EFFECT OF SWEET POTATO FLOUR ON QUALITY OF COOKIES

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ABSTRACT

This study was carried out at Food Technology Section, Post Harvest Research Centre, AARI, Faisalabad to investigate effect of replacement of wheat flour with sweet potato flour on quality of cookies. Sweet potato flour, composite flours and cookies were analyzed for colour changes and other physical and sensory attributes. Sweet potato flour was supplemented at proportions (5, 10, 15, 20 and 25%) with plain wheat flour in standard formulations of cookies. The addition of sweet potato flour lowered the width of cookies from 282.00 to 264.00 mm among treatments while thickness was also decreased from 68.90 to 65.00 mm. Ultimately the value of spread factor also reduced from 41.47 to 40.00 with increasing level of sweet potato flour. No significant difference for physical parameters of cookies was observed during storage. The colour value for cookies i.e. L*, a* and b* varied from 65.26 to 61.82, 20.37 to 16.95 and 28.89 to 25.95, respectively. Sensory evaluation revealed that level of sweet potato flour beyond 10 percent lowered the overall acceptability. Within treatments maximum score for overall acceptability was observed for T2 (8.60) having 10 percent sweet potato flour followed by T3 (8.40) containing 15 percent sweet potato flour at 0 day. T2 was also found to be the most acceptable with respect to organoleptic characteristics especially taste and flavour developed during baking as compared to other treatments during storage.

KEYWORDS: Ipomola batatas; flour; cookies, keeping quality; Pakistan.

INTRODUCTION

Sweet potato (Ipomoea batatas L.) is an important alternative source of carbohydrates and attains fourth place after rice, corn and cassava. Presently, this crop is considered as having low economic value but it has significant social importance. It is most versatile for snack food, but it is used as staple food or as a rice substitute in many countries (28).

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Sweet potato has a large potential to be used as food in developing nations with limited resources because of short maturity time, ability to grow under diverse climatic conditions and on less fertile soil. Sweet potato flour can serve as a source of energy and carbohydrates, beta carotene (pro-vitamin A), minerals (Ca, P, Fe and K) and dietary fibre which can add natural sweetness, colors and flavour to processed food products (24, 27).

Traditionally cookies are made from wheat flour but small quantities of other cereal flours or starches can also be added to give special flavour or structural properties. In recent years the interest in high fibre content in foods has greatly increased. High dietary fibre supplemented cookies have been prepared by replacing wheat flour with cereal by-products like corn bran, rice bran or barley husk (4, 8, 22).

Most of the research has been focused on the development of new products using sweet potato flour rather than on efficient methods to produce and store the flour (10). Hagenimana et al. (7) reported that addition of orange-fleshed sweet potato in buns, chapattis and mandazis greatly increased the content of total carotenoids in these products. Addition of various proportion of sweet potato flour in wheat flour can increase the nutritive values in terms of fibre and carotenoids. This also helps lower the gluten level and prevent from coeliac disease (23). Blending of sweet potato flour with wheat flour can be used for production of bakery goods with improved functional properties and reduced retrogradation, staling rate and production time (1) and also helps in making a good baking product with increased economic value.

Baking industry in Pakistan is flourishing day by day. A wide variety of baked goods is available in market to fulfill consumer demand for nutritional requirement. Now people are becoming more conscious about their health and nutrition. They require foods that are convenient with good taste, reasonable price and carry favorable nutritional image. Besides other baked products, cookies are one of the most popular bakery products, widely consumed due to its ready-to-eat nature, good nutritional quality, low cost and longer shelf life that has also been enriched with dietary fibre (3). Biscuits are ideal for their nutritional value, palatability, compactness and convenience. These are also important food reserves for exploration, in war or flood and as an aid for the famished people. Many travelers and explorers have, over the centuries, been grateful to humble cookies for these properties. Indeed, cookies still form a significant component of many emergency food supplies.

The present research was conducted to find out most suitable proportion of sweet potato flour and wheat flour for cookies preparation keeping in view its physical and sensory parameters.

MATERIALS AND METHODS

This study was conducted in Food Technology Section, Post Harvest Research Centre, AARI, Faisalabad, Pakistan during the year 2010. Sweet potato and other ingredients for the preparation of cookies e.g. wheat flour, sugar, shortening, baking powder and eggs were purchased from local market. Sweet potato roots were washed and trimmed to make them free from soil and other foreign materials, rotten part or insect damage, etc. These were peeled and cut into thin slices manually. Slices were then immersed in solution containing potassium meta-bisulphite (0.5%) for 15 minutes. Sweet potato slices were dried on perforated wooden trays in a tunnel dehydrator at 60°C till 10 percent moisture content. The dried chips were milled into flour using the grinder and passed through 80 mesh sieve to obtain flour of uniform size. Flow diagram for preparation of sweet potato flour cookies is given below:

Fig.1. Flow diagram for preparation of sweet potato flour cookies
Wheat flour and sweet potato flour were used in different proportions viz. 100:0 (T₀), 95:5 (T₁), 90:10 (T₂), 85:15 (T₃), 80:20 (T₄) and 75:25 (T₅). Cookies were prepared with some modifications according to the method as described in AACC (3) with the formulation as given in Table 1.

