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NUTRITIONAL EVALUATION OF SOME BAKERY PRODUCTS FORTIFIED BY DEFATTED WHEAT GERM FLOUR

M. A. Salem(1), M.E.A. El-sayed(1), M.A. El-Bana(2) and Mariam A. El-Khatib(2)

(1) Food Sci. and Tech. Dept., Fac. of Agric. Tanta Univ., Egypt.

(2) Food Tech. Res. Inst., Agric. Res. Center, Giza, Egypt

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ABSTRACT: *This study was carried out to investigate the utilization of microwave defatted wheat germ flour (MDWGF) as replacement of wheat flour at different levels (5, 10, 15, 20 and 25%) to prepare protein and minerals enriched biscuits and balady bread. The chemical composition of wheat flour and MDWGF was determined. Chemical composition and physical properties as well as organoleptic evaluation of prepared biscuits and balady bread were also investigated. Minerals analysis of MDWGF and wheat flour as well as biscuits and balady bread were determined. Results indicated that the MDWGF contained a high protein content (28.21 %) compared to that of wheat flour 72% (10.16%), wheat flour 82% (11.65 %) and MWGF (22.68 %). Ash content of MDWGF (4.30 %) was significantly higher than those of MWGF (3.50%), wheat flour 72% (0.65%) and wheat flour 82% (0.95%). MDWGF had values of phosphorus, potassium, calcium, iron, Magnesium and zinc, significantly higher than those of wheat flour. The protein and minerals contents of biscuit and balady bread contained MDWGF increased significantly with increasing the replacement ratio. Addition of MDWGF as replacement of wheat flour until level of 15% gave significant effect on sensory characteristics prepared biscuit and balady bread. Organoleptic properties of biscuit and balady bread samples contained MDWGF until 15% as replacement ratios of wheat flour are nearly similar to control sample. Based on the obtained results, the new product of biscuit contained MDWGF can be covered protein and minerals of nutritional needs of schoolchildren in developing countries and could be recommended as a food aid in institutional feeding programs for pupils in different school stages. And also improve the nutritional quality of balady bread especially in developing countries to avoid the malnutrition prevalent.*

Key wards: *Stabilization wheat germ flour, rheological properties of wheat germ flour, some bakery products fortified by defatted wheat germ flour*

INTRODUCTION

Wheat is the most important stable food crop for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops (Shewry, 2009). It is nutritious, easy to store and transport and can be processed into various types of food. Wheat is considered a good source of protein, minerals, B-group vitamins and dietary fiber (Shewry, 2007).

Whole wheat grain includes the endosperm, bran and germ. Wheat Germ (WG), one of the main by-products from the flour milling industry is the most nutritious part of the wheat kernel. It is a rich source of vitamin E, vitamin B group, unsaturated fatty acids, proteins, dietary fiber and minerals (Nichelatti and Hidvegi, 2002). It is also reported to contain some functional phytochemicals at a relatively low cost such as flavonoids, sterols, octacosanols and glutathione. Therefore, WG is considered to be healthy foods that can help people prevent certain cancers and other health problems. Raw wheat germ (RWG), containing as much as 10 to 15% oil is mainly used in food, medical and cosmetic industries as a source of oil (Zhu *et al.,* 2006).

WG contains 28% protein which improved the nutritional values due to presence of higher amounts of essential amino acids compared to other cereal. so, protein content of defatted wheat germ (DWG) about 30%. Therefore, DWG is rich in essential amino acids such as lysine, methionine and threonine, in which many cereals are deficient (Yiqiang *et al*., 2001 and Muhammad *et al*., 2007). On the other hand, it is sensitive to oxidation that may cause destruction of essential fatty acids and vitamins (Sjovall *et al*., 2000). Oxidation can be prevented and shelf life prolonged by inactivating the enzymes under heat treatment or by oil extraction (Sjovall *et al.,* 2000).

Wheat bread and cookies are widely accepted and consumed in many developing countries and therefore offer a valuable supplementation vehicle for nutritional improvement. However, cookies have been suggested as a better use of composite flour than bread because of their ready-to-eat form, wide consumption and relatively long shelf-life (Lorens *et al.,* 1979). Protein enriched cookies are attractive for target areas, such as child-feeding programmes, low-income groups and disaster relief operations (Claughton and Pearce, 1989). Cookies with these characteristics have been produced from blends of wheat and cowpea (McWatters *et al.,* 2003) or soybean and wheat (Shrestha and Noomhorm, 2002).

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 (Jones, 2008 and Gupta *et al.,* 2013). Furthermore, it contains a high fiber which prevent and reduced risk in type 2- diabetes, obesity and cardiovascular diseases (McKevith, 2004).

Furthermore, raw germ weakens bread dough due to the presence of glutathione, a powerful reducer that weakens the gluten network by the breaking disulphide bonds (Every *et al.,* 2006).

Incorporation of wheat germ either raw or stabilized resulted in decrease in dough rheological properties, as measured in farinograph and extensograph (Srivastava *et al.,* 2007).

