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Nutrient composition of millet composite flour

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Abstract
Millets are a group of small seeded species of cereal crops, widely grown around the world for food and fodder. Millets are comparable to major cereals with respect to their nutritional features and also are very good sources of carbohydrates, micronutrients and phytochemicals with nutraceutical properties. Study was carried out to evaluate the nutrient composition of millet composite mix. The millet composite flour was analysed for proximate principles like moisture, protein, fat, ash, fibre, carbohydrate, dietary fibre, mineral composition and essential amino acid profile using standard procedure. Results revealed that the protein, fat, ash, energy and crude fibre content was significantly higher in composite flour compared to wheat flour. The insoluble fibre, total dietary fibre content was significantly higher in composite flour (20.59 g and 26.65 g/100 g) compared to wheat flour (18.45 g and 23.48 g/ 100 g). All the minerals in composite flour were significantly higher compared to wheat flour. It can be concluded that millets have better nutritional quality than wheat flour.

Keywords: Millet, nutrient, mineral, essential amino acids, composite flour

Introduction
Millets are a group of small seeded species of cereal crops, widely grown around the world for food and fodder. The word 'milli' refers to thousands of grains that can be held in a handful and millets are called small, coarse or minor millets. The group includes millets such as little millet (*Panicum miliare*), foxtail millet (*Setaria italica*), kodo millet (*Paspalum scrobiculatum*), common millet (*Panicum miliaceum*), barnyard millet (*Echinochloa frumentacea*), pearl millet (*Pennisetum glaucum* L.) and finger millet (*Elusine coracana*).
India is the top most producers of millets followed by Nigeria for the year 2000 and 2009. In India, eight millets species (Sorghum, Pearl millet, Finger millet, Foxtail millet, Kodo millet, Proso millet, Barnyard millet and little millet) are commonly cultivated under rain fed conditions. Further, in each of the millet growing areas at least 4 to 5 species are cultivated either as primary or allied crop in combination with the pulses, oilseeds, spices and condiments.
Millets are not only comparable to major cereals with respect to their nutritional features but are very good sources of carbohydrates, micronutrients and phytochemicals with nutraceutical properties. The millet grain contains about 65% carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fibre which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the blood stream during digestion. Lower incidence of cardiovascular diseases, duodenal ulcer and hyperglycemia (diabetes) are reported among regular millet consumers. Millet grains are also rich in important vitamins *viz*., Thiamine, riboflavin, folic acid and niacin. Millets are comparable to rice and wheat or rich in some of the minerals as well as fatty acids. Millets vary largely in composition of carbohydrates as proportion of amylose and amylopectin content vary from 16-28 and 72-84 percent, respectively (Rao *et al.*, 2017) [7].

Methodology
The importance of coarse cereals in direct human consumption is declining even though they possess good nutritive value. Minor millets not only have better nutritional value but they also have phytochemicals and antioxidants. Although millets are nutritionally superior to cereals their utilization in the country is not wide spread. One possible way of enhancing utilization of millet is by blending them with conventional cereal like wheat. Thus composite flour was developed and its nutritional quality was evaluated.
The millet composite flour and wheat flour were analysed for proximate principles like moisture, protein, fat, ash, fibre, carbohydrate and dietary fibre.

Moisture
The moisture content was determined by oven drying method. The 10 g of sample was taken in a pre-weighed petric dish and dried in oven at 105 °C till the petri dish with its content was constant. The samples were cooled in desiccators and weighed, each time before weighing, the petri dish was cooled in desicator. Moisture content of the sample was expressed in g/100 g of sample (Anon., 2000) [5].

Crude protein
Total nitrogen content of the moisture free sample was estimated using Kelplus of Pelican make. Organic nitrogen when digested with concentrated sulphuric acid in the presence of a catalyst (potassium sulphate and copper sulphate) was converted in to ammonium sulphate and was further distilled to obtain nitrogen. Nitrogen was multiplied with a constant 6.25 to get crude protein content (Anon., 2000) [5].

Crude fat
Fat content was estimated in moisture free samples using solvent extraction method, by refluxing with petroleum ether in Socs Plus of Pelican model (Anon., 2000) [5].

Ash
The ash content was determined by taking about 5g of the sample into a crucible. The crucibl till all the sample completely charred, after that the crucible was kept in muffle furnace for about four to five hours at about 600˚C. This was repeated till two consecutive weights were same and the resultant ash is uniform in color (white or gray) and free from unburnt carbon and fused lumps (Anon., 2000) [5].
Then it was cooled and weighed

Crude fibre (%)
Crude fiber was estimated from moisture and fat free sample. The residue obtained after digestion with acid and alkali was dried in crucible. The difference in weight of crucible before and after ashing of the digested residue was taken as weight of crude fiber (Anon., 2000) [5].

