DEVELOPMENT, CHARACTERIZATION AND MICROBIOLOGICAL EVALUATION OF DEFATTED GROUNDNUT COOKIES

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Abstract
The present study was conducted to replace wheat flour by defatted groundnut flour at 0 (T0), 5 (T1), 10 (T2), 15 (T3) and 20% (T4) to prepare cookies and evaluate them for various physicochemical parameters during storage. The values for protein and moisture content increased while carbohydrates decreased with increase in level of substitution. The physical parameters showed decreasing trend with increase in substitution levels. However, cookies weight increased with the increase in substitution levels. The hardness showed an increasing trend with increase in the groundnut flour and decreased with the advancement of storage. Sensory quality parameters decreased with increase in level of substitution. The calorific value increased with substitution. All the substitution levels used were acceptable but 10% substitution (T3) showed better results in terms of sensory properties. The total plate count increased to 1.16×10^4 after 30 days of storage for 20% substituted sample.

Practical applications:
Protein energy malnourishment is a main health concern in developing and under developing countries. Ground nut is one of the highly proteinicious crops used primarily for oil extraction. Utilization of groundnut in daily diet is enhanced by preparing highly desirable nutritious, novel and value added groundnut based food products. The use of groundnut meal in bakery products can be functionally and nutritionally better for both industrial applications and for consumers. This paper reports the commercial potential of defatted ground nut flour as a raw material for preparation of cookies.

Keywords: Groundnut flour; cookies; textural analysis; sensory evaluation

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1. INTRODUCTION

In human nutrition food crops have occupied an essential place as they are rich in calories and are major source of proteins for large proportion of population especially in developing countries (Singh and Singh 1991). For human diet legumes are major source of protein and are having unique properties in term of their nutritional value. Legumes are also rich in carbohydrate, fiber, some minerals and vitamins. Animal and plant sources are commercially used for protein foods and for their functional ingredient property (Periago and Vidal 1998). Due to limited supply and increased cost of animal protein, research focus geared towards the study of plant protein source, their functional properties and utilization of protein available locally, particularly from the under-utilized oil seeds and legumes which are high in protein (Enujugha and Ayodele-Oni 2003). Plant protein plays an important role in human diet, especially for developing countries where the intake of protein is lesser than the required. The utilization of plant as a source of protein mostly rely on nutritional and functional properties they impart to foods, which in turn depends mostly on their beneficial qualities (Asgar et al. 2010).

Protein quality enhancement is mainly done by wheat flour fortified with non-wheat protein source thereby improving the amino acid profile. Moreover, unfavorable changes can also affect the physical characteristics like dough quality and baking properties. Cereal based foods are enriched with other sources of protein like oil seeds and legumes. Legumes and oilseeds have attained considerable attention because they are high in lysine, an
essential amino acid in most cereals (Deshpande et al. 2000).

Defatted groundnut flour, after oil extraction, having nutritive value which is high consisting of 20 to 30% carbohydrate, 45-60% protein, 4 to 6% minerals and 3.8 to 7.5% crude fiber (Young and Hammons 1978). Whole seed groundnuts contain crude protein which ranges from 22-30%. Legumes and oil seeds are placed above all because of desirable and distinct texture and nutty flavour. Groundnuts contain niacin (vitamin B₃), copper, beta-sitosterol (a form of phytosterol) etc. which have been reported to possess functional properties like boosting of memory power, lowering or control of cholesterol levels, protecting against cardiovascular disease and protecting against cancer by inhibiting tumor growth. Groundnut processing produces underutilized by product known as defatted groundnut that has likely to use in food system because of low fat concentrate that are used for comminuted meat products, preparation of beverages, composite flours, fermented food products and supplementation of protein in bakery and weaning foods (Venkataraman 1998). Fortification of cereal foods with oilseeds or legumes has gained greater attention for value addition. Cookies enriched with protein are an attractive target for all age groups, child feeding programmes, disaster relief operations and for people who fall under low income groups (Claughton and Pearce 1989). Composite flour fortification is used to prepare the cookies to increase their nutritive value (Baljeet et al. 2010). Many researches showed that the nutritive value can be improved by preparing protein rich cookies made from blend of composite flour, soybean with field pea (Shrestha and Noomhorm 2002) and wheat flour is replaced by defatted groundnut flour (DFGN) left after extraction of oil was mechanically compressed and passed through sieve having 150 mesh sieve size to obtain DFGN flour. Each extraction was run in triplicate and the final value is the average of all. The resulting sample was used for the preparation of cookies.