This study was carried out to utilize of Microwave defatted wheat germ (MDWG) flour as replacers of wheat flour for preparing rich protein and minerals biscuit and balady bread .

MATERIALS AND METHODS

Materials:

Fresh wheat germ was a gift from Middle and West Delta Milling Company at Banha. Wheat flours (72 and 82% extraction) were purchased from Delta Middle and West Milling Company, Tanta, Egypt. Salt, fresh bakery yeast, suger, oil, baking powder, vanillin and eggs were purchased from the local market of Tanta city at EL-Gharbia Governorate.

Methods:

1. Preparation of defatted wheat germ flours (DWGF):

Wheat germ contains several enzymes, such as dipeptidase, proteinase, lipase, lipoxidase and phytase. In order to stabilize it, wheat germ was treated by microwave stabilized wheat germ (MWG): A microwave oven with 550 W output power was used for the stabilization of wheat germ. The moisture content of raw wheat germ was adjusted to 21% before treatment. One hundred gram of sample was packed in a microwave-safe polyethylene bag and subjected to microwave heating for 3 min at 120 ºC and then cooled at room temperature Ramezanzadeh *et al.* (2000). The microwave wheat germ (50g) was soaked in 200 ml n-hexane at room temperature for 48 hr, then filtered and the solvent was removed by rotary evaporator according to Kahlon *et al.* (1992). The microwave defatted wheat germ meal was milled using a laboratory scale hammer mill. The resulting flour (MDWGF) was sieved through a 60-mesh screen and was kept in polyethylene bags and stored at 4°C until used.

2. Preparation of laboratory made biscuits:

Method of Gaines and Tsen (1980) with some modifications by Alobo (2001) was used to prepare the biscuit samples. Blends containing 5, 10, 15, 20 and 25% of microwave defatted wheat germ flours (MDWGF) was used as replacement of wheat flour (72% extraction). The basic ingredients were 420g of flour blends, 130g corn oil, 200g sugar, 50g of whole egg, 5g of salt, 5g of vanilla, 15g of baking powder and water variable. The dry ingredients were thoroughly mixed in a bowl by hand for 3 min. Other ingredients were added and mixed in a rotary mixer (Moulinex model Depose type 171) for 5 min, using a wooden rolling pin. The dough was formed to round pieces (3cm diameter and 5 gram weight each) by using manually biscuit former. The formed pieces of biscuit were backed in an electric oven at 175± 5ºC for 30min.The baked biscuit was stayed at room temperature to cool. Subjected to sensory evaluation and the rest was packaged in polyethylene bags and stored for further analysis.

3. Preparation of laboratory made balady bread:

Balady bread was manufactured from hard flour (82% extraction) using the following formula as described by El-Talawy and Khorshid (1982). About 500g hard wheat flour (82% extraction) was mixed with 2g table salt (NaCl) and water .Baking yeast 5 g was added to the mixture. microwave defatted wheat germ flour with the replacement rates 5%, 10%, 15%, 20%and 25% of the wheat flour was added. The mixture was mixed till reached to the optimum consistency of the dough. The formed dough was fermented at room temperature for 30min, then divided into about 125g pieces, rounded, flattened, proofed for 30min at room temperature and baked at 350ºC.The baked bread was stand in the air to reach to room temperature and then taken for analysis.

4. Chemical analysis:

Moisture, ash, crude fat, crude protein and crude fiber content were determined according to the methods of AOAC (2005). Total carbohydrates was calculated by difference. Available carbohydrates were calculated by subtracting crude fiber from total carbohydrates. The factors, n = 5.70 (for wheat flour, microwave wheat germ and microwave defatted wheat germ), and n = 6.25 (for biscuits and baldy beard) were used for conversion of nitrogen to crude protein. Mineral contents calcium, iron, magnesium, and zinc were conducted using the atomic absorption spectrophotometer (Perken Elmer Model 20180) following the method of Pearson (1976). Total phosphorus was determined colorimetrically using ascorbic acid method as described by Murphy and Riley (1962). Potassium was estimated using flam photometer as given by Pearson (1976). Amino acids were estimated using amino acid analyzer (Beckman amino acid analyzer, Model 119 CL) as described by Sadasivam and Manickam (1992).

5. Rheological properties:

Farinograph and extensograph tests was carried out on wheat flour as a control and wheat flour mixtures using methods of AACC (2005). Farinograph parameters i.e., water absorpation, dough development time, dough stability, dough tolerance index and weakening using a farinograph type (910/05001 BrabenderFarinograph West Germany Hz50) at Rheological Lab., Food Technology Research Institute. Res. Cent., Giza Egypt. Extinsograph parameters i.e., extensibility, elasticity after 5 min, maximum elasticity, proporational number and energy were determined using an extensograph (type, 86001 Brabender Extinsograph West Germany Hz50) at Rheological Lab., Food Technology Research Institute. Res. Cent., Giza Egypt.

