65 ± 1.71[b]	5.72 ± 0.58[b]	79.1 ± 16.51[ab]	140.88 ± 14.44[b]
2% (1 WGP + 1 DFP)	7.30 ± 0.98[a]	15.83 ± 2.12[a]	6.53 ± 0.87[a]	97.30 ± 11.98[a]	165.09 ± 22.12[a]
4% (2 WGP + 2 DFP)	7.10 ± 0.49[a]	16.23 ± 1.11[a]	6.32 ± 0.47[ab]	76.46 ± 5.01[b]	160.63± 11.03[a]
6% (3 WGP + 3 DFP)	6.85 ± 0.51[b]	16.60 ± 1.24[a]	6.95 ± 0.46[a]	74.33 ± 6.01[b]	158.08 ±11.86[ab]

* Equal quantity of DFP and WGP powders were mixed well and the mixture was replaced wheat flour to produce blends with 2, 4 and 6% levels.
Means ± standard deviation of means of three determinations.
Means in the same row with different letters are significantly different (P<0.05).

4. Conclusion

Addition mixture of WGP and DFP to wheat flour could be used without any observed detrimental effect on balady bread sensory properties and improve the nutritional quality of balady bread especially in developing countries to avoid the malnutrition prevalent. Also, useful for those which suffering from high glucose, triglycerides and total cholesterol diseases**.**

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