EVALUATION OF DOUGH CHARACTERISTICS AND QUALITY OF EGYPTIAN BALADY BREAD CONTAINING MILLET FLOUR

Salah Mansour¹, Hassan Siliha², Gehan El-Shourbagy² and Fouad Abou-zaid¹
¹Food Processing Department, Desert Research Center Ministry of Agriculture, Egypt.
²Food Science Department, Faculty of Agriculture, Zagazig University, Egypt.

ABSTRACT

This work aims to evaluate the chemical composition of whole and sieved millet flours compared with wheat flour and assess the rheological properties of the resultant doughs by substitution of wheat flour with different ratios of millet flour (0-10-15-20-25 and 30%), as well as physical and sensorial characteristics of the produced Egyptian Balady bread. Chemical composition of whole millet, sieved millet and wheat flour (72% extraction) showed that both whole millet and sieved millet flours had higher contents of protein, fat, magnesium, phosphorus and manganese compared to wheat flour. The rheological characteristics measured by (Farinograph and Extensograph) showed that increasing millet level in dough led to adverse effect on most rheological characteristics. Physical properties of the produced balady bread illustrated that bread sample of 10% millet flour had insignificant reduction in specific volume compared with control sample. Bread samples of all studied treatments were sensory accepted, but the bread sample of 10% millet flour was not significantly different from the control sample. The results of the present study confirm the potential for substitution of wheat flour by millet flour (the best ratio is 10%) aiming to improve the nutritional value of balady bread in terms of protein, fat and some minerals as well as maintaining acceptable level of physical and sensorial attributes.

Keywords: wheat, millet blends, chemical composition, balady bread, rheological properties, physical characteristics sensory attributes.

Introduction

The challenges of the 21st century, such as climate changes, water scarcity, increasing world population, rising food prices, and other socioeconomic impacts are expected to result in great threats to agriculture and food security worldwide, especially for the poorest people who live in arid and sub-arid regions (Saleh et al., 2013). Cereals and cereal products are staple foods in most human diets McKevith et al. (2004). The importance of cereals and cereal products is also supported by the fact that global food security depends to the greatest degree on cereal production, which yearly amounts to approximately 2600 million tons FAO, (2019). Consumption of whole grain cereal products is associated with higher diet quality and nutrient-dense foods delivering protein, lipids, B vitamins (including thiamin, niacin, riboflavin), vitamin E, and minerals (calcium, magnesium, potassium, phosphorus, iron, and sodium) (O’Neil et al., 2010).

Excessive dependence of the African nations on wheat importation led to a loss in foreign earnings and protein-energy malnutrition (PEM), which is one of the major challenges encountered by the continent in the production of staple foods (Temba et al., 2016). Baking with wheat flour alone does not provide the required amino acids in bread because wheat flour limited concentration of lysine and does not contain methionine (Mubaiwa et al., 2017 and Saleh et al., 2013).

Millet is one of the most important drought-resistant crops and the 6th cereal crop in terms of world agriculture production. (Devi et al., 2014). It has several advantages such as drought resistance, insect resistance, short growth duration, and high yield. It contains a variety of carbohydrates, proteins, fats, vitamins and minerals, and other essential nutrients, as well as abundant phytochemicals, which are associated with antioxidant properties and inhibit the action of malignant cell proliferation Devi et al. (2014).

Millet contains significant amounts of methionine (2.5%) (Saleh et al., 2013), some minerals and bioactive compounds. Millets have nutraceutical properties in the form of antioxidants which have positive effect on human health such as lowering blood pressure decreasing, risk of heart disease, prevention of cancer and cardiovascular diseases, diabetes and decreasing tumor cases etc Singh et al. (2016).

