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Abstract:

The aim of this study was to investigate the effect of replacing wheat (72% extract) with psyllium husk at three levels (5, 10 and 15%) in bread production on rheology properties, sensory characteristics, baking quality and chemical composition in comparison with 100% wheat flour bread. Also the effect of rats fed on bread containing psyllium husk on blood glucose and lipid profile against diabetes induced by streptozotocin were studied. Thirty male albino rats of *Sprague Dawley* strain were divided into two main groups, the first group (A) (n= 5 rats) was fed on the basal diet only as a negative control group (–ve) normal rats. The rats of the second main group (n= 25 rats) were intraperitoneally injected with STZ at dose (30 mg/kg body weight) 2 times to induce diabetes and fed on basal diet (BD), then diabetic rats divided into 5 sub-groups (B, C, D, E, F) (5 rats in each group), group (B) the positive control group (+ve) was fed on the basal diet and four other groups (C, D, E, F) were fed on basal diet plus bread blended with (0, 5, 10, 15%) psyllium husk, respectively for six weeks, the prepared bread was added at 40% from the basal diet. Results revealed that the addition of psyllium husk to toast bread caused a significant decrease ($p<0.05$) in body weight gain, blood glucose level, total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL-c) and very low density lipoprotein (VLDL-c). Meanwhile these additives caused a significant increase ($p<0.05$) in high density lipoprotein (HDL-c) values in serum of all diabetic rat groups compared with the positive control group (+ve) without psyllium husk bread. In addition, the bread quality characteristics were acceptable by the sensory panel. Hence, psyllium husk is good for use as fiber enriching agent in bread production.

Key words: Psyllium husk, Bread, Diabetes, Streptozotocin, Lipids and Rats.

Introduction:

Psyllium (plantago ovata forst) a plant appears every year and found first in India (**Iqbal, 1993 and Dahr *et al*., 2005**). This plant was used a lot in traditional methods of medicine. The husk of Psyllium is mechanically removed from the seed (**Anderson *et al*., 1999**). This plant is famous for it`s ability in laxatio (**Marlett and Fischer, 2002 and Marlet *et al*., 2000)** also it's ability of reducing the serum total and LDL cholesterol concentration in hypercholesterolemic adults (**Olson *et al*., 1997 and Anderson *et al*., 1999**), besides it helps in issues related with glucose concentrations in postprandial all the day and post-lunch, also with diabetes of Type 2 (**Anderson *et al*., 1999**).

The husk fiber of psyllium is thik and those water-soluble fibers can be prepared by taking the husk out of blond psyllium seed (*Plantago Ovata*). Studies proved that psyllium has a good effect on glycemic and lipid control in patients of Type 2 diabets (**Pastors *et al*., 1991 and Gupta *et al*., 1994**).

Studies concentrated on soluble fibers like oats, psyllium, pectin and guar gum, and also other specialized studies proved the ability of these fibers in lowering total and LDL cholesterol (**Glore *et al*., 1994; Truswell, 1995; Pearson *et al*., 2003 and Forman and Bulwer, 2006**). It has been proved as well that those fibers can control the body weight through slowing the gastric off loading (**Delargy *et al*., 1997**).

Experiments made using animals and human proved that a gel formation fraction near to 55-60% of the psyllium husk is in charge of laxation and decreasing cholesterol rates **(Marlett, 1997; Marlett *et al*., 2000 and Marlett and Fisher, 2002)**. The husk of psyllium helps in being a life, and in the increment of stool output and adding a gel-like form to excreta (**Marlett *et al*., 2000**). Another benift of those fibers lays on lowering cholesterol rates and the danger of colon cancer (**Anderson, 1991**). Universaly, health organization advice with reduction of animal fats and protines, and maximizing taking grains which considered a substantial source of dietary fibers, although white bread is widly expened as a Type of bread.

So, the best way to rise to absorb fibers is to improve a kind of brad full of high fiber content. We can provide bread with dietary fiber like wheat bran **(Ranhotra *et al.*, 1990 and Sidhu *et al.*, 1999**), gums, like guar gum and modified celluloses and b-glucans (**Knuckles *et al.*, 1997**).

Studies of **Anderson *et al.* (1999); Anderson *et al.* (2000a) and Anderson *et al.* (2000b)** proved that the effect of psyllium in lowering plasma LDL-C, that psylllium was an important therapy for hypercholesterolemic men and women through lowering LDL-C by 7%. Also psyllium is safe and efficient with individuals with Type 2 diabets (**Horton *et al.*, 1994; Fernandez, 1995; Anderson *et al.*, 1999 and Anderson *et al.*, 2000,**).

In general, psyllium promotes physical properties of doughs, because of the structure during the kneading process which is looking like a film. This was distinguished in technological and nutritional quality of final bread **(Renzetti *et al.*, 2008 and Brites *et al.*, 2010)**. The husks of psyllium seed have the hightest level of the soluble fiber about 70%. This fiber is a polimer of arabinose, galactose, galacturonic acid, and rhamnose (**Nelson, 2001).**

The present study was carried out to evaluate chemical composition and functional properties of wheat flour and pasyllium husk. Also, rheological properties of four different dough formula with pasyllium husk herbs. Also, the effect of feeding on the bread with pasyllium husk in the scope of their investigation on Hyperglycemia rats.

Materials and Methods:

Materials:

Pasyllium husk:

(*Plantago ovata*) was obtained from Agriculture Research Center, Giza, Egypt.

Bread materials:

Wheat (72% extract), compressed yeast, sugar, bakery shortening and salt (NaCl) were obtained from the local market in Mansoura, Egypt. Potassium bromate (odorless white powder), was purchased from El-Gomhoria Company for chemical and drugs, Cairo, Egypt.

Animals:

Thirty male albino rats of *Sprague Dawley* strain, weighting (135±5*g*) were purchased from the animal house of Agriculture Research Center, Giza, Egypt.

Streptozotocin (STZ):

Was purchased from El-Gomhoria Company for chemical and drugs, Cairo, Egypt.

Methods:

Preparation of bread:

Straight dough was used according to the AACC method (**Anonymous, 1990**) was followed as shown in Table A.

Table (A): The formula preparation and backing methods for control bread.

Content of the used formula for control		Preparation of dough and baking	
Ingredients	**Quantity (*g*)**		
Flour	100	Mixing	Optimum time (3 min)
Compressed yeast	3.0	Fermentation	75 min
Sugar	2.5	Remixing	25 sec
Bakery shortening	4.0	Recovery	20 min
Salt (NaCl)	1.5	Proofing (at 86°F, RH 75%)	55 min
Potassium bromate	10 *ppm*	Baking	25 min at 450°F
Water	Optimum (*ml*)		

Experimental:

The study was carried out by supplementing wheat flour (72%xtraction) with psyllium husk at 5, 10 and 15% on flour weight basis for bread production.

