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PRODUCTION AND EVALUATION OF HIGH FOLIC ACID BALADY BREAD

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ABSTRACT

Deficiency of folic acid in human lead to macrocytic (megaloblastic) anemia and leukopenia, hence, this study targeted to utilization of by-product which obtained during mill wheat and characterized by its high folic acid content. Total folic acid (TFA) was determined in fine bran (FB) and wheat germ (WG) and they found to contain 316 and 286 µg/100g, respectively. Balady bread samples (prepared from wheat flour 82 and 72% extraction rate) were fortified by different levels of FB and WG. The results indicated that TFA contents increased from 124 to 318 µg/ 100g in balady bread samples fortified by FB and WG. Chemical composition of balady bread samples fortified by FB and WG showed the same trend since; protein, fat, fiber and ash were increased. Values of total dietary fiber, iron, zinc and calcium were also enhanced. Sensory evaluation results showed that there were no significant differences among all balady bread samples for diameter and separation of layers, but other characteristics of sensory evaluation were adversely affected with the exception of balady bread samples prepared from wheat flour 72% extraction containing different levels of FB and WG. Accordingly, FB and WG can be recommended as natural rich sources of folic acid supplement for balady bread produced from wheat flour 72 % extraction rate.

Key words: *balady bread, fine bran, folic acid, wheat germ.*

1. INTRODUCTION

Folic acid is the group name (also termed folates or folacin) given to a number of yellow crystalline compounds related to pteroglutamic acid. Folic acid is one of the water soluble B vitamins .It is found in whole wheat, soy bean, yeast, wheat germ, wheat bran and green leafy vegetable. So, these products could be considered an ideal natural supplement for producing folic acid baked products. Among cereals, wheat (approx. 363 g/ capita/day) is frequently consumed as balady bread with each meal. In Egypt, they are the main dietary energy source, providing about 66% of energy (FAO 2005).

Folic acid deficiency during pregnancy has been found to cause neural tube defects (NTD) in newborn babies (West *et al*., 2012). The role of folic acid in prevention of ischaemic heart disease, prevention of leukopenia, decreasing plasma homocysteine, prevention of colorectal cancer, prevention of neuro cognitive decline and prevention of macrocytic (megaloblastic) anemia has also recently received increased attention (Houghton *et al.*, 2011, Kim *et al.*, 2012 and Walker *et al.*, 2012).

An alternative to folic acid fortification of stable foods could be to increase the folate content in cereal foods, either by bio – processing methods such as germination (*e.g.* cereal grains) and fermentation (*e.g.* bread) or by use folate – rich fractions obtained by milling for maintenance of optimal health, as well as prevention of disease (Katina *et al.*, 2007 and Hefni & Witthöft 2011).

With the use of novel milling technology, it has become commercially viable to isolate the aleurone layer of cells from wheat grain and to prepare a novel flour from this fraction that has a natural folate concentration of; 500 µg/100 g. This study has shown that products made from wheat aleurone flour is a good source of bioavailable, natural folate (Fenech *et al.*, 1999).

Fortification of the wheat flour used for balady bread baking with iron and folic acid was recently introduced in Egypt (personal communication with Prof Azza Gohar, National Nutrition Institute, Cairo, Egypt) since these micronutrient deficiencies are widespread. Anaemia is a major public health problem with a prevalence of 30-50% among children aged 2-5 years and women of reproductive age (EDHS, 2005), which can be a result of iron, folate or vitamin B12 deficiency. A complement or alternative to mandatory folic acid fortification could increase the natural folate content in Egyptian balady bread by bioprocessing techniques.

Balady bread is the most popular items consumed nearly by all levels of society in Egypt, ready to eat, availability in different time and affordable cost, thereby, the present study has been planned (1) to produce balady bread with increased folic acid content (2) to produce balady bread fortified by fine bran and wheat germ (3) to evaluate different balady bread samples.

2. MATERIALS AND METHODS

2.1. Materials

Whole wheat, wheat flour (82 and 72% extraction rate), wheat fine bran and wheat germ were obtained from Middle and West Delta Mills Company, Benha City, El Qualiubiya Governorate, Egypt. Active dry yeast was purchased from local supermarket.