Substitution of wheat flour with millet flour for bread production may be useful in improving the nutritional value of the bread and may also reduce the excessive dependence on wheat and thus, reduce the cost of wheat importation. Man et al. (2016) evaluated the quality of bread making by substituting wheat flour with different proportions of millet flour (0, 10, 20, and
30% the bread with millet flour and the control sample were subjected to physico chemical and organoleptic analyses they noticed that addition of millet flour in bread making improved physco chemical and sensory attributes. Bread volume and crumb structure were accepted by panalists, they concluded that addition of 30% millet flour in bread formulation led to an accepted product by consumers. Therefore, this study was carried out to evaluate the chemical composition of millet flour compared to wheat flour and assess the rheological properties of the resultant doughs and sensory characteristics of wheat Balady bread produced by addition of millet flour

Material and Methods

Materials

- Millet Shandaweel 1 was obtained from Filed Crops Institute, Agricultural Research Center Ministry of Agriculture, Giza, Egypt.
- The other ingredients used for bread making (72% extraction wheat flour, yeast and salt) were purchased from local market, Giza, Egypt.

Methods

Processing of Millet Flour

According to method Olapade et al., 2011 was used. Millets were manually cleaned by washing in clean water using local and decanted by sedimentation, draining and drying in cabinet drier at 50°C for 6h. The resulted dried millets were milled into flour using hammer mill (2014 hot model PC 120) and sieved to pass through 0.2mm mesh.

Bread Making:

Egyptian Balady bread was baked using six composite flour blends of sieved millet flour and wheat flour(extraction 72%) as follows: control (0: 100%), (10:90), (15:85), (20:80%), (25:75%), and (30:70%), respectively. Balady bread was prepared by mixing 100 g of the previous composite flour blends with 0.5 g of active dry yeast, 1.5 g of sodium chloride, 75–80 ml of water and mixing by hand for about 6 min to form the dough. The dough was left to ferment for 1 h at 30°C and 85% relative humidity, and was then divided into 125 g pieces. The pieces were arranged on a wooden board that had been sprinkled with some modifications. About 0.5 g of the sample was weighed into 10 ml graduated cylinder. Water was added to the sample-oil mixture and thoroughly mixed with 10 ml of refined pure groundnut oil using vortex mixer. Samples were allowed to stand at room temperature for 3 h. The volume of settled particles was recorded.

Determination of water absorption capacity

According to Diniz and Martin (1997) Water absorption capacity (WAC) of sample was determined with some modifications. About 0.5 g of the sample was dissolved with 10 ml of distilled water in centrifuge tubes and vortexed for 30 s. The dispersions were allowed to stand at room temperature for 30 min, centrifugated at 3000 rpm for 25 min. The supernatant was filtered with Whatman No 1 filter paper and the volume retrieved was accurately measured. The difference between initial volumes of distilled water added to the sample and the sample obtained after filtration was determined. The results were reported as ml of water absorbed per gram of sample.

Water Absorption Capacity = Amount of water absorbed / Weight of sample.

Determination of dispersibility

According to Kulkarni et al. (1991) dispersibility was determined. The flour sample (10 g) was weighed into a graduated cylinder. Water was added to the make up to 100 ml mark. It was shaken vigorously, and allowed to stand for 3 h. The volume of settled particles was recorded.

Oil absorption capacity (milliliter of oil per gram of sample) was calculated.

Oil absorption capacity (milliliter of oil per gram of sample) was calculated. Formulated oil (VO) was weighed into pre-weighed 15 ml centrifuge tubes and thoroughly mixed with 10 ml (V1) of refined pure groundnut oil using vortex mixer. Samples were allowed to stand for 30 min. The sample-oil mixture was centrifugated at 3000 rpm for 20 min. Immediately after centrifugation, the supernatant was carefully poured into a 10 ml graduated cylinder, and the volume recorded (V2).

Oil absorption capacity (milliliter of oil per gram of sample) was calculated.