6. Physical properties of biscuits:

Five replicates for each sample were measured for weight, diameter and height (thickness). The method of Zoulias *et al.* (2002) was used for the measurement of biscuits diameter.

7. Sensory evaluation:

Organoleptic evaluation of different prepared biscuits was performed by a semi-trained panel of twenty members using nine-point hedonic-scale ratings for color, taste, aroma, texture and overall acceptability Watts *et al.* (1989).

The balady breads were also examined for the organoleptic proprieties including color, appearance, taste, aroma and texture according to Singh *et al.* (1990).

8. Staling of balady bread:

Freshness of balady bread, loaves for reach formula tested by alkaline water retention capacity determination, according to the method of (Kitterman and Rubenthaler, 1971).

9. Statistical analysis:

Most of the received data were analyzed statistically using the analysis of variance and the means were further tested using the least significant difference test (LSD) as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Gross chemical composition of wheat flour (72 and82%), microwave wheat germ flours and microwave defatted wheat germ flour (g/100g on dry weight):

The gross chemical composition of wheat flour (72% and 82% extraction) microwave wheat germ flour (MWGF) and MDWGF are recorded in Table (1). The obtained results show that MDWGF contains a significant higher crude protein 28.21% compared with that of wheat flour (72% extraction) 10.16%, wheat flour (82% extraction) 11.65% and MWGF 22.68%. MWGF contains the highest content of fat 11.40% followed by wheat flour (82% extraction) 1.41%, MDWGF 1.14% and wheat flour (72% extraction) 0.95%.

Furthermore, MDWGF is very rich in protein (28.21%), ash (4.30%) and fiber (5.51%) compared with that of wheat flour (72% extraction), wheat flour (82% extraction) and MWGF. This means, that the MDWGF addition of bakery products would be improved protein and minerals contents of the final product. Data in this respect are in agreement with the findings of numerous investigators (Abd Raboh, 2012; Ali *et al*., 2013; Abd El-Hafez 2013 and Mahmoud *et al.,* 2015).

2. Minerals content of wheat (72 and 82% extraction) and microwave defatted wheat germ flours:

From the results in Table (2), it could be observed that MDWGF contains higher values in all determined elements compared to that of wheat flour and it is very rich in potassium 1047 mg/100g.

Table (1): Gross chemical composition of wheat (72 and82%), microwave wheat germ and microwave defatted wheat germ flours (g/100g on dry weight basis):

Sample / Chemical composition	WF (72%)	WF (82%)	MWGF	MDWGF
Moisture	11.22 [d]	11.80 [c]	12.90 [b]	13.70 [a]
Crude protein	10.16 [d]	11.65 [c]	22.68 [b]	28.21 [a]
Fat	0.95[c]	1.41[b]	11.40[a]	1.14[c]
Ash	0.65[d]	0.95[c]	3.50[b]	4.30[a]
Crude fiber	0.78 [d]	1.20 [c]	1.85 [b]	5.51 [a]
Total carbohydrates	88.27 [a]	85.99 [b]	62.42 [d]	66.35 [c]
Available carbohydrates	87.49 [a]	84.79 [b]	60.57 [d]	60.84 [c]

Each value is an average of three determinations.
Values followed by the same letter in row are not significantly different at $P<0.05$.
WF 72%: Wheat flour extraction 72%, WF 82%: Wheat flour extraction 82%,
MWGF: Microwave wheat germ flour, MDWGF: Microwave defatted wheat germ flour.

Table (2): Minerals content of wheat flour (72 and 82% extraction) and microwave defatted wheat germ (g/100g on dry weight):

Components / Samples	P	K	Ca	Fe	Mg	Zn
WF 72%	316.30	125.00	32.90	1.81	127.20	3.97
WF 82%	319.00	138.00	36.20	2.11	129.00	4.21
MDWGF	655.00	1047.00	45.80	7.36	306.90	8.90

The iron content of MDWGF is higher three times than that of wheat flour (72% extraction). The iron is important for the schoolchildren, which mostly needs more iron to avoid the anemia especially in developing countries. The results indicated that MDWGF is a good source for the minerals.

The results are in agreement with that reported by Abd El-Hady (2012);Kan (2012) and Hussein *et al.* (2013).

3. Amino acid analysis:

Protein quality a partly dependent upon its amino acid make up. Amino acid compositions of MWGF and MDWGF were presented in Table (3). It can be seen that MDWGF contained higher levels of amino acids compared with those of MWGF. Moreover, lysine of MDWGF (4.61%) which could be considered the first limiting essential amino acid in cereal is higher than that the model value issued for adult by the FAO/WHO/UNO (1985). However, the amount of Lysine in MDWGF (4.61%) could not meet the FAO //WHO//UNO reference pattern for infant (5.80%). Therefore, DMWGF could show beneficial complementary effect when consumed with cereal proteins, which were low in lysine.