2.2. Methods

2.2.1.Preparation of whole wheat flour and wheat germ meal

Whole wheat sample was milled *via* laboratory mill (1400, Perten) to get the whole wheat flour. While wheat germ was first roasted at 135°C for 15 min. then milled to obtain wheat germ meal.

2.2.2. Preparation of balady bread

Balady bread formulas are shown in Table (1). Balady bread prepared as the following procedures: one hundred gram of each sample was mixed with water (as formation of dough need), 1% sodium chloride and 1.5% active dry yeast. The ingredients were kneaded for 20 min. in mixer laboratory mechanical. The dough was fermented for one hr. at 30°C under 85% relative humidity (RH). Dough was divided into 100 gm pieces. Pieces were molded on a wooden board previously sprinkled with fine layer of bran and left for 15 min. at 30°C and 85% (RH). The pieces were flattend to about 20 cm diameter and 0.5 cm thickness then proofed at 30°C and 85% (RH) for 30 min. then baked at 450-500°C for 1-2 min. in electric oven. Bread loaves were allowed to cool on rack for 30 min. before organolyptic evaluation, and then packed in polyethylene bags until next analysis according to the method of Mohamed *et al.* (1996).

2.2.3. Determination of chemical composition

Moisture protein, fat, crude fiber and ash contents were determined according to the methods of AOAC (2000) and carbohydrate calculated by difference. Minerals content (iron, zinc and calcium) were digested according to the method of AACC (2000) and determined by Atomic Absorption Spectrophotometry (model 3300, Perkin-Elmer, Norwalk). Total dietary fiber was estimated according to the method of AACC (2000).

2.2.4. Determination of total folic acid

Reversed-phase gradient HPLC method was performed. Using the HPLC instrument. Dionex (ASI-100 automated sample injector - P680 × pump gradient - 170μ - U.V detector) according to the method of Póo – Prieto *et al.* (2006). The folates were separated on an ODS-hypersil (5μm, 4.6×250 mm) analytical column. A flow rate of 1 ml / min was used. The mobile phase program consisted of 3 min with 100% A (28 mmol/L diabasic potassium phosphate and 60 mmol/L phosphoric acid in water) followed by a linear gradient of 10 min to 70 % A : 30 % B (28 mmol/L dibasic phosphate) and 60 mmol /L phosphoric acid in 200 ml/l acetonitrile and 800 ml/L water). A second linear gradient from 70% A: 30% B to 45%A: 55% B was then run over the next 17 min, followed by a third linear gradient to 43%A: 57% B over the next 15 min. At 45 min, the column was equilibrated for 5 min in the initial conditions and another sample analysis could be initiated immediately. The absorbance of folic acid was monitored with a detector set at 280 nm,using standard folic acid solution.

2.2.5. Bread texture profile analysis:

The changes in the texture profile of bread due to staling were measured using the penetration test. A QTS texture analyzer (CNS Farnell, Hertfordshire, UK) was used to measure the force required for penetration of a round – bottom (2.5 cm diameter × 1.8 cm height) probe at a velocity of 30 mm/min into the bread. The settings of the texture analyzer were: Trigger Value at 0.05 N and Target Value at 30 mm according to the method of Sourki *et al.* (2010).

2.2.6. Sensory evaluation

The balady bread loaves were sensory evaluated for color & appearance, diameter, separation, biting textures, aroma, taste and crumb texture according to method of Mohamed *et al.*, (1996).

2.2.7. Statistical analysis

The gathered results in present study were statistically analyzed using the SPSS version 10.0

Table (1): Preparation of different formulas.

