Effect of germination on the nutritional and anti-nutritional contents of mungbean (Vignaradiata)

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The study was designed to evaluate the effect of germination on the nutritional and anti-nutritional component of mungbean (Vignaradiata) seeds. Nutrient investigated includes proximate (carbohydrate, fat, fiber, ash, moisture, and protein), minerals (calcium, iron, magnesium, potassium, phosphorous and sodium), vitamins (Vitamin A, C, B₁, and B₂) and anti-nutritional factors (phytic acid, oxalate, tannin and flavonoids). The analysis included determination of nutrients on both raw and germinated mungbean flour. Mungbean seeds were germinated for a period of 72 h under room temperature, harvested, dried and processed into flour. Germination was found to increase the moisture (15.79 to 33.33%), protein (18.63 to 28.43%) and fiber (14.57 to 18.57%) content of mungbean seeds. While fat (1.69 to 0.17%), ash (2.67 to 1.60%) and carbohydrate (46.47 to 16.83%) contents of mungbean seed were reduced with germination. Germination also increased the calcium (1.63 to 4.44 mg), iron (6.47 to 9.19 mg), magnesium (5.20 to 7.99 mg) and potassium (1187.5 to 1360.3 mg) contents of mungbean seeds while a decrease in the phosphorous (96.36 to 59.36 mg) and sodium (52.44 to 26.27 mg) content of mungbean was observed. The investigated vitamins (Vitamin A, C, B₁, and B₂) were enhanced by germination from 22, 2.5, 1.4 and 17.87 mg for vitamin C, thiamin (B₁), riboflavin (B₂) and Vitamin A, respectively in non-germinated mungbean seeds to 26.77, 2.83, 3.73 and 20.47 mg in the same other for germinated seeds. Germination was also found to decrease the anti-nutritional factors phytic acid (214.33 to 188.93%), oxalate (0.027 to 0.016%), tannin (331.58 to 227.59%) and flavonoid (2.93 to 0.6%) in mungbean seed. It was concluded that germination significantly increased some vital nutrients (protein, fiber and moisture) content in mungbean seed while decreasing the anti-nutritional factors (phytic acid, oxalate, tannin and flavonoid) in mungbean seed.

Key words: Mungbean, germination, proximate, mineral, vitamin, anti-nutrient.

INTRODUCTION

Legumes are important source of dietary proteins (Sthe, 1996) and serves as major protein sources in the diets of the poor in the underdeveloped and developing countries where animal protein in general is seldom affordable. In addition to this, legumes have low environmental impact compared to other rich protein foods (Carlssen-Kanyama and Genzaley, 2009).

Mung bean (Vignaradiata), also called green gram is a tropical legume, widely grown in Asia, particularly in Thailand, India, Pakistan and Bangladesh (Hussain and Burhanddin, 2011). Mung beans are grown widely for use as human food (as dry beans or fresh sprouts). Mungbean has an edge over other legumes due to its very short growth duration and ability to fit widely diverse cropping system (AVRDC, 1995). It has the potential of becoming an important crop in south eastern Nigeria, having an average potential grain yield of 3.5 t/ha (Agugo et al., 2009). Dried seeds of mungbean can be eaten whole or split, cooked, fermented or milled into flour (Mubarak, 2005). As a food, mungbean contain balanced nutrients including protein, dietary fiber and significant amounts of bioactive phytochemicals (Dongyan et al., 2014). In western cultures, mungbean sprouts are popularly used as a fresh salad vegetable (Lambrides, 2007). Mungbean can serve as vital source of vegetable, protein, minerals and vitamins in
developing countries if well utilized. Just like other legumes, anti-nutritional factors may hinder the proper utilization of mungbean as staple foods. The anti-nutritional factors (phytate, tannin and oxalate) present in mungbean can cause gastro-intestinal discomforts and also result in non-availability of certain nutrients (Urbonor et al., 2005). However, heamagglutinin, tannin and phytic acid found in mungbean have been reported to have biological functions promoting digestion and eliminating toxins (Lin and Liwz, 1997).

