Incorporating of Soy Flour in Wheat Bread and its Effects on Growth and Renal Function in Young Rats

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Abstract:
Quantity and quality of dietary protein considered to be a nutritional problem and the search for inexpensive and quality protein foods considered as a vital mission to improve and enhance the nutritional quality of bread as it had been recognized as a stable food in Egypt., Hence this study aims to examine the effect of mixing defatted soy flour (DSF) and wheat flour on the breads’ quality in addition to investigate the effects of these mixtures on growth and kidney function in young rats. Different flour mixtures of wheat and DSF were used in preparing of tested breads which were subjected to sensory evaluation. Thirty six young male albino rats 50-70 g were divided into six groups and fed the experimental diets for 4 weeks as follows: group (1) Control group fed on basal diet; group (2) fed on 100% protein from defatted soy flour (DSF 100%); group (3) fed on 100% protein from wheat flour (W 100%); group (4) fed on 90% protein from wheat flour and 10% DSF protein (W 90%+ DSF 10%); group (5) fed on 85% protein from wheat flour and 15% DSF protein (W 85%+ DSF 15%), and group (6) fed on 80% protein from wheat flour and 20% DSF protein (W 80%+ DSF 20%). Biological evaluation was undertaken by determination of body weight gain, Feed Efficiency Ratio (FER) and protein Efficiency Ratio (PER); and at the end of the experimental period blood was collected and serum total protein, albumin, globulin, uric acid, creatinine and serum urea was determined. Results indicated that wheat 100% bread had the highest score in overall quality and acceptability, followed by bread of wheat 90%+ DSF 10%, whereas the bread of wheat 80%+ DSF 20% had the lowest score value. And the biological and biochemical results showed that the addition of DSF to wheat flour enhanced the protein quantity and quality of bread as illustrated by increments of weight gain and FER values of groups fed on wheat and DSF mixtures, and by increasing of serum total protein in group fed mixtures of wheat and DSF; on the other hand serum urea was significantly (P< 0.05) increased on mixture of wheat and SDF at 15and 20% levels. The results of this study revealed that, the addition of 10 and 15% DSF to wheat bread have good acceptability and it can be used to enhance the quantity and quality of wheat bread protein.

Key words: Wheat, Soy, sensory evaluation, rats, growth, serum total protein, kidneys function.
Introduction:

Malnutrition and poverty poses a major challenge to low-income families in developing nations and are very critical for a growing child (Ikpeme-Emmanuel et al., 2012). In most of developing countries both quantity and quality of dietary protein considered to be a major nutritional problem. Therefore, the search for inexpensive and quality protein foods considered as a vital mission for food researchers to improve and enhance the nutritional quality of bread as it had been recognized as a stable food in Egypt. The typical Egyptian per capita of daily bread was approximately 392 g baladi bread/day (Shehata and Mohamed, 2015); and it was estimated to be the one of the main source of daily energy and protein intake with legumes, as reported by Breisinger et al. (2013) who stated that, Egyptian diet characterized by poor dietary diversity with high dependence on cereals and cheap food.

In recent years, there has been a considerable interest in the effects of soybean and soy-based products in human health (Ali et al., 2005). It was hypothesized that, addition of soy flour to bread improves the protein quantity and quality in order to increase the protein intake and improving of nutritional status for those who are in danger of malnutrition (Mahmoodi et al., 2014). Soy is a complete high quality protein, which could be added to a wide variety of products to enhance the nutritional quality of foods (Endres et al., 2003). Hence this study aims to examine the effect of mixing soy flour and wheat flour on the quality attributes of tested breads prepared from varied mixtures of wheat and soy flours at different levels, in addition to investigate the biological and biochemical effects of these mixtures on growth, blood proteins and serum urea, creatinine and uric acid as an indicator of kidney function in young rats in order to develop more nutritionally bread.