Chemical analysis:

Moisture, protein, fat, crude fibers and ash contents were determined according to the methods of **A.O.A.C. (1995).** Carbohydrate was calculated by the following equation according to **Chatffeld and Adams (1940)**:

Carbohydrates = 100–(% moisture + % protein + % fat + % ash+ % crude fibers).

Functional properties:

Oil absorption and hydration capacity:

The oil absorption and hydration capacity of samples were determined by the method of **Rosario and Flores (1981)**.

Gelation:

The gelation of samples was determined by the method of **Iyen and Singh (1997)**.

Rheological properties of dough:

Rheological properties of the different produced doughs were carried out with Farinograph and Extensograph tests according to **A.A.C.C (2000**) methods**.** Samples were tested by brabender Farinograph model no. 178507 for determining water absorption, arrival time, dough development time, dough stability, mixing tolerance index and degree of weakening. Extensibility (E), resistance to extension (R), proportional number (R/E) and dough energy were determined by the Brabender Extensograph apparatus model no. 7724584.

Sensory evaluation:

Sensory evaluation of bread were carried out by fifty person to determine their sensory characteristics according to **Moor (1970)** which expressed as (10) excellent, (9) very good, (8) good, (7) medium, (6) fair, (5) poor, (4) very poor, (3) extremely poor.

Baking quality:

The loaves were packed in polyethylene bags and analyzed for height, volume weight and specific volume according to the method of **(Penfield and Campbell, 1990).**

Preparation of basal diet:

The basal diet was prepared according to **Reeves *et al.* (1993)**. Basal diet consists of 14% casein, 10% sucrose, 5% corn oil, 0.25% choline chloride and 1% vitamin mixture according to (**Campbell, 1963**). Salt mixture 3.5% according to **Hegested *et al.* (1941)**, 5% fibers and the remainer was corn starch up to 100%.

Induction of diabetes:

Rats were rendered diabetic by injection of twice intraperitoneal (i.p.) with STZ (30 *mg/kg* body weight). The difference between first and second injection was three days. Twice injection of STZ acted to induce a gradual destruction of β-cell of islets of *langerhans* leading to high l evels of blood glucose in rats (**Zhang *et al.*, 2008**). Diabetic groups with blood glucose level higher than 200 ml/dl were considered diabetic (**Mona and El-Yamani, 2011**).

Design of the experiment:

Thirty male albino rats of *Sprague Dawley* strain weighting (135±5*g*) were kept in stainless steel cages under hygienic conditions for one week on basal diet for adaptation. Rats were divided into two main groups, the first group (A) (n= 5 rats) was fed on the basal diet only as a negative control group (–ve) normal rats. The rats of the second main group (n= 25 rats) were intraperitoneally injected with STZ at dose (30 *mg/kg* body weight) 2 times to induce diabetes and fed on basal diet (BD), then diabetic rats divided into 5 sub-groups (B, C, D, E, F) (5 rats in each group), group (B) the positive control group (+ve) was fed on the basal diet and four other groups (C, D, E, F) were fed on basal diet plus bread blended with (0, 5, 10, 15%) psyllium husk, respectively for six weeks, the prepared bread was added at 40% from the basal diet.

*Group of rats were divided as follows:

Group (A): Negative control group (–ve), fed on the basal diet only.

Group (B): Positive control (+ve), diabetic rats were fed on BD without any treatment

Group (C): Diabetic rats were fed on BD + 100% wheat flour bread (control).

Group (D): Diabetic rats were fed on BD + wheat flour bread blended with 5% psyllium husk.

Group (E): Diabetic rats were fed on BD + wheat flour bread blended with 10% psyllium husk.

Group (F): Diabetic rats were fed on BD + wheat flour bread blended with 15% psyllium husk.

Body weight (BW) was recorded weekly and feed intake was measured daily during the experimental periods. At the end of the experiment, biological evaluation of the tested diets was carried out by determining total feed intake, body weight gain (BWG) and feed efficiency ratio (FER) according to **Chapman *et al.* (1959)**. At the end of the experiment of period (6 weeks), blood samples were taken from internal canthus near the lachrymal glands in the eyes of rats with heparinized capillary tubes and kept in heparinized test tubes then centrifuged to separate plasma that was used in the estimation of blood glucose and other biochemical parameters according to **Wayne (1998).**

Biochemical analysis:

Blood glucose was determined according to **Wayne (1998).**

Liver enzymes:

Serum alanine and aspartate aminotransferases (ALT and AST) were assayed by **Henry (1974) and Yound (1975).**

Serum lipids profile:

Total cholesterol, triglycerides, low density lipoproteins, high density lipoprotein and very low density lipoproteins were carried out according to the method of **Rashel nad Janine (1993) and Wamick (2000).**

Statistical analyses:

The treatment means were compared using the least significant difference test (LSD) at 5% level of probability as outline by **Waller and Duncan (1969).**

Results and Discussion:

Chemical composition of ingredients used in the study:

Chemical composition of wheat flour (WF) and psyllium husk (PH) is given in Table (1). These materials regarding chemical composition were evaluated for moisture, protein, ash, fat, crude fiber and carbohydrates. Data show that psyllium husk is higher in ash, fibers and carbohydrates, compared with WF as recorded 2.30 ± 0.57, 8.10 ± 0.28 and 78.02 ± 0.2%, respectively. On the other hand wheat flour was higher in moisture, fat and protein in comparing with PH as recorded 12.80 ± 0.01, 1.58 ± 0.04 and 9.50 ± 0.01%, respectively. The largest part of psyllium husk consisted of carbohydrates (70.7%), while ash and protein contents accounted for only 3.4% and 7.1%, respectively. The sum of non-cellulosic carbohydrate, galacturonic acid, protein and ash accounted for over 85% of the total dry matter (**Craeyveld *et al.*, 2009**).

Table (1): Chemical composition of the ingredients used at this experiment.

Samples	Wheat flour	Psyllium husk
Moisture%	12.80±0.01	11.00±0.01
Protein%	9.50±0.01	0.42±0.13
Ash%	0.69±0.02	2.30±0.57
Fat%	1.58±0.04	0.16±0.17
crude fiber%	4.32±0.02	8.10±0.28
Carbohydrates%	71.11±0.05	78.02±0.2

*Each value is the mean ± SE

Functional properties of ingredients used at this experiment:

Data concerning functional properties hydration capacity, oil absorption and least gelation concentration of wheat flour and psyllium husk as raw materials were recorded in Table 2. Hydration capacity and oil absorption of PH were observed more as recorded 3.00 and 1.00 ml g^{-1}, respectively whereas least gelation concentration of PH was found as same as wheat flour value (8.0 ml g-1).