Table (3): Amino acids composition (g/100g protein) of microwave wheat germ flour and microwave defatted wheat germ flour:

Amino acids	MWGF	MDWGF	FAO/WHO/UNO (1985)	
			Infant	Adult
Essential amino acids:				
Leucine	2.19	5.24	6.60	1.90
Isoleucine	1.25	2.92	2.80	1.30
Lysine	2.27	4.61	5.80	1.60
Methionine	0.59	1.60	-	-
Cystine	0.34	0.56	-	-
Phenylalanine	1.10	3.57	-	-
Tyrosine	0.84	2.11	-	-
Threonine	1.45	2.70	3.40	0.90
Valine	1.73	3.22	3.50	1.30
Tryptophan	-	-	1.10	0.50
Non-essential amino acids:				
Alanine	2.42	4.33	-	-
Arginine	2.91	6.90	-	-
Aspartic acid	3.21	5.22	-	-
Glutamic acid	3.37	9.91	-	-
Glycine	2.18	4.71	-	-
Histidine	0.83	2.10	1.90	1.60
Proline	1.26	3.12	-	-
Serine	1.41	3.30	-	-

* Tryptophan was not determined – MWGF: Microwave wheat germ flour – MDWGF: Microwave defatted wheat germ flour.

The obtained results are in line with those reported by Ge *et al*. (2000); Ge *et al.* (2001) and Al-Hooti *et al.* (2002). Who reported that, wheat germ protein has been classed with effectively superior animal proteins and is rich in amino acids, especially the essential amino acids, lysine, methionine, and threonine, in which many cereals are deficient.

4. Rheological properties of wheat flour (82% extraction) dough and its blends:

a. Farinograph test:

The farinograph test indicated that, the capacity of water retention of the dough was increased with the mentioned addition and lead to the induction of more hydrogen bonds in the gluten-carbohydrate complex of the dough (Gliadin fraction) which forces the dough resistance (Ibrahim *et al.,* 1990).

Results in Table (4) show the rheological properties evaluated by farinograph apparatus for six samples using wheat flour with or without MDWGF. From these results it could be noticed that water absorption of the samples increased with increasing the dry material for instance with increasing microwave defatted germ flour levels, caused an increase in (58.4%) as a result to replacement wheat flour with 25% MDWGF. Differences in water absorption of the samples can be due to the presence of gluten in the flour which can absorb a large amount of water.

It has been reported that the glutathione present in the germ can degrade gluten network and, hence, reduce its water absorption ability (Shurpalekar and Haridas Rao, 1978; Srivastava *et al.,* 2007). However, Qarooni (1996) reported that substituting raw wheat germ (1-3%) with flour could slightly increase the water absorption of the dough. Srivastava *et al*. (2007) found that replacement of raw wheat germ (5, 10, 15 and 20%) had no significant effect on the water absorption of the dough. They also reported that inactivation of glutathione by different methods (e.g. roasting) increased water absorption of the dough.

Dough development time is necessary to indicate the time in minutes required to form stable dough. The dough development time increased with increasing replaced MDWGF as compared to the control.

Dough stability time is an indicator of dough strength. The results show that with increasing the level of MDWGF replacement in the dough, the stability time decreased significantly, probably due to the dilution effect of microwave defatted germ flour on gluten content of the samples.

Table (4): Effect of replacement levels of microwave defatted wheat germ flour as partial substitute in a part with wheat flour (82%extraction) on farinograph parameters:

Parameters / Samples	Farinograph				
	Water absorption (%)	**Arrival time (min)**	**Dough development (min)**	**Stability time (min)**	**Dough weakening (B.U.)**
Control (100%WF)	54.6	1.0	2.0	6.0	80
95% WF+5% MDWGF	54.8	1.5	2.5	5.5	100
90%WF+10%MDWGF	55.0	1.5	2.5	5.0	110
85%WF+15%MDWGF	56.1	2.0	3.0	4.5	135
80%WF+20%MDWGF	57.2	2.5	3.5	4.0	145
75%WF+25%MDWGF	58.4	3.0	3.5	3.5	165

WF: Wheat flour extraction 82%.
MDWGF: Microwave defatted wheat germ flour.

May be due to greater increase in water absorption with incorporation of drum dried germ in blend might have been due to the processing conditions wherein starch would have been gelatinized to a greater extent and stated that incorporation of wheat germ had weakening effect on rheological characteristics of the dough. This was more evident in consistent decrease in dough stability, when anyone of the heat-treated germ was incorporated into the blend. Results of present study clearly indicated that extent of reduction in dough stability was dependent on the severity of heat treatment received by the germ (Srivastava *et al*., 2007).

The data in the same Table show that dough weakening increased as a result of replacement MDWGF. These results are in agreement with data obtained by Gómez *et al.* (2012) and Majzoobi *et al.* (2012).

b. Extensograph test:

Results in Table (5) show the effect of replacement MDWGF at 5, 10, 15, 20 and 25% replacement to wheat flour on the extensograph parameters. From these results it could be noticed that such replacement led to a decrease in the resistance to elasticity, proportion number and energy. Contrary to the extensibility was increased. These results are in agreement with Gómez *et al*. (2012).

