Formulation, Chemical and Textural Analysis of biscuits prepared with Malted Green Gram (Vigna Radiata)

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Abstract

Several types of weaning foods and convenience foods are available in markets which are usually nutritious blends of cereals and pulses. The nutrients targeted are mostly not easily absorbed by body. Malting is a controlled germination process which activates the enzymes of the resting grain resulting in high bioavailability of nutrients. Green gram procured was malted by optimizing time and temperature and malt thus produced was chemically and nutritionally analyzed (moisture, ash, protein, iron and calcium). Malted green gram thus prepared was used to partially replace refined wheat flour in biscuit preparation by standardizing at different levels of incorporations 25, 30, 40, 50 and 55%. Biscuits prepared were analyzed for their sensory attributes and the most accepted variations were selected. The developed variations were then further analyzed for their nutritional and textural properties. Sensory evaluation results revealed that 40% incorporation of malted green gram flour was the most acceptable followed by 50% level. Ash and fiber contents gradually increased with higher incorporation levels. The protein, iron and calcium content of biscuits with 40% malted flour increased by 32.7, 470.13 and 29.14% respectively compared to control biscuits. Textural attributes as fracturability increased with the incorporation of malted green gram flour. Results indicate that malted green gram biscuits had improved nutrient content along with their high bio-availability for easy absorption and are available as a ready to eat nutrient powerhouse product.

Key words: New Product Development, Weaning Foods, Green Gram, Biscuits, Malting.

1. Introduction

Protein energy malnutrition among children is one of the major problems India is facing today. It is majorly attributed to the low nutritional quality of traditional feedings (1). The interaction of poverty, poor health and poor complementary feeding practices has a multiplier effect on the general welfare of the children population and also contributes significantly towards growth retardation, poor cognitive development, illness and death amongst children in developing countries (2). Therefore, development of acceptable, high protein quality, Ready To Eat (RTE) products is on rise to improve human diets, particularly among the vulnerable groups. Among the RTE snacks, biscuits possess several attractive features including wider consumption base, relatively long shelf life and good eating quality.

No one legume or cereal can provide adequate amounts of all nutrients to meet the nutritional requirements of a child. Pulses combined with cereals offer the most practical way of solving the problem of protein malnutrition in countries like India. Green gram (Vigna radiata) belongs to the family Leguminoseae. Green gram is one of the important pulse crops in India since ancient times and it is believed to be a native of India and Central Asia. Legumes are rich in protein, complex carbohydrates (dietary fibres) and are important source of minerals and vitamins. Among the grain legumes, green gram is known for its easy digestibility, low flatulence potential and high protein content (3). However, their efficient utilization is affected by the presence of anti-nutritional factors such as tannins, phytins and trypsin inhibitors. To increase the usefulness anti-nutritional factors however needs to be addressed.

Malting is a controlled germination process which activates the enzymes of the resting grain resulting in the conversion of...
of starch to fermentable sugars, partial hydrolysis of proteins and other macromolecules (4). Several studies have reported higher levels of nutrients and lower levels of anti-nutritional factors in sprouts compared to the non-germinated seeds. During germination there is a substantial increase in combined β-amylase activity. Superoxide dismutase (SOD)-like activity increases significantly when compared to the raw seeds upon germination which is two-fold higher and almost three-fold higher than on the last day of germination (5). Drying process in malting, stops the germination process further and presents enzymes in active form along with high bio-accessibility of nutrients in the end product. Moreover, due to dehydration the total solids viz. sugars, proteins, minerals etc are concentrated, exerting osmotic pressure to inhibit the micro-organisms (6).

Long shelf life of biscuits makes large scale production and distribution possible. Biscuits are made by baking dough from refined wheat flour, water and other ingredients. The process of refining of wheat removes bran and germ, which are the major source of nutrients. Hence, biscuits prepared from refined wheat flour, posses low nutritional quality. Hence, several studies have reported incorporation of nutritionally rich ingredients into the making of biscuits (7, 8). Biscuit being commonly eaten by all age groups make an attractive RTE option for protein fortification and other nutritional improvements, particularly for children feeding programmes, the elderly and low income groups. The protein from legumes provides lysine, which is the first limiting amino acid in wheat. The protein enrichment in bakery products may be achieved through incorporation of protein rich non-wheat flours. Therefore, fortification with high protein with reduced anti-nutritional factors and nutrients in biologically active form from malted green gram flour could provide a good opportunity to improve the nutritional quality of many people.