Table (2): Functional properties of the ingredients used at this experiment:

Samples	Wheat flour	Psyllium husk
Hydration capacity (ml g)$^{-1}$	1.60	3.00
Oil absorption (ml g)$^{-1}$	0.90	1.00
Least gelation concentration (*W/V*)	8.00	8.00

Rheological properties of wheat flour dough:

Farinograph and Extensograph parameters of four different dough formulas (wheat flour and wheat flour with 5, 10 and 15% psyllium husk) were represented in Tables (3 and 4). These dough formulas regarding

Farinograph were evaluated for water absorption, arrival time, dough development time, dough stability and mixing tolerance. It could be noticed from the results that the supplementation of wheat flour with psyllium husk at 5, 10 and 15% caused an increasing in all of Farinograph scores as compared to the wheat flour formula (control). Data show that water absorption, arrival time, dough development time and dough stability increased by increasing the PH level in formulas whereas, the increasing of PH level in wheat formulas caused decreasing in mixing tolerance and dough weaking.

Extensograph parameters such as extensibility, resistance to extension, proportional number and dough energy were measured in dough formulas (wheat flour & wheat flour with 5, 10 and 15% PH) as show in Table 4. From the data we could be observed that the addition of PH to wheat caused gradually increasing in resistance to extension, proportional number and dough energy. Whereas extensibility decreased gradually by increasing PH percentage addition in dough formulas as recorded 115, 105, 95 and 75 *mm* for the control, 5, 10 and 15% PH, respectively. When doughs faces a lack in gluten, this lead to a poor abilities of gas expansion and rentention during leavening process which lead to bread with low volume and low softness (**Gallagher *et al.*, 2004 and Mariotti *et al.*, 2009**).

Cappa *et al.* (2013) found that there is a low standard of conforming is to be found in good doughs during leavening process especially, when the ingredients with high water content are added to the recipes. Fibers may play a positive effect on the quality of bread staling like (crumb, softness and springiness) by raising absorption of water of dough (**Chen, Rubenthaler *et al.*, 1988 and Wang *et al.*, 2002**).

Table (3): Farinograph parameters of wheat flour dough.

Samples	Water absorption (%)	Arrival time (*min*)	Dough development time (*min*)	Dough stability (*min*)	Mixing tolerance index (*BU*)	Dough weakening (*BU*)
Control (WB)	61	1.5	2.5	6	20	60
5% PHB	90	3	4	12	80	120
10% PHB	120	5	7	22	70	110
15% PHB	150	10	12	26	60	100

Table (4): Extensograph parameters of wheat flour dough.

Samples	Extensibility (E) (*mm*)	Resistance to extension (R) (*BU*)	Proportional number (R/E)	Dough energy (cm^2)
Control (WB)	115	420	3.65	85
5% PHB	105	480	4.57	80
10% PHB	95	560	5.89	70
15% PHB	75	770	10.27	60

Effect of using different levels of psyllium husk on the sensory evaluation of bread:

Mean of sensory characteristics of toast bread blended with 5, 10 and 15% psyllium husk (PH) was shown in Table (5). Significant differences ($p<0.05$) were observed between the control and PH bread samples in taste, toast bread blended with 5% PH recorded the highest scores in taste (8.9 ± 0.13) and odor (8.42±0.08). Color scores decreased gradually by adding PH. Results show that texture affected by increasing PH percentage in toast bread in comparing with the control as recorded 8.76 ± 0.11, 8.58 ± 0.08, 8.12 ± 0.08 and 7.58 ± 0.08 for control, 5%, 10 and 15% PH bread, respectively. It could be noticed that overall acceptability scores decreased gradually by incensing PH percentage in bread as compared to wheat bread (control).

On the other hand, having a big amount of fibers in dough, needs a large amount of water to ensure the success of dough (**Mariottiet *et al.*, 2009**).

Water and flour are the most important ingredients in bread recipes, because they affect texture and crump, especially water has effective functions. It is important to solubilizing other contents, for hydrating proteins and carbohydrates, also for improving protein network (**Maache-Rezzoug *et al.*, 1998**). Water also play a vital role in changes related to starch happed during making bread (e.g. gelatininzation and retro gradation), and enhancing the quality and shelf-life of bread (e.g. in terms of bread softness and frailty of crust) (**Wagnar *et al.*, 2007**).

Table (5): Scores of sensory evaluation of bread blended with different levels of psyllium husk.

Samples	Parameters				
	Taste (10)	Odor (10)	Texture (10)	Color (10)	Overall acceptability (10)
Control (WB)	8.8±0.11^{ab}	8.30±0.10^{a}	8.76±0.11^{a}	9.16±0.11^{a}	9.18±0.13^{a}
5% PHB	8.9±0.13^{a}	8.42±0.08^{a}	8.58±0.08^{b}	8.84±0.08^{b}	8.76±0.23^{b}
10% PHB	8.7±0.08^{b}	7.98±0.08^{b}	8.12±0.08^{c}	8.16±0.11^{c}	8.28±0.14^{c}
15% PHB	8.2±0.08^{c}	7.70±0.10^{c}	7.58±0.08^{d}	8.58±0.27^{b}	7.74±0.13^{d}

*WB: Wheat bread *PHB: Psyllium husk bread

*Each value is the mean ± SE.

*a, b and c means in the same row with different superscripts are different significantly ($P< 0.05$).

Effect of using different levels of psyllium husk on the baking quality of bread:

Data concerning the backing quality, loaf height, loaf volume, loaf weight and specific volume of toast bread blended with (5, 10 and 15%) psyllium husk are represented in Table (6). Significant differences ($p<0.05$) were observed between the control and PH bread in all baking quality parameters. It could be noticed that loaf height, loaf volume and specific volume decreased gradually by increasing PH level in toast bread as compared to the control, meanwhile the addition of PH to wheat toast bread caused a significant decrease ($p<0.05$) in the loaf weight gradually by increasing its percentage in comparing with wheat toast bread as recorded 220.33 ± 0.57, 230.33±0.57, 237.67±1.52 and 245.33±0.57*g* for control & 5, 10 and 15% PH bread, respectively.

Hardenss and Young' Modulus estimated that a dough with high amount of water (i.e. lower dough consistency) is a need to preserve the piece more soft during its shelf-life (**Gallagher *et al.*, 2003 and Mariotti *et al.*, 2009**).

Cappa *et al.* (2013) illustrated that the highest rise and suitable volume after baking is due to the high stickiness of dough (DA500), because of the existence of 2.5% psyllium, that let the formation of the film-like structure essential to a fine technological quality of the final bread.Although, these amazing features of bread, (BA500) distinguished by the highest crumb solidity of the fresh product, because of low crumb moisture.

In spite of adding psyllium husk that resulted in weak effect on bread, the most obvious effect is the diminishing of loaf volume, the dark crumb appearance, the grow of crumb stability. Also, in some methods taste of bread is gained, as for example ،when adding guar gum (**Lai *et al.*, 1989 and Knuckles *et al.*, 1997**). Moreover, the eventual is fiber-rich dough have water obsorbation, became shorter and have lowered leavening possibilities (**Gan *et al.*, 1992; Park *et al.*, 1997 and Luarikainen *et al.*, 1998**).

Table (6): Physical characteristics (baking quality) of bread blended with different levels of psyllium husk.