FC = ([V1 - V2])×100

Determination of swelling index

Method Ukpabiai and Ndimele (1990) was used. The swelling index (SI) of the samples was determined by putting 25 g of each sample in a 250 ml measuring
cylinder. Distilled water (150 ml) was added and allowed to stand for four hours before observing the level of swelling. The swelling index was calculated.

\[ SI = \text{volume after soaking} - \text{volume before soaking} \]

Weight of sample

**Determination of swelling capacity**

Calculate swelling capacity (SC) by gel obtained from swelling index was used:

\[ \% SC = \frac{\text{weight of wet gel}}{\text{weight of sample}} \times 100 \]

**Chemical composition**

Moisture, crude protein, fiber, ash and ether extract (fat) were determined by the standard procedures described in the A.O.A.C. (2005). While, total carbohydrates were calculated by difference.

**Energy value**

Total calories were calculated according to the method of Mahgoub (1999) using the formula as shown in the following equation:

\[ \text{Total energy (kcal/100g)} = \left[ (\% \text{carbohydrate} \times 4) + (\% \text{protein} \times 4) + (\% \text{fat} \times 9) \right] \]

**Determination of minerals:** The minerals (Ca, Mg, K, P, I, Mn, Zn) were determined according to the method described by A.O.A.C. (2005) using the dry ashing method for the preparation of samples. The Perkin Elmer (Model 4100Z1 Atomic Absorption spectrophotometer) was used for the determination.

**Sensory evaluation of bread:**

According to Meilgaard, Civille et al. (2007) Sensory evaluation of bread samples was performed using nine point hedonic scale twenty panelists were selected for sensory analysis. Panelists from staff members from of Department of plant production, Unit Food processing of Desert Research Center and doctors Department of Food Science Faculty of Agriculture Zagzig University. Balady breads were evaluated for taste, odor, crust color, crump color dark to light, consistency. Acceptability (1 represented dislike extremely, 4-5 represented acceptable and 8-9 represented like extremely).

**Statistical analysis**

The data were statistically analysed according to (SAS, 2003) using one -way classification. All data percentages were transformed to their arc-sin values before analysis and differences among treatment means were determined by Duncan’s New Multiple Range test (Duncan, 1955).

**Results and Discussion**

The chemical composition of Whole Millet flour, Sieved Millet flour and Wheat flour (72% extraction) is tabulated in Table 1.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fibers</th>
<th>Total Carbohydrate</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour (Extract 72%)</td>
<td>14.24</td>
<td>13.50ab</td>
<td>1.73b</td>
<td>1.47</td>
<td>0.85b</td>
<td>83.30a</td>
<td>402.57</td>
</tr>
<tr>
<td>Whole Millet flour</td>
<td>14.33</td>
<td>16.05a</td>
<td>5.00a</td>
<td>2.11</td>
<td>2.53a</td>
<td>76.82b</td>
<td>416.00</td>
</tr>
<tr>
<td>Sieved Millet flour</td>
<td>14.02</td>
<td>15.21ab</td>
<td>4.89a</td>
<td>1.71</td>
<td>0.64b</td>
<td>78.19b</td>
<td>417.61</td>
</tr>
<tr>
<td>IPROBABILITIES</td>
<td>NS</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

* NS = Not significant (P<0.05)  ** = (P<0.001)  ** = (P<0.0001)

The presented data in Table (1) showed that, whole millet flour had the highest contents of protein (16.05%), fat (5.01%), ash (2.11%) and fiber (2.53%). While, wheat flour (72% extraction) possessed the lowest contents of protein (13.5%), fat (1.73%) and ash (1.47 %), Sieved millet flour laid between them, with protein content 15.21%, fat content 4.89% and ash content 1.71%.

The opposite situation was observed for total carbohydrates, where, wheat flour recorded that highest value (83.30%) while the lowest value was related to the whole millet flour (76.82%).