Table 1. Formulation for cookies.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour</td>
<td>200 g</td>
</tr>
<tr>
<td>Sugar</td>
<td>100 g</td>
</tr>
<tr>
<td>Shortening</td>
<td>100 g</td>
</tr>
<tr>
<td>Baking powder</td>
<td>3 g</td>
</tr>
<tr>
<td>Eggs</td>
<td>1 (in No)</td>
</tr>
<tr>
<td>Water</td>
<td>15 – 20 mL</td>
</tr>
</tbody>
</table>

After weighing the ingredients accurately, fat and sugar were creamed in a mixer with a flat beater for two minutes at slow speed, followed by addition of eggs. Creaming continued till foaming was occurred. The wheat flour, baking powder and water were added to the creaming mass and mixed to a homogeneous mixture for five minutes at high speed. Finally, flour containing various proportions of sweet potato flour, which had been sieved twice with baking powder was added and mixed for three minutes at medium speed.

The dough was then sheeted to a thickness of 3.00 mm with the help of a rolling pin and aluminum frame of standard height. The cookies were cut with a cookies die of 35 mm diameter and transferred to a lightly greased baking tray at a proper distance. The cookies were baked at 218°C in baking oven for 10-12 minutes. After baking, cookies were cooled at room temperature and packed in air tight polythene bags for further storage studies.

**Proximate analysis of sweet potato flour and plain wheat flour**

Sweet potato flour and plain wheat flour were analyzed for moisture, protein, ash, fat and crude fibre and nitrogen free extract, according to the methods described in AACC (1).

**Colour (Lab)**

The colour values of flour and cookies were measured using the L*, a* and b* colour space (CIE-LAB Space) with Color Tech-PCM (USA). The L* value indicates (lightness), a* and b* values are chromaticity coordinates (a* from red (+) to green (-) and b*, from yellow (-) to blue (-)).
Physical analysis of cookies

The packed cookies, prepared from different levels of sweet potato flour were placed at room temperature. Physical characteristics of cookies like width, thickness and spread factor were measured fortnightly for 90 days storage according to the methods described in AACC (3).

**Width (W):** Width of cookies was measured by placing six cookies horizontally (edge to edge) and rotated at 90° angle for duplicate reading.

**Thickness (T):** The thickness of cookies was measured by placing six cookies on one another and the duplicate reading was recorded.

**Spread factor (SF):** The spread factor was calculated according to the formula SF = (W/T x CF) x 10 where CF=Correction factor at constant atmospheric pressure (10.0 in this case).

Sensory evaluation

Characteristics like colour, flavour, taste and overall acceptability were evaluated by a panel of five semi-trained judges selected from Food Technology Section, AARI, Faisalabad. Sensory characteristics like colour, flavour, taste and overall acceptability were measured at 15 days interval upto 90 days, according to the procedure described by Meilgaard et al. (14).

Statistical analysis

The data obtained were statistically analyzed for analysis of variance (ANOVA) by using 2-factorial completely randomized design using LSD at P≤0.05 according to the method described by Steel et al. (21).

**RESULTS AND DISCUSSION**

Proximate analysis of sweet potato flour and plain wheat flour

Proximate analysis (Table 2) indicated that moisture content of sweet potato flour was 8.7 percent with high fibre (8.5%) but very low protein contents (3.1%). The ash percentage in sweet potato flour was recorded upto 2.1 percent with 76.39 percent nitrogen free extract (NFE). These results are in close agreement with findings of Singh et al. (20) who have reported 8.7 percent moisture contents, 2.3 percent protein, 9.4 percent fibre and 1.56
Table 2. Proximate analysis of sweet potato flour and plain wheat flour.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Composition (%)</th>
<th>Sweet potato flour</th>
<th>Plain wheat flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture</td>
<td>8.7</td>
<td>11.9 ± 0.1</td>
</tr>
<tr>
<td>2</td>
<td>Protein</td>
<td>3.1</td>
<td>11 ± 0.07</td>
</tr>
<tr>
<td>3</td>
<td>Fat</td>
<td>1.21</td>
<td>1.68 ± 0.06</td>
</tr>
<tr>
<td>4</td>
<td>Fibre</td>
<td>8.5</td>
<td>0.07 ± 0.08</td>
</tr>
<tr>
<td>5</td>
<td>Ash</td>
<td>2.1</td>
<td>0.68 ± 0.01</td>
</tr>
<tr>
<td>6</td>
<td>NFE</td>
<td>76.39</td>
<td>74.67 ± 0.1</td>
</tr>
</tbody>
</table>

percent ash in sweet potato flour. Mebpa et al. (13) also reported similar results regarding composition of plain wheat flour i.e. 11.31 percent moisture, 12.86 percent protein, 1.40 percent lipids, 0.82 percent crude fat and 0.46 percent ash.