The aim of this study was to prepare green gram malt and standardize biscuit preparation by partial replacement of refined wheat flour with green gram malt. The sensory evaluation of the prepared biscuits was also done which were then nutritionally and texturally analyzed.

Fig 1: Preparation of Green gram malt

2. Materials and Methods

2.1. Materials

Refined wheat flour was obtained from Delhi Flour Mill, New Delhi and green gram was obtained from Hauz Khas market, New Delhi. Green gram was sieved, cleaned, washed and dried before malting. The other consumable products were obtained from Hauz Khas market, New Delhi and they were as follows-fat, sugar, coconut powder and baking powder.

2.2. Preparation of malted green gram flour

The process of preparation of malted green gram flour was standardized according to the method described by Pathirana et al with slight modifications (6). The cleaned green gram grains were steeped in water for 18hrs at room temperature and allowed to germinate for 72hrs. They were mixed regularly and watered when appeared dry. Germinated grains were then dried in a dehydrator, rootlets removed, grinded to fine malt powder and stored in an air-tight container for further use.

Table 1. Recipe for biscuit samples

<table>
<thead>
<tr>
<th>Replacement Levels</th>
<th>RWF (g)</th>
<th>Malted Green gram Flour (g)</th>
<th>Butter (g)</th>
<th>Sugar (g)</th>
<th>Coconut Powder (g)</th>
<th>Baking Powder (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. (25%)</td>
<td>22.5</td>
<td>7.5</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>1/4 t</td>
</tr>
<tr>
<td>II. (30%)</td>
<td>21</td>
<td>9</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>1/4 t</td>
</tr>
<tr>
<td>III. (40%)</td>
<td>18</td>
<td>12</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>1/4 t</td>
</tr>
<tr>
<td>IV. (50%)</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>1/4 t</td>
</tr>
<tr>
<td>V. (55%)</td>
<td>13.5</td>
<td>16.5</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>1/4 t</td>
</tr>
</tbody>
</table>

RWF: Refined Wheat Flour
2.3. Standardization of biscuit

Biscuit was prepared by partially replacing refined wheat flour (RWF) with 25, 30, 40, 50 and 55% of malted green gram flour (MGF). The percent increase in replacement was done till they were acceptable without giving off flavors (Table 1). Recipe was tried and modified to mask the malt off-flavor with ajwain or carom (Trachyspermum ammi), cocoa powder and coconut powder. The recipe with coconut powder was finally selected with due consideration from sensory panel. Recipe of the standardized biscuits was as follows- cereal mixture (100%), fat (50%), sugar (43%), coconut powder (40%), milk (20%) and baking powder (4%). Preparation was as follows- Firstly, cereal mixture and baking powder were sieved together aiding in better mixing of baking powder. Coconut powder was then added to the above mixture. Fat (butter) and sugar were creamed together separately and as creaming continued, flour mixture and milk was added to form dough. The biscuit dough obtained was sheeted on a metal platform to a thickness of 3 mm using wooden rolling pin. The dough was cut into circular shape using a metallic cutter and arranged on a baking sheet and baked in a pre-heated oven to 160°C until golden brown. After baking, biscuits cooled to room temperature, packed in polypropylene pouches and sealed for further analysis.

<table>
<thead>
<tr>
<th>Nutritional Components</th>
<th>Refined Wheat Flour</th>
<th>Raw Green Gram Flour</th>
<th>Malted Green Gram Flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>10.3 ± 0.03</td>
<td>10.45 ± 0.02</td>
<td>9.1 ± 0.03</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.48 ± 0.1</td>
<td>2.68 ± 0.12</td>
<td>1.82 ± 0.11</td>
</tr>
<tr>
<td>Protein (g/100g)</td>
<td>7.71 ± 0.03</td>
<td>26.08 ± 0.03</td>
<td>30.5 ± 0.05</td>
</tr>
<tr>
<td>Iron (mg/100g)</td>
<td>0.83 ± 0.12</td>
<td>5.5 ± 0.14</td>
<td>4.9 ± 0.35</td>
</tr>
<tr>
<td>Calcium (mg/100g)</td>
<td>14.1 ± 0.11</td>
<td>130 ± 0.23</td>
<td>123 ± 0.14</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations (n=3)

2.4. Nutritional Analysis

Percentages of moisture, ash and protein (Kjeldahl method) were determined according to the method described by AOAC (9). Furthermore, percentages of iron and calcium were determined using the atomic absorption spectroscopic method (9).

