QUALITY OF SOME BAKERY PRODUCTS MADE FROM WHEAT-BARLEY AND OAT FLOUR BLENDS

BY

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B.Sc. Agric. Sci. (Food Science and Technology), Tripoli University, 1994

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ABSTRACT

Hasan El-Taeb. Quality of some Bakery Products Made from Wheat, Barley and Oat Flour Blends, Unpublished Ph.D. Thesis, Department of Food Sciences, Faculty of Agriculture, Ain Shams University, 2018.

This study was carried out to investigate the possibility of utilization of barley and oat flour in production of pan bread and biscuit. Strong wheat flour of (72% extraction) was replaced by 10, 15 and 20% barley or oat flour. The effect of such replacement on physical and chemical characteristics of the blends and baking properties, as well as the acceptability of produced pan bread and biscuit were studied. The results indicated that barley or oat flour had a higher content of chemical composition than that in wheat flour, whereas, protein, lipid, ash, crude fiber, dietary fiber, β-glucan, phytochemicals and antioxidant activity, and the results indicated that addition of barley or oat flour to wheat flour, lead to decrease wet gluten and gluten index with increasing the replacement level with barley or oat flour. Falling number values of all blends were decreased with increasing oat flour, but increased at levels of 10 and15% barley flour.

The results obtained from farinograph noticed that substituted of wheat flour with barley flour at different rates 10, 15, 20, 25, 30% led to increase the rate of absorption and consistently for maximum strength and the weakness of dough. Also, adding oat flour, at different rates of absorption and don't affect arrival time, while, the same increased the stability of the dough and the dough weakness. The result of resistance to extension obtained from extensograph as a result of adding barley at different rates led to decline in rubber dough and the resistance and the relative number and energy of resulting dough. While, oats at different rates led to decline in rubber dough and energy, while increasing resistance to extension. The replacement of wheat flour with 10% barley or oat flour is successfully produced pan bread with sensory characteristics of prepared bread. The results revealed that crude protein,

lipids, ash and crude fiber contents of prepared pan bread had gradually increased with increasing the replacement level with barley or oat flour in comparison to control pan bread sample, except the crude protein decreased for bread produced by added barley flour.

At 15% barley flour with improver the resulted pan bread was not significantly different from control for crust color, crumb color, taste. Generally, it could be concluded that, the pan bread produced by substitution 10%, 15% barley or 10% oat flour gave bread loaves more sensory acceptable. The partial replacement of wheat flour with oat flour is not improving the rate of bread staling in comparison to control sample.

For biscuit, there is a significant decrease in both of biscuit volume and specific volume for biscuit prepared by replacement of wheat flour with barley or oat flour except 20% barley flour in compared to control sample. On the other hand, there were no significant differences between the thickness and spread ratio of biscuit (control) compared to biscuit with barley or oat-wheat composite flour

Generally, it could be concluded that replacement with 10 and 15% barley flour and all replacement of oat flour, gave biscuit with sensory acceptable.

Biological experiment was conducted to study the effect of pan bread made form barley or oat flour on 35 male rats with height of cholesterol in the blood. At the end of the experiments, rats with high in cholesterol can feed with pan bread made from barley and oats to reduce both of cholesterol and blood sugar.

Keywords: Barley flour, Oat flour, Wheat flour, Rheological properties, Pan bread, Sensory evaluation

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INTRODUCTION

Bread is an important staple food in both developed and developing countries. Wheat (*Triticum aestivum*) flour of both hard and soft wheat classes has been the major ingredient of leavened bread for many years because of its functional proteins.

Cereals and their derivatives are the most important foods in the human diet mainly because of the energy that they provide, due to their high carbohydrate content.

Wheat is one of the world largest edible cereal crops **(Atwell, 2001).** Wheat products are the least expensive and major source of calories intake and staple food commodity especially in developing countries. Several developing countries have encouraged the initiation of programs to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour. Many efforts have been carried out to promote the use of composite flours, in which a portion of wheat flour is replaced by locally grown crops, to be used in bread, thereby decreasing the cost associated with imported wheat **(Olaoye *et al.*, 2006).** However, wheat flour proteins are deficient in some essential amino acids such as lysine which lowering the quality and nutritional properties of foods and their products **(Dhingra and Jood, 2004).**

