



Minor Millets: A Power House of Nutrients

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Millets have substantial benefits as a drought-resistant crop, yield good productivity in the areas with water scarcity, possesses remarkable edibles and nutritive values. Nutritional quality of food is the most important parameter for maintaining human health and complete physical wellbeing. Since nutritional wellbeing is the driving force for development and maximization of human genetic potential. Therefore the study was undertaken to investigate the nutrient composition of selected minor millet. The mean moisture content of millet ranged from 8.0 to 10.1 percent. Among the minor millet proso (12.3g/100g) and foxtail millet (12.0g/100g) showed the highest protein content than other millets and lowest was in barnyard millet (6.3g/100g). Fat and ash content in millets ranged from 0.9 to 4.4g/100g and 1.3 to 2.0g/100g respectively. The highest crude fiber content was recorded in barnyard millet (9.9g/100g), followed by kodo millet (9.2g/100g) and lowest in proso millet (2.3g/100g). Carbohydrate content in finger millet was significantly higher (76.3g/100g), followed by proso millet (74.0g/100g) and least was recorded in foxtail millet (67.0g/100g). The energy value of selected millets ranged from 330 to 362 Kcal. Results showed that 'F' value indicated a significant difference to exist among the selected millets for all the nutrients studied ($p \leq 0.05$).

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1. INTRODUCTION

Millets hold great potential in contributing substantially to food and nutritional security of the country and they are not only a powerhouse of nutrients but also climate resilient crops and possess unique nutritional characteristics. Millets are nutritionally superior to wheat and rice due to their higher levels of protein with a more balanced amino acid profile, dietary fibre, and minerals such as iron, zinc and phosphorous. Millets can provide nutritional security and act as a shield against nutritional deficiency, especially among children and women [1].

In addition to their nutritive value, several potential health benefits such as preventing cancer and cardiovascular diseases, lowering blood pressure, reduced risk of heart disease, cholesterol and rate of fat absorption, delaying gastric emptying and supplying gastrointestinal bulk have been reported for millets [2,3]. Millets have traditionally played an important role in farming and food culture in many regions of the world, including Sub-Saharan Africa and South Asia. India is the world's largest producer of millets. In India, millets are cultivated in an area of 15.48 million hectares producing 17.2 million tonnes with a yield of 1111 kg/ha [4].

Identifying nutritional importance of millets Government of India has declared millets, a popular food in many parts of Karnataka, as "Nutri- Cereals". Promotion of production and consumption of millets through conscious efforts at the global level is likely to contribute substantially to fight against targeted hunger and mitigate the effect of climate change in the long run.

Knowledge about the nutritional status of millet is becoming increasingly important among consumers given nutritional deficiency disorders. Health-conscious consumers are interested in having millets with good nutritional quality. Therefore, the objective of this study is to investigate the proximate composition of selected minor millets in terms of nutrition.

2. MATERIALS AND METHODS

2.1 Preparation of Sample

Samples were cleaned by removing foreign materials, stones, and grits. They were grounded

into a fine powder and dried in a hot air oven for further chemical analysis. Analysis of the samples was done using standard procedures [5].

2.2 Moisture Content

The known quantity of the sample was taken in a petri dish and weighed. The petri dish along with a known weight of the sample was dried in a hot air oven at 105°C for 3 hours after that petri dish was removed from the oven, cooled in a desiccator and weighed. The procedure continued until the weight of the petri dish with the sample was constant. The moisture content of the sample was calculated as follows:

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Weight of the sample}} \times 100$$

2.3 Estimation of Total Protein

The protein content of the dried food grain samples was estimated as the percent of total nitrogen by Micro-Kjeldhal method and then multiplied by per-cent nitrogen by using conversion factor 6.25.

$$\text{Protein (g/100g)} = \frac{\text{Titre value} \times \text{Normality of HCl} \times 14.001 \times 6.25}{\text{Sample weight (g)} \times 1000} \times 100$$