Materials and Methods:

Wheat flour (all purpose flour) was obtained from local market in Cairo- Egypt, and defatted Soy flour (DSF) was purchased from agriculture research center, Giza-Egypt; and samples of both flours were subjected to chemical composition analysis in order to estimate: moisture, protein, fat, ash and fiber.

Chemical analysis:

Protein was estimated by Micro Kjeldahl according to the method of AOAC (2000). Fat, ash and fiber were estimated according to AOAC (2000). Carbohydrate was calculated by difference. The data in Table (1) showed the chemical composition of wheat and DSF, and the result of wheat composition was in line with that of Khorshid et al. (2011).
Table (1): Chemical composition of wheat flour and defatted soy flour

Table (1): Chemical composition of wheat flour and defatted soy flour
DSF represented as g % (Mean ± S.D).

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Fiber</th>
<th>Ash</th>
<th>Carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSF</td>
<td>5.93±1.08</td>
<td>50.93±0.55</td>
<td>4.52±1.69</td>
<td>2.9±0.16</td>
<td>6.58±0.35</td>
<td>29.92±0.27</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>12.19±0.10</td>
<td>12.33±0.09</td>
<td>1.49±0.01</td>
<td>1.24±0.01</td>
<td>0.79±0.08</td>
<td>72.17±0.82</td>
</tr>
</tbody>
</table>

Sensory Evaluation:

Bread loaf was prepared according to the standard formula (Long, 1991), and tested breads (Control wheat bread and breads containing 10, 15 and 20% DSF) were subjected to orgranoleptic evaluation. Panelists (10 members) were asked to rank various samples for color, aroma, texture, and taste on 11-point scale of zero (dislike extremely) to 10 (like extremely), the overall quality then was calculated according to the method mentioned by Kramer and Twigg (1966). Samples of tested breads were provided to panelists in identical white trays, coded with 3-digit random numbers and served at the same time. Water was served in between samples assessment to enable panelists rinse properly and neutralize carryover flavors in their mouth.

Experimental design:

Thirty six young male albino rats of Sprague Dawely strain weighing 50-70 g were taken from animal house of Egyptian Organization for Biological Products and Vaccines (VACSERA) Cairo-Egypt, and housed individually in a wire cages at 25°C. Rats were then divided into six groups (of 6 rats each) as follows: Control group (1) fed on a basal diet, and the other 5 groups fed the experimental diets for 4 weeks as follows: group (2) fed on 100% protein from defatted soy flour (DSF 100%); group (3) fed on 100% protein from wheat flour (W 100%); group (4) fed on 90% protein from wheat flour and 10% protein from defatted soy flour (W 90%+ DSF 10%); group (5) fed on 85% protein from wheat flour and 15% protein from defatted soy flour (W 85%+ DSF 15%), and group (6) fed on 80% protein from wheat flour and 20% protein from defatted soy flour (W 80%+ DSF 20%).

Standard basal diet was prepared with modification according to Reeves et al. (1993). The experimental diets were prepared by adding of wheat and DSF flours to the expense of casein, corn oil and starch to produce the required protein levels (10%) from wheat, DSF and their mixtures in accord to the chemical composition of wheat and DSF flours.
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Table (2): Composition of control and experimental diets (at 10% protein level), represented as g/ kg diet.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DSF 100%</th>
<th>Wheat 100%</th>
<th>W90% + DSF 10%</th>
<th>W 85% + DSF 15%</th>
<th>W 80% + DSF 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein</td>
<td>125.00</td>
<td>--</td>
<td>--</td>
<td>811.00</td>
<td>730.00</td>
<td>690.00</td>
</tr>
<tr>
<td>Wheat</td>
<td>--</td>
<td>--</td>
<td>811.00</td>
<td>730.00</td>
<td>690.00</td>
<td>649.00</td>
</tr>
<tr>
<td>DSF</td>
<td>--</td>
<td>196.00</td>
<td>--</td>
<td>20.00</td>
<td>29.00</td>
<td>39.00</td>
</tr>
<tr>
<td>Corn Starch</td>
<td>668.00</td>
<td>612.00</td>
<td>4.00</td>
<td>65.00</td>
<td>95.00</td>
<td>126.00</td>
</tr>
<tr>
<td>Corn Oil</td>
<td>100.00</td>
<td>91.00</td>
<td>88.00</td>
<td>88.00</td>
<td>89.00</td>
<td>88.00</td>
</tr>
<tr>
<td>Minerals Mixture #</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Vitamins Mixture *</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Choline Chloride</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Cellulose</td>
<td>50.00</td>
<td>44.00</td>
<td>40.00</td>
<td>40.00</td>
<td>40.00</td>
<td>41.00</td>
</tr>
<tr>
<td>Cod Liver Oil</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>