Samples	**Parameters**			
	Loaf height (cm)	**Loaf volume $(cm)^3$**	**Loaf weight (g)**	**Specific volume $(cm)^3$**
Control (WB)	10.60±0.10[a]	1323.8±1.45[a]	220.33±0.57[d]	5.76±0.06[a]
5% PHB	9.26±0.25[b]	1235.70±0.10[b]	230.33±0.57[c]	4.92±0.02[b]
10% PHB	8.03±0.15[c]	1197.5±2.10[c]	237.67±1.52[b]	4.24±0.03[c]
15% PHB	7.16±0.11[d]	1121.7±0.10[d]	245.33±0.57[a]	3.84±0.02[d]

*WB: Wheat bread *PHB: Psyllium husk bread

*Each value is the mean ± SE.

*a, b and c means in the same row with different superscripts are different significantly (P< 0.05).

Chemical composition of bread blended with different levels of psyllium husk:

Table (7) represented the chemical composition of toast bread blended with (5, 10 and 15 %) psyllium husk (P.H). Moisture content was 31.31± 0.67, 30.90 ± 0.15, 28.29±1.09 % and 27.28±0.50 WB, 5%, 10% and 15% psyllium husk bread (P.H.B), respectively. No significant differences (p<0.5) were observed between samples in protein content; however there were a significant differences (p<0.5) between the control and P.H.B samples in ash contents (0.14±0.04, 0.24 ± 0.04, 0.30 ± 0.02 and 0.32 ± 0.02%) of control, 5%, 10 and 15% P.H.B, respectively and also fat contents (32.28 ± 0.45, 30.04±0.07, 29.26±1.43 and 28.06±0.66 %) of the same samples, respectively.

It could be noticed that moisture, protein, fat and energy contents decreased, whereas ash, crude fiber and carbohydrate contents increased gradually by increasing the psyllium husk level in toast bread as compared to those of wheat bread as a control sample.

Table (7): Chemical composition of bread blended with different levels of psyllium husk.

Group of rats	Parameters						
	Moisture %	Protein %	Ash %	Fat %	Total fiber %	Carbohydrates %	Energy (*kcal*)
Control (WB)	31.31± 0.67^a	8.48± 0.41^a	0.14± 0.04^b	32.28± 0.45^a	0.15± 0.01^c	27.62± 0.37^d	434.97± 3.79
5% PHB	30.90± 0.15^a	8.40± 0.27^a	0.24± 0.04^a	30.04± 0.07^b	0.34± 0.04^b	29.93± 0.36^c	423.68± 1.18
10% PHB	28.29± 1.09^b	8.23± 0.12^a	0.30± 0.02^a	29.26± 1.43^b	0.45± 0.04^a	33.45± 0.46^b	430.10± 11.31
15% PHB	27.28± 0.50^b	8.07± 0.13^a	0.32± 0.02^a	28.06± 0.66^b	0.54± 0.03^a	35.71± 1.23^a	427.70± 1.56

*WB: Wheat bread *PHB: Psyllium husk bread

*Each value is the mean ± SE.

*a, b and c means in the same row with different superscripts are different significantly (P< 0.05).

Body weight gain of STZ diabetic rats fed on bread blended with psyllium husk:

The data in Table (8) showed that untreated diabetic rats (+ ve control group) had significant increase (p<0.05) with the feed intake (FI), body weight gain (BWG) and feed efficiency ratio (FER) when compared with the negative control rats. It could be observed that the addition of PH to wheat toast bread decreased significantly (p<0.05) BWG, FER and FI in STZ diabetic rats as compared with those of the positive control group (+ve) and 100% wheat bread rats group after feeding on psyllium husk toast bread for 6 weeks. Reduction in FI, BWG and FER levels in STZ diabetic rats were noticed obviously in rats group as increasing of psyllium husk level in toast bread during the experimental period for six weeks.

After the unexpected change to diet enriched with fiber, resulted in a great range in groups making diet with *plantago ovato* husks, weight of body was similar to that of diet free of fiber control (**Leng-Pesch, 1991**).

It has been revealed that, contentious feeding of 3.5% *plantago ovata* husk supplemented diet accompanied by reduction in body gain weigh, reduction in hyperinsulinemia and dyslipidemia, also recuperation of concentration of plasma, and reduction of TNF-circulation concentration **(Galisteo *et al.*, 2005).**

The characteristics of *plantago ovata* husks similarly help in the reduction of weight gain. Psyllium, in humans helps in the retarding of emptying stomach, through raising meal stickiness that enhance reduction of fat and sugar absorption (**Washington *et al.*, 1998)**. Diet with fiber-supplement decreased that biochemical marker in Op rats, which is equivalent to the effect of reducing food in this group (**Ott *et al.*, 2002 and Tsubone *et al.*, 2005**). The loss of weight gain persuaded by Ovata husks was attached with lowering liver heptomegaly in Op rats (**Daubioul *et al.*, 2002 and Nagao *et al.*, 2005**).

Table (8): Body weight gain of STZ diabetic rats fed on bread blended with psyllium husk

Group of rats	Parameters		
	FI (g/day)	BWG (g/day)	FER
-ve Control	25.48±0.90^{a}	2.66±0.17^{b}	0.104±0.005^{ab}
+ve Control	27.08±2.61^{a}	2.89±0.06^{a}	0.107±0.013^{ab}
Control (WB)	26.13±1.99^{a}	2.83±0.06^{ab}	0.108±0.006^{a}
5% PHB	22.11±0.99^{b}	2.36±0.16^{c}	0.106±0.008^{ab}
10% PHB	18.52±0.82^{c}	1.78±0.08^{d}	0.096±0.009^{ab}
15% PHB	15.21±0.77^{d}	1.38±0.08^{e}	0.090±0.008^{b}

*WB: Wheat bread *PHB: Psyllium husk bread * Each value is the mean ± SE.

*a, b and c means in the same row with different superscripts are different significantly (P< 0.05).

Blood glucose and liver function of STZ diabetic rats fed on bread blended with psyllium husk:

Blood glucose level and liver function in the investigated groups was shown in Table (9). The level of blood glucose decreased significantly (p<0.5) in the groups which were fed on toast bread blended with psyllium husk, gradually for 6 weeks in comparison with those of untreated STZ diabetic rats (+ve control group).

Feeding of STZ diabetic rats for 6 weeks on toast bread blended with 15% PH caused significant decrease (p<0.5) in the blood glucose (116.82±1.09 mg/dl) as compared to the positive control (212.82±2.39 mg/dl) and the wheat bread rat group (208.94±1.96 mg/dl). Data show also that untreated STZ diabetic rats (+ve group) had significant increase (p<0.05) in the serum levels of liver enzymes, AST and ALT when compared to negative control rats (-ve control). Feeding STZ diabetic rats on bread blended with psyllium husk lowered significantly (p<0.05) serum levels of AST and alt enzymes compared to the positive control group and 100% wheat toast bread rats group gradually by the increasing of PH level in bread, AST and ALT recorded 65.18±0.95 and 63.17±1.65 U/L, respectively for rats group fed on blended with 15% PH bread.

