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EFFECT OF PARTICLES SIZE OF SOME CEREAL BRANS ON THE QUALITY OF HIGH FIBER BALADY BREAD

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ABSTRACT

This research aims to study effect of the bran particle size of wheat, barley, oats, sorghum and maize as dietary fiber sources with positive health effects on the quality of the high-fiber bread. Grains were milled to produce the bran. Then, the bran were re-milled and sieved on 500 µm sieve to separate coarse bran (greater than 500 µm) and fine bran (less than 500 µm). The results showed high levels of these cereal brans of insoluble and soluble dietary fibers, proteins (except maize bran), minerals and water holding capacity and low content of carbohydrates. Coarse bran had high content in total dietary fiber and low content in carbohydrates compared with fine bran which had high water holding capacity. All kinds of brans were replaced with 10% of the wheat flour 82% extraction rate to produce high-fiber bread. Dietary fiber, moisture and water holding capacity leveld were increased in the produced high fiber bread compared with the control Balady bread. Also, moisture content and water holding capacity of the bread containing fine fiber were higher than the bread containing the coarse bran due to the increasing surface area of the fine bran. Bran of wheat, barley and sourghum recorded sensory properties better than bran of oat and maize. Also, effect of fine bran on sensory properties and freshness of the produced high fiber bread were better than coarse bran. The results recommended the possibility of producing healthy high-fiber bread using cereal brans with 10% of wheat flour without significant deteriorations in the sensory properties of bread.

***Key words**: balady bread, high fiber, physical properties.*

1. INTRODUCTION

Epidemiological and clinical studies demonstrate that consumption of dietary fiber and whole grain intake is inversely related to obesity (Tucker and Thomas, 2009), type two diabetes (Meyer, *et al.*, 2000), cancer (Park *et al.*, 2009) and cardiovascular disease (CVD) (Streppel, *et al.*, 2008). Cereal brans are a major category of dietary fiber and one that is particularly beneficial in promoting gut health and avoiding a range of diseases (Cho *et al.*, 2004). Also, cereal brans are known to have substantial concentrations of important nutrients such as soluble and insoluble fibers (Chronakis, *et al.*, 2004), minerals, vitamins, proteins and lipids (Murtaugh *et al.*, 2003). A major field of research is therefore centered on the incorporation of cereal brans into cereal-based and other food products, in forms that are attractive to consumers , as the basis for Encouring healthy diets. Cereal-based foods frequently derive their appeal from an aerated structure and bran is generally detrimental to the creation of aerated structures in these products (Campbell, 2003). Several workers have therefore studied the incorporation of bran into less aerated products including cakes, biscuits, muffins, breakfast cereals, snack foods, flat breads and pizza (De Delahaye *et al.*, 2005). Dietary fiber and whole grains contain a unique blend of bioactive components including resistant starches, vitamins, minerals, phytochemicals and antioxidants. As a result, research regarding their potential health benefits has received considerable attention in the last several decades. Brans increased the fecal concentration of sugars, bacterial mass, nitrogen, ash, fat and mass of plant material. Wheat bran contains 90% fiber and only 50–60% of oat bran fiber is insoluble (Chen, *et al.*, 1998). Cereal fibers can be used in the food industry as functional ingredients with excellent results

(Viuda-Martos *et al.*,2010).Corn bran is produced in yields of about 6 – 7% of total corn kernel. Corn bran contains potentially useful components that may be harvested through physical, chemical or enzymatic means for the production of food ingredients or additives, including corn fiber oil, corn fiber gum, cellulosic fiber gels, xylo-oligosaccharides and ferulic acid (Watson, 2003). De Kock *et al.* (1999) demonstrated that bran particle size affects quality when added to bread and found that smaller particle sizes decreased loaf volume more than larger particle sizes. In cookies, Ozturk *et al.* (2002) reported that medium (212–425μm) and coarse (425–850 μm) particle sizes gave better spread ratios, color and overall sensory scores compared with cookies made with finer particle sizes (<212 μm). Kumar *et al.* (2011) reported that wheat is an excellent source of iron and phosphorus. The objective of this research was to evaluate the effect of particle size of some cereal brans on sensory characteristics and staling of the high-fiber balady bread.

