DEVELOPMENT AND CHARACTERIZATION OF MULTIGRAIN COOKIES

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ABSTRACT
Multigrain cookies have been developed to meet the needs of health benefits of different cereal grain. Replacement of oat and barley flours with wheat flour in different levels has been carried out to evaluate the effect on physicochemical and sensory analysis of the multigrain cookies to find out the best treatment for commercialization. The results pertaining to sensory evaluation of cookies indicated that T_6 (10% oat, 10% and 80% wheat flour) got the highest score for fresh cookies which subsequently decreased but remained the highest. Physical analysis revealed that hardness was observed the highest in cookies T_0 which decreased significantly with increase in replacement of oat and barley flour. Fructurability values increased from cookies T_0 to cookies T_6 showing that cookies with oat and barley were crunchier. Color became darker and water activity of cookies increased significantly. Spread factor of cookies decreased with increasing the level of oat and barley flour.

Key Words: Oat, Barley, Wheat, Replacement, Physicochemical and Sensory

INTRODUCTION
Dietary components are now being good for human health; so there is a definite relationship between them, which revealed the commanding role of nutrients in normal functions of the body. Nutraceuticals and functional food products are become popular around the whole world. The consumer trend has been changed; they search not only for food but also for the health benefits. In coming decades, functional foods are now largest predicted trends. They are vast in number e.g., whole cereal grains, fortified or enhanced foods, vegetables & fruits, beverages and some dietary supplements (Schwager et al., 2008).

Interests have been developed to improve the nutritional quality of bread, cookies, biscuits and cakes. Barley and oat contains high contents of protein, lipids, minerals and dietary fiber (Demirbas, 2005). Oat and barley are good source of dietary fiber which save human from diabetes, cardiovascular disease, blood cholesterol and obesity (Spiller, 2001). Dietary fiber decreases sugar and blood cholesterol after meals for diabetics (Yeager, 1998). Dietary fiber contain cellulose, hemicellulose, β-glucan, gums, lignin and mucilage which reduce risk of colon cancer, hypercholesterolemia effect, absorption of glucose and improve digestive system (Potty, 1996). Barley is a good source of proteins, minerals and especially dietary fiber due to its β-glucan contents, which reduces glycemic index and blood cholesterol in body (Baik and Ullrich, 2008).

Cookies are important food items prepared from wheat flour. These are consumed by all groups of age but more commonly relished by school going children. Cookies are ideal for their nutritive value, palatability, compactness and convenience. For this purpose, wheat flour can be supplemented with other flours to make nutrient enriched final food products especially bread, biscuits and cookies. Considering the health benefits of oat and barley flour in other food product, attempts has been made to explore the effect of replacement of oat and barley with wheat flour on Physicochemical and Sensory evaluation of multigrain cookies.

MATERIALS AND METHODS
Procurement of raw material: Raw materials were purchased commercially from local market.
Sample preparation: Cookies evaluated in these experiments were prepared from commercially available flour with oat and barley flour in the ratios of 100:0:0 (T_0), 85:15:0 (T_1), 70:30:0 (T_2), 85:0:15 (T_3) and 70:0:30 (T_4), 70:15:15 (T_5), 80:10:10 (T_6). Cookies were prepared according to the method given in AACC (2000) with certain modifications. The recipe followed is composite flour (200 g), sugar (100 g), shortening (100 g), eggs (1 g) and baking powder (3 g). The ingredients were weighed accurately. Then creaming of shortening and sugar was done, followed by the addition of eggs. The flour and baking powder were added to the creamy mass and mixed to a homogenous mass by Hobart mixer for 30 min. The batter was then rolled out with rolling pin to a thickness of 3 inches having 1 inch diameter cut with the
help of a biscuit cutter. Cookies were placed on a baking tray inch distance and were baked at 425°F in a baking oven for 10 min. After cooling at ambient temperature, cookies were packed in polyethylene bags. The cookies were analyzed for physical, chemical and sensory evaluation.

Chemical analysis

Mineral profile

Potassium and Sodium were determined through flame photometer according to the method no. 40-70 and 40-71 described in AACC (2000). Iron, zinc, manganese, copper, calcium and magnesium were determined through Atomic Absorption Spectroscopy as described by Lorenz et al. (1977).

Physical analysis

Spread factor

The spread factor was calculated by determining thickness and width of cookies as placed 6 cookies around horizontal and vertical position according to the method of AACC (2000) through the following formula:

\[ SF = \frac{W}{T} \times CF \]

Where CF = Correction factor at constant atmospheric pressure (was 1.0 in this case).

Color measurement

The values of color for any product were determined by the instrument color meter (Neuhaus color test). It had upper and lower limits (55-151 respectively) for calibration with standards. The readings of the sample were compared with the standards (Rocha and Morais, 2003).