Our information asserts the distinguished effect of using those high dose of fibers for along time could develop parameters which are responsible for insulin-resistance, the pathogentic basis of metabolic Type 2 diabetes (**Grundy *et al.*, 2004**). The mechanisms of psyllium hypocholesterolmic that formerly were shown to lower absorption of cholesterol or preventing circulation of bile acids, because of psyllium physicochemical properties that has the ability to raise stickiness of meal (**Everson *et al.*, 1992**).

The alleviation in the quality total serum and LDL cholesterol, found in this study were comparable to alleviation found on studies of non-diabetic persons (**Anderson *et al.*, 1999**). It has been obvious that psyllium has the ability to lower post prandiall serum glucose and insulin rates in non diabetic persons (**Anderson *et al.*, 1995**). Great studies on none diabetic persons proved that psyllium essentially reduce concentrations of both total and LDL cholesterol (**Bell *et al.*, 1989 and Anderson *et al.*, 1991**). Psyllium in previous studies has shown to lower fasting serum glucose concentrations to lower postprandial serum glucose concentrations (30) in individuals with Type 2 diabet (**Pastors *et al.*, 1991; Wolever *et al.*, 1991**). Psyllium is a gummy material that mends glycemic and lipid control in persons with Type 2 diabets and hypercholoesterolmic (**Anderson *et al.*, 1999**). In human and animal studies psyllium has hypolipidemec effects (**Obata *et al.*, 1998; Anderson *et al.*, 2000 and Romero *et al.*, 2002**).

Table (9): Blood glucose and liver function of STZ diabetic rats fed on bread blended with psyllium husk.

Group of rats	Parameters		
	Blood glucose (mg/dl)	**AST (U/L)**	**ALT (U/L)**
-ve Control	111.66±1.25f	57.08±2.11e	54.73±1.61e
+ve Control	212.82±2.39a	155.03±1.78a	133.18±1.67a
Control (WB)	208.94±1.96b	157.16±1.10a	134.34±1.22a
5% PHB	175.56±1.58c	124.92±1.34b	112.47±1.58b
10% PHB	141.00±1.45d	94.23±1.65c	85.11±0.97c
15% PHB	116.82±1.09e	65.18±0.95d	63.17±1.65d

*WB: Wheat bread *PHB: Psyllium husk bread
*Each value is the mean ± SE.

*a, b and c means in the same row with different superscripts are different significantly (P< 0.05).

Lipid profile of STZ diabetic rats fed on bread blended with psyllium husk:

As demonstrated in Table (10), untreated STZ diabetic rats (+ve control) had a significant increase (p<0.05) in the serum levels of total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL-c) and atherogenic index (AI) while, there was a significant decrease in the serum level of (HDL-c) when compared to those fed on basal diet only (-ve control). Feeding on toast bread blended with 5, 10 and 15% PH to STZ diabetic rats for 6weeks decreased significantly (p<0.05) the elevated serum level of TC, TG, LDL-c whereas, increased serum level of HDL-c and improved atherogenic index gradually by increasing PH level in bread in comparing with those of control positive rats group (+ve control) and 100% wheat toast bread.

Bell *et al.* (1989) discovered an important net lowering in total and LDL cholesterol concentration of 4.8% and 8.2% after psyllium and placebo supplementation **(Anderson, 1999; Sprecher *et al.*, 1993 and Bell *et al.*, 1989)**. It is noticeably that Type 2 diabets suffers augmentations in the dangers of atherosclerosis and its complications **(Diabetes Care, 1996)**. The essential goal of diabetes management is keeping normal serum concentrations that mainly lower death and disability over world wide.

Romero *et al.* (2002) have reported that having psyllium resulted in a reduction 25% LDL-C) with low cholesterol diet) or 53% reduction in LDL (with high cholesterol diet),approaching with control guinea pigs (**Fernandez, 1995 and Fernandez *et al.*, 1995).** This brings that psyllium may lower the etherification of cholesterol ester in HDL and the ulterior devolve to VLDL and LDL, which is rated to be atherogenic operation **(Barter, 2000)**.

Table (10): Lipid profile of STZ diabetic rats fed on bread blended with psyllium husk

Samples	Parameters					
	TC *(mg/dl)*	**TG** *(mg/dl)*	**LDL** *(mg/dl)*	**HDL** *(mg/dl)*	**VLDL-$_C$** *(mg/dl)*	**AI** *(LDL/HDL)*
-ve Control	86.30± 2.34[e]	46.71± 1.21[d]	25.04± 1.08[f]	56.08± 1.80[a]	5.17± 0.65[d]	0.44± 0.02[e]
+ve Control	196.34± 3.75[a]	134.55± 1.51[a]	141.65± 2.92[a]	26.34± 1.20[e]	28.34± 1.44[b]	5.38± 0.24[a]
Control (WB)	198.40± 2.89[a]	136.49± 1.84[a]	135.39± 2.23[b]	28.12± 0.57[e]	34.88± 2.36[a]	4.81± 0.03[b]
5% PHB	149.78± 2.30[b]	97.20± 1.32[b]	74.79± 1.37[c]	40.99± 1.35[d]	33.98± 1.76[a]	1.82± 0.06[c]
10% PHB	112.07± 2.54[c]	72.06± 1.25[c]	52.52± 2.54[d]	45.76± 0.79[c]	13.79± 1.83[c]	1.14± 0.07[d]
15% PHB	94.36± 1.41[d]	47.66± 1.80[d]	32.37± 2.06[e]	51.76± 1.15[b]	10.22± 3.24[c]	0.62± 0.04[e]

*WB: Wheat bread *PHB: Psyllium husk bread

*Each value is the mean ± SE.

*a, b and c means in the same row with different superscripts are different significantly (P< 0.05).

Conclusion:

From the overall results, our findings confirm the beneficial effects of soluble fiber blended with psyllium husk herb in bread production in increasing protective capacity against deleterious effects of hyperglycemia and its have potential affects for both consumer appeal and imparting health benefits.

