EFFECTS OF OAT AND BARLEY ON SOME BIOCHEMICAL PARAMETERS IN HYPERGLYCEMIC RATS AND THEIR EFFECTS ON PROPERTIES OF DOUGH AND BAKED BREAD

Dr. Dalia Refaat Hassan

Faculty of Specific Education, Home Economic Dept., Fayoum University-Egypt.

المجلة العلمية المحكمة لدراسات وبحوث التربية النوعية

المجلد الثانى– العدد الأول– مسلسل العدد (٣)– يناير ٢٠١٦

رقم الإيداع بدار الكتب ٢٤٢٧٤ لسنة ٢٠١٦

ISSN-Print: 2356-8690 ISSN-Online: 2356-8690

موقع المجلة عبر بنك المعرفة المصري https://jsezu.journals.ekb.eg

البريد الإلكتروني للمجلة E-mail JSROSE@foe.zu.edu.eg

EFFECTS OF OAT AND BARLEY ON SOME BIOCHEMICAL PARAMETERS IN HYPERGLYCEMIC RATS AND THEIR EFFECTS ON PROPERTIES OF DOUGH AND BAKED BREAD

Dr. Dalia Refaat Hassan

Faculty of Specific Education, Home Economic Dept., Fayoum University- Egypt

Abstract:

Considering the effects of oat (*Avena sativa* L.) and barley (*Hordeum vulgare* L.), and their importance in the prevention and control of diabetes mellitus (DM) and cardiovascular diseases, hence the study aims to investigate the effect of adding oat and barley to the diet of hyperglycemic rats and their effects on blood glucose, total cholesterol (TC), High Density Lipoprotein (HDL) and low Density Lipoprotein (LDL) levels, and to examine the effect of mixing flour of wheat with oat and barley on rheological properties of the bread dough, and to evaluate the sensory attributes of baked breads prepared from these mixtures. Thirty male Sprague Dawley rats were divided into five groups (six rats each): Body weight gain and food intake were measured and the Feed Efficiency Ratio (FER) was calculated.

Animals were lightly anesthetized at the end of the experimental period and blood was collected. Blood glucose, total cholesterol (TC), HDL and LDL were estimated. For measurement of dough's rheological properties, dough prepared from various mixtures of wheat, oat and barley flour were subjected to Farinograph and Extensograph tests ,and the baked bread was subjected to orgranoleptic evaluation.

The results showed that body weight gain for groups of rats fed on 40% oat, barley or their mixture were lower than that of positive control group. Rats groups fed on oat, barley and their mixture showed significant ($P \leq 0.01$) decrease in blood glucose level when compared with the positive control group. Serum cholesterol and LDL levels were significantly ($P \leq 0.01$) decreased in groups fed on oat, barley and their mixture in comparison with positive control value, on the other hand serum HDL level increased significantly in experimental groups when compared to the value of positive control. Replacement of wheat flour with 40% of oat or barley increase the water absorption and the dough

resistance and extensibility decreased as a consequence of adding either oat or barley flour, wheat flour bread has higher acceptance score, followed by mixture of (wheat 60% + oat 20% +barley 20%).

Keywords: 40% Oat, 40% Barley, Rats, Glucose, Cholesterol, LDL, HDL, Farinograph- Extensograph, Sensory Evaluation.

Introduction:

In recent years, scientists and nutritionists have reached a shared conclusion that whole grains have protective effects against the development of diet-related disorders (Slavin, 2010). Whole grain consumption reduces the risk of major chronic diseases (Zhou *et al.*, 2014), and higher whole grain consumption is associated with a reduced risk of the development of cardiovascular diseases, type 2 diabetes, and certain types of cancer (Lefevre and Jonnalagadda, 2012).

Increasing whole-grain products such as oats and barley in the diet would increase intakes of both total and soluble dietary fiber, a variety of fiber components, especially soluble fiber, have been reported to have beneficial effects on glucose tolerance, particularly on postprandial glucose and insulin concentrations in normal people and people with impaired glucose tolerance. Beneficial health effects also include improving glycemic control in diabetes, decreasing the risk for developing diabetes, and reducing blood lipids (Behall *et al.*, 2004). Both oats and barley are recognized for their valuable fiber constituents having protective and therapeutic effects against the development of diet-related disorders (Brennan and Cleary, 2005; Pins and Kaur, 2006; Keenan *et al.*, 2007 and Wood 2010).

Oat (Avena sativa) is distinct among the cereals due to its multifunctional characteristics and nutritional profile. Recently the importance of oat various components has been reported as it is a good source of dietary fiber especially β- glucan. β- glucans are polysaccharides consisting of glucose residue jointed by beta linkage (Chen and Seviour, 2007 and Butt *et al.*, 2008), they are found at a high level in the cell wall of oat and barley (McIntosh et al 2005). Oat and barley β-glucan linked by linear 1-3 and 1-4 bonds (Chen and Seviour 2007; Butt *et al.*, 2008).

The Food and Drug Administration (FDA) endorsed the relationship between inclusion of soluble fiber ß-glucan in the diet and a decrease in serum cholesterol concentration by ratifying health claims for oat and barley fiber (FDA, 2006). The FDA concluded that ß-glucan (3 g/day) soluble fiber from oat bran and rolled oats or from wholegrain barley and dry-milled barley products are effective in lowering total and LDL-cholesterol concentrations (Poppitt, 2007). The results of Frost *et al.* (2011) showed that, the 40% and up to 50% substitution with high fiber barley flour might be feasible to manufacture acceptable cookies that will provide 0.8 g of soluble fiber per serving (30 g). Consuming ~2 servings with 50% barley flour substitution will provide the consumer 1.6 g of β-glucan soluble fiber which is ~50% of the recommended level by FDA.

Considering the effects of barley and oat, and their importance in the prevention and control of diabetes mellitus and cardiovascular diseases, the study aims to investigate the effect of adding oat and barley to the diet of hyperglycemic rats and their effects on blood glucose, total cholesterol, HDL and LDL levels, and to examine the effect of mixing flour of wheat with oat and/or barley on rheological properties of the bread dough, and to evaluate the sensory attributes of baked breads prepared from these flours' mixtures.