Consumer awareness about high-fiber diets and food naturally rich in components with health-promoting effects is increasing **(Siro *et al.*, 2008).** Thus, there is a great interest in improving the nutritional profile of white wheat baked goods through supplementation with flour or bran of different origins. In a multigrain approach, the use of other cereals is a recent trend in the baking industry to obtain multiple functional benefits in bakery products **(Bhatty,1986).** Among the different cereals barley has been studied in particular as a source of dietary fibre (DF), because of its high natural β-glucan content, non-starch unbranched polysaccharides, composed of (1-4) and (1-3) linked β-D-glucopyranosyl units. In addition,

barley is an important source of other bioactive compounds, that show marked antioxidant activity **(Henry, 1987).**

In fact, barley meals and fractions are now gaining renewed interest as ingredients for the production of functional foods due to its bioactive compounds, such as β-glucans and tocols **(Valeria *et al.*, 2014).**

Recently several studies were recommended to use barley seed in the human diet compared to other seeds due to pharmaceutical and nutraceutical properties **(Manach *et al.*, 2004).** Blending of barley with human diets is being intensively studied due to the presence of β-glucan and phenolic compounds which have the potential to lower cholesterol and blood glucose levels **(Cavallero *et al.*, 2002). Miller (1994)** showed that the isolated β-glucan from barley reduced glucose and insulin responses in human. Barley proteins have been recognized as a rich source of the limiting essential amino acids such as, lysine, threonine, methionine and tryptophan, (**Newman and Newman, 2006**).

Barley, is mostly known for its high amount of dietary fiber, but is also contains other important compounds, such phenolic compounds which referred to as antioxidants. In addition, to the possible health benefits associated with phytochemicals, these compounds have important functional properties. Firstly, phytochemicals in grains contribute to product quality in terms of colour, flavour and texture**.** Secondly, they also influence bread quality by interfering with the dough formation. **(Skribe *et al.*, 2009)**

In food industry, hull less barley (*Hardeum vulgaris* L.) is acknowledged as more valuable and more economical, compared with flaky barley. The hull-less barley has elevated content of β-glucans. Soluble dietary fiber, mainly β-glucans, provides the formation of viscosity; as a result, cholesterol and fat absorption are decreased **(Baik and Ullrich, 2008).**

The interest in barley has increased due to its many beneficial constituents and there is a desire to increase the amount of barley in the human diet. This can be achieved by incorporating barley in bread formula **(Charalampopoutos *et al.*, 2002).**

Oat (*Avena sativa*) is one of the most adventurous cereal grains for human diet since it contains naturally high amounts of valuable nutrients such as soluble fibers, proteins, unsaturated fatty acids, vitamins, minerals and phytochemical **(Flander *et al.*, 2007).** Oats protein was characterized by significantly higher proteins content in comparison to wheat flour. Also, oat contained more essential and conditionally essential amino acids than wheat flour and revealed much better chemical score in comparison to wheat flour **(Pastuszka *et al.*, 2012).**

Oat grains are good source of β-complex vitamins, protein, fat, minerals and heart healthy soluble fiber β-glucan. Moreover, it also useful for the control of diabetes and lipid profile. The incorporation of oat in daily diet is not only important from the nutrition stand point, but also for its therapeutic potential **(Masood *et al.*, 2008).** Oat β-glucan has been showed to lower reduced blood cholesterol. Also, the Food and Drug Administration (FDA) recognized since 1997 the efficiency of oat β-glucan in reducing the risk of coronary heart disease **(Mclntosh *et at.*,1991)**

Oat grains represent a rich source of bioactive components (e.g. dietary fibers, antioxidant, phenolics, lignin, vitamins, minerals) linked to the reduced risk of cardiovascular disease, cancer, diabetes obesity and coronary heart disease **(Ragaee *et al.*, 2011)**. Also, oat grains are rich in lipids with a high content of unsaturated fatty acids **(Youngs *et al*, 1982).** They also contain various compounds with antioxidative activities that protect the lipids from oxidation and are important for the storage stability of various oat products. A high content of lipid soluble antioxidants (tocopherols, yellow pigments) and phenolics (polyvinylopoly pyrrolidone bound phenolics, ferulic acid) in hulless oat (*Avena mada*)

representing an important source for the development of functional foods **(Mallory, 2018).**

Whole oat flour was added to white wheat flour at a replacement of different level to observe the effects of fibers on phenolic compounds, antioxidant capacity, dietary fiber fractions and starch digestibility in vitro. When incorporation level increased, free and bound phenolics and antioxidant capacity increased of cereal products, such bread. Soluble, insoluble and dietary fiber fractions and total minerals also increased **(Ragaee *et al.*, 2011).**

The present study was carried out to investigate the feasibility of replacement wheat flour with different levels from barley or oat flour to produce pan bread, the plan of research as follows:

1- Determination of proximate chemical composition of wheat, barley and oat flour.
2- Determination of total phenolic, total flavonoids and antioxidant activity in wheat, barley and oat flour.
3- Evaluation of effect of replacement wheat flour with barley or oat flour on rheological properties of dough.
4- Evaluation the physical characteristics and sensory properties of pan bread containing variable levels from barley or oat flour composite.
5- Biological evoluation of parameters composite pan bread on food intake, body weight, total blood cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), triglyceride, total lipids, blood glucose serum.