Carbohydrates (%)
The total carbohydrate content was calculated by difference method *i.e.* subtracting the sum of the values for moisture, protein, fat, ash and crude fiber from 100.

Dietary fiber (%)
The soluble, insoluble and total dietary fiber fractions were analyzed by enzymatic, gravimetric method (Asp., *et al*. 1983). In the presence of a heat-stable α-amylase the sample was gelatinized by boiling for 15 minutes. After that it was incubated with pepsin, at acid pH for 1 hour and with pancreatin, at neutral pH for 1 hour. The insoluble dietary fibre is filtered with celite as the filter aid. Soluble dietary fibre is precipitated from the filtrate with 4 volumes of ethanol and recovered by filtration in the same way as insoluble dietary fibre.

Mineral
Preparation of mineral solution
To the ash that was obtained, 5 ml of a 1:1 solution of distilled water and fuming HCl was added. This mixture was heated over a water bath until it starts fuming and at this point, the crucible was retrieved and content was filtered into a 100 ml volumetric flask using Whatman No.40 filter paper. After thorough rinsing of the crucible and the filter paper, the volume was made up to the mark with distilled water. Aliquots of this mineral solution were taken for the estimation of all the minerals in the study.

Calcium and magnesium
Calcium was precipitated as calcium oxalate, the precipitation was dissolved in hot dilute sulphuric acid and titrated with standard potassium permanganate solution. Magnesium was converted to magnesium pyrophosphate which is estimated gravitometrically (Anon., 2000) [5].

Phosphorus
Phosphorus reacts with molybdic acid to form a phospho molybdate complex. It is then reduced with aminonapthol sulphuric acid to the complex molybdenum blue which is measured colorimetrically at 650 nm (Anon., 2000) [5].

Sodium and potassium
Sodium and potassium content were estimated using flame photometer following the method of Ranganna (1994).

Trace elements
Trace elements *viz.* iron, manganese, zinc and copper were determined in Atomic Absorption Spectrophotometer (model: AAS GBS Avanta) by following the standard AOAC (2000) method.

Essential Amino Acid
Essential amino acids isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine and were determined HPLC-PDA method (Dhillon *et al.*, 2013).

Results
Table 1 shows the proximate composition of wheat and millet composite flours. The moisture content in wheat flour was significantly higher (8.55 g/100 g) compared to composite flour (7.82 g/100 g). The protein content in composite flour was significantly higher (13.74 g/100 g) compared to wheat flour (13 g/100 g). The fat content in millet composite flour was significantly higher (5.30 g/100 g) compared to wheat flour (1.93 g/100 g). Ash content of composite flour was significantly higher (2.30 g/100 g) compared to wheat flour (1.55 g/100 g). The crude fibre content in composite flour was significantly higher (3.57 g/100 g) (p<0, 5%) compared to wheat flour (2.87 g/100 g). The carbohydrate content of wheat flour was significantly higher (74.39 g/100 g) compared to composite flour (71.34 g/100 g). The energy content in composite flour was high (388 Kcal) compared to wheat flour (367 Kcal).
The insoluble fibre content was significantly higher (p≤0.01 %) in composite flour (20.59 g/100 g) compared to wheat flour (18.45 g/100 g). The soluble fibre content was more in composite flour (6.06 g/100 g) compared to wheat flour (5.03 g/100 g). The total dietary fibre content was highly significant in composite flour (26.65 g/100 g) compared to wheat flour (23.48 g/100 g).
Mineral composition of wheat flour and composite flour is presented in Table 2. All the minerals in composite flour were significantly higher compared to wheat flour. Sodium (5.15 and 2.33 mg/100 g), potassium (154 and 144.33 mg/100 g), calcium (32.97 and 28.67 mg/100 g), magnesium(26.67 and 13.33 m g/100 g), iron (2.52 and 1.22 mg/100 g), phosphorus

(101 and 91 mg/100 g), copper (0.55 and 0.23 mg/100 g), zinc (1.02 and 0.87 mg/100 g) and manganese (0.9 and 0.63 mg/100 g) respectively.

Essential Amino Acid content of millet composite flour and wheat flour is denoted in table 3. It was found that all the amino acid content in millet composite flour were significantly higher compared to wheat flour. The Isoleucine (5.4 and 2.23 mg/100 g), leucine (11.08 and 5.44 mg/100 g), lysine (5.57 and 2.18 mg/100 g), methionine (2.55 and 1.04 mg/100 g), phenylalanine (6.37 and 3.13 mg/100 g), threonie (3.27 and 1.98 mg/100 g), tryptophan (1.17 and 0.91 mg/100 g) and valine (6.67 and 2.47 mg/100 g).