2. MATERIALS AND METHODS

2.1. Raw material

Wheat flour, groundnuts, sugar and shortening were procured from a market at Srinagar, Jammu and Kashmir. Groundnut skin was separated by rubbing the whole groundnuts between palms of hand. All the materials were separately stored at room temperature in air tight plastic containers till further use.

2.2. Preparation of defatted ground nut flour

Groundnuts (5 g) were grounded using a mechanical method and solvent extraction technique was used for defatting using petroleum ether (25 mL). The process continued for six hours, defatted groundnut flour (DFGN) left after extraction of oil was mechanically compressed and passed through sieve having 150 mesh sieve size to obtain DFGN flour. Each extraction was run in triplicate and the final value is the average of all. The resulting sample was used for the preparation of cookies.

2.3. Blend formulation and preparation of cookies

Wheat flour fortified with DFGN flour in the ratio of 0%, 5%, 10%, 15%, and 20%. Treatments were prepared and designated as T₀, T₁, T₂, T₃, and T₄ respectively. Cookies were made according to the method of McWatters et al. (2003) with slight modification. The ingredients were 100g wheat flour, 95g butter, 50g sugar and baking powder 5g and mixed with other ingredients such as DGFN in a planetary mixer (Model SM-25, SINMAG, Japan) for 2 min at 214 rpm. The dough was aged for 35 minutes and then sheeted manually by means of rolling pin up to a thickness of 5mm. The cookies were cut with a 50mm diameter with
the help of cookie cutter and then were transferred to lightly greased baking trays. The trays were then placed in baking oven (Model SM-601T, SINMAG, Japan) at 220°C for about 10 minutes. The trays were taken out, cooled at ambient temperature for 60 min and packed in air tight polythene bags (LDPE) till further analysis.

2.4. Chemical composition of flours and cookies
The moisture, crude protein, crude fat, total ash and crude fibre contents of flours and cookies were determined by AACC (2000) methods. Carbohydrate content was calculated by difference method (Ihekoronye and Ngoddy, 1985) and calorific value was estimated by Atwater factor method.

2.5. Physical and organoleptic evaluation of cookies
Physical parameters of cookies: diameter, thickness, weight, spread factor and spread ratio were measured on 3 replicates and their values of mean were recorded. Vernier calliper was used to measure cookie thickness and diameters. Weights were weighed using a Mettler digital top loading balance (PC 400; Mettler, Buchi Switzerland). Sensory evaluation of product was attributed on the basis of color, taste, crispiness and overall acceptability, according to the preference method of Peryam and Pilgrim, 1957. Panel consists of trained judges to assess the sensory qualities of cookies based on 5 point hedonic scale.

2.6. Texture analysis of cookies
Textural analysis was measured by using a texture analyzer (TA HD Plus, Texture analyzer), to determine the required force to break the individual cookies. The individual cookies were placed at a distance of 5 mm/with slotted insert (HDP/Bs) under the Knife edge, using load cell of 25 kg, 1.5mm/spre-test speed, 2.0 mm/s ofTest-speed and post-test speed of 10.0 mm/s were used for this test.

2.7. Storage studies
The freshly prepared cookies were stored for 30 days in LDPE and subjected to analysis (moisture, protein, fat, ash, fibre, and carbohydrate contents) at 15 day intervals as per the methods described earlier.