REVIEW OF LITERATURE

Although it is well known that no other crop can achieve the baking properties of wheat, composite flours became the subject of numerous studies. For the developing countries the use of composite flours had the following advantages. A saving of hard currency promotion of high yielding, native plant species, as well as a better supply of protein for human nutrition and better overall use domestic agriculture production **(Buguse *et al.*, 2001)**

Barley (*Hordiun vulgare*) has not yet been used as the main ingredient in such common food commodities as pasta, noodles or yeast leavened baked products .However, partial replacement of wheat with whole barley or barley components may result development of acceptable and functional products **(Izydorczyk *et al.*, 2001).** Also, Oat (*Avena sativa*) is one of the most adventurous cereals grains for human diet since it contains naturally high amounts of valuable nutrients such as soluble fibers, proteins, unsaturated fatty acids, vitamins, minerals and phytochemicals **(Flander *et al.*, 2007).**

2.1.Chemical composition and nutritional quality of flours.

2.1.1. Wheat flour

The chemical composition of wheat flour depends on the extraction rate. As long as this is below (100% extraction) the composition of the flour will differ, from that of the grain. On the other hand, as consequence of removal of bran and germ, the flours non starch carbohydrate content will be low **(Hargin and Morrison, 1980).**

Many researchers studying the chemical composition of wheat flour, these compounds depends on the type of wheat and extraction rate. The results of the researchers illustrated in **Table(1).**

Table (1) Composition of potential ingredients from wheat, barley and oat flour

Flour source	Chemical composition						References
	Moisture	Protein	Lipid	Crude Fiber	Ash	Carbohydrates	
Wheat flour		11.51-	1.19-1.67		0.54-0.60		**Fadly et al. (2010)**
		12.34	0.9	0.30	0.76		**Martinez (2013)**
	14.30	12.1	1.34	1.90	0.54	70	**Angilani & Collar (2012)**
	12.90	13.4	1.0		0.38	72.3	**Zucco et al. (2012)**
	10.43	13.33	2.33	1.40	0.53	71.57	**Pasha et al.(2013)**
	13.12	11.83	1.86	1.91	1.02	70.28	**Barnwal (2013)**
	12.89	10.28		0.56	0.55		**Pauccan & Man (2013)**
	11.80	9.63	1.53	3.8	0.49		**Maiya et al. (2013)**
Barley four		11.65	2.31	6.75	2.22		**Phyllis (2003)**
		12.10	2.70	2.60	2.40	80.00	**Dahab (2006)**
	11.25	12.45	3.60	3.82	2.40	73.30	**El-Ashaal (2013)**
	8.80	10.70	1.50	6.50	2.50	69.60	**Gbra et al. (2013)**
Oat flour	15.61	16.92	6.10	4.92	1.80		**Alexandra et al (2012)**
	13.30	13.00	7.50	10.30	3.19		**Massod et al (2008)**
		16.90	6.90	10.60		66.3	**Mushtay et al. (2014)**

2.1.2. Barley flour:

Barley meals and fraction are now gaining removed interest as ingredients for the production of functional foods. Several studies were recommended the chemical composition of barley flour .The researchers results are illustrated in **Table (1).** Also**, Aman *et al*. (1985)** mentioned that, the percentage of moisture, crude protein content ranged between 9 up to 14%,10 up to15 respectively, and crude fat content was less than crude protein 1.43 up to 7% in barley meal. As for fiber content it ranged among 1.20 up to 3.45%. Starch content represented the highest percentage (58-67%) as compared with chemical components.

Starch was the major constituent of barley, accounting for 51-64% followed by total non-starch polysaccharides 23-41% .The content of total *arabino xylans* in was higher 7-16%. The hull-less barley varieties were lower in non-starch polysaccharide content, but higher in protein and β-glucans than the hulled samples. **Holtekjolen *et al.* (2008).**On the other hand, **Quinde *et al*. (2004**) showed that, the whole barley grain contained about 65-68% starch, 10-17% protein, 4-9% β-glucan, 2-3% free lipids and 1.5-2.5% minerals.

