Effect of Feeding Psyllium Husk (Plantago Ovata) Herbs on Rats suffering from Hyperglycemia

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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 diabetes (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 benif 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 psyllium 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 diabetes (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 highest 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 psyllium husk. Also, rheological properties of four different dough formula with psyllium husk herbs. Also, the effect of feeding on the bread with psyllium husk in the scope of their investigation on Hyperglycemia rats.

Materials and Methods:

Materials:

Psyllium 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±5g) 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.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantity (g)</th>
<th>Preparation of dough and baking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour</td>
<td>100</td>
<td>Mixing Optimum time (3 min)</td>
</tr>
<tr>
<td>Compressed yeast</td>
<td>3.0</td>
<td>Fermentation 75 min</td>
</tr>
<tr>
<td>Sugar</td>
<td>2.5</td>
<td>Remixing 25 sec</td>
</tr>
<tr>
<td>Bakery shortening</td>
<td>4.0</td>
<td>Recovery 20 min</td>
</tr>
<tr>
<td>Salt (NaCl)</td>
<td>1.5</td>
<td>Proofing (at 86°F, RH 75%)</td>
</tr>
<tr>
<td>Potassium bromate</td>
<td>10 ppm</td>
<td>Baking 25 min at 450°F</td>
</tr>
<tr>
<td>Water</td>
<td>Optimum (ml)</td>
<td></td>
</tr>
</tbody>
</table>

Experimental:

The study was carried out by supplementing wheat flour (72% extraction) 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 remainder 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 levels 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±5g) 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.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Wheat flour</th>
<th>Psyllium husk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture%</td>
<td>12.80±0.01</td>
<td>11.00±0.01</td>
</tr>
<tr>
<td>Protein%</td>
<td>9.50±0.01</td>
<td>0.42±0.13</td>
</tr>
<tr>
<td>Ash%</td>
<td>0.69±0.02</td>
<td>2.30±0.57</td>
</tr>
<tr>
<td>Fat%</td>
<td>1.58±0.04</td>
<td>0.16±0.17</td>
</tr>
<tr>
<td>Crude fiber%</td>
<td>4.32±0.02</td>
<td>8.10±0.28</td>
</tr>
<tr>
<td>Carbohydrates%</td>
<td>71.11±0.05</td>
<td>78.02±0.2</td>
</tr>
</tbody>
</table>

*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:

<table>
<thead>
<tr>
<th>Samples</th>
<th>Wheat flour</th>
<th>Psyllium husk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydration capacity (ml g⁻¹)</td>
<td>1.60</td>
<td>3.00</td>
</tr>
<tr>
<td>Oil absorption (ml g⁻¹)</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>Least gelation concentration (W/V)</td>
<td>8.00</td>
<td>8.00</td>
</tr>
</tbody>
</table>

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 weakening.

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.

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

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

<table>
<thead>
<tr>
<th>Samples</th>
<th>Extensibility (E) (mm)</th>
<th>Resistance to extension (R) (BU)</th>
<th>Proportional number (R/E)</th>
<th>Dough energy (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (WB)</td>
<td>115</td>
<td>420</td>
<td>3.65</td>
<td>85</td>
</tr>
<tr>
<td>5% PHB</td>
<td>105</td>
<td>480</td>
<td>4.57</td>
<td>80</td>
</tr>
<tr>
<td>10% PHB</td>
<td>95</td>
<td>560</td>
<td>5.89</td>
<td>70</td>
</tr>
<tr>
<td>15% PHB</td>
<td>75</td>
<td>770</td>
<td>10.27</td>
<td>60</td>
</tr>
</tbody>
</table>

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. gelatininization 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.

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

*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±0.57g for control & 5, 10 and 15% PH bread, respectively.

Hardness and Young’s 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 sorption, 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.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Parameters</th>
<th>Loaf height (cm)</th>
<th>Loaf volume (cm³)</th>
<th>Loaf weight (g)</th>
<th>Specific volume (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (WB)</td>
<td></td>
<td>10.60±0.10⁶</td>
<td>1323.8±1.45⁶</td>
<td>220.33±0.57⁷</td>
<td>5.76±0.06⁸</td>
</tr>
<tr>
<td>5% PHB</td>
<td></td>
<td>9.26±0.25⁵</td>
<td>1235.70±0.10⁹</td>
<td>230.33±0.57⁸</td>
<td>4.92±0.02⁹</td>
</tr>
<tr>
<td>10% PHB</td>
<td></td>
<td>8.03±0.15⁴</td>
<td>1197.5±2.10⁴</td>
<td>237.67±1.52⁵</td>
<td>4.24±0.03⁴</td>
</tr>
<tr>
<td>15% PHB</td>
<td></td>
<td>7.16±0.11⁴</td>
<td>1121.7±0.10⁴</td>
<td>245.33±0.57⁶</td>
<td>3.84±0.02⁵</td>
</tr>
</tbody>
</table>

*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.