2.8. Microbial analysis of the cookies
Total plate count and yeast and mold count in the sample at different storage intervals were assessed by the method as described by American Public Health Association (APHA, 1967).

2.9. Statistical analysis
All the experiments were measured in triplicate. The means and standard deviations were generated and analyzed using Minitab. Significance was accepted at $p \leq 0.05$ levels.

3. RESULTS AND DISCUSSION

3.1. Chemical analysis of flours and cookies
The chemical composition of wheat flour and DFGN flour used for cookie preparation are presented in Figure 1.

![Figure 1: Chemical composition of wheat flour and defatted groundnut flour](image-url)
Crude protein (52.62%), ash (4.7%) and crude fat (1.75%) are higher in the case of DFGN flour than of wheat flour. For control and DFGN flour significant difference (p≤0.05) was also obtained for these chemical parameters. It was found that wheat flour contains a high amount of carbohydrate (73.7%), moisture (9.50%) and dietary fiber (2.50%). These results are in consonance with Riaz et al. (2007). Defatted groundnut flour contained 31.75% carbohydrate, 7.48% moisture, 4.7% ash, 1.75% fat content and 1.7% dietary fiber.

Cookies enriched with DFGN flour were highly nutritious, this increasing value of protein content might be due to the appreciable amount of protein (52.62%) present in defatted ground nut flour and each increment level of defatted groundnut flour raised the total protein content by 5.5% and cookies prepared with 20% level of DFGN flour contained twice as much protein (29.47%) as the T (14.31%) shown in Table 2. Similar results were observed in whey protein concentrate enriched biscuits by McWatters (1978). These reports showed that the protein malnutrition is prevented by considering cookies enriched with DFGN flour as food supplements. Supplementation of DFGN showed an increase in moisture content of cookies up to 4.82%, ash up to 2.33% and fat value up to 14.78%, while as crude fiber decreased to 0.21% and carbohydrate value decreased to 48.39% (20% of DFGN level).

3.2. Physical characteristics of cookies

The physical characteristics of cookies are presented in Table 1. Significant difference (p≤0.05) was observed for thickness, diameter, spread ratio and spread factor of cookies supplemented with 5 to 15% DFGN flour and the control (100% wheat flour). Spread ratio of cookies is reduced with increase in the level of supplementation of DFGN flour. It might be during mixing when dough viscosity is increased by rapid partitioning of free water to hydrophilic sites and thus thereby limiting cookie spread. These results were also observed by (Seker et al. 2010). Spread factor also lowers as ingredients as available water from flour and other ingredients are absorbed during dough mixing, thus resulting in lower spread factor. These results are in accordance with Arshad et al. (2007) for cookies prepared by wheat-defatted wheat germ flour, McWatters et al. (2003) also reported similar result for cookies made wheat cowpea bean flour.

3.3. Calorific value

Calorific value increased in all treatments with increasing supplementation level of DFGN flour (Table 3), which might be due to fat and protein enhancement in DFGN flour supplemented cookies. Gallagher et al. (2005) also reported that the increasing supplementation level of WPC in biscuits increased the calorific value.

3.4. Organoleptic evaluation of cookies

Table 3 summarises the effect of DFGN flour on the sensory attributes of cookies. Cookies which were accepted by the panellist resembles close to the control (100% wheat flour) and those which were prepared from wheat flour containing 10% DFGN flour only. The low score for overall acceptability was given to blends of cookies prepared by more than 10% of DFGN flour as colour darkening, crumby texture and beany flavour. Darkening color of cookies is due to caramelization of sugar and the Maillard reactions between amino acids and sugars (Alobo, 2001). Flavor is an important factor for evaluating the overall acceptability of DFGN supplemented cookies. Cookies containing more than 10% DFGN flour had a beany flavor and aftertaste. This might be due to slight charring smell of proteins imparted by DFGN flour as reported by Giami et al. (2005). Texture is another parameter for determining the quality of DFGN flour supplemented cookies. Panelist described that increase in supplementation level; the cookies become harder this could be due to high water absorption capacity of DFGN flour than wheat flour, resulting in dehydration and relatively drier dough, which may increase the cookie hardness (Giami and Bekebain, 1992).
The moisture content for DFGN cookies packaged in LDPE and stored at room temperature is given in Table 4. The mean moisture content in all treatments along with control (T₀ to T₄) showed increasing trend from 3.38 to 3.79% throughout the storage period. The moisture content of all treatments differed significantly (p≤ 0.05) except in T₀ and T₁ which are statistically at par. However an increasing trend was observed during the defatting as well as during storage. According to Giami and Bekebain (1992) this significant deviation;