Texture analysis

Texture analysis of multigrain cookies was done by the TA.XT II texture analyzer. The display shows the results in term of force (g) and distance in term of millimeters (mm). The data was collected by its software for checking the results (Piga et al., 2005).

Water activity

Water activity of multigrain cookies was determined by hygropalm water activity meter. The ground sample multigrain cookies were filled in the plastic cups to the top and the Hygro palm probe was inserted in these cups. After almost three to four minutes the display was show the water activity reading (0-1), along with temperature (Piga et al., 2005).

Sensory evaluation

The cookies were evaluated by a panel of judges for color, taste, flavor and texture (Meilgaard et al., 1991).

Statistical analysis

The data was analyzed by using analysis of variance with the help of statistical package 8.1.

RESULTS AND DISCUSSION

Physical analysis

Spread factor is determined by the ratio of the values of width to the thickness. The highest spread factor was obtained by T₀ which is 4.62 followed by T₁ which is 4.59, whereas lowest spread factor was attained by T₅. Results of this study are comparable to the observations of Gupta et al. (2011). All the treatments for color showed highly significant results to each other. The mean value of color in T₃ was 164.33 which were significantly higher than T₀, T₁, T₂, T₄, T₅ and T₆ having values of 164.22, 147.00, 148.78, 161.78, 145.22 and 146.67 respectively. Lower values show higher (darker product) color in the product, while greater values were meant for lighter colors i-e; T₃ with color score 145.22 is darkest of all treatments while T₁ have 164.33 higher values and is lightest in color of all treatments. This increase in color darkness or decreasing value is accompanied by the increase in oat and barley flour with different levels.

The mean values of treatments for hardness (Force) ranges from 1700g to 2944.6g. This shows that T₀ had high values for hardness 2944.6g followed by T₀ had 2655.7g and it gradually decreased towards T₄ having 1700.4g. While the values for fracturability (Distance) ranges from 74.14cm having the highest values for T₀ and having lowest values for T₅. The present readings are similar with the results reported by Gupta et al. (2011), prepared cookies with barley flour supplementation at different levels from 0-40%. As barley flour increases hardness of cookies decreases from 4 to 2.5kg in terms of force.

The ratio of the vapor pressure of water in a food to the vapor pressure of pure water at the same temperature is called water activity (aw) of product. It is established that water activity has been related to chemical, biological and physical properties of foods and other products as compared to its total moisture content. Water activity effects on aroma, flavor, color, stability, texture and acceptability of raw and processed food product (Rockland, 1969). The mean values for water activity of all the treatments. The mean value for T₀ was 0.1760 which was lower than T₁, T₂, T₃, T₄, T₅ and T₆ having values of 0.1760, 0.1958, 0.2169, 0.2064, 0.1958, 0.1994.
### Table 1: Physical analysis of multigrain cookies

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Force</th>
<th>Distance</th>
<th>Water Activity</th>
<th>Color</th>
<th>Spread Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>2655.7 b</td>
<td>74.147 d</td>
<td>0.1760 e</td>
<td>164.22 a</td>
<td>4.622 a</td>
</tr>
<tr>
<td>T1</td>
<td>2133.7 c</td>
<td>74.835 cd</td>
<td>0.1958 d</td>
<td>147.00 bc</td>
<td>4.594 a</td>
</tr>
<tr>
<td>T2</td>
<td>1801.3 d</td>
<td>75.278 bc</td>
<td>0.2169 a</td>
<td>148.78 b</td>
<td>4.402 b</td>
</tr>
<tr>
<td>T3</td>
<td>2070.8 c</td>
<td>75.887 ab</td>
<td>0.2064 bc</td>
<td>164.33 a</td>
<td>4.393 b</td>
</tr>
<tr>
<td>T4</td>
<td>1700.4 d</td>
<td>74.832 cd</td>
<td>0.1958 d</td>
<td>161.78 a</td>
<td>4.322 c</td>
</tr>
<tr>
<td>T5</td>
<td>2500.4 b</td>
<td>75.336 bc</td>
<td>0.1994 cd</td>
<td>145.22 c</td>
<td>4.25 d</td>
</tr>
<tr>
<td>T6</td>
<td>2944.6 a</td>
<td>76.249 a</td>
<td>0.2076 b</td>
<td>146.67 bc</td>
<td>4.297 cd</td>
</tr>
</tbody>
</table>

Values for a particular column followed by different letters differ significantly ($p < 0.05$)

