Effect of Germination on Anti-oxidant Activity, Total Phenols, Flavonoids and Anti-nutritional Content of Finger Millet Flour

Abioye VF*, Ogunlakin GO and Taiwo G
Department of Food Science and Engineering, LAUTECH, Ogbomoso, Oyo State, Nigeria

Abstract
Finger millet (Eleusina coracana) is a minor cereal, nutritionally important as a good source of minerals. It also contains polyphenols which are phytochemicals with anti-oxidant activity. Some of the health benefits of millet foods include hypocholesterolemic, hypoglycemic and anti-ulcerative properties associated with reduced cancer, cardiovascular diseases, and others. High amounts of anti-nutrients in finger millet make the micronutrients less bio-accessible which could be reduced by processing such as germination. Therefore, this study evaluated the effects of germination on anti-oxidant activity, total phenolic content, flavonoids and anti-nutritional content of finger millet flour. Finger millet seeds were presoaked (9 h), germinated at room temperature, and the samples collected at 0 h, 12 h, 24 h, 48 h, 72 h, and 96 h. The germinated sample and ungerminated samples (control) were dried and milled into flour for further analyzes. The flour samples were analyzed for anti-oxidant activity, total phenolic content, flavonoids and anti-nutritional content. Total phenolic and tannin content decreased significantly (p<0.05) in from 38.46% to 42.63% and 33.33% to 61.66%, respectively, while flavonoid and anti-oxidant activity increased significantly (p<0.05) from 26.66% to 33.33% and 48.30% to 51.13%, respectively. There were reductions in the anti-nutritional contents of the finger millet flour with the increase in the days of germination. This study revealed that germination could enhance the anti-oxidant activity of finger millet and reduce the anti-nutritional contents, hence increase its potential as a functional food.

Keywords: Germination; Finger millet flour; Anti-nutritional

Introduction
Finger millet (Eleusina coracana) is a tropical crop which belongs to the group of minor cereals. It is mainly consumed in India and Africa. It is an important cereal because of the excellent storage properties of the grains and the nutritive value. It constitutes a staple food for a large segment of the population in these countries. It is adapted to various agro-climatic conditions. It is one of the most nutritious cereal grains and it tastes better than most other cereal grains. Its annual world production is about 4.5 million tones out of which Africa produces about two million tones [1-5].

Finger millet is rich in protein, mineral content, and dietary fiber. It is valuable because it contains the amino acid, methionine which is lacking in diet of hundreds of millions of the poor who lives on starchy staples such as cassava, plantain, polished rice and maize meal. Finger millet is mostly recognized nutritionally for being a good source of minerals including manganese, magnesium and phosphorus. Some of health benefits associated with regular intake of millet foods include hypocholesterolemic, hypoglycemic and anti-ulcerative properties. They are very rich in phytochemicals which is believed to lower cholesterol and reduces cancer and cardiovascular diseases. The acidic methanol extracts from the seed coat showed high antibacterial and antifungal activity.

Anti-oxidants are radical scavengers that inhibit or slow down the oxidation of other molecules by blocking the propagation of oxidizing chain reactions that lead to degenerative diseases such as cancer, inflammation, anemia, neuro-degeneration, cardiovascular and ageing. Phenols and flavonoids, which are excellent anti-oxidants, can scavenge reactive oxygen and nitrogen species thereby preventing the onset of oxidative diseases in the body. It has been reported that populations consuming sorghum and millet have lower incidences of esophageal cancer than those consuming wheat or maize [3,6-9]. A recent study has also demonstrated that millet phenolics may be effective in the prevention of cancer initiation and progression in vitro. Finger millet was reported to contain highest amounts of anti nutrients among millets, such as tannins, phytates, saponin and others. These anti-nutrients in finger millet make the micornutrients less bio-accessible. Tannins reduces apparently digestibility of protein and energy. Phytate interference with mineral absorption, especially calcium and zinc has been reported in finger millet while oxalates affect calcium and magnesium metabolism and react with protein to form complexes which have an inhibitory effect on peptic digestion.

However, these anti-nutrients can be removed by processing techniques such as germination, soaking, roasting, fermentation, and dehulling among others. Reductions of such anti-nutritional factors by processing methods such as soaking, sprouting, cooking, malting and fermentation have long been documented by many researchers. Several studies have shown that germination improves the nutritive value of cereals and legumes. Germination has also been found to decrease the levels of anti-nutrients present in cereals and maximize the levels of some of the utilizable nutrients [10,11]. This study therefore evaluated the effects of germination on anti-oxidant activity, total phenols, flavonoids and anti-nutritional content of finger millet flour.