Materials and Methods:

In Egypt during 2012/2013 the average per capita daily bread was 2.8 loaf of bread a day (the net weight of bread loaf is 140 gram) which equal to 392 gm baladi bread per day (Shehata and Mohamed, 2015). Based on β-glucan content of oat and barley, the calculated amount of oat and/or barley needed to provide the sufficient amount of soluble fiber (>3 gm/ day), will be 92 gm from oat or barley or their mixture which represent 40% of flour mixtures needed for preparing bread loaf (392 gm) as following: Control wheat bread and tested breads containing wheat 60% + oat 40 % (WO); wheat 60% + barley 40% (WB), and mixture of wheat 60% + oat 20% + barley 20% (WOB). The wheat flour was a commercial baker's flour. Whole oat and barley flour were obtained from the Cairo local market. β-glucan content was determined using β-glucan enzymatic assay kit (Michniewicz, et al. 2003). Wheat, oat and barley flour were analyzed for determination of moisture, protein, lipid, ash, and crude fiber according to AACC methods (1990).

Table (1): Recipe for preparing bread loaf from various wheat, oat and barley mixtures.

Ingredients	Wheat 100% (Control bread)	Wheat 60% + oat 40% (WO 40%)	Wheat 60% + barley 40% (WB 40%)	Wheat 60% + oat 20% + barley 20% (WOB 20+20%)
Wheat flour (gm)	229.00	137.00	137.00	137.00
Oat Flour (gm)	----	92.00	----	46.00
Barley Flour (gm)	----	----	92.00	46.00
Salt (gm)	4.00	4.00	4.00	4.00
Sugar (gm)	23.00	23.00	23.00	23.00
Dry Milk (gm)	5.00	5.00	5.00	5.00
Yeast (gm)	4.00	4.00	4.00	4.00
Margarine (gm)	11.00	11.00	11.00	11.00

Thirty male Sprague Dawley rats weighing about 110–130 g were obtained from the Egyptian Organization for Biological Products and Vaccines (VACSERA). Rats were housed individually in cages under controlled conditions. They were maintained on a basal diet prepared according to Reeves *et al.* (1993) for one week as adaptation period. All diets and water were provided ad-libitum. Rats were injected intraperitoneally with a freshly prepared solution of Alloxan monohydrate in saline (300m M NaCl) at a dose of 120 mg/ kg of bodyweight after overnight fasting for 12 h according to Al-Shamaony *et al.* (1994) and Ndiaye *et al.* (2008). Alloxan was obtained from El-Gomhuryia Company for Chemical industries, Cairo, Egypt. All diagnostic kits were purchased from Gamma Trade for Scientific Services and Consultation, Giza, Egypt.

Since Alloxan injection can provoke fatal hypoglycemia as a result of reactive massive release of pancreatic insulin, rats were kept for the next 24 h on a 5% glucose solution as beverage to prevent severe hypoglycemia (Gupta *et al.*, 1989). Fasting blood samples were collected from the retrorbital sinus in anesthetized rats using a micro hematocrit tube and blood glucose levels were measured to investigate the induction of diabetes. Rats displaying blood glucose level of 250 mg/dl were defined as diabetics and were chosen for the experiment (Kulkarni *et al.*, 2002; El-demerdash *et al.*, 2005 and Ragavan and Krishnakumari 2006).

Experimental Design:

The experimental animals were divided into five groups (six rats per group): (1) normal control group fed basal diet, (2) Alloxan induced diabetic positive control group (DM) fed basal diet, (3) DM rats fed basal diet 40% oat (DM-oat), (4) DM rats fed basal diet 40% barley (DM-barley) and (5) DM rats fed basal diet 20% oat + 20% barley (DM-oat + barley) for 6 weeks. Oat, barley and their mixture were added to basal diet as replacement of corn starch.

Measurement of Body Weight and Food Intake:

Body weight gain and food intake were measured and the Feed Efficiency Ratio (FER) was calculated:

FER= body weight gain (g)/ dietary intake (g).

Biochemical Analysis:

Animals were lightly anesthetized with diethyl ether after 12 hours of fasting at the end of the experimental period and blood was collected from the retrorbital sinus. Blood samples were centrifuged and sera were obtained. Blood glucose was estimated by commercially available glucose kit based on glucose oxidase method according to Trinder (1969). The method of Allain *et al.* (1974) was used for the determination of serum total cholesterol (TC), where High Density Lipoprotein cholesterol (HDL) was determined according to the method of Burstein *et al.* (1970) and the Low Density Lipoprotein cholesterol (LDL) was determined according to Friedwald *et al.* (1972).

Rheological properties of breads' dough:

For measurement of dough's rheological properties, dough prepared from wheat100% (Control bread) and breads containing: wheat 60% + oat 40% (WO 40%); wheat 60% + barley 40% (WB 40%), and the mixture of wheat 60% + oat 20% + barley 20% (WOB 20+20%), were subjected to Brabender Farinograph and Extensograph tests according to the methods of AACC (2000). The Farinograph properties included: water absorption, arrival time, mixing time, dough stability and softening of wheat flour dough and its blends with oat, barley and their mixture. These properties were determined using a Farinograph type (PL), Germany. 300 grams of tested samples were used. The Extensograph tests were carried out to measure dough resistance, energy and extensibility according to AACC (2000).

Bread baking:

Bread loaf was prepared according to the standard formula (Long, 1991). The ingredients were mixed in a dough mixer for 5 minutes (70 rpm). The resultant dough was punched and then fermented for 2 hours at 30-32°C and relative humidity of 85%. The dough was molded, and then fermented for about 10 minutes. Breads were baked at 245-295°C.

Sensory evaluation:

Control wheat bread and tested breads containing wheat 60% + oat 40% (WO); wheat 60% + barley 40% (WB), and mixture of wheat 60% + oat 20% + barley 20% (WOB) were subjected to orgranoleptic evaluation. Panelists (12 members) were asked to rank various samples for color, taste, aroma, texture and overall quality on a scale of zero to 10 according to the method mentioned by Kraumer and Twig (1960).