5. Chemical composition of biscuit:

The results in Table (6) indicate that protein content of biscuit, contained MDWGF replacement of wheat flour, is significantly higher than that of control. Where it increases markedly with increasing the replacement ratio from 11.55% in control to 15.82%in biscuit contained 25% MDWGF.

Table (5): Effect of replacement different levels of MDWGF as partial substitution to WF (82%extraction) on extinsograph parameters:

Parameters / Samples	Extinsograph			
	Elasticity (B.U)	**Extensibility (mm)**	**P.N**	**Energy (Cm^2)**
Control (100%WF)	320	125	2.56	54
95% WF+5% MDWGF	310	130	2.38	48
90%WF+10%MDWGF	300	135	2.22	43
85%WF+15%MDWGF	290	140	2.07	36
80%WF+20%MDWGF	280	145	1.93	31
75%WF+25%MDWGF	270	150	1.80	26

WF: Wheat flour extraction 82%.
MDWGF: Microwave defatted wheat germ flour.
P.N: proportion number.

Table (6): Chemical composition of biscuits contained different replaced levels of MDWGF (g/100g dry weight):

Samples / Chemical composition	Control	MDWGF				
	WF	5%	10%	15%	20%	25%
Moisture	6.35[c]	6.55[c]	6.73[b]	6.81[ab]	6.95 [a]	7.02 [a]
Crude protein	11.55[f]	12.32[e]	13.24[d]	14.15[c]	15.05 [b]	15.82 [a]
Fat	8.06[a]	7.91[a]	7.87[a]	7.82 [a]	7.78 [a]	7.68 [b]
Ash	0.61[c]	0.80b[c]	0.98[b]	1.15 [b]	1.36 [a]	1.54 [a]
Crude fiber	1.13[c]	1.32[c]	1.56[b]	1.76[b]	2.00[a]	2.15[a]
Total carbohydrates	79.78[a]	78.97[b]	77.91[c]	76.88 [d]	75.81 [e]	74.96 [f]
Available carbohydrates	78.65[a]	77.65[b]	76.35[c]	75.12 [d]	73.81 [e]	72.81 [f]

Each value was an average of three determinations.
Values followed by the same letter in row are not significantly different at p ≤ 0.05.
WF: Wheat flour 72%; MDWGF: Microwave defatted wheat germ flour.

In addition, the crude fiber and ash contents of biscuits prepared from MDWGF as replacement of WF were higher than those of control biscuit. At the its fat content is lower than that of control. These effects increase with increasing of replacement level. It could be noticed that biscuit prepared using MDWGF as replacement of wheat flour was considered more nutritive. The consumption about 100g of the sample contained 25% MDWGF would provide more than half of the recommended daily requirement for protein 25-30g/day as recommended by (FAO/WHO, 1973) for children aged between 5 and 19 years. This fact suggests that biscuits supplemented with MDWGF may be useful as food supplements for the alleviation or prevention of protein malnutrition in developing countries. These results are in agreement with those reported by Arshad *et al.* (2007) for cookies supplemented with DWG, Ahmed *et al.* (2010) for biscuits with added DWGP and Bansal and Sudha (2011) for biscuits replaced wheat flour with either steamed or DWG.

6. Minerals content of prepared biscuit:

Minerals play an important role in human nutrition. Some are essential for much component as hem for blood. (National Academy of Sciences, 2001).

The results in Table (7) show that biscuit with replacement wheat flour with MDWGF has higher levels of phosphorus, potassium, calcium, iron, zinc and magnesium compared with those of control. The effect of using MDWGF in the biscuits blends increased minerals contents of biscuit. From the above mentioned data, it can use the with wheat flour to obtain a satisfied biscuit rich in some important minerals. These results are somewhat in agreement with those reported by Arshad *et al.* (2007) for cookies supplemented with DWG.

Table (7): Minerals content (mg/100g) of biscuits made using microwave defatted wheat germ flour (MDWGF) at different levels as replacement for wheat flour:

Samples / Components	Control	MDWGF				
		5%	10%	15%	20%	25%
P	313.30	327.50	346.00	358.00	380.00	396.00
K	101.20	148.00	193.00	235.00	270.00	301.00
Ca	39.10	39.80	40.90	41.50	41.80	42.60
Fe	1.75	1.92	2.41	2.61	2.91	3.12
Mg	120.00	134.00	142.00	150.00	162.00	169.00
Zn	3.80	4.02	4.23	4.50	4.81	5.01

WF: Wheat flour 72%; MDWGF: Microwave defatted wheat germ flour.

7. Physical characteristics of biscuit:

Physical characteristics of biscuits are presented in Table (8). The biscuit made with replacement wheat flour with MDWGF had reduce in heights and diameters while increased weights comparing with control. These effects increased with increasing level of replacement of wheat flour with MDWGF.