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture content (%)</th>
<th>Protein (%)</th>
<th>Ash (%)</th>
<th>Crude fat (%)</th>
<th>Crude fiber (%)</th>
<th>Carbohydrate (%)</th>
<th>Weight (g)</th>
<th>Diameter (mm)</th>
<th>Thickness (mm)</th>
<th>Spread factor</th>
<th>Spread ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>2.43±0.02</td>
<td>12.37±0.11</td>
<td>1.69±0.10</td>
<td>11.49±0.08</td>
<td>1.86±0.05</td>
<td>70.25±0.07</td>
<td>6.02±0.01</td>
<td>46.02±0.03</td>
<td>10.83±0.20</td>
<td>42.65±0.00</td>
<td>42.65±0.03</td>
</tr>
<tr>
<td>T₁</td>
<td>2.57±0.21</td>
<td>14.33±0.10</td>
<td>1.95±0.05</td>
<td>12.65±0.05</td>
<td>1.07±0.04</td>
<td>67.45±0.15</td>
<td>7.15±0.02</td>
<td>43.32±0.40</td>
<td>10.62±0.20</td>
<td>41.73±0.30</td>
<td>41.73±0.02</td>
</tr>
<tr>
<td>T₂</td>
<td>3.27±0.15</td>
<td>20.4±0.12</td>
<td>2.07±0.01</td>
<td>13.73±0.14</td>
<td>0.85±0.03</td>
<td>59.58±0.22</td>
<td>7.45±0.02</td>
<td>42.25±3.0</td>
<td>10.44±3.0</td>
<td>40.46±2.0</td>
<td>40.46±2.0</td>
</tr>
<tr>
<td>T₃</td>
<td>3.75±0.20</td>
<td>25.31±0.16</td>
<td>2.27±0.03</td>
<td>14.15±0.09</td>
<td>0.99±0.02</td>
<td>53.93±0.09</td>
<td>7.71±0.01</td>
<td>41.08±3.0</td>
<td>10.38±2.0</td>
<td>39.57±1.0</td>
<td>39.57±0.09</td>
</tr>
<tr>
<td>T₄</td>
<td>4.82±0.18</td>
<td>20.47±0.24</td>
<td>2.33±0.05</td>
<td>14.78±0.18</td>
<td>0.21±0.01</td>
<td>48.39±0.16</td>
<td>8.02±0.03</td>
<td>40.02±2.0</td>
<td>10.16±1.0</td>
<td>39.38±1.0</td>
<td>39.38±0.01</td>
</tr>
</tbody>
</table>

Values are means of three replications ± standard deviation; a, b, c, d superscripts are significantly (p< 0.05) different within a column.