2. MATERIALS AND METHODS

Wheat, barley, oat, sorghum and maize were obtained from Field Crops Research Institute, Giza, Egypt. Wheat flour (82% extraction) was obtained from South Cairo Mills Co. Yeast and salt were purchased from the local market.

2.1. Preparation of Grains bran: Grains were milled to produce the bran. Then, the resulted brans were re-milled and sieved on 500 micron sieve to separate coarse bran (greater than 500 microns) and fine bran (less than 500 microns).

2.2. Preparation of Balady bread: Coarse and fine brans of wheat, barley, oat, sorghum and corn were replaced with 10% of wheat flour (82% extraction) to prepare wheat flour blends. Yeast, salt and water were added to the previous blends with 3 g, 2 g and 100 ml, respectively. High fiber balady bread was prepared according to (Sallam *et al.*, 1995) in the experimental bakery of Food Technology Research Institute.

2.3. Sensory evaluation of bread: Bread quality attributes were evaluated after cooling during 30 min for crust and crumb attribute determinations. Appearance (15), layers separation (15), crumb texture (15), crust color (15), taste (20), odor (20) and overall acceptability (100) were determined according to (Faridi and Rubenthaler, 1984) with some modifications. Sensory characteristics were determined by ten panelists from the staff members of the Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

2.4. Determination of staling rate: The staling rate of bread was measured by determination of alkaline water retention capacity (A.W.R.C) using the method of (Kitterman and Rubenthaler, 1971).

2.5. Gross chemical composition: Moisture, crude proteins, lipids, total dietary fibers (TDF), soluble (SDF) and insoluble dietary fibers (IDF) and ash contents of wheat flour (82% extraction), cereal brans and produced bread were determined by the standard procedures described in the A.O.A.C. (2005). Total carbohydrates were calculated by difference according to the following equation: Total carbohydrates = 100 – (% crude proteins + % crude fats + % ash). Total calories were calculated using the equation mentioned by FAO/ WHO (1974). Where, energy (calories) = 4 (carbohydrate + protein) + 9 (fat).

2.6. Determination of minerals: Calcium was determined by EDTA titration according to the method recommended by the A. O. A. C. (2005). Iron, zinc, potassium and manganese were determined using atomic absorption spectrophotometer (Perkin Elmer Instrument Model 2380) according to the methods recommended by the A. O. A. C. (2005).

2.7. Statistical Analysis: Data were statistically analyzed by the variance and least significant difference (L.S.D) at 0.05 level according to the method described by McClave, and Benson (1991).

3. RESULTS AND DISCUSSION

3.1. Chemical composition of wheat flour and cereal brans

Chemical composition of wheat flour and cereal brans is shown in Table (1). Data demonstrated that total dietary fibers (TDF), proteins, fats, carbohydrates, and ash content in coarse bran were similar to that in the fine with some minor differences. Data showed also that TDF content of corn, barley and wheat was high in comparison with sorghum and oat. Also, sorghum and oat bran had high carbohydrate content. Also barley, wheat and oat brans had high ash content. In contrast, corn bran had the lowest content of proteins, carbohydrates and ash.

Table (1): Chemical composition of wheat flour and cereal brans.

Raw materials	Carbohydrates (%)	TDF[a] (%)	Proteins (%)	Fats (%)	Ash (%)
Wheat flour (82%)	78.9	5.1	13.5	1.7	0.8
Coarse wheat bran	31.8	45.1	15.1	3.7	4.3
Fine wheat bran	34.8	43.5	15.3	3.3	3.1
Coarse barley bran	26.6	47.5	18.8	2.3	4.8
Fine barley bran	29.7	44.8	19.2	1.3	5.0
Coarse oat bran	39.6	34.9	16.0	5.5	4.0
Fine oat bran	42.5	30.3	16.7	5.7	4.8
Coarse sorghum bran	50.4	35.5	13.3	0.1	0.7
Fine sorghum bran	52.4	33.4	13.0	0.2	1.0
Coarse corn bran	14.6	77.5	5.3	2.0	0.6
Fine corn bran	10.5	80.0	7.0	1.8	0.7