Germination is an inexpensive and simple method of improving nutritive value of legumes. It is considered a potentially beneficial process for legume seed transformation which may decrease undesirable components such as alkaloids and phytates (Muquiz et al., 1998; Oboh et al., 1998; Orue et al., 1998), increase protein digestibility (Schulze et al., 1997), consequently improving nutritional quality. Studies have shown that germination enhances the nutritive value of legumes by inducing the formation of enzymes that reduces or eliminates the anti-nutritional and indigestible factors common in legumes (El-Adawy et al., 2003). The oligosaccharides present in mungbean are soluble in water and can be eliminated by adequate presoaking, germination or fermentation (Dongyan et al., 2014).

Apart from helping to remove some of the anti-nutritional factors present in seeds, germination enables seed takes up water, oxidizes oils and carbohydrates stores within the seed and break down storage proteins to provide energy and amino acids necessary for normal physiological processes and for growth (Urbano et al., 2006). The energy offered by mungbean sprouts is lower than that in cereals, which is beneficial for individuals with obesity and diabetes (Zheng, 1999). According to Kruawan et al. (2012) overall regular consumption of mungbean could regulate the flora of enter bacteria, decrease the absorption of toxic substances, reduce the risk of hypercholesterolemia and coronary heart disease and prevent cancer. Mungbean seed can be processed in various forms to provide dietary diversification. The present research work investigates the effect of germination on the general nutrient (proximate, minerals, vitamins, and anti-nutrient) compositions of mungbean.

**MATERIALS AND METHODS**

**Procurement of raw materials**

Two (2 kg) kilogram of mungbean seed was procured from local farmers from the northern region of Nigeria.

**Sample preparation**

Mungbean seeds were cleaned to remove dirt’s and any form of impurity. Cleaned mungbean seeds were shared into two portions. A portion was processed into flour with the seed coat to pass through a 40 mesh sieve, packaged in an air tight container and stored for chemical analysis.

The second portion was washed and soaked by submerging the sample in distilled water in transparent container for 12 h at room temperature. Thereafter, the seeds were taken out to a tray covered with a muslin cloth and kept in a room temperature after removing the adherent moisture with an absorbent cloth. The sample was allowed to germinate/sprout within 3 days (72 h), during this period distilled water was sprinkled on the white muslin cloth every 6 h. After 72 h, the sprout were harvested and dried in an oven at 70°C, processed into flour, packed and stored in an air tight container for chemical analysis.

**Chemical analysis**

**Proximate composition:** The proximate (moisture, ash, fibre, fat and protein) content of mungbean samples were determined following the standard methods of AOAC (2005), the carbohydrate content of the samples were calculated by simple difference method as reported by Onwuka (2005).

**Mineral composition:** Minerals (sodium and potassium) content of the samples were determined by flame photometer as described by AOAC (2005); calcium, magnesium and phosphorus were determined by Atomic absorption spectrophotometer as described by AOAC (2002). The iron content of the samples was determined following the method described by Onwuka (2005).

**Vitamin composition:** Vitamins (vitamin C, A, B, and B3) content of the samples were determined using the method described by AOAC (2002).

**Anti-nutritional factors:** Anti-nutrient (tannin, oxalate, phytic acid and flavonoids) compositions of the two different samples of mungbean were determined following the standard methods of AOAC (2002).

**Statistical analysis**

Results were expressed as mean values of three (triplicates) separate determinations. Raw data were analyzed statistically using mean, standard deviation and T-test. Significant differences was determined at $P<0.05$ level.

**DISCUSSION**

Table 1 presents the proximate composition of the germinated and non-germinated mungbean seeds.
Table 1. Proximate composition of mungbean samples.

<table>
<thead>
<tr>
<th>Nutrient components</th>
<th>Samples</th>
<th>Germinated (%)</th>
<th>Non-germinated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content</td>
<td></td>
<td>33.33±0.31</td>
<td>15.79±0.09</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>1.60±0.20</td>
<td>2.67±0.13</td>
</tr>
<tr>
<td>Total fat</td>
<td></td>
<td>0.17±0.04</td>
<td>1.69±0.08</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td>28.43±0.64</td>
<td>18.63±0.25</td>
</tr>
<tr>
<td>Fiber</td>
<td></td>
<td>18.57±0.35</td>
<td>14.57±0.70</td>
</tr>
<tr>
<td>Total carbohydrate</td>
<td></td>
<td>16.83±0.53</td>
<td>46.27±0.61</td>
</tr>
<tr>
<td>Energy</td>
<td></td>
<td>180.66±0.91</td>
<td>274.55±0.68</td>
</tr>
</tbody>
</table>

The values are mean ± standard deviation. Figures with the same superscripts indicates no significant difference. Figures with different superscripts indicate significant difference.