Colour analysis of flour blends and cookies

Effect of sweet potato flour on colour values of flour blends and cookies was significant (Tables 3). L* value of flour blends decreased significantly from 95.75 to 84.96 with increasing the proportion of sweet potato flour. However this value decreased from 65.26 to 61.82 in the cookies. The value of a* increased from 2.62 to 5.92 with increasing the proportion of sweet potato flour in flour blends. In cookies the results showed a decline of a* value from 20.37 to 16.95 (Table 3). It indicated that redness in flour blends increased with the addition of sweet potato flour while in cookies redness decreased. The b* value which shows yellowness of flour increased significantly from 9.84 to 14.65 while in cookies this value reduced from 28.89 to 25.95 with increasing the proportion of sweet potato flour (Table 3). The yellow-orange colour of sweet potato flour was due to the presence of carotenoid pigments, which affected the red-green chromaticity (24). The results coincide with those of Singh et al. (19) who observed similar pattern in colour changes in the preparation of sweet potato flour incorporated cookies at different proportions.

Table 3. Effect of sweet potato flour on color of flour blends and cookies.

<table>
<thead>
<tr>
<th>Wheat flour sweet: potato flour</th>
<th>Color values of flour blends</th>
<th>Color values of cookies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L*</td>
<td>a*</td>
</tr>
<tr>
<td>100:0</td>
<td>95.75d</td>
<td>2.62a</td>
</tr>
<tr>
<td>95:5</td>
<td>93.69c</td>
<td>3.25b</td>
</tr>
<tr>
<td>90:10</td>
<td>90.78ab</td>
<td>3.98bc</td>
</tr>
<tr>
<td>85:15</td>
<td>89.71bc</td>
<td>4.56c</td>
</tr>
<tr>
<td>80:20</td>
<td>87.94b</td>
<td>5.03cd</td>
</tr>
<tr>
<td>75:25</td>
<td>84.96a</td>
<td>5.92d</td>
</tr>
</tbody>
</table>

The values denoted by different letters in the same column are significantly different (p<0.05)

The flour blends were analyzed for colour changes in each treatment. It was observed that with gradual increase in sweet potato flour there was a reduction in L* value while a* and b* values were gradually increased with the addition of sweet potato flour. Similar results are also found by Singh et al. (19) while studying effect of incorporating sweet potato flour in wheat flour on quality characteristics of cookies.

**Physical characteristics**

**Width (W):** Analytical results indicated (Fig. 1) that different levels of sweet potato flour showed significant effect on the width of cookies. A decreasing trend was found with the increase of sweet potato flour level. At 0 day storage, T₀ exhibited maximum width (288mm) followed by T₁ (282mm), while T₅ exhibited minimum width (264mm) followed by T₄ (269mm). It is clear that enhancement in level of sweet potato flour significantly decreased the width of cookies which is attributed to an increase in fibre contents due to addition of sweet potato flour, a rich source of dietary fibre.

![Fig. 1. Effect of treatments and storage on width of cookies](image)

However, storage exhibited non-significant effect on the width of cookies. Sharif et al. (17) prepared fibre and mineral enriched de-fatted rice bran supplemented cookies. They observed a decreasing trend in width from 44.15 to 36.53mm with percent increase in rice bran incorporation. Cookies baked from flours with lipids have smaller diameters than those baked from un-extracted flours. So, it can be inferred that due to smaller fat content (1.21%) in sweet potato flour than soft wheat flour (typically 2%), diameter and width of cookies decreased with an increase in sweet potato flour proportion (15).

**Thickness (T):** The thickness of cookies decreased significantly from 68.9 to 65.00mm among treatments, with increasing percentage of sweet potato
flour (Fig. 2). The results revealed that at 0 day $T_0$ and $T_1$ exhibited maximum thickness (68.10mm) and (68.90mm) respectively, followed by $T_3$ (67.00mm) while $T_5$ exhibited minimum thickness 65.00mm. It is evident that increased level of sweet potato flour significantly decreased the thickness of cookies.

The results for storage study had shown non-significant effect on cookies thickness which decreased from 68.9 to 64.65mm during 0 to 90 days interval. These results are in close agreement with the findings of Singh et al. (19) who studied the effect of incorporating sweet potato flour with wheat flour on quality characteristics of cookies. They observed that thickness of cookies decreased from 48 to 40mm with increase in sweet potato flour percentage.