The obtained results were similar to those reported for cookies prepared from wheat –cowpea (McWatters *et al.,* 2003), wheat-soybean flour blends (Shrestha and Noomhorm, 2002) and biscuits prepared from DWG (Abd El-Hady, 2012).

8. Organoleptic evaluation of biscuits:

The effects of replaced MDWGF on the sensory quality of biscuits are summarized in Table (9). Sensory characteristics of sample prepared using MDWGF 5% replaced had nearly similar scores of control.

While biscuits contain MDWGF at levels more than 5% had lower scores for sensory characteristics especially taste of sample contained 25% MDWGF. The low overall acceptability of the biscuits from blends containing more than 15% MDWGF is attributed to the panelists. Generally, all samples prepared with MDWGF are acceptable for the sensory evaluation. Color is one of significant factors, which affect acceptability of food products by consumer. It is desired that biscuits should have red golden color. Darkening of biscuits is attributed to sugar caramelization and maillard reactions between sugars and amino acids (Alobo, 2001). The biscuits had sweetish taste and pleasant flavor of even replacement ratio of 15%. Increase the replacement ratio (20% and 25%) was predominant flavor and taste of wheat germ and drymouth feel. This result agreed with Bansal and Sudha (2011).

Table (8): physical characteristic of biscuits made of different replacement levels of microwave defatted wheat germ flour:

Samples / parameters	Control (WF)	5% MDWGF	10% MDWGF	15% MDWGF	20% MDWGF	25% MDWGF
Weight (g)	9.66 [c]	9.71 [c]	10.01 [b]	10.04 [b]	10.65 [a]	10.76 [a]
Diameter(cm) D	6.45 [a]	6.13 [b]	5.63 [c]	5.24 [d]	4.94 [e]	4.76 [c]
Height (cm) H	0.91 [a]	0.88 [a]	0.86 [a]	0.74 [b]	0.62 [b]	0.61 [b]
Spread ratio(D/H)	7.09 [b]	6.97 [b]	6.55 [c]	7.08 [b]	7.84 [a]	7.80 [a]

Each value was an average of three determinations.

Values followed by the same letter in row are not significantly different at $p \leq 0.05$.
WF: Wheat flour extraction 72%, MDWGF: Microwave defatted wheat germ flour.

Table (9): Organoleptic characteristics of biscuits made of different replacement levels of MDWGF:

Samples / Parameters	Control (WF)	MDWGF 5%	MDWGF 10%	MDWGF 15%	MDWGF 20%	MDWGF 25%
Color	9.50[a]	9.40[a]	9.30[ab]	9.20[b]	8.85[c]	8.90[c]
Taste	9.35[a]	9.30[a]	8.80[b]	8.80[b]	8.75[b]	8.20[c]
Aroma	9.10[a]	8.90[ab]	8.80[b]	8.70[b]	8.70[b]	8.50[c]
Texture	9.35[a]	8.50[b]	8.50[b]	8.50[b]	8.30[b]	8.25[b]
Overall acceptability	9.33[a]	9.31[a]	8.85[b]	8.80[b]	8.65[b]	8.44[c]

Each value was an average of three determinations.
Values followed by the same letter in row are not significantly different at $p \leq 0.05$.
WF: Wheat flour extraction 72%, MDWGF: Microwave defatted wheat germ flour.

9. Chemical composition of balady bread with different replacement levels of MDWGF:

Protein, ash and crude fiber content of balady bread significantly increased as the replacement levels of MDWGF in the dough raised (Table 10).

On the other hand, fat and total carbohydrates are gradually decreased. The increase in protein content of balady bread contained with MDWGF might be a result of the appreciably higher protein content of MDWGF. These results are confirmed with the results of Abd El-Hafez (2013).

10. Minerals content of prepared balady beard:

The results in Table (11) show that balady beard prepared with replaced MDWGF instead of wheat flour has higher levels of phosphorus, potassium, calcium, iron, zinc and magnesium compared with those of control. The effect of using the

MDWGF increased minerals contents of balady beard.

These results are confirmed with Arshad *et al.,* (2007) who reported that supplementation of cookies with DWGF significantly increased the levels of all minerals.

Table (10): Chemical composition of balady beard made with different replacement levels of microwave defatted wheat germ flour (g/100g on dry weight):

Chemical composition	Control	MDWGF				
	(WF)	5%	10%	15%	20%	25%
Moisture	10.10[a]	9.90[a]	10.00[a]	9.80[b]	9.73[b]	9.82[b]
Crude protein	10.20[f]	11.03[e]	11.83[d]	12.81[c]	13.65[b]	14.55[a]
Fat	1.00[a]	1.01[a]	0.97[a]	0.95[a]	1.00[a]	0.96[a]
Ash	1.31[c]	1.44[c]	1.58[b]	1.73[b]	1.86[a]	2.01[a]
Crude fiber	2.15[d]	2.41[c]	2.61[b]	2.85[ab]	3.03[a]	3.13[a]
Total carbohydrates	87.49[a]	86.52[b]	85.62[c]	84.51[d]	83.49[e]	82.48[f]
Available carbohydrates	85.34[a]	84.11[b]	83.01[c]	81.66[d]	80.46[e]	79.35[f]

Each value was an average of three determinations.
Values followed by the same letter in row are not significantly different at $p \leq 0.05$.
WF: Wheat flour 82%, MDWGF: Microwave defatted wheat germ flour.

