

## Comparative evaluation of proximate analysis, mineral composition, antioxidant activity and resistant starch of finger millet flour and foxtail millet flour with refined wheat flour

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### ABSTRACT

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The present study was conducted to evaluate the proximate analysis, mineral composition, antioxidant activity and resistant starch of finger millet flour and foxtail millet flour and their comparison with refined wheat flour. Finger millet grain and foxtail millet grain were procured from district Champawat. Proximate analysis of finger millet flour, foxtail millet flour and refined wheat flour was done by methods given by AOAC (2004). All the samples were analysed in three replicate. Resistant starch yield was determined by using the glucose oxidase assay (McCleary *et al.*, 2002). The antioxidant activity of finger millet flour, foxtail millet flour and refined wheat flour was estimated by the method of Zhang and Hamazu (2004) with some modifications. The results of proximate analysis showed significantly higher amount of total ash (2.51 %), crude protein (12.23 %), crude fat (3.49 %), crude fiber (4.79%), and energy (353 kcal) in foxtail millet flour as compared to finger millet flour and refined wheat flour. The insoluble dietary fiber content was significantly higher for foxtail millet flour (11.01%). However, finger millet flour contained significantly higher amount of soluble dietary fiber (7.00%) and total dietary fiber (17.06%) than foxtail millet flour and control refined wheat flour. Foxtail millet flour contained higher amount resistant starch (15.10 %) than finger millet flour (14.85%) and refined wheat flour (1.01 %). Total antioxidant activity was also found highest in finger millet flour (71.07 %) as compared to foxtail millet flour (65.85%) and refined wheat flour (20.62%).

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**Keywords:** Proximate analysis, antioxidant activity, resistant starch, mineral, millets

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### Introduction

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A large shift from consumption of coarse grains such as sorghum, barley, rye, maize and millet to more refined cereals, like polished rice and wheat is seen especially among the urban population and higher income groups. These changes could result in a significant decrease in the overall fiber content of the diet that contributed to increasing prevalence of chronic degenerative diseases like overweight/ obesity, diabetes etc. Recent studies indicated that minor millets such as foxtail and finger millet are nutritionally superior to conventional food grains and exhibit hypoglycemic effect due to presence of higher proportion of complex carbohydrate, resistant starch and slow rising sugars. In addition, millets contain water soluble gum  $\beta$ -glucan which improve glucose metabolism. Therefore, the millets are suitable in diabetic diet to improve metabolic control of glucose. Finger millet (*Eleusine coracana*), also known as African millet or ragi is an annual plant widely grown as a cereal in the arid areas of Africa and Asia. Foxtail millet (*setaria italica*) is one of the most important food crops of the semiarid tropics, originated from China, and is now planted all over the world (En *et al.*, 2008 ; Amadou *et al.*, 2011). Mostly people of our country use wheat flour or refined wheat flour for making different food products. As people still are not aware about the nutritional benefits of these coarse millets. Finger millet and foxtail millets are highly nutritious and contain higher amount of fibre which makes them suitable for many diseases like diabetes, obesity etc. The present study was undertaken to study the nutritional quality of finger millet and foxtail millet flour and its comparison with refined wheat flour.

## **Materials and Methods**

### **Nutrient analysis of finger millet flour, foxtail millet flour and refined wheat flour**

#### **3.7.1 Proximate analysis**

Proximate composition is the term applied to the proportion of moisture, crude fat, crude fibre, crude protein, total ash and carbohydrates present in the food. Proximate analysis of finger millet flour, foxtail millet flour and refined wheat flour was done by methods given by AOAC (2004). All the samples were analysed in three replicate.

#### **Moisture**

Two gram of flour sample was taken in a clean, dried and weighed aluminum dish. The content was dried in oven at  $130 \pm 3^\circ\text{C}$  for 1 hour till a constant weight was obtained and cooled in desiccator. After cooling, the loss in weight was taken as moisture content and expressed in terms of percentage.

$$\text{Per cent moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

$W_1$  = Weight of empty aluminum dish

$W_2$  = Weight of aluminum dish + sample before drying

$W_3$  = Weight of aluminum dish + sample after drying

#### Total ash

Ash content was calculated as the difference between the final and initial weight of porcelain dishes and results were expressed in percentages.

$$\text{Ash (\%)} = \frac{W_2 - W_1}{W} \times 100$$

$W_1$  = Weight of crucible (before incineration)