References:

1. **A.A.C.C. (2000):** Approved methods of the AACC (10th ed.).St Paul, MN: American Association of Cereal Chemists (Methods 08-01, 30-25, 44-15A, 46-10, 54-10, 54-21).
2. **Anderson, J.W. (1991):** Lipid responses of hypercholesterolemic men to oat-bran and wheat-bran intake. American Journal of Clinical Nutrition, 54, 678–683.
3. **Anderson, J.W.; Allgood, L.D.; Jan Turner, J.; Peter, R.; Oeltgen, P.R.; Bruce, P. and Daggy, B.P. (1999):** Effects of psyllium on glucose and serum lipid responses in men with type 2 diabetes and hypercholesterolemia1–3. *Am J Clin Nutr*., 70:466–73.
4. **Anderson, J.W.; Allgood, L.D.; Lawrence, A.; Altringer, L.A.; Jerdack, G.R.; Hengehold, D.A. and Morel, J.G. (2000a):** Cholesterol-lowering effects of psyllium intake adjunctive to diet therapy in men and women with hypercholesterolemia: meta-analysis of 8 controlled trials. *Am. J. Clin. Nutr*., 71: 472–479.
5. **Anderson, J.W.; Davidson, M.H.; Blonde, L.; Brown, W.V.; Howard, W.J.; Ginsberg, H.; Allgood, L.D. and Weingand, K.W. (2000b):** Long-term cholesterol-lowering effects of psyllium as an adjunct to diet therapy in the treatment of hypercholesterolemia. *Am. J. Clin. Nutr.*, 71: 1433–1438.
6. **Anderson, J.W.; Floore, T.L.; Geil, P.B.; Spencer O'Neal, D. and Balm, T.K. (1991):** Hypocholesterolemic effects of different bulk-forming hydrophilic fibers as adjuncts to dietary therapy in mild to moderate hypercholesterolemia. *Arch Intern Med*., 151:1597–602.
7. **Anderson, J.W.; O'Neal, D.S.; Riddell-Mason, S.; Floore, T.L.; Dillon, D.W. and Oeltgen, P.R. (1995):** Postprandial serum glucose, insulin, and lipoprotein responses to high- and low-fiber diets. *Metabolism*., 44: 848–54.
8. **Anonymous (1990):** Approved Methods. American Association of Cereal Chemists, St. Paul, Minnesota.
9. **A.O.A.C. (1995):** Official methods of analysis Association of Official Analytical Chemists. 15th Ed. Washington, D.C, U.S.A.

10. **Barter, P. (2000):** CETP and atherosclerosis. Arterioscler. *Thromb. Vasc. Biol*., 20: 2029–2031.

11. **Beck, B.; Max, J.P.; Fernette, B. and Richy, S. (2004):** Adaptation of ghrelin levels to limit body weight gain in the obese Zucker rat. Biochm. *Biophys. Res. Commun*., 318: 846–851.

12. **Bell, L.P.; Hectorne, K.; Reynolds, H.; Balm, T.K. and Hunninghake, D.B. (1989):** Cholesterol-lowering effects of psyllium hydrophilic mucilloid. *JAMA*, 261:3419–23.

13. **Brites, C.; Trigo, M.J.; Santos, C.; Collar, C. and Rosell, C.M. (2010):** Maize-based gluten-free bread: Influence of processing parameters on sensory and instrumentalquality. *Food and Bioprocess Technology*, 3(5), 707–715.

14. **Brown, L.; Rosner, B.; Willen, W.W. and Sacks, F.M. (1999):** Cholesterollowering effects of dietary fiber: a meta analysis. Am. J. Clin. Nutr. 69: 30–42.

15. **Campbell, J.A. (1963):** "Methodology of protein evaluation". RAG Nut. *Document R 10, led. 37. June Meeting New York.*

16. **Cappa, C.; Lucisano, M. and Mariotti, M. (2013a):** Influence of Psyllium, sugar beet fibre and water on gluten-free doughproperties and bread quality. *Carbohydrate Polymers*, 98: 1657– 1666.

17. **Cappa, C.; Lucisano, M. and Mariotti, M. (2013b):** Rheological properties of gels obtainedfrom gluten-free raw materials during a short term ageing. *LWT-Food Science andTechnology*, 53, 464–472.

18. **Champan, D.G.; Gastilla, R. and Campbell, J.A. (1959):** Evaluation of protein efficiency ratio. *Can. J. Biochem. Physiol*., 37: 647-686.

19. **Chatffeld, C. and Adams, G. (1940):** Proximate composition of American Food. Materials, MDSA; Cir., 549.

20. **Chen, H.; Rubenthaler, G.L.; Leung, H.K. and Baranoski, J.D. (1988):** Chemical, physical,and baking properties of apple fiber compared with wheat and oat bran. *Cereal Chemistry*, 65(3), 244–247.

21. **Craeyveld, V.V.; Delcour, J.A. and Courtin, C.M. (2009):** Extractability and chemical and enzymic degradation of psyllium

(*Plantago ovata Forsk*) seed husk arabinoxylans. *Food Chemistry*, 112 (2009) 812–819

22. **Daubioul, C.; Rousseau, N.; Demeure, R.; Gallez, B.; Taper, H.; Declerck, B. and Delzenne, N. (2002):** Dietary fructans, but not cellulose, decrease triglyceride accumulation in the liver of obese Zucker *fa*/*fa* rats. *J. Nutr*. 132: 967–973.

23. **Delargy, H.J.; O'Sullivan, K.R.; Fletcher, R.J. and Blundell, J.E. (1997):** Effects of amount and type of dietary fiber (soluble and insoluble) on short-term control of appetite. *Int J Food Sci Nutr*., 48 (1): 67–77.

24. **Dhar, M.K.; Kaul, S.; Sareen, S. and Koul, A.K. (2005):** Plantago ovata: Genetic diversity, utilization and chemistry. *Plant Genetic Resources:Characterization and Utilization*, 3: 252–263.

25. **Diabetes Care (1996):** Detection and management of lipid disorders in diabetes (consensus statement);19 (suppl 1):S96–102.

26. **Everson, G.T.; Daggy, B.P.; McKinley, C. and Story, J. (1992):** Effects of psyllium hydrophilic mucilloid on LDL cholesterol and bile acid synthesis in hypercholesterolemic men. *J. Lipid Res.*, 33 : 1183–1192.

27. **Fernandez, M.L. (1995):** Distinct mechanisms of plasma LDL lowering by dietary soluble fiber. Specific effects of pectin, guar gum and psyllium. *J. Lipid Res.*, 36: 2394–2404.

28. **Fernandez, M.L.; Ruiz, L.R.; Conde, A.K.; Sun, D.M.; Erickson, S. and McNamara, D.J. (1995):** Psyllium reduces plasma LDL in guinea pigs by altering hepatic cholesterol metabolism. J. *Lipid Res*., 36: 1128–1138.

29. **Forman, D. and Bulwer, B.E. (2006):** Cardiovascular disease: Optimal approaches to risk factor modification of diet and lifestyle. *Curr Treat Options Cardiovasc Med.*; 8(1):47–57.

30. **Galisteo, M.; Sa´ nchez, M.; ´o Vera, R.; Gonza´ lez, M.; Anguera, A.; Duarte, J. and Zarzuelo, A. (2005):** A Diet Supplemented with Husks of *Plantago ovata* Reduces the Development of Endothelial Dysfunction, Hypertension, and Obesity by Affecting Adiponectin and TNF-_ in Obese Zucker Rats1**.** *J. Nutr*., 135: 2399–2404.

31. **Gallagher, E.; Kunkel, A.; Gormley, T.R. and Arendt, E.K. (2003):** The effect of dairy andrice powder addition on loaf and crumb characteristics, and on shelf life (inter-mediate and long term) of gluten-free breads stored in a modified atmosphere. *European Journal of Food Research*, 218, 44–48.