### Table 2: Mineral contents of multigrain cookies mg/100g

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Ca</th>
<th>Mg</th>
<th>Cu</th>
<th>Fe</th>
<th>Na</th>
<th>K</th>
<th>Zn</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>51.5a</td>
<td>2.3d</td>
<td>0.17b</td>
<td>8.72c</td>
<td>1.5e</td>
<td>7.2g</td>
<td>4.25a</td>
<td>0.021d</td>
</tr>
<tr>
<td>T1</td>
<td>48.39d</td>
<td>2.7bc</td>
<td>0.19b</td>
<td>9.16bc</td>
<td>1.73d</td>
<td>8.5f</td>
<td>3.94c</td>
<td>0.0253cd</td>
</tr>
<tr>
<td>T2</td>
<td>45.51g</td>
<td>3.1a</td>
<td>0.24a</td>
<td>9.65a</td>
<td>2.23c</td>
<td>10.4e</td>
<td>3.54f</td>
<td>0.0363b</td>
</tr>
<tr>
<td>T3</td>
<td>49.18c</td>
<td>2.6c</td>
<td>0.19b</td>
<td>9.16bc</td>
<td>3.2b</td>
<td>16.36c</td>
<td>3.84d</td>
<td>0.0263cd</td>
</tr>
<tr>
<td>T4</td>
<td>46.58f</td>
<td>2.9ab</td>
<td>0.24a</td>
<td>9.41ab</td>
<td>3.6a</td>
<td>18.8b</td>
<td>3.59ef</td>
<td>0.0457a</td>
</tr>
<tr>
<td>T5</td>
<td>47.32e</td>
<td>2.8b</td>
<td>0.23a</td>
<td>9.51b</td>
<td>2.2c</td>
<td>19.33a</td>
<td>4.04b</td>
<td>0.0353b</td>
</tr>
<tr>
<td>T6</td>
<td>50.62b</td>
<td>2.8b</td>
<td>0.17b</td>
<td>8.81c</td>
<td>2.07c</td>
<td>11.7d</td>
<td>3.64e</td>
<td>0.0267c</td>
</tr>
</tbody>
</table>

Values for a particular column followed by different letters differ significantly ($p < 0.05$)

### Table 3: Sensory Analysis of multigrain cookies

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Color</th>
<th>Taste</th>
<th>Flavor</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>7.4 b</td>
<td>7.03 c</td>
<td>6.8 c</td>
<td>6.63 d</td>
</tr>
<tr>
<td>T1</td>
<td>7.33 b</td>
<td>7.36 b</td>
<td>6.97 bc</td>
<td>6.82 cd</td>
</tr>
<tr>
<td>T2</td>
<td>6.63 d</td>
<td>6.43 d</td>
<td>7 bc</td>
<td>6.93 bcd</td>
</tr>
<tr>
<td>T3</td>
<td>6.96 c</td>
<td>7 c</td>
<td>6.83 bc</td>
<td>7.16 bc</td>
</tr>
<tr>
<td>T4</td>
<td>6.9 cd</td>
<td>6.66 d</td>
<td>6.6 8c</td>
<td>6.57 d</td>
</tr>
<tr>
<td>T5</td>
<td>7.86 a</td>
<td>7.53 ab</td>
<td>7.16 b</td>
<td>7.27 ab</td>
</tr>
<tr>
<td>T6</td>
<td>7.53 b</td>
<td>7.76 a</td>
<td>7.73 a</td>
<td>7.63 a</td>
</tr>
</tbody>
</table>

Values for a particular column followed by different letters differ significantly ($p < 0.05$)
and 0.2076. As level of oat and barley flour increases, water activity also increases because these flours contain high moisture content than wheat flour. Similar results were obtained by (Mustaq et al., 2010) which ranges from 0.2 - 0.24. Were observed as 8.5, 10.4, 16.367, 18.8 and 11.7 mg/100g, respectively.

The mean value for magnesium contents in all the treatments vary significantly. The highest mean value is present in Td is 0.021mg/100g for magnesium content and lowest mean value in T0. The mean values for T1, T2, T3, Td, T5 and T6 were observed as 0.0253, 0.0363, 0.0263, 0.0457, 0.0353 and 0.0267 mg/100g, respectively.

**Mineral profile**

The mean value for T0 is 51.5 mg/100g for calcium content is highest among the treatments, and T2 has lowest mean value 45.51mg/100g. The mean values for T1, T3, T4, T5 and T6 were observed as 48.39, 49.183, 46.58, 47.32 and 50.62 mg/100g, respectively. These results show reducing trend of calcium content with high the level of oat and barley flour because inhibitors i.e. higher polyphenol and phytic acid contents than wheat which bind calcium in food (Dhingra and Jhood, 2001). The mean values for iron content, T2 has highest mean value 9.6533 mg/100g followed by T3 which has mean value of 9.51 mg/g. Same trend in results is obtained in T1 and T3 which had values of 9.1667 and 9.16 mg/100g, respectively. With increasing concentrations of oat and barley flour in treatments, there is a gradual increase in Iron contents of multigrain cookies. The results are similar to Gupta et al. (2011). These results are also confirms the analysis of iron by Skrbic and Cvejanov (2011) results.