$W_2$  = Weight of crucible + Weight of sample (after incineration)

$W$  = Weight of sample

#### Crude protein

Kjeldahl procedure was used to estimate crude protein. Kjeldahl procedure was used to estimate crude protein. A 2 g of sample was digested with 10 g digestion mixture (containing potassium sulphate and copper sulphate in ratio of 96:4) and 25 ml conc.  $\text{H}_2\text{SO}_4$ . This sample was digested till clear light blue colour was obtained. The volume of the digested sample was made up to 100 ml with distilled water. An aliquot of 10 ml was distilled with 10 ml of 40 per cent NaOH in distillation apparatus. The ammonia released was collected in 25 ml of 4 per cent boric acid solution containing few drops of mixed indicator (bromocresol green and methyl red in ratio of 2:1). Distillation was done for half an hour. The distillate was titrated against 0.1N sulphuric acid solution. A blank was run simultaneously under identical conditions. The nitrogen present in the sample was calculated using the formula:

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$$\text{Per cent nitrogen content} = \frac{(A - B) \times N \times V \times 0.014}{V_1 \times W} \times 100$$

Where,

A= volume of 0.01N H<sub>2</sub>SO<sub>4</sub> for sample (ml)

B= volume of 0.01N H<sub>2</sub>SO<sub>4</sub> for blank (ml)

N= normality of H<sub>2</sub>SO<sub>4</sub>

V= volume made (ml)

V<sub>1</sub>= volume of aliquot digested (ml)

W= weight of the sample

Protein content was calculated by multiplying the per cent nitrogen by conversion factor 6.25.

#### **Crude fat**

It was estimated using SOCS plus method **AOAC (2004)**. The amount of extracted fat was expressed on per cent basis. Per cent crude fat was calculated as follows.

$$\text{Per cent crude fat} = \frac{\text{weight of fat}}{\text{weight of sample}} \times 100$$

#### **Crude fibre**

The fibre content was determined using the method of AOAC (2000).

$$\text{Percent crude fiber} = \frac{W_2 - W_1}{\text{weight of sample}} \times 100$$

Where,

W<sub>1</sub> = Weight of filter paper (g)

W<sub>2</sub> = Weight of residue + filter paper (g)

#### **Carbohydrates (by difference)**

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The carbohydrate content present in the sample was expressed as per cent and determined by “difference” i.e. by subtracting the sum of the values (per100g), moisture, crude protein, crude fat, crude fibre and total ash from 100.

Per cent Carbohydrate = 100 – [moisture (%) + ash (%) + crude fat (%) + crude protein (%) + crude fibre (%)]

### **Energy value**

The physiological fuel value (Kcal/100g) of sample was calculated by summing up the products of multiplication of per cent protein, fat and carbohydrates present in the sample by 4, 9 and 4 respectively i.e.

Physiological fuel value (Kcal/100g) =  $4 \times \text{protein}\% + 9 \times \text{fat}\% + 4 \times \text{carbohydrates}\%$

### **Estimation of minerals**

All the minerals were analysed in three replicate.

### **Preparation of ash solution**

Ash solution was prepared by the method described by **AOAC (2010)**. The ash was moistened with 2-3 drops of distilled water. Five ml of hydrochloric acid was added to the sample and was evaporated to dryness. The residue was dissolved by adding 2 ml of hydrochloric acid and covered with a watch glass. It was then heated for 5 min on a water bath and finally it was washed and filtered through whatman no. 42 filter paper. The volume was made up to 100 ml using distilled water.

### **Calcium**

Calcium content in the sample was determined titrimetrically by method of **AOAC (2010)**. Calcium content was calculated using the following formula:

$$\text{Calcium (mg/100g)} = \frac{2 \times (A-B)}{w} \times \frac{V}{V_1} \times 100$$

Where,

A= volume of 0.1 N KMnO<sub>4</sub> used for sample (ml)

B= volume of 0.1 N KMnO<sub>4</sub> used for blank (ml)

V= total volume of ash solution made

V<sub>1</sub>= volume of ash solution used (ml)

w= weight of the sample

### **Phosphorous**

Estimation of phosphorous was done by method given by **Fiske and Subbarow (1925)**.

### **Estimation of Dietary Fibre**

It was determined by the method given by **Asp and Johansson (1981)**. All the samples were analysed in three replicate.