Table 2. Mineral composition of mungbean samples.

<table>
<thead>
<tr>
<th>Nutrient components</th>
<th>Samples</th>
<th>Germinated (mg/100g)</th>
<th>Non-germinated (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td></td>
<td>4.44±0.15</td>
<td>1.63±0.16</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
<td>9.19±0.47</td>
<td>6.47±0.03</td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
<td>7.99±0.04</td>
<td>5.20±0.20</td>
</tr>
<tr>
<td>Phosphorus</td>
<td></td>
<td>59.36±0.50</td>
<td>96.36±0.45</td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
<td>1360.30±0.43</td>
<td>1187.50±0.50</td>
</tr>
<tr>
<td>sodium</td>
<td></td>
<td>26.27±0.64</td>
<td>52.44±0.06</td>
</tr>
</tbody>
</table>

The values are mean ± standard deviation. Figures with the same superscripts indicates no significant difference. Figures with different superscripts indicate significant difference.

Table 3. Vitamin composition of mungbean samples.

<table>
<thead>
<tr>
<th>Nutrient components</th>
<th>Samples</th>
<th>Germinated (mg/100g)</th>
<th>Non-germinated (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C</td>
<td></td>
<td>26.77±1.11</td>
<td>22.00±0.46</td>
</tr>
<tr>
<td>Vitamin A</td>
<td></td>
<td>20.47±0.94</td>
<td>17.87±0.07</td>
</tr>
<tr>
<td>Thiamin</td>
<td></td>
<td>2.83±0.09</td>
<td>2.50±0.07</td>
</tr>
<tr>
<td>Riboflavin</td>
<td></td>
<td>3.73±0.09</td>
<td>1.40±0.04</td>
</tr>
</tbody>
</table>

The values are mean ± standard deviation. Figures with the same superscripts indicates no significant difference. Figures with different superscripts indicate significant difference.

Table 4. Anti-nutrient composition of mungbean samples.

<table>
<thead>
<tr>
<th>Anti-nutrient components</th>
<th>Samples</th>
<th>Germinated (%)</th>
<th>Non-germinated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytic acid</td>
<td></td>
<td>188.93±1.102</td>
<td>214.33±0.58</td>
</tr>
<tr>
<td>Oxalate</td>
<td></td>
<td>0.016±0.003</td>
<td>0.03±0.004</td>
</tr>
<tr>
<td>Tannin</td>
<td></td>
<td>227.59±1.54</td>
<td>331.58±0.65</td>
</tr>
<tr>
<td>flavonoid</td>
<td></td>
<td>0.60±0.96</td>
<td>2.93±0.67</td>
</tr>
</tbody>
</table>

The values are mean ± standard deviation. Figures with the same superscripts indicates no significant difference. Figures with different superscripts indicate significant difference.

The sprouting treatment significantly \((P<0.05)\) increased the moisture content from (15.79 to 33.33%), protein; (18.63 to 28.43%), and fiber (14.57 - 18.57%) in mungbean seed. On the other hand the carbohydrate (16.83%), fat (0.17%), and ash (1.60%) content of sprouted mungbean sample were lower compared to the non-sprouted seeds. The observed differences in the moisture, protein and fibercontent of the sprouted and non-sprouted mungbean could be attributed to germination which the seeds was subjected to. Increase in moisture could be as a result of the hydration of seeds during soaking. Usually during germination dry seeds are expected to absorb water and increase in size. The result corresponds with the findings of most researchers in seed germination (Osman, 2007; Khattak et al., 2008; Mubarak, 2005), but varies with the finding of Ohtsubo et al. (2005), who observed lower moisture content in germinated brown rice: Germination is thought to increase the protein content of seeds may
be due to synthesis of protein enzymes (proteases) or a compositional change following the degradation of other constituents during germination (Kaushik et al., 2010). The high protein content observed with germinated mungbean seeds tallied with findings of most researchers (Ohshubo et al., 2005; Camacho et al., 1992; Obizoba, 1991; Urbano et al., 2005; Khatoon and Prakah, 2006). Fiber is an important component in the diet that performs various functions ranging from helping in free bowel movement to weight management. The fiber content of mungbean seeds increased during germination. The increase in fiber might be that the micro flora enzymes hydrolysed complex carbohydrate to release fiber (Jimenez et al., 1985) or due to synthesis of structural carbohydrates such as cellulose and hemicellulose constituents of cell walls of plant seed (Chung et al., 1998).