3.5. Storage studies
3.5.1. Effect of supplementation of defatted groundnut flour on proximate composition of cookies during storage
The moisture content for DFGN cookies packaged in LDPE and stored at room temperature is given in Table 4. The mean moisture content in all treatments along with control (T₀ to T₄) showed increasing trend from 3.38 to 3.79% throughout the storage period. The moisture content of all treatments differed significantly (p≤ 0.05) except in T₀ and T₁ which are statistically at par. However an increasing trend was observed during the defatting as well as during storage. According to Giami and Bekebain (1992) this significant
increase in moisture content in all the samples may be attributed to the fact that the cookies were stored in LDPE pouches at ambient temperature and high relative humidity that may have caused migration of water into the pouch, thus increasing the moisture content of the cookies. Similar trend was observed by Eke et al (2009) in banana cake and Warhadpande et al (2010) in chicken blood plasma incorporated cakes. Table 4 depicted that the mean values for ash content of all treatments (T0 to T4) decreased throughout the period of storage which ranged from 2.14 to 1.93%. On the 30th day of storage the lowest ash content was found in T0 (1.57%) followed in order by T1, T2, T4 and T3. Non-significant (p≤0.05) increase in ash content was observed in all treatments. However, decreasing trend was observed during the storage period. The decreased trend in ash with storage might be due to higher values in moisture content of cookies during storage and due to poor moisture barrier properties of packaging materials.

Protein content of DFGN cookies in all treatments decreased significantly (p≤ 0.05) during storage. During storage protein molecules splits causing hydrolysis of peptide bonds with the help of enzyme known as protease. Similar decrease of protein content in cookies with storage has been reported by Pasha et al. (2002).

Results pertaining to variations in fat content during storage are presented in Table 4.

**Table 4**: Effect of various treatments and storage periods on the moisture content (%) of defatted groundnut cookies during storage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Fibre (%)</th>
<th>Carbohydrate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Days</td>
<td></td>
<td>Days</td>
<td>Days</td>
<td>Days</td>
<td>Days</td>
</tr>
<tr>
<td>T0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>15</td>
<td>30</td>
<td>0</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
<td>5.37±0.015</td>
<td>5.73±0.015</td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>15</td>
<td>30</td>
<td>0</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
<td>5.37±0.015</td>
<td>5.73±0.015</td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>15</td>
<td>30</td>
<td>0</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
<td>5.37±0.015</td>
<td>5.73±0.015</td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
</tr>
<tr>
<td>T3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>15</td>
<td>30</td>
<td>0</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
<td>5.37±0.015</td>
<td>5.73±0.015</td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
</tr>
<tr>
<td>T4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>15</td>
<td>30</td>
<td>0</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
<td>5.37±0.015</td>
<td>5.73±0.015</td>
<td>5.03±0.015</td>
<td>5.73±0.005</td>
</tr>
</tbody>
</table>

Values are means of three replications ± standard deviation; a, b, c superscripts are significantly (p< 0.05) differ within a row and A, B, C, D, E are significantly (p< 0.05) different within a column.
The mean values of fat content in all the treatments (T₀ to T₄) showed a decreasing trend which ranged from 13.43-13.0 (%) throughout the period of storage. Treatments having different fat content varied significantly (p≤ 0.05) except T₂ and T₃ which are at par. However, an increasing trend was observed within the treatment and decreasing trend was found during the storage period. The increase in storage period increases the moisture content but decreases the fat content of cookies. Similar results were reported by Singh and Mohamed (2007).

The mean values of fiber content in all treatments (T₀ to T₄) showed a decreasing trend which ranged from 0.92-0.81(%) during storage period. Significant difference in fiber content (p≤ 0.05) was seen between T₀ and rest of the treatments. A non-significant decrease in fiber content of T₀ followed by T₁, T₂, T₃ and T₄ was observed. However, a decreasing trend was observed during defatting as well as during the storage period. During storage hemicelluloses and other structural polysaccharides are degraded, thereby decreasing the crude fiber. Similarly trend was observed by Singh et al. (2006) in pearl millet cake. Carbohydrate content decreases with increase in proportion of defatted groundnut flour in various treatments. With progression of storage period, the carbohydrate content increased significantly due to breakdown of insoluble polysaccharides into simple sugars. These results are in accordance with the Nnam (2002).