# Minerals mixture prepared according to Campell (1961).
* Vitamins mixture prepared according to Hegested *et al.* (1941).

Biological evaluation of tested diets was undertaken by determination of body weight gain, food intake, Feed Efficiency Ratio (FER) and protein Efficiency Ratio (PER) in young rats. The FER and PER were calculated for each group according to the method described by AOAC (2000).

Biochemical analysis:

At the end of the experimental period, animals were lightly anesthetized with diethyl ether, and blood was collected from the hepatic portal vein. Blood samples were collected and centrifuged at 3000 rpm for 15 min to separate serum, which stored at -20°C until further biochemical analysis. Serum total protein was determined according to the method of Gornall *et al.* (1949), where serum albumin were determined using the method described by Doumas and Biggs (1971), serum globulin were calculated by subtracting serum albumin from serum total protein. The method of Caraway (1955) was used to determine serum uric acid, while serum creatinin level was measured by the method of Bohmer (1971) and serum urea was determined according to Marsch *et al.* (1965).
Statistical analysis:

The statistical analysis was conducted according to Snedecor and Cochran (1967), using one way analysis of variance technique (ANOVA). The significant difference among means evaluated by least significant difference (L.S.D) method at levels of probability $P \leq 0.05$ and $P \leq 0.01$. All the data analysis was performed using SPSS software (Version 16; SPSS Inc Chicago., USA).

Results and Discussion:

Figure (1 and 2) showed that, the wheat 100% bread had the highest score in overall quality, followed by bread of wheat 90% + DSF 10%, whereas the bread of wheat 80% + DSF 20% had the lowest score value. These results were in agreement with the findings of Ribotta et al. (2010) who found that soy-wheat flour in ratio of 90:10 w/w showed a major improving effect on dough rheological properties, and with Mashayekh et al. (2008) who concluded that, adding of 3-7% defatted soy flour produced a good bread loaf comparable to wheat bread. Dhingra and Jood (2004) concluded that soy flour could be added to bread flour up to level of 10% without any significant change in organoleptic characteristics. On the other hand, adding of 20% DSF to wheat resulted in poor quality of bread, which could be due to the fact that, soy flour increased solubility of the wheat gluten, producing a weakening of the gluten network (Perez et al., 2008) and decreasing availability of water to build up in gluten network (Roccia et al., 2009). Furthermore, Qian et al. (2006) showed that, adding of soy protein powder depresses loaf volume, gives poor crumb characteristics and decreases acceptability by consumers, and Julianti et al. (2015) illustrated that, as the level of soybean flour increases, the decrease in specific volume was more remarkable, and the incorporation of soy proteins changes the properties of bread. In addition, Mashayekh et al. (2008) concluded that, overall acceptability score significantly decreased with increasing DSF substitution levels.

Results demonstrated in Table (3) showed that, rats group fed on DSF 100% as the sole source of protein has a non significant lower FER and PER values, on the other hand group fed on wheat 100% illustrated significant ($P \leq 0.01$) decrements in weight gain, FER and PER when compared with the control group. However, there was a difference in the food intake of the rats fed on mixtures of wheat and DSF which may be attributed to the different composition of the diets, probably the characteristic taste of soy or its odor, thereby making it more acceptable (Silva et al., 2015). The result concerning the weight gain, FER and PER of rats group fed on wheat 100% were in agreement with recent study of
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Fig. (1): Control wheat bread (A- A1), wheat 90%+ 10% DSF (B- B1), Wheat 85 %+ DSF 15% (C-C1) and Wheat 80%+ DSF 20% (D-D1).