The TDF (total dietary fibre) was calculated as:

Total dietary fibre = insoluble dietary fibre + soluble dietary fibre

### **Resistant starch**

Resistant starch yield was determined by using the glucose oxidase assay (**McCleary et al., 2006**). The samples were analysed in three replicate.

### **Total antioxidant activity**

The antioxidant activity of finger millet flour, foxtail millet flour and refined wheat flour was estimated by the method of **Zhang and Hamauzu (2004)** with some modifications. All the samples were analysed in three replicate.

### **Statistical analysis**

The proximate composition, mineral estimation, resistant starch and antioxidant activity of all the samples were analyzed statistically. Simple statistical tools such as mean, standard deviation

(SD), standard error (SE) and percentages used. The analysed values of nutrients were subjected to one way ANOVA test in order to measure significant differences.

## Results and discussion

The moisture content of finger millet flour was 10.43 per cent. **Gopalan *et al.* (2010)** reported a moisture content of 13.1 per cent in finger millet. Foxtail millet flour showed moisture content of 8.93 per cent. Refined wheat flour showed a moisture value of 12.03 per cent. Significant difference was observed between all the three flours. Total ash represents the mineral content. The total ash content of finger millet flour and foxtail millet flour was 2.20 and 2.51 per cent respectively. Significant difference was seen in the total ash content of the both the millet flour. **Malleshi *et al.* (2004)** reported 2.7 per cent ash in whole and 1.8 per cent ash in milled finger millet flour. Refined wheat flour showed an ash content of 0.73 per cent. Both the millet flour showed significant difference from refined wheat flour. The crude protein content of finger millet flour and foxtail millet flour was observed to be 10.40 and 12.23 per cent, respectively. Both the millet differed significantly in protein content. . Refined wheat flour showed 9.84 per cent protein. Finger millet flour, foxtail millet flour and refined wheat flour showed a crude fat content of 1.17, 3.49 and 0.77 per cent respectively. All the flours were significantly different from each other in fat content. **Malleshi *et al.* (2004)** reported a fat content 0.8 per cent in milled finger millet flour. The crude fibre content of finger millet and foxtail millet was 4.20 and 4.79 per cent, respectively. Significant difference was seen in the crude fibre content between the two millet flour. Per cent carbohydrate content (by difference) of finger millet flour and foxtail millet flour was 71.58 and 68.03 per cent, respectively. Significant difference was seen in the carbohydrate content of both the millet flours. The per cent carbohydrate of refined wheat flour was 76.30 per cent. It was calculated on the basis of physiological energy obtained from per cent carbohydrate, protein and fat. The energy content (per 100 g) of finger millet flour and foxtail millet flour was 339 and 353 Kcal/100g, respectively. Both the millet flour differed significantly with respect to energy content. The energy content of refined wheat flour was 351 Kcal/100g. Foxtail millet flour contained significantly higher amount of physiological energy than finger millet flour.

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The insoluble dietary fibre content of finger millet, foxtail millet flour and refined wheat flour was 10.06, 11.01 and 5.16 per cent, respectively. The soluble dietary fibre content of finger millet flour, foxtail millet and refined wheat flour was 7.00, 5.40 and 1.70 per cent, respectively. Significant difference was found in all the flours. Finger millet flour contained significantly higher amount of soluble dietary fibre than foxtail millet flour and refined wheat flour. However, soluble dietary fibre content of foxtail millet flour was significantly higher than refined wheat flour. The total dietary fibre (TDF) content of finger millet flour, foxtail millet and refined wheat flour was 17.06, 16.42 and 6.86 per cent, respectively. Finger millet flour, foxtail millet flour and refined wheat flour showed a resistant starch content of 14.85, 15.10 and 1.01 per cent, respectively (Table 1). No significant difference was found in the resistant starch content of finger millet flour and foxtail millet flour. Starch content of both the millet flour was significantly different from refined wheat flour. The total antioxidant activity was expressed as percentage of DPPH decrease. The DPPH free radicals, which are stable in ethanol, show maximum absorbance at 517 nm. In present study finger millet flour exhibited significantly ( $p \leq 0.05$ ) higher antioxidant activity (71.07 per cent) compared to the foxtail millet flour (65.85 per cent) as well as refined wheat flour (20.62 per cent) (Table 1). Significant difference was observed between all the flours with respect to antioxidant activity.