3.5.2. Effect of storage on hardness of DFGN cookies

Significant differences were observed among different levels of DFGN cookies which were packaged in LDPE pouches with respect to hardness (kg) over the storage period of 30 days. The highest peak force for hardness of fresh cookies was 5.05kg which decreased significantly to 4.61kg as the storage period approaches 30 days. Mean peak force values increased among treatments (3.61 to 5.71kg). This might be due to the fact that DFGN flour has more water absorption power than wheat flour, resulting in dehydration and relatively drier dough, which may increase the cookie hardness because of increased level of DFGN. This trend supports the claim of Giami and Bekebain (1992).

3.5.3. Effect of defatted groundnut flour on microbiological studies (Total Plate Count and fungal count) of cookies during storage

Microbiological analysis of defatted groundnut cookies was determined at 0, 15 and 30th day of storage. The total plate count of DFGN cookie samples at various storage levels are presented in Table 5.

### Table 5: Effect of defatted groundnut flour on hardness, total plate count and fungal count of cookies during storage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Hardness</th>
<th>Total plate count</th>
<th>Fungal count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Days</td>
<td>Days</td>
<td>Days</td>
</tr>
<tr>
<td>T₀</td>
<td></td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.18±0.06</td>
<td>3.50±0.07</td>
</tr>
<tr>
<td>T₁</td>
<td>4.67±0.06</td>
<td>4.33±0.07</td>
<td>4.15±0.05</td>
</tr>
<tr>
<td>T₂</td>
<td>4.98±0.05</td>
<td>4.00±0.05</td>
<td>4.00±0.08</td>
</tr>
<tr>
<td>T₃</td>
<td>5.43±0.07</td>
<td>5.32±0.05</td>
<td>5.14±0.05</td>
</tr>
<tr>
<td>T₄</td>
<td>6.00±0.08</td>
<td>5.92±0.05</td>
<td>5.81±0.14</td>
</tr>
</tbody>
</table>

TLTC= Too low to count

Values are means of three replications ± standard deviation; a, b, c superscripts are significantly (p< 0.05) different within a row and A, B, C are significantly (p< 0.05) different within a column.
It is evident from the table that with increasing level of defatted groundnut flour (T₀ to T₄) and there was a slight increase in total plate count from 0.81×10⁴ to 0.92×10⁴ cfu/g at 15th and 30th day of storage respectively. However an increasing trend was observed within the treatment as well as during the storage period. This might be due to the fact that the growth of bacterial takes places as moisture content of cookies increases with time. However, the microbial load in cookies is in consonance with the microbiological standards of fortified blended foods with whole wheat flour. Similar results were reported by Oluwamodupe et al. (2012).

The fungal count of cookie samples at various storage levels are presented in Table 5. Fungal counts were between 0.68 ×10⁴ to 0.79 ×10⁴ cfu/g at 15th and 30th day of storage respectively. However at 0 day, microscopic signs of fungal spoilage were not detected, but at 15th and 30th day of storage, all samples showed macroscopically signs of fungal growth. Fresh baked cookies were free of fungal and spore, as thermal process inactivates all growth during baking, so cookies were contaminated during cooling and packaging process. Reports showed that 1g of flour contains 8,000 mold spores (Cauvain, 2003). Increase in fungal growth during increased interval of storage period is due to corresponding increase in moisture value (Oluwamodupe et al.2012).

4. CONCLUSION

Protein rich human diet has attracted the people of all age group to use the plant extract as a source of functional food and a value added product. These products encouraged to use high protein plant material as an important ingredient in variety of food and food products. Baked products like cakes, breads, snakes, biscuits and cookies etc are gaining popularity in market, as it is a best way of improving nutritional and functional properties through incorporation of vegetable protein. Defatted groundnut flour supplemented cookies had better nutritional quality as a result of increased protein content derived from DFGN flour. From the present study it can be concluded that cookies supplemented with 20% of DFGN flour were rich in nutrition but lower score were received on different sensory attributes while those with 10% level of DFGN flour showed better performance with regard to sensory attributes. The textural properties showed that hardness of cookies increased with the increasing levels of DFGN flour.

5. REFERENCES