Materials and Methods
Finger millet seeds that were used for this research were procured from a main market in Zaria, Kaduna state, Nigeria. The chemicals used were of analytical grade.

Germination
About 100 g of finger millet seeds were surface sterilized for 30
mins in a 1% sodium hypochlorite solution. The finger millet seeds were rinsed 5 times with distilled water (1:3 v/v), steeped in water for 9 h and then drained. The presoaked seeds were allowed to sprout on sterile germinating vessels at 25°C lined with filter paper which was kept moist by layers of damp cotton wool for 5 days [12-17]. The finger millet seeds were milled, packaged and sealed in an air tight polythene bags for further analyses.

Analyses

Determination of anti-oxidant activity

Determination of free radical scavenging activity (ORAC): DPPH scavenging activity was carried out by the method of Onwuka [13]. 250 µg/ml of African Yam bean seed extract with methanol was dissolved in DMSO (dimethyl sulfoxide) and taken in test tubes in triplicates. Then 5 ml of 0.1 M ethanol solution of DPPH (1,1, Diphenyl-2-picrylhydrazyl) was added to each of the test tubes and were shaken vigorously. It was allowed to stand at 35°C for 20 minutes. The control was prepared without any extracts. Methanol was used for base line corrections in absorbance (OD) of sample and measured at 517 nm. A radical scavenging activity was expressed as 1% scavenging activity and was calculated by the following formula.

\[
\text{Radical scavenging activity} = \frac{\text{OD}_{\text{Sample}} - \text{OD}_{\text{Control}}}{\text{OD}_{\text{Control}}} \times 100
\]

Where, OD: Corrections in absorbance

Determination of total phenolic contents: Total phenol content of the sample was determined using the method of. Sample (50 µl) was put in test tubes and the volume was made up to 500 µl using distilled water [11,18-21]. Then, 250 µl of folin-ciocalteu reagent was added into test tube followed by 1.25 ml of 20% sodium carbonate solution. The tube was vortexed before incubated in the dark for 40 minutes. Absorbance was read at 725 nm using spectrophotometer.

Determination of total flavonoids: Aluminium chloride colorimetric method was used for flavonoids determination [14]. Each plant extracts (0.5 ml of 1:10 g/ml) in methanol were separately mixed with 1.5 ml of methanol, 0.1 ml of 10% aluminium chloride, 0.1 ml of 1 M potassium acetate and 2.8 ml of distilled water. It remained at room temperature for 30 min; the absorbance of the reaction mixture was measured at 415 nm with a double beam Perkin Elmer UV/Visible spectrophotometer, USA. The calibration curve was prepared by preparing quercetin solutions at concentrations 12.5 to 100 g.ml⁻¹ in methanol.

Determination of anti-nutritional factors: The anti-nutritional factors determined on the samples included the tannin, phytate, oxalate and trypsin inhibitor. The condensed tannins were determined by the method of Morrison et al. [22] which was a modification of the vanillin method of Burns [14] using 1.0 mg ml⁻¹ of catechin in 1% HCl- by the method of Morrison et al. [22] which was a modification of the oxalate and trypsin inhibitor. The condensed tannins were determined factors determined on the samples included the tannin, phytate, oxalate and trypsin inhibitor. The condensed tannins were determined factors determined on the samples included the tannin, phytate, oxalate and trypsin inhibitor. The condensed tannins were determined

Table 1: Proximate composition (%) of germinated finger millet flour.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fat</th>
<th>Fibre</th>
<th>Ash</th>
<th>Carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9.20</td>
<td>8.57</td>
<td>1.67</td>
<td>2.30</td>
<td>3.47</td>
<td>72.00</td>
</tr>
<tr>
<td>B</td>
<td>8.87</td>
<td>8.90</td>
<td>1.80</td>
<td>2.33</td>
<td>3.60</td>
<td>71.93</td>
</tr>
<tr>
<td>C</td>
<td>9.17</td>
<td>9.15</td>
<td>1.83</td>
<td>2.33</td>
<td>3.67</td>
<td>71.63</td>
</tr>
<tr>
<td>D</td>
<td>9.17</td>
<td>9.47</td>
<td>1.77</td>
<td>2.50</td>
<td>3.73</td>
<td>69.70</td>
</tr>
<tr>
<td>E</td>
<td>9.10</td>
<td>9.63</td>
<td>1.87</td>
<td>2.60</td>
<td>3.73</td>
<td>71.32</td>
</tr>
<tr>
<td>F</td>
<td>9.10</td>
<td>9.80</td>
<td>1.87</td>
<td>2.65</td>
<td>3.73</td>
<td>71.40</td>
</tr>
</tbody>
</table>

Table 2: Anti-nutritional factors of germinated finger millet flour.