[a] indicates total dietary fibers

3.2. Dietary fiber components and water retention capacity of wheat flour and cereal brans

Dietary fiber components and alkaline water retention capacity of wheat flour and cereal bran are shown in Table (2). Data cleared that cereal brans are excellent sources of TDF, SDF and IDF in comparison with wheat flour (82%). Data showed also that bran of corn, barley and wheat had higher content of total and insoluble dietary fiber in comparison with sorghum and oat. In contrast, bran of barley and oat had higher content of soluble dietary fibers in comparison with wheat, sorghum and corn. Although barley has not traditionally been roller-milled like wheat to obtain flour and bran, this may change in the near future because of barley's high soluble fiber content and its potential use in many food products (Zheng *et al.*, 2011). Also, data cleared that fine bran had higher water holding capacity in comparison with coarse bran. Data showed also that fine bran of barley, oat and wheat had higher water holding capacity in comparison with sorghum and corn.

3.3. Mineral content of wheat flour and cereal brans

Mineral content of wheat flour and cereal bran is shown in Table (3). Data showed that wheat, barley, oat and sorghum brans are good sources of iron, zinc and calcium in comparison with wheat flour (82%). Data showed also that coarse bran content of these minerals was higher than fine bran. Similar results in mineral content of barley bran were found by Bhatty, (1993).

Table (2): Dietary fiber component and water retention capacity of wheat flour and cereal brans.

Raw materials	TDF (%)	IDF (%)	SDF (%)	AWRC (%)
Wheat flour (82%)	4.1	1.3	2.8	-
Coarse wheat bran	45.1	41.8	3.3	253.0
Fine wheat bran	43.5	38.9	4.6	277.5
Coarse barley bran	47.5	34.2	13.3	280.2
Fine barley bran	44.8	30.3	14.5	290.4
Coarse oat bran	30.3	21.0	9.3	265.4
Fine oat bran	34.9	23.5	11.4	280.5
Coarse sorghum bran	35.5	30.4	5.1	165.9
Fine sorghum bran	33.4	26.2	7.2	230.5
Coarse corn bran	77.5	76.0	1.5	194.8
Fine corn bran	80.0	78.0	2.0	243.1

Table (3): Mineral content (mg/ 100g) of cereal bran

Raw materials	Fe	Zn	Ca	K	Mn
Wheat flour (82%)	1.9	2.0	22.0	315	0.5
Coarse wheat bran	12.2	4.2	25.5	800	2.0
Fine wheat bran	12.0	3.8	23.8	740	1.8
Coarse barley bran	14.4	7.0	30.4	750	2.2
Fine barley bran	13.5	6.0	28.1	730	2.0
Coarse oat bran	9.7	3.8	40.2	750	3.0
Fine oat bran	7.2	3.2	36.3	700	2.8
Coarse sorghum bran	5.5	1.6	18.5	250	1.2
Fine sorghum bran	5.4	3.3	15.8	400	1.9
Coarse corn bran	2.9	1.4	14.0	250	0.6
Fine corn bran	3.1	1.6	13.1	300	0.7

3.4.Effect of particle size of cereal bran on the chemical composition and energy level of high fiber bread

Effect of particle size of cereal bran on the chemical composition and energy level of high fiber bread is shown in Table (4). Data showed that cereal bran increased total dietary fiber content of the high fiber bread. On the other hand, data cleared that cereal brans decreased carbohydrates and energy level of the high fiber bread. Data showed also that except for corn and oat brans, coarse brans of cereal decreased carbohydrate level of bread more than the fine brans. Data cleared also that except for corn bran, coarse bran of cereal increased TDF content of bread more than the fine bran.

Table (4): Effect of particle size of cereal brans on chemical composition of the high-fiber bread.

High fiber bread with:	Carbohydrates (%)	TDF[a] (%)	Proteins (%)	Fats (%)	Ash (%)	Energy (Kcal)
Control	79.72	5.0	12.7	1.50	1.08	383.18
Coarse wheat bran	74.62	9.4	12.8	1.67	1.51	364.71
Fine wheat bran	75.03	9.0	12.9	1.68	1.39	366.92
Coarse barley bran	76.36	8.3	12.2	1.58	1.56	368.46
Fine barley bran	76.54	8.1	12.3	1.48	1.58	368.68
Coarse sorghum bran	76.2	8.5	12.7	1.45	1.15	368.65
Fine sorghum bran	76.47	8.1	12.7	1.55	1.18	360.63
Coarse oat bran	76.12	7.5	13.0	1.90	1.48	373.58
Fine oat bran	76.22	7.2	13.1	1.92	1.56	374.56
Coarse corn bran	73.05	12.1	11.9	1.55	1.40	353.75
Fine corn bran	72.62	12.6	12.1	1.53	1.15	352.65