**Table :1 Proximate composition of finger millet flour, foxtail millet flour and refined wheat flour per 100 g**

Nutrient	Finger millet flour	Foxtail millet flour	Refined wheat flour	S.Em.±	CD at 5 %
Moisture	10.43 ± 0.04	8.93±0.23	12.03±0.05	0.43	0.14
Crude protein	10.40±0.03	12.23±0.02	9.84±0.01	0.10	0.35
Crude fat	1.17±0.01	3.49±0.21	0.77±0.04	0.11	0.39
Crude fibre	4.20±0.05	4.79±0.45	0.30±0.03	0.58	0.20
Total ash	2.20 ± 0.02	2.51±0.05	0.73±0.20	0.63	0.22
Carbohydrate (by difference)	71.58±0.01	68.03±0.02	76.30±0.16	0.12	0.42

- All results are mean± standard deviation for three individual determinations on dry weight basis

- S.Em -Standard error of mean, CD- Critical difference

### Mineral content

The calcium content of finger millet flour and foxtail millet flour was 186.41 and 30.36mg/100g. Significant difference was found in the calcium content between the two millet flour. Refined wheat flour contained 20.66 mg/100g calcium. Finger millet flour, foxtail millet flour and refined wheat flour differed significantly with respect to calcium content. Finger millet flour and foxtail millet flour contained 172.36 and 182.66 mg/100 g phosphorus, respectively. Refined wheat flour contained 76.16 mg/100g phosphorus. The phosphorus content of the flours used differed significantly being highest for foxtail millet flour and lowest for refined wheat flour. Iron content of finger millet flour and foxtail millet flour was 2.49 and 2.17 mg/100g, respectively. The iron content of refined wheat flour was 1.81 mg/100g. The zinc content of finger millet flour and foxtail millet flour was 0.87 and 0.86 mg/100 g, respectively. The differences in the zinc content of the two millet flour were non-significant. The zinc content of refined wheat flour was 0.76 mg/100g. The copper content in finger millet flour and foxtail millet flour was 0.14 and 0.25 mg/100g, respectively Refined wheat flour contained 0.05 mg/100g copper. The finger millet flour, foxtail millet flour and refined wheat flour contained 0.024, 0.03 and 0.01mg per 100 g chromium, respectively (Table 2).

**Table: 2 Mineral content of finger millet flour, foxtail millet flour and refined wheat flour**

Nutrient	Finger millet flour	Foxtail millet flour	Refined wheat flour	S.Em.±	CD at 5 %
Calcium (mg/100g)	186.41±0.21	30.36±0.48	20.66±0.32	0.90	3.12
Phosphorus (mg/100g)	172.36±0.12	182.66 ±0.52	76.16±0.38	0.78	2.71
Iron(mg/100g)	2.49±0.01	2.17±0.03	1.81±0.03	0.35	0.12
Zinc(mg/100g)	0.87±0.01	0.86 ±0.02	0.76 ±0.01	0.12	0.44
Copper(mg/100g)	0.14±0.01	0.25±0.01	0.46±0.04	0.41	0.14
Chromium (mg/100g)	0.24±0.02	0.30±0.01	0.11±0.02	0.19	0.67

All results are mean± standard deviation for three individual determinations on dry weight basis  
- S.Em -Standard error of mean, CD- Critical difference

The insoluble dietary fibre content of finger millet, foxtail millet flour and refined wheat flour was 10.06, 11.01 and 5.16 per cent, respectively. The insoluble dietary fibre content of the finger millet flour and foxtail millet flour did not differ significantly. The soluble dietary fibre content of finger millet flour, foxtail millet and refined wheat flour was 7.00, 5.40 and 1.70 per cent, respectively. Significant difference was found in all the flours. Finger millet flour contained significantly higher amount of soluble dietary fibre than foxtail millet flour and refined wheat flour. However, soluble dietary fibre content of foxtail millet flour was significantly higher than refined wheat flour.

The total dietary fibre (TDF) content of finger millet flour, foxtail millet and refined wheat flour was 17.06, 16.42 and 6.86 per cent, respectively. The total dietary fibre content of both the millet flour did not differ significantly.