Samples (No.)	Wheat flour (g)	Fine bran (g)	Wheat germ (g)
1	Whole wheat flour (100)	-	-
2	82% extraction (100)	-	-
3	72% extraction (100)	-	-
4	82% extraction (75)	25	-
5	82% extraction (75)	-	25
6	82% extraction (75)	15	10
7	82% extraction (75)	10	15
8	72% extraction (75)	25	-
9	72% extraction (75)	-	25
10	72% extraction (75)	15	10
11	72% extraction (75)	10	15

windows program (SPSS, Inc., 1998, Chicago, II). Data were expressed as means ± SEM. Statistical analysis was performed using one-way analysis of variance followed by Tukey post hoc test. Duncan's tests were done to compare a pair of group means.

3. RESULTS AND DISCUSSION

3.1. Chemical composition of raw materials

Raw materials were chemically analyzed and the results were summarized in Table (2). The data revealed that the highest protein and ash contents (44.17 and 6.43%), respectively were found in active dry yeast. Meanwhile, wheat germ meal was rich in fat content (9.50%). In the meantime, fine bran characterized by its higher fiber content (8.60%) than that of other raw materials. At the same time, wheat flour (72 and 82% extraction) was higher in carbohydrates content (87.49 and 83.84%) consecutively than that of other raw materials. These data are similar to results obtained by Reed & Nagodawithcnan (1991), Sidhu *et al.* (1999), Farouk *et al.* (2002), Louz *et al.*, (2010) and Metwalli and Abdelrasoul (2010).

Table (2): Chemical composition (%) of raw materials (on dry weight basis)*.

Samples	Protein	Fat	Fiber	Ash	Carbohydrates**
Whole wheat flour	15.29	2.13	3.01	2.22	77.35
Wheat flour (82% ext)	11.12	1.78	1.81	1.45	83.84
Wheat flour (72% ext)	10.23	1.14	0.61	0.53	87.49
Fine bran	17.80	4.50	8.60	5.80	63.30
Wheat germ	21.40	9.50	2.50	5.40	61.20
Active dry yeast	44.17	1.23	1.97	6.43	46.20

***Each value is a mean of duplicate determination. **Calculated by difference.**

3.2. Folic acid content of raw materials

With respect to total folic acid (TFA) content of raw materials, the obtained data in Table (3) showed that the highest TFA content (1652 µg/100g) was found in active dry yeast followed by fine bran 316 µg/100g, wheat germ meal 286 µg/100g, whole wheat flour 43 µg/100g, wheat flour 82% extraction 32 µg/100g and wheat flour 72% extraction 28 µg/100g. These results are in concide with those noticed by Reed & Nagodawithcnan (1991), Osseyi *el al.*, (2001), Hefni *et al.*, (2010) and Hefni & Witthöft (2012). On the other side, Jägerstad *et al.*, (2005) mentioned that folates are concentrated to the outer layers of the kernel wheat and fractions taken from different parts of the kernel wheat can thus have significantly different folate contents. Fenech *et al.* (2005) found the aleurone together with germ and bran during milling .

Table (3): Folic acid content (µg/100 g) of raw materials (on dry weight basis).

Samples	Folic acid
Whole wheat flour	43
Wheat flour (82% ext)	32
Wheat flour (72% ext)	28
Fine bran	316
Wheat germ meal	286
Active dry yeast	1652

3.3.Chemical composition of balady bread

With regard to chemical composition of balady bread prepared from different formula (11 samples). The data in Table (4) showed statistically significant difference between the samples ($p \geq 0.05$). The results in Table (4) indicated that replacement both wheat flour (82 and 72% extraction) by different levels of FB and WG led to augment the contents of protein (ranged from 10.25 to 16.68%), fat (ranged from 1.15 to 4.54%), fiber (ranged from 0.70 to 3.63%) and ash (ranged from 0.98 to 2.87%) in balady bread samples. These results are in agreement with those obtained by Sidhu *et al.*(1999) and Farouk *et al.* (2002) who found that addition of FB and WG to wheat flour led to increase the protein, fat, fiber and ash contents of bread.