[a] refer to total diety fibers, s

3.5. Effect of particle size of cereal brans on the dietary fiber component and moisture level of high fiber bread

Effect of particle size of cereal brans on the dietary fiber component and moisture content of high fiber bread are shown in Table (5). Data showed that cereal bran increased TDF, IDF, SDF and moisture content of the high fiber bread. Data cleared also that coarse bran of cereal decreased moisture content of the high fiber bread more than the fine bran. Sosulski and Wu, (1988) found that total dietary fiber contents of the acceptable fiber breads were 21% for corn bran, 13% for wheat bran and 6% for wild oat bran breads.

Table (5): Effect of particle size of cereal brans on the dietary fiber component and moisture content of high fiber bread.

Bread with 10% of:	TDF (%)	IDF (%)	SDF (%)	Moisture (%)
Control	5.0	3.5	1.5	34.3
Coarse wheat bran	9.4	7.3	1.8	38.2
Fine wheat bran	9.0	7.1	2.1	40.4
Coarse barley bran	8.3	6.5	1.8	38.7
Fine barley bran	8.1	6.1	2.0	40.6
Coarse sorghum bran	8.5	6.1	2.4	37.9
Fine sorghum bran	8.1	5.7	2.4	38.5
Coarse oat bran	7.5	5.5	2.0	39.2
Fine oat bran	7.2	5.2	2.0	40.5
Coarse corn bran	12.1	10.5	1.6	39.8
Fine corn bran	12.6	10.9	1.7	40.4

3.6.Effect of brans particle size on sensory properties of the high fiber balady bread

Effect of bran particle size on sensory properties of the high-fiber balady bread are presented in Table (6). Data showed that cereal bran significantly decreased the sensory properties of the high-fiber balady bread. Also, coarse bran reduced the sensory properties of the high-fiber balady bread more than the fine bran. Data demonstrated also that sensory properties of the high-fiber balady bread with bran of sorghum, barley and wheat were more acceptable than balady bread with bran of oat and corn.

Table (6): Effect of bran particle size on sensory properties of balady bread.

Bread with 10% of:	Appearance (15)	Layers separation (15)	Crumb texture (15)	Crust color (15)	Taste (20)	Odor (20)	Overall acceptability (100)
Control	15.0^{a}	15.0^{a}	15.0^{a}	14.0^{a}	18.0^{a}	18.0^{a}	95.0^{a}
Coarse wheat bran	12.5^{c}	13.0^{bc}	12.5^{b}	14.0^{a}	16.0^{b}	16.0^{b}	86.0^{b}
Fine wheat bran	14.0^{ab}	14.0^{ab}	13.0^{b}	14.0^{a}	17.0^{ab}	17.0^{ab}	89.0^{a}
Coarse barley bran	14.0^{ab}	14.0^{ab}	13.0^{b}	14.0^{a}	17.0^{ab}	17.0^{ab}	89.0^{a}
Fine barley bran	14.0^{ab}	14.0^{ab}	13.0^{b}	14.0^{a}	17.0^{ab}	18.0^{a}	90.0^{a}
Coarse sorghum bran	13.0^{bc}	14.0^{ab}	13.0^{b}	14.0^{a}	17.0^{ab}	18.0^{a}	89.0^{a}
Fine sorghum bran	13.0^{bc}	14.0^{ab}	13.0^{b}	14.0^{a}	18.0^{a}	18.0^{a}	90.0^{a}
Coarse oat bran	12.5^{c}	13.0^{bc}	12.5^{b}	13.0^{b}	14.0^{c}	15.0^{bc}	79.0^{c}
Fine oat bran	13.0^{bc}	12.5^{c}	12.5^{b}	13.0^{b}	14.0^{c}	15.0^{bc}	80.0^{bc}
Coarse corn bran	12.0^{c}	12.6^{c}	12.4^{b}	13.0^{b}	16.0^{b}	16.0^{b}	82.0^{bc}
Fine corn bran	13.0^{bc}	13.5^{bc}	13.5^{b}	14.0^{a}	15.0^{bc}	14.0^{c}	83.0^{bc}

