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Evaluation 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 physico- chemical properties and nutrient composition of millet composite mix. Physical characteristics of millet composite flour including particle size, water absorption, weight, volume, bulk density, total soluble solids, gluten content, colour, were assessed by following standard procedures. The millet composite flour was analysed for proximate principles like moisture, protein, fat, fibre, carbohydrate and dietary fibre. 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) respectively. It can be concluded that millets have better nutritional quality than wheat flour.

Keywords: Millet, nutrient, Physico-chemical, 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.
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. With this background a study was carried out to evaluate the physico- chemical properties and nutrient composition of millet composite flour.

Methodology
Physical characteristics of millet composite flour including particle size, water absorption, weight, volume, bulk density, total soluble solids, gluten content, colour, were assessed by following standard procedures.

Water absorption capacity
The flour of 5g was taken into a centrifuge tube and thoroughly mixed with 30 ml distilled water. The sample was allowed to stand for 30 minutes and centrifuged at 1500 rpm speed for 30 minutes. The free water was decanted into a graduated cylinder and volume recorded. The value was expressed as the grams of water absorbed per gram of sample (Nawabueze, 2006) [8].

Weight
Weight of the flour was recorded in triplicates using electronic weighing balance. Mean weight was expressed in g.

Volume
The composite flour of 25g was poured in to 100 ml measuring cylinder. The measuring cylinder was tapped till the flour goes down. Then final reading of flour was recorded as final volume.

Bulk density

Bulk density was calculated from the weight and volume as follows-

$$\text{Bulk density (g/ml)} = \frac{\text{Weight (g)}}{\text{Volume (ml)}}$$

Total soluble solids

Total soluble solids (TSS) in flour were determined by using refractometer of 0-32 ºBrix. A drop of flour mixed with distilled water (at 20 ºC) was placed on clean and dry prism and calibration was done at zero line on the scale. Then the samples of flour was analyzed for their TSS value by reading the line of demarcation on the scale.

Gluten content

Weighed sample (20 g) was taken in to a bowl and 12.5 ml water was added to it and mixed with hand to form a stiff dough ball. The dough ball was kept into water for half an hour, after half an hour the dough ball was washed with hand under tap water until free from starch. The wet gluten obtained was weighed and its weight was expressed in percentage of the original flour sample (20g). Then the wet gluten was kept in dish and was placed in a hot air oven at 100 ˚C for 2 h. After cooling in desicator the dry gluten was weighed and its weight was expressed in percentage of the original flour sample (Austin and Ram, 1971) [3].

$$\text{Gluten (g/100 g)} = \frac{\text{Weight of gluten (g)}}{100} \times 25$$

Color

The millet composite flour was subjected to colour assessment in spectrophotometer Konica Minolta, CM-2600/2500d model. The model was measured in chromatic components of 'L' (black to white), 'a' (redness to greenness) and 'b' (yellowness to blueness).

Particle size

Hundred grams of flour was taken and passed through different meshes of BSS standards from 60, 85, 100, 150, 200 and 240 with sieve opening of 0.250, 0.180, 0.150, 0.106, 0.075 and 0.063 µm respectively. The sample was passed from bigger to smaller mesh size. The sample above the sieve was weighed and recorded.

The millet composite flour and wheat flour were analyzed 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 petri 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) [1].

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) [1].

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) [1].

Ash

The ash content was determined by taking about 5 g of the sample into a crucible. The crucible was kept in muffle furnace for about four to five hours at about 600 ˚C till all the sample completely charred. 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) [1]. Then it was cooled and weighed.

Crude fibre (%)

Crude fibre 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) [1].

Carbohydrates (%)

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

Dietary fibre (%)

The soluble, insoluble and total dietary fibre fractions were analyzed by enzymatic, gravimetric method (Asp., et. al., 1983) [2]. 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.

Results and discussion

The water absorption of wheat flour was significantly lower than millet composite flour (Table.1). Similar result was reported by who stated that, use of increasing amount of multigrain blend from 0-40 g/ 100 g increased farinograph water absorption, which is due to presence of fibre in the multigrains.

Wheat is the grain with high gluten level, which is combination of gliadin and glutenin. Gliadin is very sticky when wet and very extensible and imparts adhesive properties to gluten. Glutenin is a large and complex protein which gives dough strength and elasticity. Gluten content of wheat flour was higher than millet composite flour (Table 1). This is due to reduction of gluten of wheat flour with addition of 50 percent millets which do not contain gluten. Similar results were observed in a study conducted by Choudhary *et al.*, (2012) [5], who reported decrease in gluten content with increase in the addition of ragi flour in composite flour blend. These results are in close agreement with the results found by

Dhingra and Jood (2004) [6] for composite flour. Poongodi and Jemima (2009) [9] also reported that the dry gluten content decreased significantly with the increase in the percent of millet blend in the preparation of composite flour.