3.4. Folic acid content of balady bread

In respct of TFA content of balady bread samples the present results (Fig. 1) elucidated that values of TFA content started with 124 µg/100g in the sample No. (3) and reached to 318 µg/100g in the sample No. (6). It is noteworthy from the same Figure that sample No. (4,6 & 7) can supply about two – third TFA when comparing with Recommended Dietary Allowance (RDA) (400µg/day) as mentioned by Stevenson *et al.* (2000). Thereafter, samples No. (1, 5, 10 &11) can provide about half TFA when comparing with (RDA/d). Then samples No. (2,3,8 &9) can give about third TFA when comparing with (RDA/d). The total folic acid loss between spiked flour and bread was investigated by some trials whereas Hefni and Witthöft (2011) evinced that baking process caused about 15% TFA losses in baked bread. Also, Osseyi *et al.* (2001) and Kariluoto *et al.*(2004) evidenced that TFA losses due to baking process were about 20-25%. With these values it can be postulated that FB and WG can be considered as a substantial sources of folic acid and as an alternative important strategy for increasing folic acid in the diet. Kariluoto *et al.* (2004) found that folate content increased during sourdough fermentation commonly used in rye baking and the increase was associated mainly with the growth of yeast. Yeast was able to compensate folate losses both in rye and wheat baking not only by its high folate content itself but also by synthesizing folates. There was no difference between total folate contents of wheat breads baked using either sponge-dough or straight- dough method. Changes in folate content during rye baking were accompanied by changes in vitamen distribution. Sourdough fermentation affects not only sensory and microbiological but also nutritional quality. The results suggest that by the means of screening and selecting appropriate yeast and lactic acid bacteria it could be possible to enhance natural folate content in bread. And so, Jägerstad *et al.* (2005) stated that some food process techniques can enhance folate content, *e.g.* bioprocessing including fermentation. Bread is sample of foods produced by the fermentation of yeast, itself a rich source of folate. Wheat breads baked using a sponge-dough or straight-dough method contained 2.5 times more folates than bread leavened with baking powder.

3.5. Dietary fiber

Respecting total dietary fiber (TDF) content in balady bread samples, the finding results in Table (5) demonstrated that sample No. (6) had the highest significant difference (14.53%) in TDF content. On the contrary, sample No. (3) had the lowest significant difference (5.25%) in TDF content. These results are in accordance with those mentioned by Sidhu *et al.* (1999) who found that TDF content in bread fortified by FB and WG was found to be far superior than that of the bread unfortified.

3.6. Mineral contents

Regarding mineral contents in balady bread samples the results in Table (5) elucidated that sample No. (7) had a maximum values of Fe, Zn and Ca contents (4.43, 3.57 & 49.91 mg/100 g), respectively. In contrast, sample No. (3) had a minimum values of Fe, Zn and Ca contents (2.42, 1.80 & 45.16mg/100g), respectively. These results are in concide with those obtained by Bedeir and Al Amri (2008) who proved that adding wheat germ to wheat flour led to ameliorate Fe, Zn and Ca contents in bread supplemented with wheat germ compared to unsupplemented bread.

3.7. Bread texture profile analysis

Concerning bread texture profile analysis the results in Table (6) evident that the samples which recorded low values were more freshly (low staling rate), *vice versa*, samples which recorded high values were less freshly (high staling rate). The sample No. 4 was optimal and fresher than other samples in relation to firmness. This might be due to the high water absorption capacity of bran, consequently increase shelf-life of bread sample and enhance firmness of bread as mentioned by Laurikainen *et al.*(1998).

3.8. Sensory evaluation

In relation to sensory evaluation of balady bread prepared from different formulas, the results in Table (7) indicated that samples No. (1, 2, 3, 5, 6, 9, 10 and 11) were the best samples and were not significantly different for color and

Table (4): Chemical composition (%) of balady bread (on dry weight basis)*.

