Estimation of nutritive composition of seven small millets

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Abstract
Small millets are one of the underutilized groups of cereal grains. Millets are considered as rich source of energy, carbohydrate and protein as compared to other cereals but have more calcium, iron, dietary fibre and Vitamin E content. The presence of dietary fibre and phenolic compounds in small millets help in the prevention of many diseases such as diabetes, cardiovascular diseases and cataractogenesis. Different types of millets were analyzed for their nutritive values and the study resulted that Foxtail Millet is rich source of protein with a value of 14%, brown top Millet is rich source of fibre and zinc with values of 16.08% and 66.10mg respectively. Iron content is rich in Kodo millet with a value of 206.5mg and Calcium content is rich in Finger millet with a value of 3811.98mg.

Keywords: Small Millets, Proximate composition, Minerals, Energy, Fibre

Introduction
Small Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Millets are small-seeded grasses that are hardy and grow in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture (Himanshu et al., 2018). Millets are one of the cereals asides the major wheat, rice and maize. They are grown mostly in marginal areas under agricultural conditions in which major cereals fail to give substantial yields.

Small Millets are important foods in many underdeveloped countries because of their ability to grow under adverse weather conditions like limited rainfall. In contrast, millet is the major source of energy and protein for millions of people in Africa (Issoufou et al., 2013) [7]. Millet is a very important crop with following characteristics: millet is known to be a drought-resistant crop, resistance to pests and diseases, short growing season as compared to other major cereals. Millets are unique among the cereals because of their richness in calcium, dietary fibre, protein and polyphenols (Devi et al., 2011) [9]. Nutritional quality of food is the most important parameter for maintaining human health and complete physical wellbeing. Some of the agricultural foods are not using as human main food because of unawareness of people. Millets are one of them. Millets are being used as animal and bird feed. Millet has many nutritious and medical functions. These are underutilized and neglected crop because of little knowledge to people and some critical problems like lower cooking quality, taste and low bioavailability of millets. These problems can be solved and make them valuable as food for poor families to combat malnutrition and important source of income (Sarita and Ekta Singh, 2016) [13].

Small Millets are highly nutritious, non-glutinous and non-acid forming foods. Hence they are soothing and easy to digest. They are considered to be the least allergenic and most digestible grains available. Millets contain about 8% per cent protein and 4% per cent fat. They are rich source of vitamins and minerals. Millets are especially rich in calcium. The dietary carbohydrate content of millets is also relatively high. Although a considerable portion of nutrients is concentrated in the seed coat, the bioavailability of nutrients present in the endosperm is higher than the seed coat nutrients. Anti-nutritional factors such as phytates and polyphenols are also present in millets but they are mostly confined to the seed coat and the milled millets are generally free from the anti-nutritional factors (Kumar, 2010) [9].

Materials and Methods
Different types of small millets which were grown predominantly in Agricultural Research Station, Vizianagaram were collected for nutritive analysis. The small millets underwent for nutritive analysis were namely Brown top millet (BTAVT6), Banyard millet (VMVC331),
Foxtail millet (SIA-3022), Proso millet (CO5), little millet (OLM-203), Kodo millet (CO3) and Finger millet (VR-847). All different types of millets were harvested and then cleaned using degrader which is used for removing stones and aspirator which is used for removing sand and other dust particles. Then the cleaned grains were subjected in dehuller for removing husk from the grains, after dehulling rice was obtained from all different types of grains. Once the rice has been obtained from the grains, again the rice was subjected to aspirator to remove the remaining dust particles. After all these processes the cleaned rice was obtained. The cleaned rice varieties of different types of millets each of 200g quantity were packed in the polythene zip lock covers and were sent for nutritive analysis to Quality Control Laboratory, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The nutrients analyzed were ash, moisture, protein, fat, crude fibre, energy, iron, zinc and calcium for all different types of millets.