2.5. Sensory Evaluation

Selected biscuit samples coded with different numbers were presented to 30 trained panelists from Institute of Home Economics, University of Delhi, New Delhi. A five point Hedonic rating scale (1- Unsatisfactory to 5- Excellent), was used. Panelists were asked to rate each sensory attribute; appearance, color, texture, taste, aftertaste and overall acceptability.

Table 3. Effect of malted green gram flour on sensory characteristics of biscuits

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean ± SD</th>
<th>F. Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>With 40% GM</td>
</tr>
<tr>
<td>Appearance</td>
<td>3.90±0.80</td>
<td>3.73±0.73</td>
</tr>
<tr>
<td>Colour</td>
<td>3.83±0.94</td>
<td>3.50±0.97</td>
</tr>
<tr>
<td>Texture</td>
<td>3.90±0.84</td>
<td>3.60±0.93</td>
</tr>
<tr>
<td>Taste</td>
<td>4.03±0.61a</td>
<td>3.75±0.62ab</td>
</tr>
<tr>
<td>After taste</td>
<td>3.95±0.83a</td>
<td>3.61±0.60ab</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>4.03±0.66a</td>
<td>3.71±0.90ab</td>
</tr>
</tbody>
</table>

GM= Green gram malt biscuits
Values are means ± standard deviations
Means with different superscripts are significantly different as tested by Tukey'sHSD
*Significant at p <0.05

Fig 2. Comparison of peaks among the biscuit samples (an average of three determinations)
2.6. Texture Analysis of the Biscuits
Texture analysis of the standardized biscuits was done by using the Texture Analyzer TAXT2 with exponent software. The hardness and fracturability of the biscuits were analyzed. Biscuits in triplicate were put in the analyzer where once the trigger force was attained; the force was seen to increase until such time till the biscuit fractures and breaks into pieces. This is observed as the maximum force and can be referred to as ‘hardness’ of the sample. The distance at the point of break is the resistance of the sample to bend and so relates to the ‘fracturability’ of the sample. The results were obtained in the form of a graph, force vs time or distance (Fig 1). Once the tests were performed, the results were analyzed through MACRO (software for analysis of curve) (10).

2.7. Statistical analysis of Data
The statistical analysis was conducted using the SPSS package. The sensory analysis was statistically analyzed. Analysis of variance and Tukey’s HSD was used to assess significant differences between means at 5% level of probability. Each experiment (in triplicate) repeated at least twice and the values presented in terms of means ± standard deviation.

3. Results and Discussions
3.1. Nutritional analysis of raw materials
Mean values for analysis of raw materials are tabulated in Table 2. The moisture content of refined wheat flour and malted green gram flour was 10.3 and 8.2% respectively. Ash content of MGF and RWF were 2.68 and 0.48% respectively. It could be attributed to least amount of fiber present in RWF lost during its refining with the removal of bran and germ. It was observed that ash and moisture percents decreased post malting of green gram. Protein content of RWF, green gram flour and MGF was 7.71, 23.08 and 30.5% respectively. It was also observed that protein content increased during malting of green gram grains as supported in similar studies by Kaushik et al (11). The increase seen could be due to a compensatory increase in free amino acids and peptides (12) and increase in non-protein nitrogenous constituents. Green gram contains a significant amount of tannins that is mostly present in seed coat. Germination and malting of green gram reflects its beneficial effect in the improved bio-availability of nutrients.

3.2. Sensory evaluation of produced biscuits
Biscuits were standardized by replacing RWF with MGF at different levels and by trying with different flavors like cocoa, coconut powder and also ajwain were tried for masking off-flavor. Sugar content was varied and adjusted at each level of replacement to assess the acceptability of the biscuits with maximum incorporation possible. While standardizing, coconut powder was finally selected as a masking agent and mid evaluations suggested that incorporations could go as high as 50% replacement with MGF. Therefore, two variations i.e. 40 and 50% incorporations levels were selected for final evaluations along with control (Table 3). Biscuits having 40% replacement of RWF with MGF were found to be most acceptable in appearance, color, taste, after taste and overall acceptability by the members of panel with no significant difference when compared to control. The obtained results are in agreement with those of Sudha et al (13) and Leelavathi and Rao (14) that biscuits made with higher level of fiber from sources of wheat, oats and barley are more acceptable than lower levels.