Samples No.	Protein	Fat	Fiber	Ash	Carbohydrates
1	$15.34^{c}\pm0.012$	$2.15^{f}\pm0.058$	$3.11^{b}\pm0.015$	$2.26^{b}\pm0.011$	$77.14^{c}\pm0.237$
2	$11.79^{h}\pm0.01$	$1.82^{g}\pm0.012$	$1.94^{f}\pm0.023$	$2.03^{g}\pm0.008$	$82.42^{b}\pm0.242$
3	$10.25^{i}\pm0.028$	$1.15^{h}\pm0.057$	$0.70^{g}\pm0.012$	$0.98^{i}\pm0.011$	$86.92^{a}\pm0.294$
4	$15.54^{c}\pm0.063$	$2.54^{e}\pm0.145$	$3.63^{a}\pm0.008$	$2.87^{a}\pm0.017$	$75.42^{g}\pm0.173$
5	$15.60^{c}\pm0.057$	$4.54^{a}\pm0.034$	$2.56^{b}\pm0.021$	$2.48^{d}\pm0.017$	$74.82^{g}\pm0.232$
6	$15.93^{b}\pm0.011$	$3.49^{c}\pm0.005$	$3.50^{a}\pm0.577$	$2.69^{c}\pm0.017$	$74.39^{h}\pm0.173$
7	$16.68^{a}\pm0.14$	$4.45^{a}\pm0.029$	$3.22^{b}\pm0.115$	$2.57^{d}\pm0.067$	$73.08^{i}\pm0.046$
8	$12.60^{g}\pm0.11$	$2.00^{f}\pm0.115$	$2.98^{c}\pm0.017$	$1.84^{h}\pm0.015$	$80.58^{c}\pm0.288$
9	$13.23^{f}\pm0.11$	$4.29^{a}\pm0.059$	$2.13^{e}\pm0.057$	$2.39^{f}\pm0.006$	$77.96^{d}\pm0.248$
10	$14.06^{e}\pm0.24$	$3.24^{d}\pm0.063$	$2.54^{d}\pm0.083$	$2.60^{c}\pm0.057$	$77.56^{d}\pm0.323$
11	$14.78^{d}\pm0.034$	$3.55^{c}\pm0.088$	$2.45^{d}\pm0.021$	$2.51^{d}\pm0.006$	$76.71^{c}\pm0.346$

***Values are mean±SE**

Table (5): TDF (%) and mineral contents (mg/100 g) of balady bread (on dry weight basis)*.

Samples No.	TDF	Fe	Zn	Ca
1	$13.89^{b}\pm0.031$	$4.29^{a}\pm0.015$	$3.45^{a}\pm0.008$	$49.32^{a}\pm0.035$
2	$11.63^{d}\pm0.081$	$3.47^{c}\pm0.028$	$2.33^{d}\pm0.011$	$46.35^{ab}\pm0.069$
3	$5.25^{g}\pm0.144$	$2.42^{e}\pm0.018$	$1.80^{e}\pm0.081$	$45.61^{b}\pm0.080$
4	$13.73^{b}\pm0.112$	$3.74^{b}\pm0.026$	$2.41^{d}\pm0.031$	$47.37^{ab}\pm0.298$
5	$11.91^{d}\pm0.153$	$4.27^{a}\pm0.089$	$3.42^{b}\pm0.088$	$49.75^{a}\pm0.229$
6	$14.53^{a}\pm0.081$	$4.36^{a}\pm0.043$	$3.50^{a}\pm0.003$	$49.86^{a}\pm0.199$
7	$12.61^{c}\pm0.057$	$4.43^{a}\pm0.02$	$3.57^{a}\pm0.010$	$49.91^{a}\pm0.02$
8	$9.54^{e}\pm0.032$	$2.92^{d}\pm0.003$	$1.96^{e}\pm0.026$	$46.40^{ab}\pm0.476$
9	$8.21^{f}\pm0.089$	$3.30^{c}\pm0.014$	$2.82^{c}\pm0.018$	$47.25^{ab}\pm0.069$
10	$13.15^{c}\pm0.112$	$3.51^{bc}\pm0.027$	$2.84^{c}\pm0.011$	$48.11^{ab}\pm0.041$
11	$11.36^{d}\pm0.064$	$3.58^{b}\pm0.011$	$2.96^{c}\pm0.015$	$48.55^{ab}\pm0.109$