Fig. (2): Mean score values for quality attributes of Control wheat bread, wheat 90%+ 10% DSF (B- B1), Wheat 85%+ DSF 15% and Wheat 80%+ DSF 20%.
Table (3): Effect of wheat and DSF protein on weight gain (g/day), food intake (g/day), FER, PER and selected protein metabolism parameters in young rats (Mean ± S.E).

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>DSF 100%</th>
<th>Wheat 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight Gain g</td>
<td>63.00±1.03</td>
<td>62.33±1.09</td>
<td>47.33±0.42**</td>
</tr>
<tr>
<td>Food intake g</td>
<td>194.83±1.56</td>
<td>195.67±0.88</td>
<td>245.17±2.7**</td>
</tr>
<tr>
<td>FER</td>
<td>0.33±0.01</td>
<td>0.32±0.01</td>
<td>0.19±0.01**</td>
</tr>
<tr>
<td>PER</td>
<td>3.23±0.05</td>
<td>3.19±0.04</td>
<td>1.93±0.03**</td>
</tr>
<tr>
<td>Serum Total Protein mg/dl</td>
<td>5.56±0.02</td>
<td>5.33±0.04**</td>
<td>5.15±0.02**</td>
</tr>
<tr>
<td>Serum Albumin mg/dl</td>
<td>2.51±0.06</td>
<td>3.56±0.02**</td>
<td>3.12±0.05**</td>
</tr>
<tr>
<td>Serum Globulin mg/dl</td>
<td>3.05±0.07</td>
<td>1.77±0.03**</td>
<td>2.03±0.04**</td>
</tr>
<tr>
<td>Serum Urea mg/dl</td>
<td>36.76±0.17</td>
<td>61.91±0.29**</td>
<td>69.84±0.33**</td>
</tr>
<tr>
<td>Serum Creatinine mg/dl</td>
<td>0.25±0.02</td>
<td>0.27±0.02</td>
<td>0.27±0.02</td>
</tr>
<tr>
<td>Serum Uric Acid mg/dl</td>
<td>1.23±0.09</td>
<td>1.30±0.01</td>
<td>1.16±0.04</td>
</tr>
</tbody>
</table>

* Significant differences from control at P≤0.05. ** Significant differences from control at P≤0.01.

Mahmoodi et al. (2014) who reported that rats fed on wheat had the lowest body weight gain, and furthermore Chou (1983) confirmed that, cereal preparations are not adequate to meet the requirements of a growing child. On the other hand group fed on DSF 100% showed lower values than that of control group for weight gain, FER and PER, and at the same time it was significantly higher than that of group fed on wheat 100%. That was in harmony with the recent findings of Silva et al. (2015) who reported that, the growth of rats fed soy protein-based beverage and soy-based formula was lower than those fed cow’s milk based formula. These results could be explained on the basis that, soy contains many kinds of anti-nutritional factors, such as trypsin inhibitor, lectin, α-amylase inhibiting factor, goitrin, soybean antigen (Gu et al., 2010). These anti-nutritional factors affect the nutritional value (Sun and Qin, 2005); and inhibit animals growth by the action of trypsin inhibitor and lectin. Furthermore, to reduce the anti-nutritional content, soy must be subjected to thermal treatment before consumption (Gu et al., 2010).