32. **Gallagher, E.; Gormley, T.R. and Arendt, E.K. (2004):** Recent advances in the for-mulation of gluten-free cereal-based products. Food Science and Technology, 15,143–152.

33. **Gan, Z.; Galliard, T.; Ellis, P.R.; Angold, R.E. and Vaughan, J.G. (1992):** Effect of the outer bran layers on the loaf volume of wheat bread. *Journal of Cereal Science*, 15, 151–163.

34. **Glore, S.R.; Van Treeck, D.; Knehans, A.W. and Guild M. (1994):** Soluble fiber and serum lipids: a literature review. *J Am Diet Assoc*., 94: 425–436.

35. **Grundy, S.M.; Hansen, B.; Smith, S.C.Jr; Cleeman, J.I. and Kahn, R.A. (2004):** Conference Participants. Clinical management of metabolic syndrome. Report of the American Heart Association/ National Heart, Lung, and Blood Institute/American Diabetes Association Conference on Scientific Issues Related to Management. *Circulation*, 109: 551–556.

36. **Gupta, R.R.; Argawal, C.G; Singh, G.P. and Ghatak, A. (1994):** Lipid-lowering efficacy of psyllium hydrophilic mucilloid in non insulin dependent diabetes mellitus with hypercholesterolemia. Indian J. Med. Res., 100:237–41.

37. **Hegested, D.; Mills, R. and Perkins, E. (1941):** "Salt mixture". *J. Biol. Chem*., 138: 459.

38. **Henry, R.J. (1974):** Clinical chemist: Principles and techniques, *2nd ed, Hagerstown (MD) Harper and Row*, 525-882.

39. **Horton, J.D.; Cuthbert, J.A. and Spady, D.K. (1994):** Regulation of hepatic 7_-hydroxylase expression by dietary psyllium in the hamster. *J. Clin. Investig*. 93: 2084–2092.

40. **Iqbal, M. (1993):** International trade in non-wood forest products: An overview. Food and Agriculture Organization of the United Nations. Rome.

41. **Iyen, L. and Singh, U. (1997):** Functional properties of wheat and chickpea composite flours. *Food Aust.*, 49: 1-7.

42. **Knuckles, B.E.; Hudson, C.A.; Chiu, M.M. and Sayre, R.N. (1997):** Effect of b-glucan barley fractions in high-fibre bread and pasta. *Cereal Foods World*, 42(2), 94–100.

43. **Lai, C.S.; Hoseney, R.C. and Davis, A.B. (1989):** Effects of wheat bran in breadmaking. Cereal Chemistry, 66: 217–219.

44. **Laurikainen, T.; Harkonen, H.; Autio, K. and Poutanen, K. (1998):** Effects of enzymes in fibre-enriched baking. *Journal of Science and Food Agriculture*, 76: 239–249.

45. **Leng-Pesch Low, E. (1991):** *Plantago ovata* seeds as dietary fibre supplement: physiological and metabolic effects in rats. *British Journal qf Nutrition, 66*, 331-349**.**

46. **Maache-Rezzoug, Z.; Bouvier, J.-M.; Allaf, K. and Patras, C. (1998):** Effect of principalingredients on rheological behaviour of biscuit dough and on quality of biscuits.Journal of Food Engineering, 35: 23–42.

47. **Mariotti, M.; Lucisano, M.; Pagani, M.A. and Ng, P.K.W. (2009):** The role of corn starch,amaranth flour, pea isolate, and Psyllium flour on the rheological propertiesand the ultrastracture of gluten-free doughs. *Food Research International*, 42: 963–975.

48. **Marlett, J.A. (1997):** Sites and Mechanisms for the Hypocholesterolemic Actions of Soluble Dietary Fiber Sources. In Dietary Fiber in Health and Disease; Plenum: New York, NY, pp 109– 121.

49. **Marlett, J.A.; Kajs, T.M. and Fischer, M.H. (2000):** An unfermented gel component of psyllium seed husk promotes laxation as a lubricant in humans. American Journal of Clinical Nutrition, 72(3): 784–789.

50. **Marlett, J.A. and Fischer, M.H. (2002):** A poorly fermented gel from psyllium seed husk increases excreta moisture and bile acid excretion in rats. *Journal of Nutrition*, 132 (9): 2638–2643.

51. **Mona, S.A. and El-Yamani (2011):** Cinnamon, cardamom and ginger impacts as evaluated on hyperglycemic rats. *J. Specific Education*, 18(20): 664-679.

52. **Moor, M.L. (1970):** Introducing Foods, Laboratory Manual of Food Preparation and Evaluation. 2nd Ed. MacMillan. pub. Co. Inc., New York, Coclier, London.

53. **Nagao, K.; Inoue, N.; Wang, Y.M.; Shirouchi, B. and Yanagita, T. (2005):** Dietary conjugated linoleic acid alleviates nonalcoholic fatty liver disease in Zucker (*fa*/*fa*) rats. *J. Nutr*. 135: 9–13.

54. **Nelson, A.L. (2001):** High Fiber Ingredients. *St. Paul, MN*: Egan Press.

55. **Obata, K.; Ikeda, K.; Yamasaki, M. and Yamori, Y. (1998):** Dietary fiber, psyllium, attenuates salt-accelerated hypertension in stroke-prone spontaneously hypertensive rats. *J. Hypertens.* 16: 1959–1964.

56. **Olson, B.H.; Anderson, S.M.; Becker, M.P.; Anderson, J.W.; Hunninghake, D.B. and Jenkins, D.J.A. (1997):** Psyllium-enriched cereals lower blood total cholesterol and LDL cholesterol, but not HDL cholesterol, in hypercholesterolemic adults: Results of a meta-analysis. Journal of Nutrition, 127(10), 1973–1980.

57. **Ott, V.; Fasshauer, M.; Dalski, A.; Meier, B.; Perwitz, N.; Klein, H.H.; Tshop, M. and Klein, J. (2002):** Direct peripheral effects of ghrelin include suppression of adiponectin expression. *Horm. Metab*. Res., 34: 640–645.

58. **Park, H.; Seib, P.A. and Chung, O.K. (1997):** Fortifying bread with a mixture of wheat fibre and Psyllium Husk fibre plus three antioxidants. *Cereal Chemistry*, 74, 207–211.

59. **Pastors, J.G.; Blaisdell, P.W.; Balm, T.K.; Asplin, C.M. and Pohl, S.L. (1991):** Psyllium fiber reduces rise in postprandial glucose and insulin concentrations in patients with non-insulin-dependent diabetes. Am J Clin Nutr., 53:1431–5.

60. **Pearson, T.A.; Bazzarre, T.L.; Daniels, S.R.; Fair, J.M.; Fortmann, S.P. and Franklin, B.A. (2003):** American Heart Association guide for improving cardiovascular health at the community level. *Circulation*; 107: 645–651.

61. **Penfield, M. and Campbell, A.M. (1990):** Experimental food science, *3rd ed. Academic press, inc. London*, 33-34.