***Values are mean ± SE**

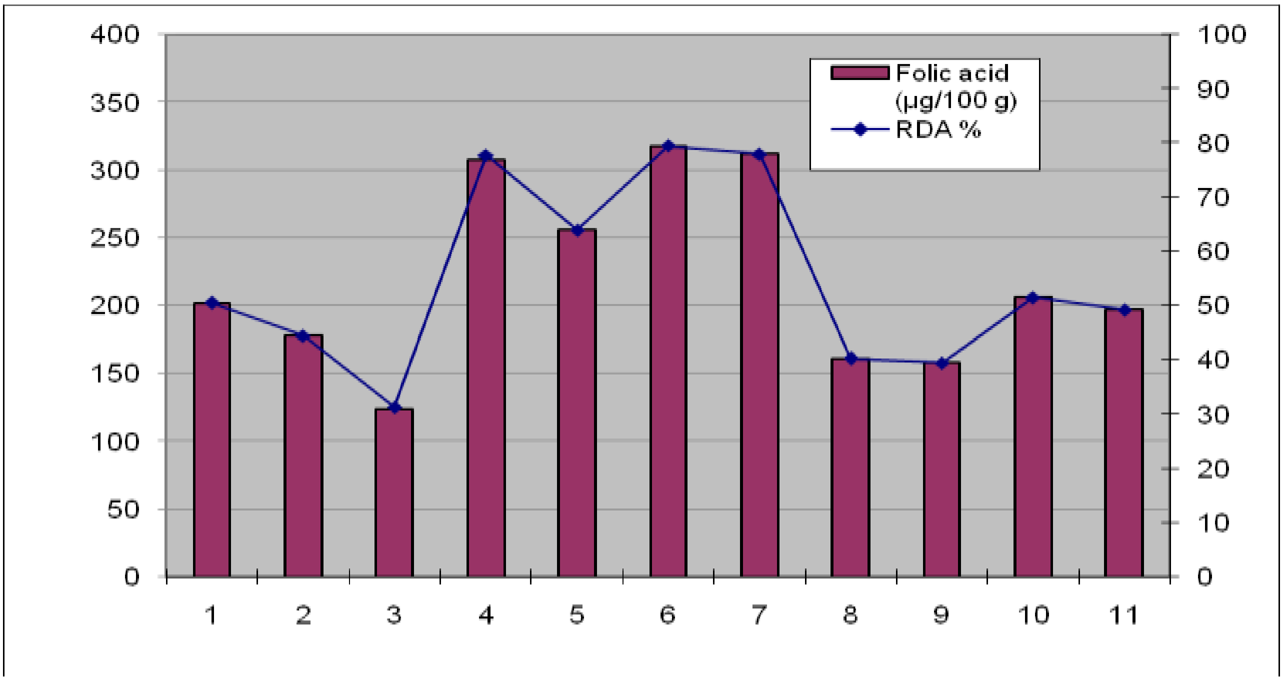

Fig. (1): Total folic acid content (μg/100 g) and RDA (%) of balady bread

Table (6): Bread texture profile analysis.

Samples No.	Firmness	Cohesiveness	Gumminess	Chewiness	Springiness	Resilience
Bread texture profile analysis at zero time						
1	19.3	0.658098784	12.701307	8.90568	0.7011628	0.3883721
2	16.59	0.783585487	12.999683	10.9005	0.8385236	0.6020761
3	12.29	0.872295818	24.677249	21.5646	0.8738636	0.5034091
4	23.2	0.83979226	19.48318	16.1146	0.8271028	0.5280374
5	4.85	0.756577031	3.6693986	3.10987	0.8475138	0.5801105
6	11.89	0.841809025	10.00911	8.8183	0.881024	0.487952
7	9.51	0837202708	7.961798	7.1529	0.898409	0.634027
8	9.65	0.85559749	8.2565158	6.74267	0.8166479	0.640045
9	10.85	0.884156318	22.855441	18.6999	0.8181818	0.4306818
10	5.6	1.226155444	3.8623896	3.62858	0.9394645	0.5296857
11	4.63	0.67149013	1.839883	0.83065	0.4514673	0.5428894
Changes in bread texture profile analysis after 48 hours storage period.						
1	1.59	0.813	1.29	1.13	0.87	1.17
2	2.75	0.672	1.85	1.44	0.78	0.67
3	3.42	0.637	0.948	0.692	0.729*	0.787
4	1.49*	0.856	1.53	1.467	0.954	1.09
5	5.08**	0.875**	4.44	3.73	0.840	0.648
6	2.73	0.863	2.36	1.96	0.830	1.06
7	3.52	0.771	2.72	2.17	0.796	0.63*
8	3.62	0.811	2.938	2.65	0.904	0.801
9	2.31	0.627	0.608*	0.533*	0.876	1.20**
10	4.25	0.511*	3.87	2.97	0.769	0.76
11	3.81	0.840	5.41**	8.68**	1.60**	0.848