These findings are in agreement with different results reported by Abd El-kader, 2016, Ghorbelt el al., 2009 Himanshu et al., 2018, Nadia, 2013, Saleh et al., 2013 and Lansakara et al., 2016 who found that moisture content of millet and wheat flours ranged from 14.22 to 14.64 and from 14.24 to 14.78%, respectively, protein content ranged from 15 to 16.10 and from 10.01 to 12.55%, respectively, ash content ranged from 1.67 to 2.20 and from 1.67 to 2.68 %, respectively, fat content ranged from 4.80 to 5.80 and from 1.64 to 1.96%, respectively, and total carbohydrates ranged from 55 to 79.84 and from 70.88 to 81.83 %, respectively.

Concerning the energy values, sieved millet flour had the highest value (417.61 k cal/100gm) followed by whole millet flour (416 k cal/100gm), and wheat flour (402.57 k cal/100gm). This may be due to the higher contents of fat and carbohydrates.

**Minerals content of wheat flour, whole millets flour and sieved millet flour**

The minerals content of wheat, whole millets and Sieved millet flours were demonstrated in Table (2).

The highest mineral concentration in whole millet flour, was phosphorus with 585.42 mg/100g followed by potassium 513.22 mg/100g magnesium with 225.50 mg/100g followed calcium 56.20 mg/100g and Iron 16.12 mg/100g compared to those found in wheat flour (318.67, 495.73, 168.5, 47.5 and 9.2 mg/100g,, respectively).

As for Sieved millet flour, the highest value was phosphorus with 517.25 mg/100g followed by potassium 473.55 mg/100g magnesium with 203.25 mg/100g followed by calcium 43.75 mg/100g and Iron...
with 8.14 mg/100g. These results agree with those reported by M. Abd El-Kader (2016) who found potassium, magnesium, and iron contents of millet were 504.45, 195.31, and 3.01 mg/100g, respectively. While those of wheat flour were 518.84, 149.23 and 3.01 mg/100g, respectively.

Table 2: Minerals content (mg100g) of wheat, whole millets and sieved millet

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Wheat flour (72% extraction)</th>
<th>Whole Millet flour</th>
<th>Sieved Millet flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>47.5</td>
<td>56.20</td>
<td>43.75</td>
</tr>
<tr>
<td>Magnesium</td>
<td>168.5</td>
<td>225.50</td>
<td>203.25</td>
</tr>
<tr>
<td>Potassium</td>
<td>495.73</td>
<td>513.22</td>
<td>473.55</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>318.67</td>
<td>585.42</td>
<td>517.25</td>
</tr>
<tr>
<td>Iron</td>
<td>9.2</td>
<td>16.12</td>
<td>8.14</td>
</tr>
<tr>
<td>Manganese</td>
<td>2.20</td>
<td>3.97</td>
<td>3.75</td>
</tr>
<tr>
<td>Zinc</td>
<td>5.15</td>
<td>6.95</td>
<td>4.81</td>
</tr>
</tbody>
</table>

Table 3: Farinographic Characteristics for the Wheat flour (extract 72%) fortified with sieved millet flour

<table>
<thead>
<tr>
<th>Samples name</th>
<th>Water absorption% (W.A)</th>
<th>Arrival time (Min)</th>
<th>Dough Development (D.D.D.T) (Min)</th>
<th>Stability time (D.S.T) (Min)</th>
<th>Degree of Softening (S.D) (B.U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour</td>
<td>69.0</td>
<td>1.0</td>
<td>2.5</td>
<td>12.0</td>
<td>25</td>
</tr>
<tr>
<td>Sieved Millet flour</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>90% wheat flour + 10 sieved millet flour</td>
<td>68.5</td>
<td>1.0</td>
<td>1.5</td>
<td>11.0</td>
<td>30</td>
</tr>
<tr>
<td>85% wheat flour + 15% sieved millet flour</td>
<td>65.0</td>
<td>1.0</td>
<td>1.5</td>
<td>11.0</td>
<td>50</td>
</tr>
<tr>
<td>80% wheat flour + 20% sieved millet flour</td>
<td>64.4</td>
<td>1.0</td>
<td>1.5</td>
<td>10.5</td>
<td>50</td>
</tr>
</tbody>
</table>