Table (11): Minerals content of balady beard made with different replacement levels of MDWGF (mg/100g on dry weight):

Samples / Components	Control	MDWGF				
	(WF)	5%	10%	15%	20%	25%
P	315.20	331.00	348.00	365.00	383.00	393.00
K	121.00	165.90	210.80	258.30	300.10	338.30
Ca	25.10	25.60	26.10	26.51	27.21	27.55
Fe	2.03	2.25	2.51	2.80	3.01	3.32
Mg	123.00	131.80	140.50	149.00	158.00	167.10
Zn	4.00	4.30	4.50	4.72	5.00	5.21

WF: Wheat flour 82%, MDWGF: Microwave defatted wheat germ flour.

11. Staling of balady beard:

Table (12) shows the effect of replacement MDWGF (at levels 5, 10, 15, 20 and 25%) with wheat flour on the reduction in the staling of balady bread stored for 48hrs, at room temperature.

The data shows that alkaline water retention capacity (AWRC) of bread loaves is decreased by increasing the storage periods after baking, but increased with increasing levels of MDWGF (from 5 to 15%).

Alkaline water retention capacity (AWRC) in Table (12) for control sample of balady bread made from 100%wheat flour (82% extraction) at zero time, after 24 hr. and 48 hr. was 360, 305 and 260%, respectively. Also AWRC in the same Table of balady bread made from wheat flour with MDWGF at levels of (5, 10, 15, 20 and 25% replacement) at zero time was 392, 388, 367, 339 and 325 %, respectively. The values are decreased after 24 hrs. to 332, 318, 307, 280 and 265 %, respectively. The cross pound values after 48 hrs. are 275, 270, 265, 230 and 220%, respectively. It could be concluded that the replacement of MDWGF improved the bread characteristics and retard its staling and increase freshness up to replacement 15% MDWGF. These results are confirmed with the results of Maleki *et al.* (1980); Chang *et al*. (2004) and Majzoobi *et al*. (2012).

12. Sensory evaluation of balady beard:

Organoleptic properties of balady bread containing different replacement of MDWGF are illustrated in Table (13). There is a significantly ($p<0.05$) difference in score values of taste, oder, crust color, crumb color, crumb uniformity, crust quality and over all acceptability between control and all levels of replacement.

Table (12): Staling of balady bread made from wheat flour (82% extraction) and different levels of microwave defatted wheat germ flour:

Samples	Alkaline water retention capacity (AWRC)				
	Fresh zero time	After 24 hr		After48 hr	
	%	%	RD %	%	RD %
Control (100%WF)	360	305	15.27	260	27.7
95%WF+5%MDWGF	392	332	15.31	275	29.85
90%WF+10%MDWGF	388	318	18.04	270	30.41
85%WF+15%MDWGF	367	307	16.35	265	27.8
80%WF+20%MDWGF	339	280	17.4	230	32.15
75%WF+25%MDWGF	325	265	18.46	220	32.31

RD=Reduce decrease.
WF: Wheat flour extraction 82%, MDWGF: Microwave defatted wheat germ flour.

Table (13): Organoleptic characteristics of balady bread made of different replacement levels of microwave defatted wheat germ flour:

Samples / Parameters	Control (WF)	MDWGF				
		5%	10%	15%	20%	25%
Taste(25)	22.10[d]	24.30[a]	23.90[b]	23.00[c]	23.10[c]	22.00[d]
Oder (10)	8.00[d]	9.45[a]	9.05[b]	8.40[c]	8.50[c]	7.60[e]
Crumb color (25)	21.90[e]	24.10[a]	23.80[b]	22.80[c]	22.50[d]	21.45[f]
Crumb uniformity(10)	7.55[d]	9.30[a]	8.95[b]	8.70[bc]	8.60[c]	7.40[d]
Crust color (10)	7.90[c]	9.30[a]	9.15[a]	8.30[b]	8.50[b]	7.10[d]
Crust quality (10)	7.90[d]	9.60[a]	8.95[b]	8.20[c]	8.35[c]	7.10[e]
Overall accept. (10)	8.00[d]	9.75[a]	8.90[b]	8.40[c]	7.80[de]	7.60[e]

Each value was an average of three determinations.
Values followed by the same letter in row are not significantly different at $p \leq 0.05$.
WF: Wheat flour extraction 82%, MDWGF: Microwave defatted wheat germ flour.