Statistical Analysis:

The results were expressed as (mean± SE) values. The statistical significance of mean differences between groups was tested by one way analysis of variance (ANOVA). The differences between means were tested for significance using least significant difference (LSD) test at $P \leq 0.05$ and $P \leq 0.01$. All the data analysis was performed using SPSS software (Version 16; SPSS Inc Chicago, USA).

Results and Discussion:

The chemical composition of wheat, barley and oat flour used in this investigation are shown in Table (2). It is quite clear that, moisture content was higher in wheat flour and barley flour, they have the percentage (11.77% and 10.32% respectively), whereas, protein percentage was higher in wheat flour (12.64%) as compared with its content in oat flour (11.76%) and barley flour (11.41%). On the other hand, fat and ash contents were higher in oat flour (6.50 and 2.69% respectively) compared with wheat flour (1.03% and 0.47% respectively) and barley flour (3.12% and 2.61% respectively). Fiber content in barley flour represented the highest value (6.25%) as compared with its content in oat flour (6.03%) and wheat flour (0.76%). Chemical analysis for the raw materials indicated that carbohydrate content was the highest in wheat flour (73.32%) followed by barley flour (68.54%) and oat flour (63.60%).

Table (2): Chemical composition of wheat, oat and barley flour (Mean ± SD).

	Moisture %	Protein %	Fat %	Ash %	Fiber %	Carbohydrate %	β-Glucan %
Wheat flour	11.77± 0.68	12.64± 1.05	1.03± 0.02	0.47± 0.08	0.76± 0.32	73.32± 1.72	0.51± 0.12
Oat flour	9.42± 1.49	11.76± 1.15	6.50± 0.50	2.69± 1.33	6.03± 1.66	63.60± 4.16	3.05± 0.45
Barley flour	10.32± 2.57	11.41± 0.52	3.12± 0.55	2.61± 0.18	6.25± 0.37	68.54± 1.32	3.65± 0.51

With respect to the chemical composition of cereal flour, notable differences exist between cereals and even between species and varieties within each cereal. These differences strongly affect the quality of products (Souci *et al.*, 2008 and Belitz *et al.*, 2009). Among cereals, oats are unique for their high lipid contents. Oat protein is uniquely different from other cereals, as the major protein fraction in oats is the salt-soluble globulin, which is probably the primary reason for the better nutritive value of oats (McMullen, 2000).Barley is now gaining renewed interest as a functional food ingredient because it is considered as a rich source of β-glucan (Brennan and Cleary, 2005; Soares *et al.*, 2007).

Table (3): Mean daily Food intake, body weight gain and FER, blood glucose, serum cholesterol, serum HDL and serum LDL of control and Positive control diabetic rats groups (Mean ± S.E.).

	Control	Positive Control (DM)
Food intake gm/day	13.02± 0.44	11.07± 0.49 **

Body weight gain gm/day	3.60± 0.36	3.03± 0.13
FER	0.28± 0.03	0.27± 0.01
Blood Glucose mg/dl	101.17± 1.30	281.25± 0.77 **
Serum Cholesterol mg/dl	91.69± 0.94	117.62± 0.77 **
Serum HDL mg/dl	45.00± 1.24	30.25± 0.55 **
Serum LDL mg/dl	37.40± 0.39	69.03± 0.29 **

* Significantly differed from positive control at ($P \leq 0.05$).

** Significantly differed from control group at ($P \leq 0.01$).

Data in Table (3) illustrated that, Alloxan induced diabetic rats in positive control group (DM) showed significant ($P \leq 0.01$) increments in blood glucose, serum total cholesterol and LDL, and significant ($P \leq 0.01$) reduction in the level of serum HDL.

The data in Table (4) showed that, the body weight gain for groups of rats fed on 40% oat, barley or mixture of oat and barley were lower than that of positive control group, and in addition FER values showed the same trend. These effects of oat and barley could be caused by water soluble mixed-linkage β-glucan and its viscosity, and the fact that oat β-glucan has a capacity to form highly viscous solutions (Morgan, 2000; Wood, 2004). Oat fiber prolongs satiety after meals and alleviates constipation. In the stomach and small intestine, it is mediated by a viscosity effect that retards the transport of enzymes to their substrates; increased viscosity also retards the transport of nutrients to the absorbing sites and to the unstirred layer on the absorbing surface. In the large bowel, oat fiber acts as a substrate for fermentation enhancing the formation of butyric acid which is believed to enhance the growth of normal colonic cells but decrease the growth of carcinogenic cells (Mälkki and Virtanen, 2001). Recently Zhou *et al.* (2014) stated that, a potential mechanism for β- glucan inhibition of food intake and weight gain is through its gel-forming effect, which may delay gastric emptying and reduce or delay the digestion/ absorption of macronutrients (Marciani *et al.*, 2001).

Table (4): Mean daily Food intake, body weight gain and FER of hyperglycemic rats fed on oat, barley and mixture of oat and barley (Mean ± S.E.).

	Positive Control (DM)	DM-Oat	DM-Barley	DM- Oat+ Barley
Food intake gm/day	11.07± 0.49	13.68± 0.17**	11.75± 0.57	12.10± 0.25
Body weight gain gm/day	3.03± 0.33	2.62± 0.38	2.15± 0.33**	2.87± 0.35
FER	0.27± 0.02	0.19± 0.03**	0.18 ± 0.01**	0.24± 0.01

* Significantly differed from positive control group at ($P \leq 0.05$).

** Significantly differed from positive control group at ($P \leq 0.01$).

Concerning the effect of oat and barley on blood glucose and serum cholesterol profile, data in Table (5) illustrated that, all rats groups fed on oat, barley and their mixture showed highly significant ($P \leq 0.01$) decrease in blood glucose level when compared with the positive control group. Serum cholesterol and LDL levels were significantly ($P \leq 0.01$) decreased in groups fed on oat, barley and their mixture in comparison with positive control values, on the other hand serum HDL level increased significantly ($P \leq 0.01$) in experimental groups when compared to the value of positive control. These results were matching with that of Liljeberg *et al.* (1996) who fed test meals containing common barley or high-fiber barley as bread, glucose and insulin responses after bread made with either 50% common barley/50% high-fiber barley flour or a 20/80 ratio of flours were both significantly lower than the control white bread.