The effect of replacement of wheat flour with millet flour at 10%, 15% and 20% on dough mixing properties was measured by farinograph and results are presented in Table (3). The water absorption had an important role in gluten distribution and the formation of network structure of mixed dough. It was observed that there was inverse relation of water absorption and addition ratio of millet flour which might be due to that wheat flour had more fiber and sugars which retained more water. Rosell et al. (2001) reported that the differences in water absorption are mainly caused by the greater number of hydroxyl groups which exist in the fiber structure and allow more water interactions through hydrogen bonding.

Wheat flour exhibited high water absorption (69%) but by increasing addition level of millet (from 10 to 15 and 20%) the water absorption decreased to 68.5, 65.0 and 64.4, respectively.

Regarding the dough development time wheat flour recorded the highest value 2.5 min. which affected negatively by substitution of wheat by different ratios of millet flour (10%, 15% and 20%) with constant value (1.5 min) for all substitution ratios.

Dough stability time, which is an index of dough strength, was found to decrease with increase in level of millet flour in the blend. Dough stability time for wheat flour was 12.0 min but substitution of wheat flour by 10 – 15 and 20% sieved millet resulted in lower values (11.0, 11.0 and 10.5 min respectively).

The degree of softening, which denotes the elastic proportion of dough followed a different pattern. Degree of softening was lowest for control treatment 25 comparing to the other ratios (90:10, 85:15, 80:20) which recorded 30, 50, 50 B.U respectively.

Wheat flour exhibited high water absorption, dough development time and dough stability which decreased with the millet flour substitution. Saha et al. (2011) illustrated similar farinographic characteristics in their observations on influence of millet variety on dough rheology. Lorenz and Dilsaver (1980) have also observed a decrease in water absorption in wheat and proso millet blend. Carson and Sun (2000) noticed that the water absorption capacity and dough stability of the composite flour decreased significantly with the increase in the level of sorghum. There was weakening of dough, due to the addition of sorghum, which would be due to decreased wheat gluten content (dilution effect) and competition between the proteins of sorghum and wheat flour for water (Deshpande et al., 1983; and Rao and Rao, 1997).
Extensograph Characteristic

The results of Extensiograph parameters of wheat flour (72% extraction) and wheat flour blends with 10%, 15% and 20% of sieved millet flour are given in Table (4).

The presented data showed that, elasticity of wheat dough (control) was 540 B.U but elasticity decreased with increasing the substitution ratios of wheat flour by sieved millet flour. Meanwhile, the highest reduction was that in sample with 20% sieved millet (180 B.U).

Table 4: Extensograph Characteristics for the Wheat extract 72% Fortified with Sieved Millet Flour

<table>
<thead>
<tr>
<th>Samples name</th>
<th>Elasticity (B.U)</th>
<th>Extensibility (mm)</th>
<th>P.N</th>
<th>Energy (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour</td>
<td>540</td>
<td>165</td>
<td>3.27</td>
<td>94</td>
</tr>
<tr>
<td>Sieved Millet flour</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>90% wheat flour + 10 sieved millet flour</td>
<td>220</td>
<td>135</td>
<td>1.48</td>
<td>58</td>
</tr>
<tr>
<td>85% wheat flour + 15% sieved millet flour</td>
<td>200</td>
<td>135</td>
<td>1.63</td>
<td>54</td>
</tr>
<tr>
<td>80% wheat flour + 20% sieved millet flour</td>
<td>180</td>
<td>135</td>
<td>1.33</td>
<td>43</td>
</tr>
</tbody>
</table>

From the same Table, it could be noticed that addition of millet flour to wheat flour caused a decrease in the extensibility. Results of wheat flour dough, and different blends (90:10-85:15 - 80:20) were 165, 135, 135, 135 mm, respectively.