2.4 Estimation of Fat

The fat content of the samples was estimated as crude ether extract of the moisture-free sample. The moisture-free sample (5 g) was weighed and placed into a thimble and it was plugged with cotton, the thimble was placed in soxhlet apparatus and it was extracted for 3 hours using anhydrous ether. The solvent was removed by evaporation and the round bottom flask with residue was dried in a hot air oven at 80 to 100°C. It was cooled in a desiccator and weighed.

$$\text{Fat content (g/100g)} = \frac{\text{Weight of ether extract}}{\text{Weight of the sample}} \times 100$$

2.5 Estimation of Crude Fiber

Moisture and fat-free sample was used for crude fiber estimation and expressed as gram per 100 g of the sample.

$$\text{Crude fiber (g/100 g)} = \frac{[100 - (\text{Moisture} + \text{Fat})] \times (W_e - W_a)}{\text{weight of the sample taken (moisture and fat free)}} \times 100$$

W_e - Pre-weighed ashing crucible

W_a - Weight of the crucible after ashing

2.6 Estimation of Ash

About 5 to 10 g of the sample was taken in a crucible. The crucible was placed on a clay pipe triangle and heated over a low flame until the sample was completely charred and then heated in a muffle furnace at 600°C for about 4 to 5 hours. It was then cooled in a desiccator and weighed. The procedure was continued till two consecutive weight was same and ash content was greyish white.

$$\text{Ash content (g/100g)} = \frac{\text{Weight of the ash}}{\text{Weight of the sample}} \times 100$$

2.7 Computation of Carbohydrate

The differential method was used to calculate the carbohydrate content.

$$\text{Carbohydrate (g/100)} = 100 - [\text{Protein (g)} + \text{Fat (g)} + \text{Fibre (g)} + \text{Ash (g)} + \text{Moisture (g)}]$$

2.8 Computation of Energy

Energy was computed as follows

$$\text{The energy (Kcal)} = [\text{Protein (g)} \times 4] + [\text{Carbohydrate (g)} \times 4] + [\text{Fat (g)} \times 9]$$

2.9 Statistical Analysis

The data reported in all of the tables are the averages of triplicate observations. Mean values were calculated and compared at different significance levels. Pearson's correlations of the means were determined using the software OPSTAT (CCS, Haryana Agricultural University, Hisar, India). The significance of differences between treatment means values for each trait was tested by using Duncan's multiple range tests.

3. RESULTS AND DISCUSSION

Table 1, Fig. 1, depicts macronutrients such as moisture, protein, fat, ash, crude fiber, carbohydrates, and energy content in millets under the study.

Moisture: The moisture is the loss in weight which the substance undergoes by evaporation during the reversible process of drying to practically constant weight, which does not undergo detectable significant alteration other than the reversible loss of moisture content. It is

one of the most critical physiological factors in the flourishing grain storage of the food grain. High moisture content leads to increased susceptibility towards the storage spoilage due to the fungal and insect problems, respiration and germination. However, the moisture content in the growing crop is naturally high and only starts to decrease as the crop reaches maturity.

The moisture content of selected millets under the study ranged from 8.0 to 10.1 g/100. However, the moisture content was within the tolerable level for cereals and is highly acceptable in terms of their good keeping quality due to their low moisture content. Among the millets, kodo millet showed higher moisture content of 10.1g/100g. Present findings for moisture content of millets are in tune with that report [6]. However, a slightly higher range of moisture content was reported [7,8] in the different genotypes of millets and locally available small millets. The considerably higher or lower difference in moisture content depends on several factors viz., the stage of maturity, season, weather pattern and drying facilities. Statistically 'F' test applied for shows a significant difference to existing among the millets for moisture content.

Protein: Proteins are fundamental to the living process and to carry out ample functions essential for the sustenance of life. Hence protein being one of the most important nutrients should be supplied through diet in an adequate amount [9]. Therefore, it is essential to assess the protein content in the available food grain sources to meet the protein requirement of the body.