The results of present study were in agreement with Behall *et al.* (2004) who demonstrated that, oat and barley consumption reduces glucose and insulin responses. The higher soluble fiber content resulted in a smoother response curve, lower peak values. The beneficial reductions in glucose and insulin can result if sufficient soluble fiber is consumed; they suggested that increasing the total oat and/or barley content of the diet might lower the risk for type 2 diabetes. The differences noted in glycemic responses between the two grains could be accounted for the difference in ß-glucan content, in fact, a dose response for soluble fiber for lowering glucose and insulin postprandially has been reported, in addition McMullen (2000) concluded that, the most important beneficial effects of ß-glucan are their contribution to a lowering of serum cholesterol and as well moderating blood glucose in diabetics.

Table (5): Mean blood glucose, serum cholesterol, serum HDL and serum LDL of hyperglycemic rats fed on oat, barley and mixture of oat and barley (Mean± S.E.).

	Positive Control (DM)	DM-Oat	DM-Barley	DM- Oat+ Barley
Blood Glucose mg/dl	281.25± 0.77	236.58±1.21 **	217.33±1.14 **	225.50± 1.56**
Serum Cholesterol mg/dl	117.62± 0.77	104.97±1.08 **	96.75± 0.72**	102.19± 0.53**
Serum HDL mg/dl	30.25± 0.55	42.88±1.17 **	39.22± 0.49 **	40.37± 0.66**
Serum LDL mg/dl	69.03± 0.29	48.33±0.46 **	43.15± 0.29 **	46.98± 0.30**

* Significantly differed from positive control group at ($P \leq 0.05$).

** Significantly differed from positive control group at ($P \leq 0.01$).

Evidences suggest that dietary fiber from whole grains may be responsible for some of the beneficial health effects. β-glucan, a soluble fiber found in oats and barley, has been shown to reduce glycemia (Tosh, 2013) and cholesterolemia (Othman *et al.*, 2011). It was illustrated that, in mice, whole grain oat improved insulin sensitivity and plasma cholesterol profile and the effects were associated with the changes in cecal microbiota composition (Zhou *et al.*, 2014).

Different physiological effects of β -glucan in isolated form or as a constituent of oat and barley products are related to its viscosity: attenuation of postprandial plasma glucose and insulin responses, high transport of bile acids towards lower parts of the intestinal tract and high excretion of bile acids or lowering of serum cholesterol levels (Butt *et al.*, 2008).

In the present study, the serum cholesterol, HDL and LDL responses to feeding of oat, barley and their mixture were in line with the findings of Arshadi *et al.* (2014) and Abo Taleb *et al.* (2015) who stated that, barley and oat extract simultaneously cause reduction of blood fats and cholesterol. Furthermore, barley and oat extracts reduce concentration of LDL and glucose, and increase concentration of HDL, and the barley extract has more useful effect than oat extract in reduction of blood lipid parameters. Johansson (2006) demonstrated that, oat and barley β-glucans are plant polysaccharides resistant to digestion and absorption in the small intestine, and they attenuate both blood glucose and cholesterol. The reduction of cholesterol by oat and/or barley may be due to the fact that, oat bran increased fecal cholesterol and bile acid excretion and increased production of short-chain fatty acids, on the other hand, barley may decreased cholesterol by the inhibition of the rate-limiting enzymes for cholesterol and bile acid synthesis (Kahlon, 2001). High viscosity retards the mixing of luminal contents which may slow down the transport of digestive enzymes to their substrates, impair the emulsification of lipids, and retard the transportation of nutrients to the absorbing (Mälkki and Virtanen, 2001).

The cholesterol-lowering effects of oats have been attributed to the β-glucan fractions in humans (Othman *et al.*, 2011) and animals (Delaney et al., 2003; Immerstrand *et al.*, 2010 and Bae *et al.*, 2010). Several mechanisms have been proposed for the hypocholesterolemic effect of β -glucan including increasing viscosity of intestinal contents and reduced absorption of dietary cholesterol and reabsorption of bile acids (Lund *et al.*, 1989); increasing binding of luminal bile acids by β- glucan thereby decreasing enterohepatic circulation of bile acids with subsequent increased hepatic uptake of circulating cholesterol for bile acids synthesis; or reducing hepatic cholesterol synthesis secondary to improved insulin sensitivity (Bell *et al.*, 1999); and inhibiting hepatic cholesterol synthesis by acetate (Karlsson *et al.*, 2013) and propionate (Zhang *et al.*, 2012) produced by colonic bacteria fermentation of soluble fibers.

Table (6): The effect of mixing flour (wheat 60%+ oat 40%), (wheat 60%+ barley 40%) and (wheat 60%+ oat 20%+ barley 20%) on rheological properties of the dough by Farinograph analysis.

	Water Absorption %	Arrival Time (Min)	Dough Development (Min)	Stability Time (Min)	Softening Degree (B.U.)
Wheat 100% (Control)	55.9	1.0	1.5	2.5	60
Wheat 60%+ Oat 40%	70.6	4.0	5.0	11.0	30
Wheat 60%+ Barley 40%	72.8	4.5	5.5	7.0	90
Wheat 60%+ Oat 20%+ Barley 20%	64.9	3.5	3.5	12.0	100

Quality of wheat flour is a key in making appropriate dough for a given end product. In the current study, qualities of dough prepared from different flour were assessed using Farinograph and Extensograph. From table (6) and figures (1 a, 1 b, 1 c and 1 d) it could be noticed that, replacement of wheat flour with 40% of oat or barley increase the water absorption from 55.9% in control sample to 70.6 and 72.8% in oat and barley dough respectively. This was in agreement with the reports of Goldstein *et al.* (2010) and Mins *et al.* (2012) who stated that, there were increases in water absorption for various fiber blended wheat flour dough. This could be explained in accord to Rieder *et al.* (2012) who illustrated that, the increase in water absorption is probably due to the high β-glucan content in the barley flour; β-glucan with its high water-binding capacity would minimize the amount of free water in dough. Therefore, higher amount of water is required to reach a fully developed gluten network in flour containing β-glucan.