62. **Ranhotra, G.Sl.; Gelroth, J.A.; Astroth, K. and Posner, E.S. (1990):** Distribution of total and soluble fiber in various millstreams of wheat. *Journal of Food Science*, 55(5), 1349–1351.

63. **Rashel, B.S. and Janine, D. (1993):** Microplate method for determination of serum cholesterol, high density, lipoprotein cholesterol, triglyceride and apolipoprotein. Lipids J., 28: 151-155.

64. **Reeves, P.G.; Nielson, F.H. and Fahmy, G.C. (1993):** Reportes of the American Institute of Nutrition, adhoc willing committee on reformulation of the AIN93. *Rodent Diet. J. Nutri.*, 123: 1939-1951.

65. **Renzetti, S.; Dal Bello, F. and Arendt, E.K. (2008):** Microstructure, fundamental rheo-logy and baking characteristics of batters and breads from different gluten-freeflours treated with a microbial transglutaminase. Journal of Cereal Science, 48(1),33–45.

66. **Romero, A.L.; West, K.L.; Tosca Zern, T. and Fernandez, M.L. (2002):** The Seeds from *Plantago ovata* Lower Plasma Lipids by Altering Hepatic and Bile Acid Metabolism in Guinea Pigs1. *J. Nutr.*, 132: 1194–1198.

67. **Rosario, D.R.R. and Flores, D.M. (1981):** Functional properties of flour types of milling bean flour. J. Food Sci. Agric., 32: 175-180.

68. **Sidhu, J.S.; Al-Hooti, S.N. and Al-Saqer, J.M. (1999):** Effect of adding wheat bran and germ fractions on the chemical composition of high-fiber toast bread. *Food Chemistry*, 67, 365–371.

69. **Sprecher, D.L.; Harris, B.V. and Goldberg, A.C. (1993):** Efficacy of psyllium in reducing serum cholesterol levels in hypercholesterolemic patients on high- or low-fat diets. Ann Intern Med, 199:545–54.

70. **Truswell, A.S. (1995):** Dietary fiber and plasma lipids. *Eur. J. Clin. Nutr.*, 49 (Suppl):S105–S109.

71. **Tsubone, T.; Masaki, T.; Katsuragi, I.; Tanaka, K.; Kakuma, T. and Yoshimatsu, H. (2005):** Ghrelin regulates adiposity in white adipose tissue and UCP1 mRNA expression in brown adipose tissue in mice. *Regul. Pept.*, 130: 97–103.

72. **Wagner, M.J.; Lucas, T.; Le Ray, D. and Trystram, G. (2007):** Water transport in breadduring baking. *Food Engineering*, 78 (4): 1167–1173.

73. **Waller, M.W. and Duncan, D.B. (1969).** A boys role for symmetric multiple composition problem. An state Assocr, 65: 1985 – 1003.

74. **Wamick, G.R. (2000):** Measurement of cholesterol and other lipoprotein constituents in the clinical laboratory. *Clin and Lab. Med*., 38: 287-300.

75. **Wang, J.; Rosell, C.M. and de Barber, C.B. (2002):** Effect of the addition of different fibreson wheat dough performance and bread quality. *Food Chemistry*, 79, 221–226.

76. **Washington, N.; Harris, M.; Mussellwhite, A. and Spiller, R.C. (1998):** Moderation of lactulose-induced diarrhea by psyllium: effects on motility and fermentation. *Am. J. Clin. Nutr*., 67: 317–321.

77. **Wayne, P.A. (1998):** Procedures for the collection of diagnostic blood specimens by venipuncture Approved Standard National Committee of clinical. *Laboratory standards 4 th ed., Document.*

78. **Wolever, T.M.; Vuksan, V. and Eshuis, H. (1991):** Effect of method of administration of psyllium on glycemic response and carbohydrate digestibility. *J Am Coll Nutr*., 10:364–71.

79. **Yound, D.S. (1975):** Determination of GOT. *Clin. Chem*., 22: 21-31.

80. **Zhang, M.; Lv, X.Y.; Li, J.; Xu, Z.G. and Chen, L. (2008):** The characterization of high fat diet and multiple low-dose streptozotocin induced type 2 diabetes rat model. *Experimental Diabetes Research*, 2: 1-9.

تأثير تغذية الفئران المصابة بارتفاع سكر الدم بالخبز المدعم بقشور عشبة الأسبغول

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الملخص :

نظراً لتأثير تناول الألياف على خفض معدل نسبة السكر في الدم، ولأن الاستهلاك الشائع من الألياف أقل من الموصى به، أدى الى تطوير المنتجات الغذائية في محتواها من الألياف. استهدفت الدراسه توضيح تأثير تدعيم دقيق القمح (استخلاص ٧٢%) بنسبة ٥ ، ١٠، ١٥% من مسحوق قشور عشبة الإسبغول في صناعة خبز التوست على كل من الخواص الريولوجيه للعجين والخواص الحسيه والفيزيقية والكيميائية على الخبز مقارنة بالخبز المصنع من دقيق القمح (١٠٠%) ككنترول. كما تمت دراسة أثر تغذية الفئران المصابه بالسكرى بواسطة مادة إستربتوسيتوسين على الخبز المدعم بقشور الإسبغول. أجريت التجربه على ثلاثون فأر من سلالة *Sprague Dawley* حيث قسمت إلى مجموعتين رئيسيتين، الأولى (خمس فئران) تم تغذيتها على الوجبه الأساسيه وسميت بالمجموعه الضابطه السالبة. أما المجموعه الثانيه فكان عددها ٢٥ فأر تمت إصابتها بمادة الإستربتوسيتوسين بجرعة ٣٠ ملجم/كجم من وزن الجسم على مرتين متتاليتين لإحداث الإصابه بمرض السكر، بعد ذلك تم تقسيم الفئران المصابه بمرض السكر إلى خمس مجموعات فرعية (خمس فئران بالمجموعة)، المجموعه الفرعيه الأولى تم تغذيتها على الوجبه الأساسيه وسميت بالمجموعه الضابطه الموجبة، أما باقي المجموعات الفرعيه تم تغذيتها على الوجبه الأساسيه المضاف إليها خبز التوست المحضر بإضافة (٠، ٥، ١٠، ١٥%) على التوالي من مسحوق قشور عشبة الإسبغول لمدة ست أسابيع.

وأوضحت نتائج البحث أن تدعيم خبز التوست بقشور الإسبغول أدت إلى خفض وزن الفئران وسكر الدم وكذلك نسبة الكوليستيرول والدهون الثلاثيه في الوقت نفسه أدت إلى ارتفاع مستوى الليبوبروتينات مرتفعة الكثافه في سيرم دم الفئران المصابه بالسكرى مقارنةً بالمجموعة الضابطه الموجبه ، بالإضافه إلى جودة الخواص الحسيه والفيزيقيه للخبز، وأوصت الدراسة بتناول عشبة الإسبغول كمصدر جيد للألياف في انتاج الخبز.