3.7. Effect of particle size of bran on alkaline water retention capacity of balady bread

Effect of bran particle size on alkaline water retention capacity of balady bread is shown In Table (7). Data demonstrated that brans increased alkaline water rentation capacity of fresh balady bread in comparison with the control balady bread due to its high dietary fiber content. These results agreed with Kim and D'Appolonia (1997). They mentioned that presence of dietary fibers such as insoluble arabinoxylans increased water absorption during bread making. Sosulski and Wu, (1988) and De Kock *et al.* (1999) reported that wheat and oat bran increased water absorption of dough. Data showed also that fine brans increased alkaline water retention capacity in the high fiber balady bread more than the coarse bran. Also, fine barley brans increased alkaline water retention capacity in the high-fiber balady bread more than other brans. Data in Table (7) cleared also that alkaline water retention capacity of the high-fiber balady bread decreased with increasing the storage time. Also, brans altered the staling rate of bread in comparison with the control bread and fine barley bran recorded the highest freshness in the produced balady bread. These results agreed with Assel (2012) who reported that addition of whole naked barley flours to whole wheat flour led to decrease in balady bread staling rate and increased its freshness.

Table (7): Effect of bran particle size on alkaline water retention capacity of balady bread.

Bread with 10% of:	Alkaline water retention capacity after:		
	Fresh	12 hr	24 hr
Control	386	305	270
Coarse wheat bran	461	433	402
Fine wheat bran	481	452	424
Coarse barley bran	471	450	428
Fine barley bran	520	500	482
Coarse sorghum bran	431	403	387
Fine sorghum bran	441	419	389
Coarse oat bran	460	442	420
Fine oat bran	474	450	433
Coarse corn bran	451	430	411
Fine corn bran	461	440	418

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تأثير حجم حبيبات ردة بعض الحبوب علي جودة الخبز البلدي عالي الألياف

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ملخص

يهدف هذا البحث الي دراسة تأثير حجم حبيبات ردة القمح، الشعير، الشوفان، السورجم والذرة الشامية كمصدر للألياف الغذائية ذات التأثيرات الصحية الإيجابية علي جودة الخبز البلدي عالي الألياف. تم طحن الحبوب للحصول علي الردة، ثم أعيد طحن الردة الناتجة ونخلها بمنخل سعة ثقوبه ٥٠٠ ميكروميتر لفصل الردة الخشنة (أكبر من ٥٠٠ ميكروميتر) والردة الناعمة (أقل من ٥٠٠ ميكروميتر). أظهرت النتائج إرتفاع محتوي ردة هذه الحبوب من الألياف الغذائية بأنواعها الكلية، غير الذائبة والذائبة، البروتين (ما عدا ردة الذرة)، سعة ربط الماء والعناصر المعدنية وإنخفاض محتواها من المواد النشوية. وتميزت حبيبات الردة الخشنة بمحتوي أعلي من الألياف الغذائية الكلية وبمحتوي منخفض من المواد النشوية مقارنة بالردة الناعمة التي تميزت بقدرة أكبر علي ربط الماء. تم إستبدال الردة بأنواعها بـــ ١٠% من دقيق القمح إستخراج ٨٢% لإنتاج خبز بلدي عالي الألياف. إرتفع محتوي الخبز البلدي الناتج من الألياف الغذائية بأنواعها ومحتواه الرطوبي والقدرة علي ربط الماء بدرجة معنوية، مقارنة بالخبز البلدي الكونترول. وكان المحتوي الرطوبي والقدرة علي ربط الماء للخبز البلدي عالي الألياف المحتوي علي الردة الناعمة أعلي من الخبز المحتوي علي الردة الخشنة بسبب زيادة مساحة سطح حبيبات الردة الناعمة. وحققت ردة القمح والشعير والشوفان نتائج أفضل في الصفات الحسية من ردة السورجم والذرة الشامية. كما كان تأثير الردة الناعمة علي الصفات الحسية ودرجة الطزاجة أفضل من تأثير الردة الخشنة علي هذه الصفات. توصي النتائج بإمكانية إضافة ردة الحبوب بنسبة ١٠% لدقيق القمح إستخراج ٨٢%، لإنتاج خبز بلدي عالي الألياف صحي دون تدهور الصفات الحسية للخبز الناتج.

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