The energy values of dough prepared with different studied treatments were decreased compared to the energy value of 100% wheat flour.

Concerning proportion number (P.N) of dough, it could be noticed. That P.N was decreased as a result of substitution of wheat flour by millet flour, but the highest decrease was recorded for 20% millet flour.

Conclusion, it was easy to notice that the increased level of millet to wheat flour obtained negative impact on rheological properties. The farinograph properties depended on millet flour portions in mixtures. The increase of the amount of millet flour resulted in constant in dough development time along with lower water absorption and dough stability which was due to weakening of the protein network. Extensibility and resistance to extension decreased as the level of millet flour increased in the sample.

Functional Properties

The results of the functional properties of the composite flour are presented in Table (5).

The bulk density (BD) for control and all blends ranged from 0.63 to 0.72 g/ml. Increase millet ratio led to significant reduction of bulk density. The bulk density of the millet flours increased logarithmically with the increase in moisture content, in the moisture content range studied. It increased from 483.1 – 523.4, 486.5 – 530.8, 502.6 – 534.9, 511.2 – 550.8, and 508.4 – 551.7, and 498.3 – 541.8 kg/m³, respectively, for the flours of barnyard millet, finger millet, foxtail millet, kodo millet, little millet and poroso millet R. Viswanathan (2007). According to Bamigbola et al. (2016) obtained bulk density of 0.70 g/ml for 100% wheat flour, and 0.63 - 0.90 g/ml for composite flours consisting 65.66 – 77% wheat flour, 29% plantain flour, 5.33% tigernut flour and 77% wheat flour, 20% plantain flour, 3% tigernut flour respectively. High bulk density is a desirable characteristic for the packaging of food materials of high nutrient contents (Hassan et al., 2013). Low density, however, has been found to be useful in the formulation of complementary foods (Akpata and Akubor, 1999).

The dispersibility of the composite flour ranged from 26 – 30 ml, where increasing millet flour level had unsystematic changes in dispersibility. Eke-Ejiofor (2015) resulted that high dispersibility enhanced better reconstitution of starch in water to give fine and constituent paste.

The WAC ranged from 1.6 to 5.2%. High WAC is useful in product bulking and consistency. Increased millet content led to decrease the WAC.

The OAC of the composite flour ranged from 1.6% to 5.2%. Increase in millet content accounted for sample noticed decrease the OAC. High OAC products are better flavor retainer (Chandra and Samsher, 2013).

The foaming capacity ranged from 1.07 to 1.17%, while, the swelling capacity ranged between 6.96 and 7.08 g/g. Increase in millet content accounted for sample the foam and swelling capacities were increased of blended composite flour.

Physical quality of produced balady bread samples

The data of loaf weight, loaf volume, and specific loaf volume of the bread containing different ratios of millet are tabulated in Table (6).

The previous data in Table (6), it can be seen that as the substitution level of millet increased, the loaf volume and specific volume were decreased significantly comparing to control sample (with one exception related to Specific Volume of balady bread sample with 10% millet flour which decreased insignificantly). The decrease in loaf volume was found due to dilution effects of gluten with addition of non-wheat flour such as millet flour (Shittu et al., 2007). Leading that to decrease in gluten proportion which responsible for
maintaining the viscoelastic property of balady bread dough which ensures the increased volume of wheat bread. Rai et al. (2011) and Ballolli et al. (2014) also noticed a decrease in loaf volume with a progressive increase in the proportion of non-gluten flour such as maize meal and rice flour and foxtail millet flour, respectively.

**Sensory evaluation of Bread Millets**

The sensory parameters of the produced balady bread by substitution of wheat flour with different ratios of sieved millet flour were evaluated and the obtained results are tabulated in Table (7).