<table>
<thead>
<tr>
<th>Group of rats</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture</td>
</tr>
<tr>
<td>Control (WB)</td>
<td>31.31±</td>
</tr>
<tr>
<td></td>
<td>0.67a</td>
</tr>
<tr>
<td>5% PHB</td>
<td>30.90±</td>
</tr>
<tr>
<td></td>
<td>0.15a</td>
</tr>
<tr>
<td>10% PHB</td>
<td>28.29±</td>
</tr>
<tr>
<td></td>
<td>1.09b</td>
</tr>
<tr>
<td>15% PHB</td>
<td>27.28±</td>
</tr>
<tr>
<td></td>
<td>0.50b</td>
</tr>
</tbody>
</table>
**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 ovata* 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

<table>
<thead>
<tr>
<th>Group of rats</th>
<th>Parameters</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FI (g/day)</td>
<td>BWG (g/day)</td>
<td>FER</td>
</tr>
<tr>
<td>-ve Control</td>
<td>25.48±0.90&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.66±0.17&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.104±0.005&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>+ve Control</td>
<td>27.08±2.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.89±0.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.107±0.013&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control (WB)</td>
<td>26.13±1.99&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.83±0.06&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.108±0.006&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>5% PHB</td>
<td>22.11±0.99&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.36±0.16&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.106±0.008&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>10% PHB</td>
<td>18.52±0.82&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.78±0.08&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.096±0.009&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>15% PHB</td>
<td>15.21±0.77&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.38±0.08&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.090±0.008&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*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 pathogenic 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 prandial 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 diabetes and hypercholesterolmic (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.

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

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

*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:


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


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

منى ياسر عبد الخالق مصطفى
قسم الاقتصاد المنزلي - كلية التربية النوعية - جامعة المنصورة - مصر

الملخص:
نظراً لتأثير تناول الألياف عمى خفض معدل نسبة السكر في الدم، ولأن الاستهلاك الشائع من الألياف أقل من الموصى به، أدأ إلى تطوير المنتجات الغذائية في محتواها من الألياف. استهدفت الدراسة توضيح تأثير تدعيم دقيق القمح (استخلاص 27%) بنسبة 5، 10، 15% من مسحوق قشور عشبة الإسبغول في صناعة خبز التوست على كل من الخواص الريولوجية للعجين والخواص الحسية والفيزيقية والكميائية على الخبز مقارنة بالخبز المصنع من دقيق القمح (100%) كنتيرويل. كما تمت دراسة أثر تغذية الفئران المصابة بالسكري بواسطة استربتوسيتين على الخبز المدعم بقشور الإسبغول. أجريت التجربة على ثلاثون فأر من سلالة Sprague Dawley حيث قسمت إلى مجموعتين رئيسيتين، الأولى (خمس فئران) تم تغذيتها على الوجبة الأساسية وسميت بالمجموعة الضابطة السالبة. أما المجموعة الثانية فكان عدها 25 فأر تم تغذيتها بجامث الاستربتوسيتين بجرعة 30 ملجم/كم من وزن الجسم على مرتين متتاليتين لإحداث الإصابة بمرض السكر، بعد ذلك تم تقسيم الفئران المصابة بمرض السكر إلى خمس مجموعات فرعية (خمس فئران بالمجموعة)، المجموعه الفرعية الأولى تم تغذيتها على الوجبة الأساسية وسميت بالمجموعة الضابطة الموجبة، أما باقي المجموعات الفرعية تم تغذيتها على الوجبة الأساسية المضافة إليها خبز التوست المحضر بإضافة (0، 1، 5)

وأوضحت نتائج البحث أن تدبيع خبز التوست بقشور الإسبغول أدت إلى خفض وزن الفئران وسكر الدم وكذلك نسبة الكوليسترول والدهون الثلاثية في الوقت نفسه أدت إلى ارتفاع مستوى الليوبيروتينات مرتفعة الكثافة في سيرم دم الفئران المصابة بالسكري مقارنة بالمجموعة الضابطة الموجبة، بالإضافة إلى جودة الخواص الحسية والفيزيقية للخبز، وأوصت الدراسة بتناول عشبة الإسبغول كمصدر جيد للألياف في إنتاج الخبز.