Table 1: Nutrient composition of wheat and composite flour

	Wheat Flour	Composite Flour	t-value
Moisture (g)	8.55	7.82	21.9**
Protein (g)	13.00	13.74	2.94*
Fat (g)	1.93	5.30	41.35***
Ash (g)	1.55	2.30	22.73**
Crude fibre(g)	2.87	3.57	3.16*
Carbohydrate (g)	74.39	71.34	17.99***
Dietary fibre (g)			
Insoluble (g)	18.45	20.59	7.42**
Soluble (g)	5.03	6.06	2.49
Total dietary fibre (g)	23.48	26.65	0.76***

* Significant at 5% level of significance
** Significant at 1% level of significance
*** Highly Significant

Table 2: Mineral composition of composite flour and wheat flour (mg /100g)

	Minerals	Wheat flour	Composite flour	t-value
1	Sodium	2.33	5.15	29.07**
2	Potassium	144.33	154	4.59*
3	Calcium	28.67	32.97	2.27**
4	Magnesium	13.33	26.67	10.7**
5	Iron	1.22	2.52	23.06**
6	Phosphorous	91	101	4.8**
7	Copper	0.23	0.55	24.00**
8	Zinc	0.87	1.02	15.91**
9	Manganese	0.63	0.9	6.05**

* Significant at 5% level of significance
** Significant at 1% level of significance

Table 3: Essential amino acid content of wheat and millet composite flour (mg/100g)

Parameters	Wheat flour	Composite flour	t-value
Isoleucine	2.23	5.4	47.55**
Leucine	5.44	11.08	10.76**
Lysine	2.18	5.57	48.71**
Methionine	1.04	2.55	45.3**
Cystine	1.13	3.57	51.76**
Phenyl alanine	3.13	6.37	12.34**
Tyrosine	2.2	4.33	15.98**
Threonine	1.98	3.27	38.51**
Tryptophan	0.91	1.17	5.37**
Valine	2.47	6.67	47.39**
Histidine	2.23	4.37	17.16**

** Significant at 5% level of significance

Discussion

The protein, fat, ash was significantly higher in millet composite flour compared to wheat flour. (Table1) and the crude fibre, insoluble and total dietary fibre were significantly higher in millet composite flour compared to wheat flour, because of the addition of 50 percent of millets in the composite flour and soy bean (10 g). The protein content in the millet composite flour is significantly high because of the addition of 10 g soy bean in 100 g of the millet composite flour mix. The carbohydrate in the wheat flour was significantly high in wheat flour compared to the millet composite flour, because of the higher carbohydrate content in wheat when compared to millets (Table.1). Chhavi and Sarita (2012) [3] reported that foxtail millet flour in the proportion of 30 to 60 percent into refined wheat flour bread showed significantly higher crude protein, crude fat, total ash, phosphorus and insoluble dietary fiber. Choudhary *et al.* (2012) [4] developed a mix using soy (40 percent), pearl millet (30 percent) and wheat (30 percent) which showed higher crude ash, crude fiber, protein, crude fat, dietary fiber and energy. Indrani et.al (2011) [2], developed multigrain blend of chick pea split without husk, barley, soybean and fenugreek seeds and reported that, with increase in the percentage of multigrain blend from 0 to 40g / 100 g of wheat flour, the nutritional characteristics of composite whole wheat flour increased with respect to ash, protein, fat and dietary fiber contents. The mineral content of millet composite flour *viz*. sodium, potassium, calcium, magnesium, iron, phosphorus, copper, zinc, manganese was higher than wheat flour (Table.2).This is due to the fact that in present study, millets used in the composite mix are rich in minerals. The results are on par with the study conducted by, Geetha and Suja (1996), who reported that every 100 grams of finger millet based mix had higher protein, fat, ash, iron, phosphorous and calcium compared to rice based mix.

The essential amino acid content in composite millet mix *viz*, isoleucine, leucine, lysine, methionine, cystine, phenyl alanine, tyrosine, threonine, tryptophan, valine, histidine was higher than wheat flour (Table 3), this may be due to millets are rich source of essential amino acid. Similarly accorring to the reports of FAO.1970 and Indra and naik the amino acid contents in millets were in finger millet, foxtail millet and proso millet ie, isoleucine was 275, 475 and 416 mg/g, leucine was 595, 1044 and 679 mg/g and lysine was 405, 762 and 189 mg/g respectively.

Conclusion

The protein, fat, Ash, energy and crude fibre content was significantly higher in composite flour compared to wheat flour. The insoluble fibre, total dietary fibre content was significantly higher in composite flour (20.59 g and 26.65 g/100 g) compared to wheat flour (18.45 g and 23.48 g/ 100 g). The minerals sodium, potassium, calcium, magnesium, iron, phosphorus, copper, zinc and manganese content were significantly higher in composite flour compared to wheat flour. It was found that the amino acids such as isoleucine, leucine, lysine, methionine, phenylalanine, threonie, tryptophan and valine content in millet composite flour were significantly higher compared to wheat flour.

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