Comparable result have been reported by Sudha *et al.* (2007) when studying the effect of adding fiber of different sources (wheat, rice, oat and barley) to wheat flour on the rheological properties of the dough, they found that, by increasing the bran level from 10% to 40% the highest increase in water absorption was recorded for barley bran 63.88 to 76.28

g % and wheat bran 63.52 to 69.85 g %. It is believed that fiber incorporated dough are recognized for their capacity to absorb noteworthy amount of water. The presence of a large number of hydroxyl groups allow more water interactions through hydrogen bonds which plays a major role in absorbing more water (Rosell *et al.*, 2001).

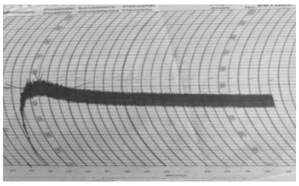
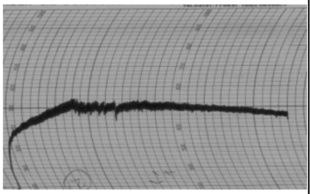
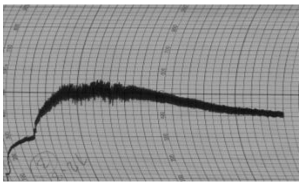
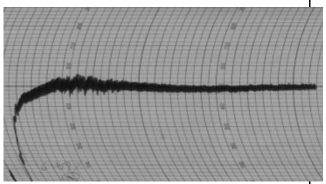
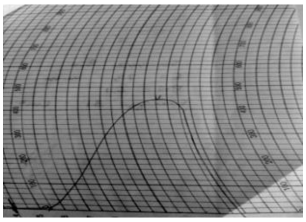
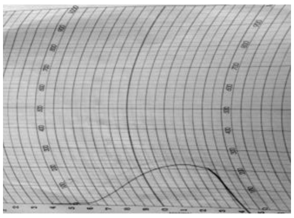
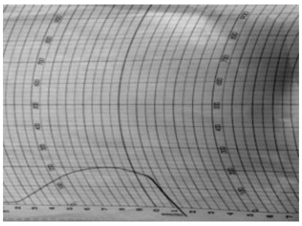
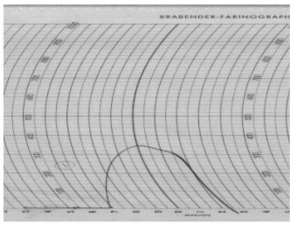
			
1 a: Wheat 100% (Control)	1 b: Wheat 60%+ oat 40%	1 c: Wheat 60%+ barley 40%	1 d: Wheat 60% + oat 20%+ barley 20%
			
1 e: Wheat 100% (Control)	1 f: Wheat 60% + oat 40%	1 g: Wheat 60%+ barley 40%	1 h: Wheat 60% + oat 20%+ barley 20%

Fig. (1): Farinograph and Extensograph tests for dough of wheat 60%+ oat 40%, wheat 60%+ barley 40% and wheat 60%+ oat 20%+ barley 20%.

The data in Table (7) and figures (1 e, 1 f, 1 g and 1 h) showed the Extensograph results for different dough prepared from wheat or its mixture with oat and barley flour, the results illustrated that dough resistance and dough extensibility decreased as a consequence of adding either oat or barley flour, probably due to the effects of gluten dilution, water retention and higher levels of fat (Salehifar and Shahedi, 2007). In the study of Hoseney (1994), as the oat level in the flour increased, the time needed for the preparation of good dough was also increased, due to a weaker formation of gluten matrix. Since pentosans and ß-glucan benefit from high water binding capacities, their presence in the oat flour caused slightly higher water absorption capacities, for dough made of oat as part of the formula in comparison with control. Oat flour had pronounced effects on dough rheological properties.

Table (7): The effect of mixing flour (wheat 60%+ oat 40%), (wheat 60%+ barley 40%) and (wheat 60%+ oat 20%+ barley 20%) on rheological properties of the dough by Extensograph analysis.

	Elasticity (Brabender Unit)	Extensibility (mm)	Proportion Number (R/E)	Energy (Cm^2)
Wheat 100% (Control)	442	86	6.10	31
Wheat 60%+ Oat 40%	220	80	2.75	30
Wheat 60%+ Barley 40%	200	100	2.00	28
Wheat 60%+ Oat 20%+ Barley20%	350	55	6.60	32

It caould be noticed from Figure (2) that wheat flour bread had higher acceptance score in color, taste, aroma, texture and overall quality, followed by mixture wheat 60%+oat 20% +barley 20%, wheat 60% +oat 40% and wheat 60% +barley 40%. Sensory evaluation results indicated a low score of oat and barley breads and this could be due to the dark color of bread and the presence of little bitter taste when the percentage of oat and barley increased (Salehifar and Shahedi, 2007). However, among tested mixtures the wheat 60%, oat 20% and barley 20% mixture was the highest in overall quality score, which indicated good acceptability by panelists.

.

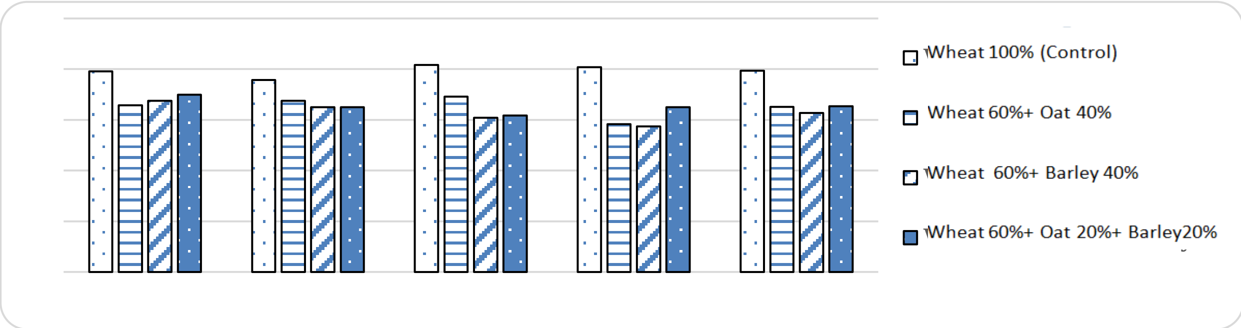


Figure (2): The effect of mixing flour (wheat 60%+ oat 40%), (wheat 60%+ barley 40%) and (wheat 60%+ oat 20%+ barley 20%) on sensory attributes of baked breads.