Aman and Newman (1986) reported that, the ash, protein, dietary fiber (DF) and β-glucan contents of the whole barley grain were 1.7, 11.16, 14.16 and 4.3%, respectively. The pearled barley fraction (external lower 5-15%) had 9, 2.4, 14, 25 and 85 times higher ash, protein, DF, β-glucan and total phenolic components (TPC), respectively, than refined wheat commercial flour. Barley grain is an excellent source of soluble and insoluble dietary fiber and other bioactive constituents such as vitamin E, B-complex vitamins, enzymes, mineral and phenolic compunds (**Izydorczyk and Dexter, 2008).**

2.1.3-Oat Flour:

Oat is one of the most adventurous cereal grains for human diet since it contains naturally high demounts of valuable nutrients such as soluble fibers, proteins, unsaturated fatty acids, vitamins, minerals and phytochemical **(Flander *et al* ,2007)** . The chemical composition of oat flour according to the researchers are illustrated in **Table (1)**. On the other hand, **Kirk and Sawyer (1999)** mentioned that, the average contents for protein, fat, starch, total dietary fiber and β-glucan of wheat-oat flour were 15-17%, 2-10%, 59-70%, 5-13% and 4-9%, respectively**. Mattila *et al*. (2005)** found that ,oats contain relatively high amounts of lipids compared with other cereal grains with substantial level of essential linoleic acid. Protein content of the hull-less oat kernel ranges from 12 to 24% the highest among cereals **(Lasztily, 1998*).***

Tian *et al.* (2010) reported that, the whole oat grain contained 11% moisture, 4% ash, 13% crude protein, 3% fat and 4% crude fibers as well as, the starch content was 51.8%.

Oat (*Avena sativa*) is distinct among the cereals due to its multifunctional characteristics and nutritional profits recent advancement in food and nutrition has revealed the important of its various componats. It is a good source of dietary fiber especially β-glucan, minerals and other nutrients oat and oat products have been proven to be helpful in the treatment of diabetes and cardiovascular disorders **(Kahlon *et al*,1993).**

2.2.Nutritional value and amino acid composition

Alu-datt *et al.* (2012) reported that the amino acid composition of barley flour revealed the significant difference in the contents of essential and non-essential amino acids. Generally, the barley flour had the highest content of the essential and non-essential amino acids compared to other protein fractions. The total amino acid recoveries were the maximum in barley flour (BF), barley protein isolate (BPI) and glutenin with values of 38.47, 34.55 and 32.72 g/100g, respectively. The highest content of

limiting essential amino acids such as lysine, threonine and methionine were obtained in BF and BPI compared to other fraction .Fortification of WF with BF improve the chemical composition and content of essential amino acid as the rate of fortification gradually increased from 0 to 15% .On the other hand, **Bodwell,(1980)** reported that the content of essential amino acids in barley flour were in range of 0.63-0.73, 0.29-0.39, 0.81-1.02, 0.47-0.51, 0.21-0.26, 0.65-0.80, 0.45-0.49 and 0.65-0.77g/100g for arginine, histidin, isoleucine, lysine, methionine, phenylalanine, threonine and valine, respectively.

Biel and Jacyno (2013) evaluate the chemical composition of four spring hulled barley varieties. The granal variety had a lower ($P \leq 0.05$) crude protein content, being the lysine content and quality of protein; Chemical Score (CS), Essential Amino Acid Index (EAAI) and Biological Value (BV) were higher in granal variety than in the other three varieties, 11.74 protein and 3.98 (g/16g nitrogen) Lysine. The values of CS, EAAI and BV of General variety were 56.9, 68.9 and 63.4, respectively. The apparent digestibility coefficients (ADC) of crude protein and of other nutrients in Granal variety were lower not significantly, expecting the pentosans ($p \leq 0.05$) than in the remaining varieties. Also, they reported that, lysine was the most limiting the quality of grain barley proteins in all examined verities. The coefficients value (SC, EAAI and BV) of the proteins of all examined barley varieties showed the good quality of a protein.

Morey (1983) determined amino acid composition of oat, the contents of lysine, threonine, cysteine, valine, methionine, isoleucine, leucine and phenylalanine for oats were 4.20, 3.65, 1.83, 5.80, 1.83, 4.20, 7.60 and 5.40 g amino acid. In addition, the lysine content of oats is higher than other cereal proteins.

Amino acid composition of different protein fractions isolated from oats were reported by **Lasztily (1998).** Oat albumin account for 1-15% of total protein, the major albumin components have molecular weights of