Significant variability was observed among the millets studied for protein content. Proso (12.3 g/100g) and foxtail millet (12.0g/100g) showed the highest protein content than other millets analyzed. Among the millets, barnyard millet had the lowest protein content of 6.3 g/100g. Protein content recorded in the foxtail millet was in tune with that report [8]. A similar finding of protein variability among the millets was also reported by [6]. The differences in the protein content observed in the present study and that reported by others may be due to the veritable difference and agro-climatic conditions grown. Statistically 'F'- value indicated a significant difference to exist among the millets for protein.

Fat: Fat is an important component of the diet that serves numerous functions in our body. It

imparts palatability to the diet and retards stomach emptying time. Fat in the diet is required for absorption and utilization of fat-soluble vitamins like vitamin A and carotene present in the diet [10].

Fat content in millets ranged from 0.9 to 4.4g/100g. Among the millets highest fat content was observed in little millet (4.4g/100g) and lowest in proso millet (0.9g/100g). Statistically 'F' value indicated significant difference to exist among the millets and major staple grains analyzed for fat content. However, the fat content in millets is found to be on par with that reported [11]. Similar findings were also observed for little millet [6]. The results are slightly lower than those reported [7] for barnyard millet. The difference in the reported and present study may be attributed to substantial genetic variability and agro-climatic conditions grown.

Total ash: Ash is the inorganic residue that remains after the removal of water and organic matter by heating in the presence of oxidizing agents. Ash is the direct indicator of mineral content present in the grain.

In the present study, the total ash content in millets ranged from 1.3 to 2.0g/100g. Among the millets, finger millet had the highest (2.0g/100g) and lowest in foxtail millet (1.3g/100g). The large diversity in ash content among the grains is due to the difference in mineral accumulation in food grains. It might also be due to the different efficiency of translocation of minerals from root tissues to edible plant organs and accumulation of the elements in edible portions [12], even growing environment and genetic differences also influence the accumulation of minerals in food grains [13]. A finding similar to the present study was also reported [14] for finger millet. The

results are lower than that reported [11] for foxtail, barnyard, kodo, proso and little millet. Statistical analysis showed a significant difference to exist among millets, as indicated by 'F' value.

Crude fiber: Crude fiber is the residue that is obtained after the subsequent washing with acid and alkali. Various research studies have highlighted the significance of fibre in the diet for health. In the present study highest crude fiber content was recorded in barnyard millet (9.9 g/100g), followed by kodo millet (9.2g/100 g) and lowest in proso millet (2.3g/100g). The slightly higher range for crude fiber content in millets (2.3 to 7.6g/100g) and also it is a general observation that bold seeded varieties contained a slightly lower amount of crude fibre than small-seeded varieties [11]. The reported values for finger millet are on par with the results reported [14]. Statistical analysis showed a significant difference among millets, for crude fibre as indicated by 'F' value.

Carbohydrates: Carbohydrates are the main energy-yielding substances in the Indian daily diet. Besides starch and other digestible carbohydrates they also contain non-digestible carbohydrates which add bulk to the diet. These are the major food source and a key form of energy for most living organisms.

Among the selected millet carbohydrate content in finger millet was significantly higher (76.3 g/100g), followed by proso millet (74.0g/100g) and least was recorded in foxtail millet (67.0 g/100g) (Fig. 2). Similar findings were reported [14] for carbohydrates in finger millet germplasm. The small millet in the present study recorded higher carbohydrate content compared to that reported [11]. The results are slightly lower than

Table 1. Proximate composition of selected minor millets

Samples	Moisture (%)	Protein (g)	Fat (g)	Total ash (g)	Crude fibre (g)	Carbohydrate (g)	Energy (Kcal)
Finger millet	9.0	7.7	1.8	2.0	3.2	76.3	343
Little millet	8.5	9.9	4.4	1.5	8.0	67.8	349
Kodo millet	10.1	8.6	2.5	1.4	9.2	68.2	330
Foxtail millet	8.0	12.0	4.2	1.3	7.0	67.0	362
Barnyard millet	8.3	6.3	2.5	1.9	9.9	71.1	333
Proso millet	9.2	12.3	0.9	1.4	2.3	74.0	353
F Value	*	*	*	*	*	*	*
SEm ±	0.15	0.24	0.06	0.07	0.15	0.45	4.42
CD (P≤0.05)	0.48	0.77	0.18	0.03	0.49	1.41	13.17