From the results of the present study, it could be concluded that incorporating of oat 20% and barley 20% in bread loaf flours' mixture, is recommended especially for people with diabetic mellitus and cardiovascular diseases to get the advantage of increasing daily intake of soluble fiber.

References:

AACC (2000): Approved Methods of the American Association of Cereal Chemists methods (32-23). 10th Ed. St. Paul, Minnesota, U.S.A.

AACC (1990): Approved Methods of Analysis of American Association of Cereal Chemists. St. Paul, Minnesota, U.S.A.

Abo Taleb, A.; Hossein K. J.; Farzad P.; Farzaneh F.; Nazanin S.J.; Rahmanian E. and Farzam M. (2015): Investigating on protective effects of barley and oat seeds extracts on pathological changes of blood factors in female rats fed with high-fat diet. Biomed. & Pharm. J. 8(1): 269-275.

Allain, C.C.; Poon, L.S.; Chan, C.S.G.; Richmond W. and Fu, P.C. (1974): Enzymatic determination of total serum cholesterol. Clin. Chem. 20: 470-475.

Al-Shamaony, L.; Al-Khazraji, S.M. and Twaiji, H.A. (1994): Hypoglycemic effect of artemisia herba alba. II. Effect of a Valuable Extract on Some Blood Parameters in Diabetic Animals. J. Ethno pharmacol. 43: 167.

Arshadi, A.; Talebi, E.; Tahery, E. and Kargar, J. H. (2014): Effect of barley and oats on high-density lipoprotein cholesterol and triglycerides in rats. Pars J of Med Sci. 12 (2): 29-35

Bae I.Y.; Kim, S.M.; Lee, S. and Lee H.G. (2010): Effect of enzymatic hydrolysis on cholesterol-lowering activity of oat beta-glucan. N. Biotechnol. 27: 85–8.

Behall, K.M.; Scholfield, D.J. and Hallfrisch, J. (2004): Diets containing barley significantly reduce lipids in mildly hypercholesterolemic men and women. Am. J. Clin. Nutr., 80:1185–93.

Belitz, H.D.; Grosch, W. and Schieberle, P. (2009): Cereals and cereal products. In: Belitz H-D, Grosch W, Schieberle P (eds) Food chemistry, 4th ed. Springer, Berlin: 670–675.

Bell, S.; Goldman, V.M.; Bistrian, B.; Arnold, A.; Ostroff, G. and Forse, R.A. (1999): Effect of beta-glucan from oats and yeast on serum lipids. Crit Rev Food Sci Nutr. 39:189–202.

Brennan, C. S. and Cleary, L. J. (2005): The potential use of cereal (1-3) (1-4)-b-D-glucans as functional food ingredients. J. Cereal Sci. 42: 1-13.

Burstein, M.; Scholnick H.R. and Morfin, R. (1970): Rapid method for isolation of lipoprotein from human serum by precipitation with polyanions, J. Lipid. Res. 11:583-595.

Butt, M.S.; Nadeem, T.M.; Khan, M. K. and Shabir, R. (2008): Oat: unique among the cereals. Eur. J. Nut. 47: 68–79.

Chen, J. and Seviour, R. (2007): Medicinal importance of fungal beta-(1–>3), (1–>6)-glucans. Mycol Res. 111:635–52.

Delaney. B.; Nicolosi, R.J.; Wilson, T.A.; Carlson, T.; Frazer, S.; Zheng, G.H.; Hess, R.; Ostergren, K.; Haworth. J. and Knutson, N. (2003): Beta-glucan fractions from barley and oats are similarly antiatherogenic in hypercholesterolemic Syrian golden hamsters. J Nutr. 133: 468–75.

El-demerdash, F.M.; Yousef, M.I. and Abou El-Naga, N.I. (2005): Biochemical study on the hypoglycemic effects of onion and garlic in alloxan induced diabetic rats. Food Chem Toxi. 43: 57-63.

FDA (2006): Food and Drug Administration: Food labeling ‘Health Claims: Soluble dietary fiber from certain foods and coronary heart disease’. In Code of Federal Regulation Title 21 Part 101.

Friedewald, W.T.; Levy, R.I. and Fredrickson, D.S. (1972): Estimation of the concentration of Low-Density Lipoprotein Cholesterol in plasma, Without Use of the Preparative Ultracentrifuge. Clin. Chem. 18, (6): 499-502.

Frost, D. J.; Adhikari K. and Lewis D. S. (2011): Effect of barley flour on the physical and sensory characteristics of chocolate chip cookies. J .Food Sci .Tech. 48(5):569–57.

Goldstein, A.; Ashrafi L. and Seetharaman, K. (2010): Effects of cellulosic fiber on physical and rheological properties of starch, gluten and wheat flour. Int. J. Food Sci. Tech. 45, 1641-46.

Gupta, M.P.; Solis, N.G.; Esposito, M. and Sanchez, S. (1989): Hypoglycemic activity of neurolaena lobata (L), R. Bri J. Ethno pharma, 10: 323.

Hoseney, R.C. (1994): Principles of cereal science and technology. 2nd Edition, Am. Assoc. of Cereal Chemists, Inc., St. Paul, PP.170.

Immerstrand, T.; Andersson, K.E.; Wange, C.; Rascon, A.; Hellstrand, P.; Nyman, M.; Cui, S.W.; Bergenstahl, B.; Tragardh, C. and Oste R. (2010): Effects of oat bran, processed to different molecular weights of beta-glucan, on plasma lipids and caecal formation of SCFA in mice. Br. J. Nutr. 104: 364–73.