*** Low value. ** High value.**

Table (7): Sensory evaluation of balady bread*

No.	Color & appearance (5)	Diameter (5)	Separation (5)	Biting textures (5)	Aroma (5)	Taste (5)	Crumb texture (5)	Overall score (35)
1	4.20^{ab} ± 0.53	4.25^{a} ± 0.58	4.30^{a} ± 0.53	3.80^{bc} ± 0.58	3.90^{bcd} ±0.56	4.00^{abc} ±0.70	3.80^{a} ± 0.53	28.25^{abc} ±3.37
2	4.55^{a} ± 0.43	4.60^{a} ± 0.31	4.40^{a} ± 0.51	4.25^{a} ± 0.26	4.15^{abc} ±0.24	4.35^{a} ± 0.24	4.00^{a} ± 0.23	30.30^{a} ± 1.43
3	4.55^{a} ± 0.64	4.60^{a} ± 0.51	4.55^{a} ± 0.55	4.15^{ab} ± 0.57	4.15^{abc} ±0.47	4.20^{ab} ± 0.34	4.00^{a} ± 0.47	30.20^{ab} ± 3.17
4	3.70^{bc} ± 0.67	4.35^{a} ± 0.70	4.30^{a} ± 0.67	3.70^{c} ± 0.42	3.70^{d} ± 0.67	3.65^{c} ± 0.62	3.35^{b} ± 0.62	26.75^{c} ± 3.18
5	4.20^{ab} ± 0.34	4.25^{a} ± 0.58	4.25^{a} ± 0.63	3.90^{abc} ±0.31	3.85^{cd} ± 0.33	3.90^{bc} ± 0.45	3.65^{ab} ± 0.52	28.00^{bc} ± 2.19
6	3.95^{b} ± 0.36	4.55^{a} ± 0.43	4.55^{a} ± 0.43	3.85^{abc} ±0.33	4.25^{abc} ±0.26	4.20^{ab} ± 0.25	3.65^{ab} ± 0.41	29.00^{ab} ± 1.20
7	3.95^{b} ± 0.43	4.45^{a} ± 0.49	4.45^{a} ± 0.49	3.80^{bc} ± 0.48	4.30^{ab} ± 0.25	4.10^{ab} ± 0.21	3.90^{a} ± 0.31	28.95^{ab} ± 1.72
8	4.40^{ab} ± 0.21	4.50^{a} ± 0.40	4.60^{a} ± 0.39	4.25^{a} ± 0.54	4.40^{a} ± 0.39	4.25^{ab} ± 0.26	4.05^{a} ± 0.43	30.45^{a} ± 1.36
9	4.25^{ab} ± 0.35	4.40^{a} ± 0.51	4.25^{a} ± 0.48	4.05^{abc} ±0.15	4.00^{abcd} ±0.23	3.90^{bc} ± 0.39	3.85^{a} ± 0.47	28.70^{abc} ± 1.53
10	4.20^{ab} ± 0.25	4.50^{a} ± 0.47	4.50^{a} ± 0.47	3.95^{abc} ±0.36	4.30^{ab} ± 0.42	4.15^{ab} ± 0.33	3.85^{a} ± 0.33	29.45^{ab} ± 1.73
11	4.20^{ab} ± 0.25	4.50^{a} ± 0.40	4.45^{a} ± 0.43	3.95^{abc} ±0.15	4.25^{abc} ± 0.42	4.10^{ab} ± 0.31	3.80^{a} ± 0.25	29.25^{ab} ± 1.35