**Estimation of Ash**
The ash content of the samples was determined by using (AOAC, 2005) \(^1\) method. The temperature of the muffle furnace was set to 600\(^\circ\)C and empty crucibles were heated for 1 hour and then cooled in a dessicator and weighed (W1). Two g of defatted sample was weighed into the crucible and weight was noted (W2). The sample was kept on flame for charring and then incinerated at 600\(^\circ\)C for 8 hours in muffle furnace. After complete ashing of the sample, crucibles were transferred into the dessicator, cooled and weighed (W3). Incineration was repeated until constant weight was obtained. The ash content of the samples was determined by using (AOAC, 2005) \(^1\) method. The temperature of the muffle furnace was set to 600\(^\circ\)C and empty crucibles were heated for 1 hour and then cooled in a dessicator and weighed (W1). Two g of defatted sample was weighed into the crucible and weight was noted (W2). The sample was kept on flame for charring and then incinerated at 600\(^\circ\)C for 8 hours in muffle furnace. After complete ashing of the sample, crucibles were transferred into the dessicator, cooled and weighed (W3). Incineration was repeated until constant weight was obtained.

**Calculation**

\[
\text{Ash} \% = \frac{\text{weight of the ash}}{\text{weight of the sample taken}} \times 100 = \frac{W_3 - W_1}{W_2 - W_1} \times 100
\]

Weight of the sample taken = W2-W1
Weight of the ash = W3-W1

\%	ext{ of nitrogen present in given sample} = \frac{\text{Sample titre value} - \text{Blank titre normality of HCl} \times 14 \times 100}{\text{Sample weight} \times 1000}

**Estimation of Fat**
Fat was determined by Soxhlet method (AOAC, 2005) \(^1\). Two g of sample was accurately weighed into a dry thimble and extracted using petroleum ether (60-80\(^\circ\) BP) in a flat bottomed flask and separated from the solvent by evaporating in oven. The flask was dried in an oven at 80\(^\circ\)C-100\(^\circ\)C and cooled till constant weight was achieved. Fat content of the samples were expressed as g/100 g of sample. The amount of fat present in given food sample was calculated by the following formula.

**Calculation**

\%	ext{fat/100g sample} = \frac{\text{Final wt of beaker} - \text{Empty weight of beaker}}{\text{Weight of sample}} \times 100

**Estimation of Moisture**
Moisture content of the samples was determined using procedure given by Association of Official Analytical Chemists (AOAC, 2005) \(^1\). Ten grams of food material was placed in known weight of dry petri dish with lid. Petri dishes were transferred to hot air oven at 100\(^\circ\)C to 105\(^\circ\)C till constant weight was obtained. It was followed by cooling in dessicator for 15 min and the final weight of sample was taken.

**Calculation**

\[
\text{Moisture} \% = \frac{\text{Sample initial Wt (W1)} - \text{Final Wt (W2)}}{\text{Initial Wt (W1)}} \times 100
\]

**Estimation of Protein**
Protein estimation of sample was carried out using Kjeldhal method (AOAC, 2005) \(^1\). The reagents required are conc. H\(_2\)SO\(_4\), digestion mixture, mixed indicator, NaOH. The Kjeldhal method can conveniently be divided into three steps.
1. Digestion
2. Neutralization
3. Titration

0.1 g of sample was weighed into a kjeldhal flask and 0.2 g of the digestion mixture was added and digested in Kelpus – kjeldhal digester with 20 ml of concentrated H\(_2\)SO\(_4\) until all the organic matter was oxidized and uniform greenish – blue digest was obtained. The digest was cooled, volume was made up to 100 ml with distilled water. An aliquot of 5 ml was taken for steam distillation in Kelpus distillation unit with excess of 40% NaOH solution (10 ml). The liberated ammonia was observed in 100 ml of 2% boric acid containing a few drops of mixed indicator. This was titrated against N/70 HCl. A simultaneous standard (Anhydrous ammonium sulphate) was done to estimate the amount of nitrogen taken up by N/70 HCl. From the nitrogen content of the sample, the protein content of different samples was calculated by multiplying with a factor of 6.25.

**Calculation**

\[
\text{Protein} \% = \frac{\text{Sample titre value} - \text{Blank titre normality of HCl} \times 14 \times 100}{\text{Sample weight} \times 1000}
\]