From table (3) it could be noticed that rats group fed on DSF and wheat had a significant increase in serum urea (61.91±0.29 mg/dl) as compared with that of control group (36.76±0.17 mg/dl), and the result for DSF was in agreement with that of Song et al. (2016) who illustrated that, soy protein increased the metabolism of non essential amino acids and sulfur-containing amino acids in the liver, indicating increased amino acid degradation in rats which could be related to the methionine limitation in soy protein, and in this condition the non essential amino acids are
abundantly available, but since these amino acids cannot be used in body protein synthesis, due to the lack of methionine, they are deaminated to produce urea.

Table (3) and Figure (3) showed that, groups fed on DSF and wheat had significantly (P≤ 0.01) lower levels of serum total protein (5.33± 0.04 and 5.15± 0.02 mg/dl., respectively) and globulin (1.77± 0.03 and 2.03± 0.04 mg/dl, respectively) as compared to control group (3.05± 0.07mg/dl), which could be due to the fact that is DSF and wheat are relatively low in methionine and lysine respectively, in addition soy contains anti-nutritional factors that could affect nutrient availability (Lonnerdal, 1994) which could impair the biosynthesis of plasma protein. As shown in table (3), there was a significant increase of serum urea in rats groups fed on DSF 100% and wheat 100%, this was in agreement with Rubio et al. (1995) who reported that, high urea values are associated with disturbances in protein metabolism and increased protein degradation, while the imbalance of amino acids resulting in an increments of amino acid catabolism. In addition the insignificant increase of uric acid in group fed on DSF was in harmony with the finding of Garrel et al. (1991) who reported, uric acid increased after ingestion of soy protein compared to casein.
From Table (4) and Figure (4) it could be noticed that the addition of DSF to wheat at level of 15 and 20% resulted in an increase in body weight gain, FER and PER values (\(P < 0.05\) and \(P < 0.01\) respectively), on the other hand the increment in FER and PER were insignificant at 10% DSF level when compared with wheat 100% group. These could be due to the fact that, wheat protein is deficient in the essential amino acid (lysine), and the addition of soy may enhance to lesser extent the amino acid balance of wheat at 15 and 20% levels. This result was in agreement with the report of Sharaf (2005) who illustrated that, the reason of adding DSF to wheat flour was to enhance quantity and quality of protein because wheat flour considered as being low quality protein, based on that, the addition of DSF to wheat improves the protein quality of the mixtures as indicated by increased FER and PER values in groups fed on W 85%+ DSF 15% and W 80%+ DSF 20% and in turn enhanced the growth of these rats groups when compared with group fed on wheat only. Moreover, in the bread baking industry, the soybean is used to increase the bread protein value and protein content from 8 - 9% up to 16% (Ribotta et al., 2010).

Table (4): Effect of feeding different levels of wheat and DSF protein on weight gain (g/day), food intake (g/day), FER and PER in young rats (Mean± S.E).

<table>
<thead>
<tr>
<th></th>
<th>Weight gain g</th>
<th>Food intake g</th>
<th>FER</th>
<th>PER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat 100%</td>
<td>47.33±0.42</td>
<td>245.17±2.70</td>
<td>0.19±0.01</td>
<td>1.93±0.03</td>
</tr>
<tr>
<td>W 90%+ DSF 10%</td>
<td>49.83±1.08</td>
<td>253.67±1.84**</td>
<td>0.20±0.01</td>
<td>1.97±0.03</td>
</tr>
<tr>
<td>W 85%+ DSF 15%</td>
<td>52.00±2.07*</td>
<td>245.67±2.67</td>
<td>0.21±0.02*</td>
<td>2.12±0.09*</td>
</tr>
<tr>
<td>W 80%+ DSF 20%</td>
<td>58.00±1.55**</td>
<td>261.00±0.45**</td>
<td>0.22±0.01**</td>
<td>2.22±0.06**</td>
</tr>
</tbody>
</table>

* Significant differences from wheat 100% at \(P < 0.05\). ** Significant differences from wheat 100% at \(P < 0.01\).