***Values followed by the same letter within the same column were not significantly different at p ≥ 0.05.**
*** Values are mean ± standard deviation.**

appearance compared to other samples. Another samples showed adverse effect on color and appearance as a result of incorporation of different levels of FB and WG. From the same table it is obvious that there were no significant differences among all samples for diameter and layers separation. Also, the same results appeared that samples No. (2, 3, 5, 6, 9, 10 and 11) were the best and were not significantly different for biting textures compared to other samples. Furthermore, samples No. (2, 3, 6, 7, 9, 10 and 11) the best and were not significantly different for aroma compared to other samples. Besides, samples No. (1, 2, 3, 6, 7, 8, 10 and 11) were the best and were not significantly different for taste compared to other samples. Moreover, samples No. (1, 2, 3, 5, 6, 7, 8, 9, 10 & 11) were the best and were not significantly different for crumb texture compared to sample No. 4. These results are agreed with those obtained by Li *et al.*(1997) who found improvement in crumb texture in pan bread fortified with wheat germ. This could be imputed to wheat germ possess high fat content. On the other side, Salmenkallio – Marttila *et al.* (2001) proved that wheat bran can decrease the volume bread, elasticity and weakens the structure. This perhaps attributed to that bran had high fiber content which destroy the gluten matrix. Therewithal samples No. (1, 2, 3, 6, 7, 8,9, 10 and 11) recorded higher overall score and were not significant than that of other samples.

It can be concluded that folic acid contents increased in balady bread baked with either fine bran or wheat germ. They could be used as a partial replacement for wheat flour in bread baking. A balady bread bio-fortified with folic acid that is acceptable to Egyptian consumer could be produced. In view of balady bread in Egypt,it is considered as backbone in diets, therefore, the aforementioned results deduced that there is an urgent need for increase concentration, the light focus on balady bread as a pattern for folic acid enrichment.

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إنتـاج وتقييم الخـبز البلدى عـالى المحتـوى من حمض الفـوليك

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ملخص

يؤدى نقص حمض الفوليك فى الإنسان إلى مرض فقر الدم والذى يؤدى إلى كبر حجم خلايا الدم الحمراء وقلة عدد كرات الدم البيضاء ومن هنا فإن هذه الدراسة تهدف إلى الاستفادة من النواتج الثانوية أثناء طحن القمح ذات المحتوى العالى من حمض الفوليك. تم تقدير حمض الفوليك فى ك ل من الردة الناعمة وجنين القمح وأظهر التحليل أن المحتوى الكلى من حمض الفوليك كان 316، 286 ميكروجرام/ 100جم على التوالى. تم تدعيم الخبز البلدي (المُعَد من دقيق القمح استخلاص 82، 72%) بنسب مختلفة من كل من الردة الناعمة وجنين القمح وأوضحت النتائج زيادة محتوى الخبز البلدى المدعم من حمض الفوليك من 124 إلى 318 ميكروجرام/ 100جم وكذلك زاد محتواه من البروتين والدهون والألياف الخام والرماد وبالمثل تحسن محتوى الخبز البلدى المدعم من الألياف الغذائية الكلية والحديد والزنك والكالسيوم وأظهر التقييم الحسى عدم وجود فروق معنوية بين كل العينات من حيث قطر الخبز وانفصال طبقات الخبز ولكن الصفات الحسية الأخرى تأثرت عكسيًا باستثناء الخبز المُعَد من دقيق استخلاص 72% والمدعم بنسب مختلفة من الردة الناعمة وجنين القمح فلم يتأثر معنويًا. بناءاً على ذلك فإنه يُوصى بتدعيم الخبز البلدى بالردة الناعمة وجنين القمح كمصادر طبيعية وغنية بحمض الفوليك خاصة مع دقيق القمح استخلاص 72 %.

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