#### **Resistant starch**

In resisting digestion in the small intestine, resistant starch like dietary fibre, becomes available as substrate for fermentation by anaerobic bacteria in the colon (Boboi *et al.*, 2007). Therefore, in the large intestine it may share many of the characteristics and health benefits currently attributed to dietary fibre such as diabetes (Elleuch *et al.*, 2011), cardiovascular disease and bowel cancer (Boboi *et al.*, 2007). Finger millet flour, foxtail millet flour and refined wheat flour showed a resistant starch content of 14.85, 15.10 and 1.01 per cent, respectively (Table 3). No significant difference was found in the resistant starch content of finger millet flour and foxtail millet flour. Starch content of both the millet flour was significantly different from refined wheat flour. Bangoura *et al* (2012) reported a value of 13.35 and 14.56 per cent for white foxtail millet flour and yellow foxtail millet flour, respectively. Bangoura *et al* (2012) found that the resistant starch content was decreased in boiled sample.

**Table 3: Dietary fibre and resistant starch content of finger millet flour, foxtail millet flour and refined wheat flour**

Nutrient	Finger millet flour	Foxtail millet flour	Refined wheat flour	S.Em.±	CD at 5 %
Insoluble dietary fibre (%)	10.06±0.52	11.01±0.56	5.16±0.05	0.53	0.98
Soluble dietary fibre (%)	7.00±0.48	5.40±0.32	1.70±0.56	0.11	0.40
Total dietary fibre (%)	17.06±0.32	16.42±0.51	6.86±0.50	0.12	0.69
Resistant starch (%)	14.85±0.21	15.10±0.40	1.01±0.32	0.45	0.15

-All results are mean± standard deviation for three individual determinations  
- S.Em- Standard error of mean, CD- Critical difference

#### Total antioxidant activity

The total antioxidant activity was expressed as percentage of DPPH decrease. The DPPH free radicals, which are stable in ethanol, show maximum absorbance at 517 nm. In present study finger millet flour exhibited significantly ( $p \leq 0.05$ ) higher antioxidant activity (71.07 per cent) compared to the foxtail millet flour (65.85 per cent) as well as refined wheat flour (20.62 per cent) (Table 4). Significant difference was observed between all the flours with respect to antioxidant activity. Finger millet showed the highest while refined wheat flour exhibited the lowest value. **Mohamed *et al* (2012)** reported the antioxidant potential of different defatted foxtail millet protein hydrolysate fraction within the range of 46.95- 84.10 per cent. The antioxidant activity of different Nepalese varieties of finger millet was reported in the range of 18.23- 77.30 per cent by **Karki and Kharel, 2012**.

**Table: 4 Antioxidant activity of finger millet flour, foxtail millet flour and refined wheat flour**

Flour	Antioxidant activity (%)
Finger millet flour	71.07±0.32
Foxtail millet flour	65.85±0.48
Refined wheat flour	20.62±0.24

S.Em.±	0.42
CD at 5 %	1.46

-Results are means of three replicates ± standard deviation  
- S.Em -Standard error of mean, CD- Critical difference

### Conclusion

Finger millet flour, foxtail millet flour and refined wheat flour were evaluated for nutritional quality. Foxtail millet flour contained significantly higher amount of total ash (2.51 %) crude protein (12.23 %), crude fat (3.49 %), crude fibre (4.79%), and energy (353 kcal/100g) as compared to finger millet flour and refined wheat flour. However, carbohydrate content was higher in refined wheat flour (76.30 %), followed by finger millet flour (71.58 %) and foxtail millet flour (68.03%).

Analysis of flours for mineral content showed that finger millet flour contained 186.41, 172.36, 2.49, 0.87, 0.14 and 0.24 mg/100g of calcium, phosphorus, iron, zinc, copper and chromium, respectively. The calcium, phosphorus, iron, zinc, copper and chromium content of foxtail millet flour were 30.36, 182.66, 2.17, 0.86, 0.25 and 0.30 mg/100g, respectively. The total dietary fibre of finger millet, foxtail millet and refined wheat flour was 17.06, 16.42 and 6.86 per cent, respectively. Insoluble dietary fibre content of finger millet flour and foxtail millet flour was 10.06 and 11.01 per cent, respectively while the soluble dietary fibre was 7.00 and 5.40 per cent for finger millet and foxtail millet flour, respectively. The resistant starch content of finger millet, foxtail millet and refined wheat flour was 14.85, 15.10 and 1.01 per cent, respectively. Total antioxidant activity was found highest in finger millet flour (71.07 %) as compared to foxtail millet (65.85%) flour and refined wheat flour (20.62%).

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