Johansson, L. (2006): Structural analyses of (1→3),(1→4)-β-D-glucan of oats and barley (dissertation). EKT series 1354. University of Helsinki, Department of Applied Chemistry and Microbiology.

Kahlon, T.S. (2001): Cholesterol-lowering properties of cereal fibers and fractions. In: Advanced Dietary Fiber Technology. McCleary BV, Prosky L (eds.) Blackwell Sci, Oxford, p. 206-220.

Karlsson, F.; Tremaroli, V.; Nielsen, J. and Backhed, F. (2013): Assessing the human gut microbiota in metabolic diseases. Diabetes. 62:3341–9.

Keenan, J. M.; Goulson, M.; Shamliyan, T.; Knutson, N.; Kolberg, L. and Curry, L. (2007): The effects of concentrated barley b-glucan on blood lipids and other CVD risk factors in a population of hypercholesterolemic men and women. Br. J. Nutr. 97: 1162-1168.

Kraumer, A. M. and Twig, B. A. (1960): Fundamentals of quality control for the food industry, AVI Publishing Co, Westport, CN: 120.

Kulkarni, J.S.; Metha, A.A.; Santani, D.D. and Goyal, R.K. (2002): Effects of chronic treatment with cromakalim and glibenclamide in alloxan induced diabetic rats, pharmacol. Res. 46: 101-105.

Lefevre, M. and Jonnalagadda, S. (2012): Effect of whole grains on markers of subclinical inflammation. Nutr. Rev. 70: 387–96.

Liljeberg, H.G.M.; Granfeldt, Y. E. and Bjorck, I.M.E. (1996): Products based on a high fiber barley genotype, but not on common barley or oats, lower postprandial glucose and insulin responses in healthy humans. J. Nutr. 126:458–466.

Long, K.A.(1991): Acceptance of bread with partial replacement of wheat bread flour by potato products in selected regions of the USSR and U,S.A., doctoral dissertation, Virginia tech, black sbury, V.A.

Lund, E.K.; Gee, J.M.; Brown, J.C.; Wood, P.J. and Johnson, I.T. (1989): Effect of oat gum on the physical properties of the gastrointestinal contents and on the uptake of D-galactose and cholesterol by rat small intestine in vitro. Br. J. Nutr. 62: 91–101.

Mälkki, Y. and Virtanen, E. (2001): Gastrointestinal effects of oat bran and oat gum. A review. Lebensm-Wiss u Technol. 34: 337-347

Marciani, L.; Gowland, P.A.; Spiller, R.C.; Mano,j P.; Moore, R.J.; Young, P. and Fillery, T.A.J. (2001): Effect of meal viscosity and nutrients on satiety, intragastric dilution, and emptying assessed by MRI. Am J Physiol Gastro Liver Physiol. 280: 1227–33.

McIntosh, M.; Stone, B.A. and Stanisich, V.A. (2005): Curdlan and other bacterial (1–3)-beta-D-glucans. Appl Microbiol Biotechnol, 68:163–73.

McMullen, M.S. (2000): Oats. In: "Handbook of cereal science and technology". Marcel Dekker, Inc., Routledge, New York. PP: 127.

Michniewicz, J.; Kołodziejczyk, P. and Obuchowski, W.R. (2003): beta-glucan enzymatic hydrolysis in cereal grains and cereal products. J. Polish. Agri. Univ. (V) 6: Issue 1.

Mins, A.; Grundas, S.; Dziki D. and Laskowski, J. (2012): Use of farinograph measurements for predicting extensograph traits of bread dough enriched with carob fiber and oat whole meal. J. Food Engi.108: 1-12

Morgan, K. (2000): Cereal β-glucans. In: Handbook of Hydrocolloids. Phillips G.O. and Williams P.A. (eds.). Woodhead Publishing Limited, Cambridge p. 287-307.

Ndiaye, A.M.; Diatta, W.S.Y.; Dièye A.N.; Faye A.M. and Bassène, B. (2008): Antidiabetic propertieso of aqueous barks extract of parinari excelsa in alloxan-induced diabetic rats. Fitoterapia., 79: 267-270.

Othman, R.A.; Moghadasian, M.H. and Jones, P.J. (2011): Cholesterol-lowering effects of oat beta-glucan. Nutr. Rev. 69: 299–309.

Pins, J. J. and Kaur, H. (2006): A review of the effects of barley b-glucan on cardiovascular and diabetic risk. Cereal Foods W.51: 8-11.

Poppitt, S. D. (2007): Soluble fiber oat and barley ß-glucan enriched products: can we predict cholesterol-lowering effects. Bri. J. Nutr. 97: 1049–1050.

Ragavan, B. and Krishnakumari, S. (2006): Antidiabetic effect of T. Arjunabark extract in alloxan induced diabetic rats. Indian J. Clin. Biochem. 21: 123-128.

Reeves, P.G.; Forrest, H.N. and Fahey, G.C. (1993): AIN-93 Purified diets for laboratory rodents: Final Report of the American Institute of Nutrition Ad Hoc Writing Committee on the Reformulation of the AIN of 76A Rodent Diet, J. Nut. 123: 1939-1951.

Rieder A.; Holtekjølen A.K.; Sahlstrøm S. and Moldestad A. (2012): Effect of barley and oat flour types and sourdough on dough rheology and bread quality of composite wheat bread. J. Cereal. Sci 55:44–52.

Rosell, C.M.; Rojas, J.A. and Benedito, D.B.C. (2001): Influence of hydrocolloids on dough rheology and bread quality. F.Hydrocolloids, 15, 75-81.

Salehifar M. and Shahedi, M. (2007): Effects of Oat Flour on Dough Rheology, Texture and Organoleptic Properties of Taftoon Bread.J. Agric. Sci. Techno. (V) 9: 227-234.

Shehata, G.A.B. and Mohamed, M.E. (2015): Some Economic Aspects of Wheat Crop in Egypt with Emphasis on Baladi Bread Manufacturing in Alexandria Governorate. Int. J. Social Science and Humanity. 5 (6)501-508.

Slavin, J. (2010): Whole grains and digestive health. Cereal Chem. 87: 292-296.