As concerns the results of sensory evaluation of bread produced using different studied treatments in Table (7), it could be noticed that, control sample (100% wheat flour) recorded the highest values for all sensory attributes (except consistency) comparing with the other studied treatments. In the same time Balady bread sample with 10% millet flour recorded insignificant reduction in all studied sensory parameters (except consistency, which increased significantly) comparing to control sample.

On the other hand, increasing the ratio of wheat substitution by millet flour led to reduce the recorded values of all studied sensory parameters.

The presented data in table (7) obviously illustrated that, samples of all studied treatments are sensory accepted (where the recorded values of all parameters ranged between 6.96 and 8.67).

<table>
<thead>
<tr>
<th>Blend</th>
<th>Weight (g)</th>
<th>Volume (cm³)</th>
<th>Specific Volume (cm³)/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>101.00</td>
<td>298.00</td>
<td>2.95</td>
</tr>
<tr>
<td>10%</td>
<td>101.00</td>
<td>292.00</td>
<td>2.89ab</td>
</tr>
<tr>
<td>15%</td>
<td>102.00</td>
<td>284.00</td>
<td>2.78bc</td>
</tr>
<tr>
<td>20%</td>
<td>103.00</td>
<td>276.00</td>
<td>2.67cd</td>
</tr>
<tr>
<td>25%</td>
<td>103.50</td>
<td>268.00</td>
<td>2.59d</td>
</tr>
<tr>
<td>30%</td>
<td>104.00</td>
<td>261.00</td>
<td>2.51e</td>
</tr>
</tbody>
</table>

Probabilities: *** NS *** *** *** ***

a, b Means in the same column in each classification bearing different letters differ significantly (* = P≤0.05 and *** = P≤0.0001).

Table 7: Sensory evaluation of balady bread produced by substitution of wheat flour with different ratios of sieved millet flour

<table>
<thead>
<tr>
<th>Blend</th>
<th>Taste (9)</th>
<th>Odor (9)</th>
<th>Crust color (9)</th>
<th>Crumb color (9)</th>
<th>Consistency (9)</th>
<th>Acceptability (9)</th>
<th>Total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8.17</td>
<td>8.35</td>
<td>8.25</td>
<td>8.28</td>
<td>8.18</td>
<td>8.25</td>
<td>49.54</td>
</tr>
<tr>
<td>10% Millet</td>
<td>8.07</td>
<td>7.96</td>
<td>8.06</td>
<td>7.90</td>
<td>8.67</td>
<td>8.13</td>
<td>48.79</td>
</tr>
<tr>
<td>15% Millet</td>
<td>7.77</td>
<td>7.79</td>
<td>7.65</td>
<td>7.75</td>
<td>7.81</td>
<td>7.75</td>
<td>46.52</td>
</tr>
<tr>
<td>20% Millet</td>
<td>7.55</td>
<td>7.45</td>
<td>7.08</td>
<td>6.96</td>
<td>6.99</td>
<td>7.20</td>
<td>43.23</td>
</tr>
<tr>
<td>25% Millet</td>
<td>7.02</td>
<td>7.39</td>
<td>6.58</td>
<td>6.89</td>
<td>6.66</td>
<td>6.81</td>
<td>41.35</td>
</tr>
<tr>
<td>30% Millet</td>
<td>6.70</td>
<td>6.66</td>
<td>6.86</td>
<td>5.94</td>
<td>6.26</td>
<td>6.48</td>
<td>38.90</td>
</tr>
</tbody>
</table>

Probabilities: *** NS *** *** *** ***

a,b Means in the same column in each classification bearing different letters differ significantly (P≤0.05).

NS = Not significant *** = (P≤0.0001)
Conclusion

From the previous results in this study it could be concluded that, potential substitution of wheat flour by millet flour (the best ratio is 10%) to improve the nutritional value of Balady bread (in terms of protein, fat and some minerals) as well as maintaining acceptable level of physical and sensorial attributes.

References

Klopfenstein, C.F. and Hoseney, R.C. (1995). “Nutritional properties of sorghum and millets”. In Sorghum and...