It could be noticed from table (5) that only rats group fed on mixture of wheat 80%+ SDF 20% showed significant increment of serum total protein in comparison with the wheat 100% group. On the other hand, addition of DSF at 10, 15 and 20% to wheat resulted in significant increase of serum albumin (\(P < 0.05\)) with decrements of serum globulin in comparison with the wheat 100% group. This result indicated that, the addition of DSF at varied levels enhanced the protein biosynthesis due to the enhancing of protein quality especially at 20% level, and the fact that, In ordinary white
bread, protein content ranges from 8 to 9% and by including soybeean, the protein content can be made up to 16% (Sharaf, 2005 and Ribotta et al., 2010). The enrichment of bread and other cereal based foods with legume flours is recommended particularly when protein utilization is inadequate, and this could be due to the fact that legumes are high in protein and lysine the limiting amino acid in most cereals (Jideani and Onwubali, 2009).

Table (5): Effect of feeding different levels of wheat and DSF protein on serum total protein, albumin and globulin levels in young rats (Mean+ S.E).

<table>
<thead>
<tr>
<th></th>
<th>Serum total protein mg/ dl.</th>
<th>Serum albumin mg/ dl.</th>
<th>Serum globulin mg/ dl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat 100%</td>
<td>5.15± 0.02</td>
<td>3.12± 0.05</td>
<td>2.03± 0.04</td>
</tr>
<tr>
<td>W 90%+ DSF 10%</td>
<td>5.16± 0.03</td>
<td>3.53± 0.22*</td>
<td>1.63± 0.07*</td>
</tr>
<tr>
<td>W 85%+ DSF 15%</td>
<td>5.21± 0.02</td>
<td>3.53± 0.13*</td>
<td>1.68± 0.13</td>
</tr>
<tr>
<td>W 80%+ DSF 20%</td>
<td>5.24± 0.03</td>
<td>3.85± 0.16*</td>
<td>1.39± 0.16*</td>
</tr>
</tbody>
</table>

* Significant differences from wheat 100% at P< 0.05. ** Significant differences from wheat 100% at P< 0.01.

The result of present study concerning serum total protein and albumin could be explained on the basis that, consumption of diet containing vegetable protein may retard kidney damage by lowering the glomerular filtration rate and urinary albumin excretion, and soy protein sustain adequate growth rate in rats and infants (Tovar et al., 2002).

Table (6): Effect of feeding different levels of wheat and DSF protein on serum urea, creatinine and uric acid levels in young rats (Mean+ S.E).

<table>
<thead>
<tr>
<th></th>
<th>Serum Urea mg/ dl.</th>
<th>Serum Creatinine mg/ dl.</th>
<th>Serum Uric Acid mg/ dl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat 100%</td>
<td>69.84± 0.33</td>
<td>0.27± 0.01</td>
<td>1.16± 0.04</td>
</tr>
<tr>
<td>W 90%+ DSF 10%</td>
<td>69.91± 0.33</td>
<td>0.29± 0.01</td>
<td>1.23± 0.01</td>
</tr>
<tr>
<td>W 85%+ DSF 15%</td>
<td>62.85± 0.30**</td>
<td>0.28± 0.01</td>
<td>1.25± 0.01</td>
</tr>
<tr>
<td>W 80%+ DSF 20%</td>
<td>59.36± 0.28**</td>
<td>0.28± 0.01</td>
<td>1.28± 0.01</td>
</tr>
</tbody>
</table>

* Significant differences from wheat 100% at P< 0.05. ** Significant differences from wheat 100% at P< 0.01.
Table (6) illustrated that, both groups of rats fed on w 85%+DSF 15% or 20% showed significant ($P < 0.01$) decrease in serum urea when compared with the group of wheat 100% or the control group; and non significant increments in serum uric acid levels. In a recent study by *Ebuehi and Okafor (2015)* they observed that, when rats fed supplemented soy flour bread at 10- 40% levels, the rats showed significant decrease in the creatinine and urea compared to control fed on wheat bread 100%, and this result was in line with the results of current study concerning the serum urea level of rats groups fed on wheat and DSF mixtures.