The result obtained from the analysis of the proximate composition of the samples is as shown in Table 1. The moisture content ranged between 9.20% and 8.87% and it increases with increase in the time of germination. From this, it is evident that during germination there are marked increases in moisture content which may be attributed to the fact that during germination the whole grains absorb moisture from the soaking medium for metabolism to initiate and this in turn influence the structure of the grain. As the soaking time increases more number of cells within the seeds is hydrated [23-25].

The protein content ranged between 8.57% and 9.80% and there was an increase in the level of protein with increase in the time of germination. This could mean that the germination method as a processing method had positive influence on the protein content of the germinated finger millet flour [26,27]. This is in line with findings of the previous researchers that germination process increases the protein content of the crop. The fat content ranged between 4.46% and 3.32% which means that there was increase in moisture content. The fibre and ash contents were between 2.30% and 2.65% and 3.47% and 3.73%, respectively. The carbohydrates were between 72.00% and 69.70% obtained with no significance difference.

Anti-nutritional factor of germinated finger millet flour

The result of the anti-nutritional composition of finger millet flour is as shown below in Table 2. The phytate ranged between 51.67 mg/100 g and 43.33 mg/100 g and there was reduction in phytate level with increase in the time of germination. This implies that germination process reduced the amount of phytate in finger millet flour to about 50% reduction. The tannin content ranged between 53.33 mg/100 g and 43.33 mg/100 g, it was also reduced to about 50% reduction. The tannin content ranged between 53.33 mg/100 g and 43.33 mg/100 g and there was reduction in phytate level with increase in the time of germination.

Means with the same alphabet within the same column are not significantly different from each other.

Means with the same alphabet within the column are not significantly different from each other.

(p>0.05)
The result of the functional properties of germinated finger millet flour is as shown in Table 3. The result of bulk density (loosed) ranged between 0.48% and 0.54%. This implies that germinating time affected the bulk density of the flour, the lesser the germination time the more the bulk density. The value obtained for bulk density (packed) ranged between 0.63% and 0.62%. The bulk density is generally affected by the particle size and the density and it is very important in determining the packaging requirement, material handling and application in wet processing in the food industry [28,29]. The swelling capacity ranged between 1.87% and 1.80%. The swelling capacity of flours depends on size of particles, types of variety and types of processing methods.

The swelling power is an indication of strength and character of the micellar network within the granule. Swelling power is the major factor controlling swelling behavior of starches [30,31]. The foaming capacity of the flour ranged between 36.20% and 38.17%. The foaming capacity of the flour ranged between 36.20% and 38.17%. Foaming capacity is a function of the solubilized protein and the polar and non-polar lipids in a sample [4]. This was reflected in Table 2 where the sample germinated for 96 h had higher protein content. The water absorption capacity of germinated finger millet flour ranged between 1.732% and 1.77%. Water absorption is the amount of water absorbed by the flour to produce dough of workable consistency [32-35]. It is determined by the protein content of the flour, the amount of starch damaged during milling and the presence of non-starch carbohydrates. The oil absorption capacity of germinated finger millet flour ranged between 1.38% and 1.45%. High oil absorption capacity is important for increasing energy density of complementary food where the ungerminated samples had the least value of oil absorption capacity. The least gelation capacity of malted finger millet flour ranged between 4.00% and 4.67%. The emulsion capacity of germinated finger millet flour ranged between 4.78% and 6.03%.

Conclusion

This study has shown that processing method such as germination has effects on the nutritional, anti-nutritional and functional properties of finger millet flour. The high protein, fat and ash suggest that finger millet could be of great importance in alleviating protein energy malnutrition. There was a general reduction in the anti-nutritional components of the seeds as germination time increased while the tannin content had about 23.33% reduction. The germination process could help in reducing the anti-nutritional factor of finger millet and hence increase the potential of the crop.

The bulk density decreased with the germination time which could have effects on the packaging requirements and the swelling power decreased with germinating time indicating that the longer the germination time the lesser the swelling capacity which may reduce the economic advantage of the seed.

References