The colour is an important quality factor directly related to the acceptability of food products. The 'a' value of millet composite flour was significantly higher (2.70) compared to wheat flour (Table 1), which indicates redness and is due to presence of finger millet in millet composite flour. Sawant *et. al.,* (2013) [10], also reported the 'a' values to range from 2.05 to 4.55 in ready to eat extruded products using finger millet from 10 to 40 percent incorporation. In the present study the 'b' values which indicate whiteness were significantly higher in the wheat flour compared to millet composite flour which may be because of the higher percentage of foxtail millet (12.5 g in 100 g) in the composite flour mix when compared to wheat flour.

With respect to particle size, on an average higher proportion of wheat flour was finer and higher proportion of millet composite flour was coarser (Table 2). Similar results were reported by (Poongodi and Jemima, 2009) [9]. The percentage of fine flour particles was reduced with increase in the percentage of millet flour. The coarseness of millet flour could be due to corneous endosperm texture or husk portion of the grain.

The protein, fat, were significantly higher in millet composite flour compared to wheat flour. (Table3) and the crude fibre (3.57 g / 100g), insoluble (20.59 g / 100g) and total dietary fibre (26.65 g / 100g) because of the addition of 50 percent of millets and soy bean (10 g) in the composite flour. The carbohydrate 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. 3). Chhavi and Sarita (2012) [4] 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) [5] developed a mix using soybean (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) [7], developed multigrain blend of chick pea split without husk, barley, soybean and fenugreek seeds further they 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.

Table 1: Physical properties of wheat and millet composite flour

Parameters	Wheat flour	Millet composite flour	t-value
Weight (g)	25.00 ± 0.03	25.00 ± 0.03	-
Volume(ml)	33.00 ± 0.06	32.33 ± 0.03	0.34
Bulk density (g/ml)	0.76 ± 0.01	0.78 ± 0.02	0.44
Water absorption capacity (%)	71.00 ± 0.07	74.67 ± 0.03	5.50**
Total soluble solids(brix)	14.00 ± 0.04	8.00 ± 0.03	33.77***
Gluten content (%)	5.34 ± 0.02	2.93 ± 0.02	16.17**
Colour			
L	88.61 ± 0.03	88.55 ± 0.02	0.45
a	1.54 ± 0.02	2.70 ± 0.02	17.78**
b	10.49 ± 0.02	9.90 ± 0.01	8.82**

* Significant at 5% level
** Significant at 1% level
*** Highly significant at 0.1% level

Table 2: Percent particle size distribution of wheat and millet composite flour

Sl. No.	Flour	BSS Standards					
		> 60 (0.250 µm)	> 85 (0.180 µm)	> 100 (0.150 µm)	> 150 (0.106 µm)	> 200 (0.075 µm)	>240 (0.063 µm)
1	Wheat flour	0.18 ± 0.15	0.93 ± 0.05	2.92 ± 0.01	28.51 ± 0.16	40.40 ± 0.27	27.06 ± 0.02
2	Millet composite flour	0.41 ± 0.02	46.28 ± 0.38	34.22 ± 0.20	14.79 ± 0.43	3.74 ± 0.05	0.56 ± 0.03
	F- Value	7.75	42237.95	72571.74	2735.62	54382.02	19152.27
	S.Em.±	0.06	0.16	0.08	0.19	0.11	0.01
	C.D.	0.25	0.61	0.32	0.73	0.44	0.05

Table 3: Nutrient composition of wheat and millet composite flour

	Wheat flour	Composite flour	t-value
Moisture (g)	8.55 ± 0.01	7.82 ± 0.02	55.75**
Protein (g)	13.00 ± 0.15	13.74 ± 0.01	5.40*
Fat (g)	1.93 ± 0.02	5.30 ± 0.25	34.07*
Ash (g)	1.55 ± 0.02	2.30 ± 0.20	8.38^{NS}
Crude fibre(g)	2.87 ± 0.01	3.57 ± 0.01	52.41**
Insoluble (g)	18.45 ± 0.15	20.59 ± 0.15	7.42**
Total dietary fibre (g)	23.48 ± 0.01	26.65 ± 0.02	0.76**
Carbohydrate (g)	74.39 ± 0.02	71.34 ± 0.02	162.88**
Energy (K cal)#	367 ± 2.51	388 ± 1.52	10.08**

* Significant at 5% level
** Significant at 1% level
#Computed

Conclusion

The water absorption capacity of the wheat flour was (71%) which was significantly lower when compared to millet composite flour (74.61%). The gluten content of wheat flour was (5.34%) was significantly higher than compared to millet composite flour (2.93%). The colour 'a' of the composite flour (2.70%) was significantly higher compared to wheat flour (1.54%). Colour 'b' of wheat flour was (10.49%) significantly higher when compared to millet composite flour (9.90%). The particle size of wheat flour was finer with maximum percent (40.40 and 27.06) flour distribution on the sieve size 200 to 240 mesh. The particle size of millet composite flour was coarser with maximum percent (46.27 and 34.12) flour distribution on the sieve size > 85 to > 100 mesh. The protein, fat, energy and crude fibre were significantly higher in composite flour compared to wheat flour. The insoluble fibre, total dietary fibre content were 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). It can be concluded that millets have better nutritional quality than wheat flour.

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