The mean value for copper content in T2 is highest 0.24mg/100g and T0 has lowest mean value 0.17. The mean values for T1, T3, T4, T5 and T6 were observed as 0.19, 0.19, 0.243 and 0.176 mg/100g, respectively. Oat and barley have high amount of copper contents, so increasing trend is occur in multigrain cookies for copper contents that confirms the similar results with Skrbic and Cvejanov (2011).

The mean values for sodium content, T4 contains highest mean value 3.6mg/100g for sodium content having 30% barley flour and T0 has lowest mean value 1.5mg/100g. The mean values for remaining treatments were ranging from 1.73 to 3.2mg/100g. The same results of Gupta et al. (2011) confirm the present results. The mean value for potassium contents in all treatments vary significantly. The highest mean value for T3 is 19.33 mg/100g for potassium content and T0 lowest mean value is 7.2 mg/100g. The mean values for T1, T2, T3, T4 and T6

The mean value for zinc contents in all treatments vary significantly. The highest mean value 4.25 mg/100g for zinc content was found in T0 and lowest mean value 3.64mg/100g in T6. The mean values for T1, T2, T3, T4 and T5 were observed as 3.94, 3.54, 3.84, 3.59 and 4.04 mg/100g, respectively. The mean value for manganese contents is represented. The highest mean value found in T2 for manganese content is 3.1 and lowest mean value in T0 is 2.3. The mean values for T1, T3, T4, T5 and T6 were observed as 2.7, 3.1, 2.6, 2.8 and 2.8 mg/100g, respectively.

**Sensory Analysis**

One of the most important criteria to assess the quality and acceptability of product development is its sensory evaluation. Quality of product firstly depends upon sensory characteristics then price. Sensory evaluation is of major reflection and is conducted to evaluate the reply of judges/consumers towards the end product (Meilgaard et al., 2007). The color results reveal that there is highly significant difference among all the treatments for color of multigrain cookies. The mean score for the color of cookies was obtained from the judges, these values are 7.4, 7.33, 6.63, 6.96, 6.9, 7.86 and 7.5 for T0, T1, T2, T3, T4, T5 and T6, respectively. T3 was at top with 7.86 score followed by T6 and T0 where as T2 receive lowest i.e. 6.63. With respect to color T3 was liked by all the judges because it has desired color to the cookies where as T0, T1 and T6 were also accepted. But T2 were not liked by the judges due to their intensive dark color. Similar results were also observed by Gupta et al. (2011), the decreasing trend of color in cookies are due to increasing level of barley flour. Similar results were also observed by Elahi, (1997), who prepare cookies from composite flour and gram and observed a decrease in color. This slight deterioration in the color of cookies was due to absorption of moisture from surroundings, oxidation of fats and Millard reaction because these contain higher levels sugar and protein contents.

The mean values for flavor of cookies exhibited that there is no significant difference between T0 and T4, whereas the highly significant results occur between remaining treatments. T1 and T3 receive fair values; T6 was at the top followed by T3 for the flavor score of multigrain cookies. The mean values T6 and T3 were liked by all the judges for flavor of multigrain cookies. T1 and T3 also liked by all the judges. All the remaining treatments obtained varying score for flavor. Similar results were observed by Gupta et al. (2011) regarding to different level of barley and oat flour. The decreasing trend was observed in his study with increasing level of barley flour. Sharif et al. (2005) prepared cookies from rice bran oil and notice decreasing trend in the flavor. Similar
results were reported by Pasha (2001) who prepared cookies with dietetic sweeteners.

The taste results concerning with the score for taste of the cookies prepared by replacing wheat flour with oat and barley flour (composite flour) are illustrated in table. The effect on treatments is although slight. Means for taste revealed that judges ranked $T_6$ at first position with 7.76 score and $T_2$ and $T_4$ are at the last position with 6.43 and 6.66. $T_1$ was also favored by the judges.

CONCLUSION

Oat and barley are good source of proteins, minerals and dietary fiber which are good for human health. As level of oat and barley flour increases in multigrain cookies mineral profile have improved. Color of cookies become darker, texture become softer, water activity slightly increased and spread factor slightly reduced. Overall, $T_6$ treatment containing 10 % oat and 10 % barley flour has shown better results for minerals, color, texture, spread factor and highly accepted by sensory panel.

REFERENCES