* Significant at $p < 0.05$ level

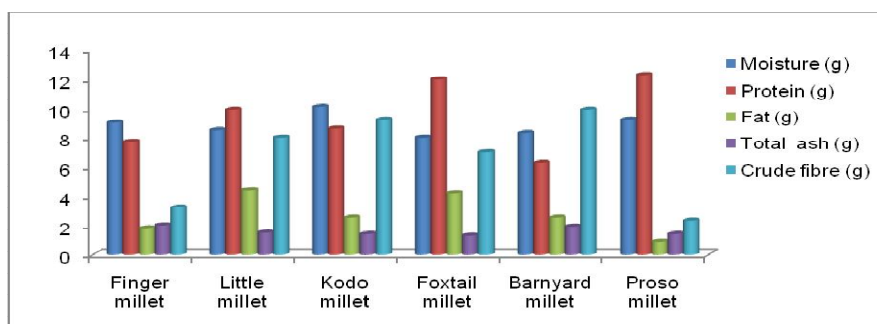


Fig. 1. Nutrient composition of selected minor millets

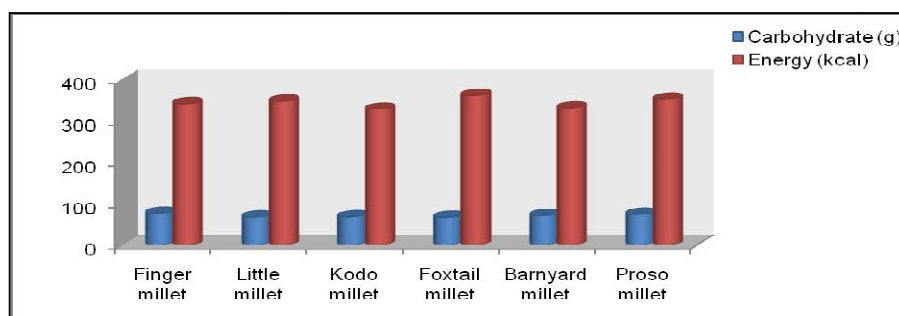


Fig. 2. Carbohydrate and energy content in selected minor millets

Table 2. Correlation co-efficient for the nutritional parameters in selected minor millets

	Moisture (%)	Protein (g)	Fat (g)	Total ash (g)	Crude fibre (g)	Carbohydrate (g)	Energy (Kcal)
Moisture (g)	1						
Protein (g)	0.102	1					
Fat (g)	-0.539	0.113	1				
Total ash (g)	-0.122	-0.816*	-0.320	1			
Crude fibre (g)	0.118	-0.458	0.586	-0.063	1		
Carbohydrate (g)	0.198	-0.229	-0.822*	0.655	-0.740	1	
Energy (Kcal)	-0.554	0.838*	0.303	-0.477	-0.488	-0.116	1

*Correlation is significant at the 0.05 level (2-tailed)

those reported [8] for barnyard millet. Genetic variation and agro-climatic conditions may be the reason for the difference recorded. Statistically, a significant difference was found to exist at a five percent level among the millets, rice and wheat for carbohydrates.

Energy: The energy value of selected millets ranged from 330 to 362 Kcal (Fig. 2). Among millets, foxtail millet had the highest energy content (362 Kcal) and the lowest was observed in kodo millet (330 Kcal). Similar findings were reported [11] for finger millet. The results are slightly lower than that reported [8] for barnyard, little, foxtail and kodo millet. Statistically 'F' value indicated significant

difference to exist among the millets for energy at a five percent level.

The results of the correlation of nutritional compositional of minor millets were presented in Table 2. The protein content was positively significant correlation against energy and negatively correlated with total ash. There was a negative significant correlation between fat and carbohydrates.

4. CONCLUSION

This investigation concluded that millets contained a good source of protein, fiber and had low-fat content. Hence

various innovative products may be developed to suit the consumer needs and also to achieve nutritional security. There is also a tremendous opportunity to develop functional food from such millets.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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