**Estimation of Crude Fibre**
The crude fiber content of the samples was determined by using (AOAC, 2005) \(^1\) method. The sample was allowed to boil with 1.25% diluted H\(_2\)SO\(_4\) washed with water, further boiled with 1.25% diluted sodium hydroxide and the remaining residue after digestion was taken as crude fiber. One g of moisture and fat free sample was weighed and were kept in the fibre bags. The glass spacer was kept into the bags. The bags were loaded in the sample carousel at the previewed positions (positions 1-12). The sample carousel was put into the glass container carefully. The glass container axial was place on the previewed position of the hot plate. The programme was started in the Fibretherm (Gerhardt). After completion of the program, the fibre bags were removed. The residue was transferred to crucible and weighed (W1) and dried over night at 80-100\(^\circ\)C in oven. Later it was transferred to dessicator for cooling and weighed (W2). The crucible was heated in a muffle furnace at 600\(^\circ\)C for 2-3 hours. Then crucible was cooled in desiccators and weighed (W3).
Observations
Weight of the sample = (W1) g
Weight of the crucible + sample before heating at 600°C = (W2) g
Weight of the crucible + sample after heating at 600°C = (W3) g
Weight of crude fibre = (W2-W3) g

Calculation

\[
\text{Crude fibre (g %)} = \frac{100 - \text{(moisture+fat)} \times \text{weight of the sample taken(moisture and fat free)} \times \text{W1}}{\text{weight of the sample(moisture and fat free)}}
\]

Estimation of Energy
Energy was determined by multiplying the protein, fat and carbohydrate values with 4, 9 and 4 respectively and totaling them (Gopalan et al., 2004) [13].

Calculation

\[
\text{Energy (kcal/100 g of rice)} = (\% \text{protein} \times 4) + (\% \text{CHO} \times 4) + (\% \text{fat} \times 9)
\]

Estimation of Iron
Iron content of the samples were determined using \(\alpha\)-\(\alpha\) dipyridyl method. The reagents required are 2, 2 dipryidyl, Hydroxylamine hydrochloride, Acetate buffer and Iron standard solution.

0.2-1.0 ml (20-100mg) of standard iron solution was taken in five separate test tubes. 2ml and 4ml of mineral solution was taken in 2 separate test tubes. 1ml hydroxylamine hydrochloride was added and mixed thoroughly and 5ml of acetate buffer and 2ml dipryidyl was added into all the test tubes. The volume was made to 25ml by adding the required amount of double distilled water and mixed thoroughly. The absorbance was read at 510nm and graph was plotted with

\[
\text{Calculation}
\]

\[
\text{Titer value } x = \frac{\text{Total volume of mineral solution}}{\text{Volume used for estimation}} \times \frac{100}{\text{wt.of the sample taken for ashing}} = \text{mg/100}
\]

Concentration of iron on X-axis and OD values on Y-axis.

Calculation

Iron mg % = \(X \times 50 \div 2 \div 100 \div \text{sample weight}\)

Results and Discussion
Small millets namely Brown top millet (BTAVT6), Banyard millet (VMBC331), Foxtail millet (SIA-3022), Proso millet (CO5), Little millet (OLM-203), Kodo millet (CO3) and Finger millet (VR-847) were analyzed for their nutritive values such as ash, moisture, protein, fat, crude fibre, energy, iron, zinc and calcium. The nutritive composition of millets were presented in Table 1.

Table 1: Nutritive Composition of Millets

<table>
<thead>
<tr>
<th>Name of the Millet</th>
<th>Ash (%)</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Crude Fibre (%)</th>
<th>Energy (kcal)</th>
<th>Iron (mg)</th>
<th>Zinc (mg)</th>
<th>Calcium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown top Millet (BTAVT6)</td>
<td>8.62</td>
<td>7.32</td>
<td>11.64</td>
<td>5.28</td>
<td>16.08</td>
<td>362.64</td>
<td>178.54</td>
<td>66.10</td>
<td>3266.27</td>
</tr>
<tr>
<td>Banyard Millet (VMVC331)</td>
<td>6.15</td>
<td>7.78</td>
<td>10.29</td>
<td>3.87</td>
<td>14.07</td>
<td>363.63</td>
<td>163.50</td>
<td>47.64</td>
<td>2661.68</td>
</tr>
<tr>
<td>Foxtail Millet (SIA-3022)</td>
<td>2.95</td>
<td>7.69</td>
<td>14.00</td>
<td>4.46</td>
<td>10.53</td>
<td>357.44</td>
<td>99.30</td>
<td>53.60</td>
<td>737.50</td>
</tr>
<tr>
<td>Proso Millet (CO5)</td>
<td>5.05</td>
<td>8.85</td>
<td>11.06</td>
<td>2.05</td>
<td>14.91</td>
<td>354.65</td>
<td>158.92</td>
<td>44.12</td>
<td>2649.14</td>
</tr>
<tr>
<td>Kodo Millet (CO3)</td>
<td>3.03</td>
<td>8.06</td>
<td>8.38</td>
<td>3.42</td>
<td>14.94</td>
<td>372.74</td>
<td>206.5</td>
<td>36.30</td>
<td>2724.76</td>
</tr>
<tr>
<td>Little Millet (OLM-203)</td>
<td>4.77</td>
<td>8.56</td>
<td>8.94</td>
<td>3.10</td>
<td>7.40</td>
<td>362.18</td>
<td>109.94</td>
<td>33.02</td>
<td>1894.66</td>
</tr>
<tr>
<td>Finger Millet (VR-847)</td>
<td>3.62</td>
<td>7.68</td>
<td>7.3</td>
<td>1.3</td>
<td>3.9</td>
<td>351.92</td>
<td>35.50</td>
<td>24.70</td>
<td>3811.98</td>
</tr>
</tbody>
</table>