Table 4. Nutritional analysis of raw materials and supplemented biscuits

<table>
<thead>
<tr>
<th>Samples</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Protein (g/100g)</th>
<th>Iron (mg/100g)</th>
<th>Calcium (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Biscuits (RWF)</td>
<td>2.0 ± 0.03</td>
<td>1.64 ± 0.12</td>
<td>10.71 ± 0.05</td>
<td>0.375 ± 0.03</td>
<td>38.85 ± 0.02</td>
</tr>
<tr>
<td>GM Biscuits (40%)</td>
<td>2.6 ± 0.04</td>
<td>2.28 ± 0.03</td>
<td>14.21 ± 0.05</td>
<td>2.138 ± 0.04</td>
<td>50.17 ± 0.04</td>
</tr>
<tr>
<td>GM Biscuits (50%)</td>
<td>2.6 ± 0.03</td>
<td>2.24 ± 0.14</td>
<td>18.1 ± 0.03</td>
<td>2.615 ± 0.03</td>
<td>65.72 ± 0.03</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations
GM- Green gram Malt biscuits
RWF- Refined Wheat Flour

3.3. Nutritional analysis of final product
As shown in Table 4, nutrient analysis of biscuits made with MGF at 40% replacement level found an increase in ash, protein (32.68%), iron (470.13%) and calcium (29.14%) when compared to control. Similar studies supported our result wherein noodles supplemented with malted ragi flour were found to be rich in protein, crude fibre and minerals especially calcium, phosphorus and iron compared to control (15). Moreover, cereal-pulse combination will further improve protein quality of the biscuits for children, elderly, pregnant or lactating women as targets. This is supported in studies, where it was observed that supplementation of oatmeal with malted barley improves nutritional status of malnourished children, as evidenced by weight gain (16). Gahlawat et al (17) also established that the effect of malting on total extractable minerals – calcium, iron, phosphorus, zinc and copper were higher and improved due to reduced content of phytic acid in barley, wheat and oat and though present in small amounts is readily absorbed in the body. Sathy et al (18) supported the above by showing that upon germination anti-nutritional factors decrease, protein content increase and maximum content of riboflavin, ascorbic acid and thiamine were observed with greater bio-availability.

3.4. Texture Analysis of the biscuits
The fracturing point for control biscuits was higher than the MGF biscuits with longer distance travelled than green gram malt biscuits having 40 and 50% incorporation with 7.338 mm, 6.683 mm and 5.187 mm respectively (Table 5 and Figure 1). With the reduced amount of RWF and replacement with malt supplemented biscuits became softer and crumblier both because of texture accounting to increasing fiber content and reduced gluten content. With similar observation and supported with a study by Gallagher et al (19) that baked products having too low gluten results in dry, sandy mouth feel. A number of studies...
have also shown that with the incorporation of millet, plantain and chickpea flour or other composite flours in biscuit making increases hardness as well as fracturability (20).

4. Conclusion

Several types of ready to eat snacks are available in market of which biscuit, common in most households is an opportunist medium to be played upon to cater per cent daily requirements of nutrients. Malting of green gram as discussed above increases the bio-availability of minerals, reduced anti-nutritional factors, enhances some of the vitamins and improve overall nutritional value. A standardization experiment thus carried out for preparation of malted green gram biscuits with maximum incorporation as well as sensory acceptability was conducted. Biscuits preparation was standardized with 40 per cent replacement of refined wheat flour using green gram malt which according to the sensory results of panel members was the most accepted variation. Biscuits, made with 50 per cent incorporation of green gram malt also demonstrated an increase in protein, iron and calcium content when compared to control along with increased bio-accessibility and availability.

Although, market is bombarded with high fiber products for obese/diabetic/cholesterol as targets, children/elderly/convalescent/nutritionally deficient targets are not much taken care of. On the flipside malted products despite fiber content limit themselves to only milk powders; a gap yet to be explored. This standardized recipe of cereal-pulse combination therefore is a step towards the further scope of experimentation and trials for a nutritious snacking option with apart from above target audience to also children, elderly, women, convalescent patients and even adults. A limitation however is drawn at the use of coconut powder which is a source of saturated fatty acids, a future study on the alternative option for increasing the acceptability of the product can help direct towards the development of a more balanced and healthy snacking option.

There is great potential to utilize green gram in a large number of cereal-based food products as a substitute partially or wholly for currently used cereal grains such as wheat, oat, rice, and maize. Hence malting which is a century old technique to improve the availability of nutrient contents of food should be reconsidered for its use by food industry for providing healthy and variety of convenience foods than only currently available in market.

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References


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