Soares, R.M.D.; DeFrancisco, A.; Rayas, D.P. and Soldi, V. (2007): Brazilian hull–less and malting barley genotypes: I. Chemical composition and partial characterization. J. Food Qual. 30: 357–371.

Souci, S.W.; Fachmann, W. and Kraut, H. (2008): In: Deutsche forschungsanstalt für lebensmittelchemie (ed) Food composition and nutrition tables. Deutsche Forschungsanstalt für Lebensmittelchemie. Med Pharm. Scientific Publishers, Stuttgart.

Sudha, M.L.; Vetrimani, R. and Leelavathi, K. (2007): The Influence of fiber from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. Food Chem. 100: 1365-70.

Tosh, S.M. (2013): Review of human studies investigating the post-prandial blood-glucose lowering ability of oat and barley food products. Eur. J. Clin. Nutr. 67: 310–7.

Trinder, P. (1969): Determination of blood glucose using an oxidase peroxidase system with a non carcinogenic chromogen. J. Clin. Patho. 22: 158.

Wood, P.G. (2010): Review: Oat and Rye β-Glucan: Properties and Function .Cereal Chemistry. 87 (4): 315-330.

Wood, P.J. (2004): Relationships between solution properties of cereal β-glucans and physiological effects – a review. Trends Food Sci Technol. 15: 313-320.

Zhang, P.P; Hu, X.Z; Zhen, H.M.; Xu, C.; and Fan, M.T. (2012): Oat beta-glucan increased ATPases activity and energy charge in small intestine of rats. J Agric Food Chem. 60:9822–7.

Zhou, A. L.; Hergert, N.; Rompato, G., and Lefevre M. (2014): Whole Grain Oats Improve Insulin Sensitivity and Plasma Cholesterol Profile and Modify Gut Microbiota Composition in C57BL/6J Mice. J Nutr doi: 10. 3945/ jn. 114. 199778.

تأثير الشوفان والشعير على بعض المقاييس الحيوية في فئران التجارب المصابة بارتفاع مستوى جلوكوز الدم وأثرهما على خصائص العجائن والخبز

د. داليا رفعت حسن

قسم الاقتصاد المنزلي – كلية التربية النوعية– جامعة الفيوم– مصر

الملخص:

لاعتبارات الاثار الصحية للشوفان والشعير واهميتهما في الوقاية والتحكم باعراض امراض ارتفاع مستوى السكر بالدم وامراض القلب والاوعية الدموية, فان هذه الدراسة تهدف الى دراسة اثر اضافة الشوفان والشعير الى وجبات الفئران المصابة بارتفاع مستوى الجلوكوز بالدم واثرهما على مستوى الجلوكوز بالدم, مستوي الكوليستيرول الكلي, الشحوم البروتينية عالية الكثافة (HDL) والشحوم البروتينية منخفضة الكثافة (LDL)، بالاضافة الى دراسة اثر اضافة الشوفان والشعير إلى خليط دقيق القمح على خصائص العجائن الناتجة وكذلك تقييم الخصائص الحسية للخبز الناتج من مخاليط دقيق القمح, الشوفان والشعير المختلفة. تم استخدام ثلاثون فارا من نوع سبارجو وتقسيمهم الي خمس مجموعات (٦ فئران بكل مجموعة) كما يلي: (١) المجموعة الضابطة وتغذت على الوجبة الضابطة، (٢) المجموعة الضابطة الايجابية (مصابة بارتفاع مستوى جلوكوز الدم) وتغذت على الوجبة الضابطة(DM)، (٣) مجموعة الفئران المصابة بارتفاع مستوى جلوكوز الدم وتغذت على وجبات بها ٤٠% شوفان (DM–oat)، (٤) مجموعة الفئران المصابة بارتفاع مستوى جلوكوز الدم والتي تغذت على وجبات بها ٤٠% شعير (DM–barley) و(٥)مجموعة الفئران المصابة بارتفاع مستوى جلوكوز الدم والتي تغذت على وجبات بها ٢٠% شوفان + ٢٠% شعير (DM–oat+ barley) لمدة ٦ اسابيع. وتم قياس كل من : الزيادة في وزن الجسم وحساب معدل كفاءة الغذاء. وبعد مرور ٦ اسابيع وانتهاء فترة التجربة تم سحب عينات الدم من الفئران وتقدير مستويات كل من: جلوكوز الدم، الكوليستيرول الكلي، الشحوم البروتينية عالية الكثافة (HDL) والشحوم البروتينية منخفضة الكثافة (LDL). وكذلك تم تقدير خصائص العجائن الناتجة من استخدام مخاليط دقيق القمح, الشوفان والشعير وتقييم الخصائص الحسية للخبز المنتج من استخدام المخاليط السابقة. اظهرت نتائج الدراسة حدوث انخفاض معنوي في وزن الفئران التي تغذت على كل من الوجبات المحتوية على ٤٠% شوفان

او ٤٠% شعير او خليط الشوفان والشعير. بالاضافة الى ان تلك المجموعات اظهرت انخفاضا معنويا في نسبة الجلوكوز بالدم عند مقارنتها بنتائج المجموعة الضابطة الايجابية، كما انخفض معنويا مستويات كلا من الكوليستيرول الكلي والشحوم البروتينية منخفضة الكثافة في المجموعات التي تغذت على الشوفان ٤٠% والشعير ٤٠% وخليط الشوفان ٢٠%والشعير٢٠%، بينما ارتفعت معنويا قيم الشحوم البروتينية عالية الكثافة لتلك المجموعات عند مقارنتها بنتائج المجموعة الضابطة الايجابية. واظهرت نتائج تقييم خصائص العجائن ان استبدال ٤٠ % من القمح بكلا من الشوفان او الشعير ادى الي ارتفاع نسبة امتصاص الماء وارتفاع مقاومة العجائن للفرد مع انخفاض في تمدد العجائن. واظهر نتائج التقييم الحسي للخبز الناتج ان خبز القمح هو الاعلى في التقبل بالنسبة الى اللون والطعم والرائحة والملمس والجودة الكلية ويليه الخبز المصنوع من خليط (القمح٦٠% + الشوفان ٢٠% + الشعير ٢٠%).