**Spread factor (S):** The results pertaining to spread factor of cookies revealed a reduction in spread factor from 42.35mm ($T_1$) to 40.00mm ($T_5$) among treatments as the level of sweet potato flour was increased (Fig. 3). At 0 day $T_0$ exhibit maximum spread factor 42.35 mm while $T_5$ exhibited minimum spread factor (40.00 mm). Remaining treatments $T_1$ (41.47 mm), $T_2$ (41.34 mm) $T_3$ (40.89 mm) and $T_4$ (40.75) also followed the same decreasing trend of spread factor. The results elucidated that treatments had significant effect on spread factor of cookies due to replacement of different levels of sweet potato flour with plain wheat flour. However, storage exhibited non-significant effect on cookies spread factor.
Hussain *et al.* (9) also found that supplementation of 30 percent flaxseed flour reduced the spread factor from 48.49 to 47.71 mm. It has been established that cookies spread is strongly correlated to the water absorption capacities of the flour (26). Since the water absorption capacity of sweet potato flour (2.375 ml/g) is higher than that of wheat flour (1 ml/g), rapid partitioning of free water to hydrophilic sites of sweet potato flour is presumed to be higher than wheat flour. Therefore, it can be concluded that sweet potato flour additions limit the spreading of cookies. Rapid partitioning of free water to hydrophilic sites during mixing increases dough viscosity, thereby limiting cookie spread.

**Sensory evaluation**

Cookies prepared under different treatments were stored at ambient temperature for 90 days. These were evaluated for colour, flavour, taste, texture and overall acceptability at 15 days interval by a panel of judges. The results are given below:

**Colour:** The scores regarding colour ranged from 8.6 to 6.4 (Fig. 4) for 90 days of storage. T2 (10% sweet potato flour) was preferred by the judges because it gave the desired colour to the cookies which distinguished it from others. However, other treatments were also acceptable.

Storage studies indicated a significant decrease in mean color score of cookies. There was darkening in colour during storage that attained lower color scores in all treatments. The mean colour scores were gradually decreased with the passage of time.
These results are in close agreement with the findings of Elahi (6) who reported a gradual decrease in colour of biscuits made from composite flours of wheat and gram during storage of 90 days. Pasha et al., (16) also observed the same pattern of decrease in colour during 60 days storage of cookies. The deterioration in colour of the biscuits might be due to the absorption of moisture from the atmosphere and as a result of Maillard’s reaction, biscuits possessed higher amounts of protein and sugar (13).

**Flavour:** Maximum mean scores of judges was recorded in T2 (8.20) followed by T3, while minimum score was observed in T5 (6.4) followed by T4 at 90 days storage interval (Fig. 5).

The storage trend showed a gradual decline in flavor of cookies which might be attributed to absorption of moisture that resulted in fat oxidation. Similar results were also recorded by Sharif et al. (17). However after 90 days of storage all the cookies remained acceptable.
**Taste:** The results revealed that all cookies obtained varying scores for taste. However, maximum score was observed in $T_2$ (8.4) while $T_5$ (7.00) had minimum scores (Fig. 6) at 0 day. Means for taste of cookies revealed that $T_3$ (8.00) and $T_4$ (7.8) were at par with each other but differed significantly from other treatments.

![Fig. 6. Effect of Storage on taste of sweet potato flour cookies](image)

Elahi (6) also found a decrease in mean score for taste from 6.62 to 5.81 after 90 days storage in biscuits prepared from composite flour. Variation in taste is due to the variable percentage of sweet potato flour used in cookies preparation while decrease in taste during storage may occur due to the rancidity of fat.

**Overall acceptability:** Overall acceptability was determined on the basis of quality scores obtained for colour, flavour and taste of cookies. The results (Fig. 7) disclosed that judges placed $T_2$ (10% sweet potato flour) at first position (8.60 scores) and $T_5$ at bottom (7.40) at 0 day.

![Fig. 7. Effect of Storage on overall acceptability of sweet potato flour cookies](image)

During storage an identical decreasing pattern in scores for overall acceptability was noted in all samples. The highest score (8.60) was noted at 0 day in $T_2$ which decreased upto 7.20 after 90 days of storage but cookies remained acceptable at the end of storage period. The decrease in overall...
acceptability was due to decrease in colour, flavour, taste, texture and crispness. Sharif et al. (18) have also reported a decreasing trend in overall acceptability from 7.24 to 6.45 after 45 days storage of rice bran supplemented cookies.

CONCLUSION

It is concluded that a proportion of 90:10 of plain wheat flour and sweet potato flour produced good results without any adverse effect on physical and sensory characteristics of cookies. It was also noted that sweet potato flour improved the flavour and texture of cookies and can significantly improve the dietary fibre and mineral contents of the product. These results can be further applied for the development of nutritious high fiber and low gluten cookies.

REFERENCES