On the other hand the carbohydrate, fat and ash content of sprouted mungbean sample were lower compared to the non-sprouted seeds. The decrease observed in carbohydrate content of sprouted mungbean seeds promotes sprouted mungbean seeds as a useful diet in weight management or any other diet related disease condition that requires reduced carbohydrate intake. The decrease may be attributed to increased starch digestibility promoted by improved hydrolytic activities of the enzymes during sprouting. It could also be due to the use of carbohydrate for metabolism by the young seedling (Obizoba, and Atu, 1993). Nevertheless the fat content of sprouted mungbean seed was lower compared to the non-sprouted mungbean seed. This result corresponds with the findings of Badshsh et al. (1991) and Chung et al. (1998) who observed significant losses in the lipid content of canola seed during sprouting. The decrease in fat content of seed could be due to total solid loss during soaking prior to germination of seeds (Wang et al., 1997) or use of fat as energy source in sprouting process (El-Adawy, 2002). Tang et al. (2014), also observed low fat content in sprouted mungbean seed. The finding showed a significant ($P<0.05$) difference in the ash content of sprouted and raw mung bean seeds. Higher value observed with the raw sample may be due to the degraded nature of the seed nutrients during processing. Table 2 showed the mineral compositions of the mungbean seeds, compositions of sprouted and non-sprouted mungbean seeds. From the result it was observed that germination significantly ($P<0.05$) increased the mineral (calcium, iron, magnesium, and potassium) content of mungbean seeds. The result corresponds with the findings of Alexander (1983). However the mineral content of both samples (germinated and non-germinated) of mungbean seeds were in comparison with the USDA (2005) recommended levels. Table 3 indicates the vitamin composition of the mungbean samples. Analysis of the table revealed that sprouting significantly increased thiamin, riboflavin and vitamin A content of mungbean seed. Fernondez et al. (1988) reported significant increase in germinated cereals. Generally, sprouting significantly ($P<0.05$) increased the vitamin (vitamin C, A, B1 and B2) content of mungbean. The increase in the vitamin C content from 22 to 26.77% in sprouted mungbean is in agreement with the studies of Fernendez et al. (1988) who reported a significant increase in ascorbic acid during germination. Riddoch et al. (1988) reported that many species of pulses produced significant quantities of vitamin C up to five days following germination. Significant increase in the content of ascorbic acid during germination of different cereals and legumes seeds has also been reported (Harmuth- Hence et al., 1987).

The anti-nutrient (phytic acid, tannin and flavonoids) factors investigated were significantly reduced during sprouting as shown in Table 4. In recent years, germination of mungbean enhances its nutritive value by inducing the formation of enzymes that reduces or eliminates the anti-nutritional and indigestible factors common in mungbean (El-Adawy, 2003). Tannins and phytate are known to reduce the availability of proteins, carbohydrates and minerals by forming indigestible complexes with the nutrients. The reduced tannin, phytate and flavonoid levels due to germination could improve the availability of nutrients in the seed. The observed reduction in tannin content after germination might result from formation of hydrophobic association of tannins with seed proteins and enzymes. Lin and Lai, (2006) found that over four days germination, levels of flavonoids decreased in mung beans which was attributed to loss of pigments in the seed coats. However, no significant ($P<0.05$) reduction occurred in the oxalate content of the two samples (Table 3). This is in line with the report of Udensi et al. (2007).

**Conclusion**

The low caloric value, enhanced mineral and vitamin and decreased anti-nutrient content of mungbean observed in germination will pose mungbean sprout a healthy food for growing children and in weight management. The seeds and sprouts are excellent examples of functional foods that lower the risk of various diseases and its use in diversified forms should therefore be encouraged.

**ACKNOWLEDGEMENT**

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