In conclusion the adding of DSF to wheat bread was supporting the growth and it could be used at 10 and 15 % level, which may enhance the protein quantity and quality of wheat bread especially for those groups who are at risk of protein deficiency.
References:


الملخص:

إن نوعية وكمية البروتين بالوجبات الغذائية تعتبر من المشاكل الغذائية ويعتبر البحث عن اطعمة بروتينية
رخية الثمن ذات جودة بروتين مرتفعة تعتبر مهجة جيدة لتحقيق الفوائد الغذائية للخبز، حيث أنه من
العوامل الرئيسية بالوجبات في مصر. لذا تهدف الدراسة إلى اختبار تأثير أثر دقيق الصويا مضخد الدهن مع
دقيق القمح على جودة الصفات الحيوية لخبز الناتج، بالإضافة إلى دراسة تأثير تلك المخلوط على النمو ووظائف
الكلي في الفئران الصغيرة، ثم استخدام مختبر مختلف من دقيق القمح ودقيق الصويا مضخد الدهن في إعادة
الخبز المختبر ومن ثم تقييم جودة الصفات الحيوية للخبز الناتج. كما تم استخدام سُنة وثلاثين فأرا من نوع البينو
وزن 100-150 جم وتتم تقسيمهم إلى ستة مجموعات كما يلي: مجموعة (1) تتغذى على الوجبة الضابطة، مجموعة
(2) وتغذى على 100% بروتين دقيق الصويا مضخد الدهن، مجموعة (3) وتغذى على 100% بروتين من
دقيق القمح، مجموعة (4) وتغذى على 90% بروتين من دقيق القمح و10% بروتين من دقيق الصويا مضخد
الدهن، مجموعة (5) وتغذى على 85% بروتين من دقيق القمح و15% بروتين من دقيق الصويا مضخد
الدهن و مجموعة (6) وتغذى على 80% بروتين من دقيق القمح و20% بروتين من دقيق الصويا مضخد
الدهن. وتم التقييم البيولوجي بواسطة قياس معدل الزيادة في وزن الجسم، معدل كفاءة الغذاء ومعدل كفاءة
البروتين، كما تم بتقييم لندية تقييم البروتين الكلي بفصل الدعم الإQUEOLIQUID بالأدوية البيولوجية. حمض البوتيلك
الكربناتي في البروتين بصل الدعم. أظهرت نتائج الدراسة حصول خبز القمح 100% على أعلى درجات تقييم الوجبة
الكلية والتقبل، وتبعت الخبز المصنوع من 90% دقيق القمح + 10% دقيق الصويا مضخد الدهن، بينما كان
الخبز المصنوع من 80% دقيق القمح + 20% دقيق الصويا مضخد الدهن هو الأقل بشكل استثنائيات، أظهرت
النتائج البيولوجية والبيوكيميائية أن إضافة دقيق الصويا مضخد الدهن إلى دقيق القمح قد أسهم في تحسين كمية
وتنوع البروتين بالوجبات المقدمة للخنازير حيث وصم ذلك من خلال زيادة معدل ا换句话说ى الوزن ومعدل كفاءة
الذات للجماعات التي تتغذى على مخلوط دقيق القمح والصويا مضخد الدهن، وكذلك ارتفاع مستوى البروتين
الكلي بفصل الدعم في الجماعات التي تتغذى على تلك المخلوط، دقيق القمح والصويا، كما ارتفع منعوتا
مستوى البروتين بفصل الدعم في الجماعات التي تتغذى على خليط دقيق القمح + 15% أو 20% من دقيق الصويا
مضخد الدهن، أوضح ذلك نتائج تلك الدراسة أن هناك تقليل جيد لخبز المصنوع من خليط الدهن + 15% أو 20% من
دقيق الصويا مضخد الدهن، والتي يمكن أن تلعب في تحسين كمية وتنوع البروتين خبز القمح.