Results showed that MDWGF could improve the taste and oder of the samples up to 15% replacement. This can be due to the wheaty and sweet taste of the germ which can affect the taste and oder of the bread positively. Moreover, MDWGF contains sugars and proteins that can interact with each other through Maillard and caramelization reactions. The products of these reactions are coloring and flavoring agents that can enhance the color of the crust (Purlis and Salvadori, 2007). Therefore, the crust color of the samples recorded higher scores when the MDWGF was added up to 15% replacement. Furthermore, an increase in the overall acceptability of the samples was observed, which can be due to their better taste, oder and color. These findings are consistent with Majzoobi *et al.* (2012).

Conclusion

From the obtained results, it could be concluded that wheat flour biscuit supplemented with MDWGF till 15% was accepted for sensory characteristics and it has high protein and minerals contents. In addition, these biscuits can be covered protein and minerals nutritional requirements of schoolchildren in developing countries from inexpensive and available sources. New prepared biscuit could be recommended as food aid in institutional feeding programs for pupils in different school stages and adults as well. also improve the nutritional quality of balady bread to avoid the malnutrition prevalent.

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التقييم الغذائي لبعض المخبوزات المدعمة بدقيق جنين القمح منزوع الدهن

موسى عبده سالم[١] ، محمود إمام عبد العزيز السيد[١] ، محمد أحمد البنا[٢] ، مريم أحمد الخطيب[٢]

[١] قسم علوم وتكنولوجيا الأغذية . كلية الزراعة . جامعة طنطا . مصر

[٢] معهد بحوث تكنولوجيا الأغذية . مركز البحوث الزراعية . الجيزة . مصر

الملخص العربي

أجريت هذه الدراسة بهدف الاستفادة من دقيق جنين القمح منزوع الدهن بنسب استبدال (٥، ١٠، ١٥، ٢٠ و ٢٥٪) لدقيق القمح لتحسين الخواص الغذائية والحسية للبسكويت والخبز البلدي. لذلك تم دراسة تأثير خلط دقيق

القمح بدقيق جنين القمح منزوع الدهن على الخواص الكميائية والطبيعية والغذائية والحسية للبسكويت والخبز البلدي الناتج.

يمكن تلخيص النتائج فيما يلي:

١- أظهرت النتائج أن جنين القمح منزوع الدهن يحتوي على نسبة عالية من البروتين (٢٨.٢١٪) مقارنة مع دقيق القمح ٧٢٪ (١٠.١٦٪)، ودقيق القمح ٨٢٪ (١١.٦٥٪) و دقيق جنين القمح (٢٢.٦٨٪) مما أدى ذلك إلى زيادة ملحوظة في نسبة البروتين في البسكويت والخبز البلدي الناتج من استبدال دقيق القمح بدقيق جنين القمح منزوع الدهن.

٢- وكان محتوى جنين القمح منزوع الدهن من الرماد (٤.٣٠٪) مرتفع عن دقيق جنين القمح (٣.٥٠٪) ودقيق القمح ٧٢٪ (٠.٦٥٪) ودقيق القمح ٨٢٪ (٠.٩٥٪). مما أدى الى زيادة ملحوظة فى نسبة الرماد في البسكويت والخبز البلدي الناتج من استبدال دقيق القمح بدقيق جنين القمح منزوع الدهن.

٣- كما كان محتوى دقيق جنين القمح منزوع الدهن من المعادن مرتفع معنويا مقارنة بدقيق القمح وخاصة الفوسفور والبوتاسيوم والكالسيوم والحديد والمغنيسيوم والزنك مما أدى ذلك الى زيادة ملحوظة في نسبة المعادن في البسكويت والخبز البلدي الناتج من استبدال دقيق القمح بدقيق جنين القمح منزوع الدهن.

٤- وكان ناتج التقييم الحسي للبسكويت والخبز البلدي الناتجان من استبدال دقيق القمح بدقيق جنين القمح منزوع الدهن اظهر أن استخدام جنين القمح منزوع الدهن حتى ١٥% كان له تأثير ملحوظ بدرجة كبيرة على الخواص الحسية أما زيادة النسبة أكثر من ١٥% كان له تأثير سلبي لحد ما على الخواص الحسية ولكنها فى كل الأحوال كانت مقبولة.

بناءا علي النتائج المتحصل عليها فإن البسكويت الناتج من استبدال دقيق القمح بدقيق جنين القمح منزوع الدهن يفي بالاحتياجات الغذائية من البروتين والعناصر المعدنية لطلاب المدارس في الدول النامية كما يمكن أن يوصى به كمنتج غذائي جيد في برامج التغذية لطلاب المدارس في مختلف المراحل الدراسية. وكذلك تم تحسين الجودة التغذوية للخبز البلدي و يوصى باستخدامه في الدول النامية لتقليل انتشار سوء التغذية.

السادة المحكمون:

١- أ.د/ محمد بسيم عطا الله — الأستاذ بكلية الزراعة – جامعة طنطا

٢- أ.د/ علاء السيد البلتاجى — الأستاذ بكلية الزراعة – جامعة المنوفية