The percentages of ash, moisture, protein, fat, energy, iron and calcium of brown top millet were 8.62, 7.32, 11.64, 5.28, 362.64 kcal, 178.54 mg and 3266.27 mg respectively. Brown top Millet is the richest source of fibre and zinc with values of 16.08g/100g and 66.10mg/100g. Singh and Chauhan (2019) [13] studied that high fibre content makes the millet to have low glycemic index and hence a better option for diabetic patients. The resistant starch contributes towards dietary fibre, which acts as a prebiotic and hence enhances the health benefits of brown top millet.

Banyard millet had 6.15% of ash, 7.78% of moisture, 10.29% of protein, 3.87% of fat, 14.07% of fibre, 363.63 kcal of energy, 163.50mg of iron, 47.64mg of zinc and 2661.68mg of calcium. (Roopashree et al., 2014) [11] in their study reported that banyard millet had 10.5% of protein, 3.6% of fat, 68.8% of carbohydrate and 398 kcal of energy.

Foxtail millet is highly nutritious and grains of foxtail millet have low glycemic index. The protein content of foxtail millet is higher among all millets with a value of 14g. Hariprasanna (2016) [6] reported that foxtail millet has a protein content of 12.3%. Results revealed that foxtail millet has an ash content of 2.95%, moisture of 7.69%, protein of 14%, fat of 4.46%, fibre of 10.53%, energy of 357.44 kcal, iron of 99.30mg, zinc of 53.60mg and calcium of 737.50mg.

Proso millet showed a protein content of 12.5%, fat content of 3.1%, fibre content of 14.2% and phosphorous content of 206mg (Cedric et al., 2017) [1]. The results revealed that proso millet has 5.05% of ash, 8.85% of moisture, 11.06% of protein, 3.87% of fat, 14.07% of fibre, 363.63 kcal of energy, 163.50mg of iron, 47.64mg of zinc and 2661.68mg of calcium.
protein, 2.05% of fat, 14.91% of fibre, 354.65 kcal of energy, 158.92mg of iron, 44.12mg of zinc and 2649.14mg of calcium. Among all millets proso millet showed a high moisture percent of 8.85.

Kodo millet has 3.03 percent of ash, 8.06 percent of moisture, 8.38 percent of protein, 3.42 percent of fat, 14.94 percent of crude fibre, 372.74 kcal of energy, 206.5mg of iron, 36.3mg of zinc and 2724.76mg of calcium. Deshpande et al (2015) reported that kodo millet contains 66.6g of carbohydrate, 353 Kcal of energy, 1.4 percent of fat and 190mg of iron. Among all the millets kodo millet has high iron content of 206.5mg and 372.74 kcal of energy.

The ash, moisture, protein, fat, crude fibre, energy, iron, zinc and calcium of little millet were 4.77%, 8.56%, 8.94%, 3.10%, 7.40%, 362.18 kcal, 109.94mg, 33.02mg and 3811.98mg respectively. Mallikarjun et al. (2013) reported that little millet showed 4.74% of ash content, 5.78% of moisture content, 7.07% of protein content, 4.64% of fat content and 377 kcal of energy.

The study reported that finger millet is the richest source of calcium content with a value of 3811.98mg/100g when compared to other millets. Finger millet is good for infants, elderly and pregnant women due to its high calcium content. It is also very good for lactating women as it helps in producing sufficient breast milk (Kimeera and Sucharitha, 2019). Finger millet provides 351.92 kcal of energy, 35.50mg of iron and 24.70mg of zinc.

References