Physico-chemical, Functional and Antioxidant Properties of Millet Flours

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Abstract—*The objective of this work was to investigate the chemical composition, functional properties, color and antioxidant activity, total phenolic content of selected finger and pearl millet flour. Bulk density, true density of finger and pearl millet flour was found to be 0.67 gml^{-1}, 0.55gml^{-1}, and 1.36gml^{-1}, 1.79gml^{-1}. The lightness (L*) value of finger and pearl millet flour was found to be 80.73 and 80.5. Results indicated that (bulk density, true density, foaming capacity, foaming stability and lightness (L*) value of two millet flours showed a non significant difference. Antioxidant activity was measured utilizing 2, 2 diphenyl-1-1 picrylhydrazyl (DPPH) radical scavenging capacity. Antioxidant activity of extracts varied from 26.40% - 31.80%. While as total phenolic of millet flour was measured by Folin–Ciocalteu reagent, TPC of extracts was 36.96 and 44.69 (mg/100g GAE). The water solubility index of finger millet flour was 7.73% as compared to pearl millet which shows 4.13%. Both finger and pearl millet are having good antioxidant activity and phenolic content and thereby they can be used ingredients in functional food formulations.*

Key words*: Finger millet, pearl millet, antioxidant activity, total phenolic content.*

1. INTRODUCTION

Millets are a group of small - seeded species of cereal crops belonging to the family Gramineae and grown widely around the world for food and fodder. The most important characteristics of millets are their unique ability to tolerate and survive under adverse condition of continuous or intermittent drought as compared to most other cereals like maize and sorghum. These are principally food sources in arid and semi-arid regions of the world. Cereals and millets are most commonly consumed food items in India. They contain a wide range of phenolics which are good sources of natural antioxidants. Millets contain phytic acid, tannins, and phenols which can contribute to antioxidant activity, important in health, ageing and metabolic diseases. Finger millet (*Eleusine coracana*) also known, as ‘ragi’ is popular millet in India, consumed without de-hulling. India is the major producer of finger millet contributing nearly 60% of global production [1]. The tiny millet grain has a dark brown seed coat, richer in polyphenols compared to other continental cereals such as barley, rice, maize and wheat. In recent years, finger millet has gained importance, because of its nutritional strength in terms of dietary and functional fiber, starch pattern, as well as high calcium and iron contents. The calcium and iron contents in finger millet varieties have been reported to be 220–450 and 3–20%, respectively [2]. Pearl millet (*Pennisetum glaucum*) is the sixth most important cereals. Pearl millet grains are mostly used for food purposes in India and Africa. Being one of the important nutricereals it is a source of staple food for rural population. Pearl millet is a rich source of proteins, minerals and fibers [3]. The amino acid profile of pearl millet is better than that of sorghum and maize and is comparable to that of wheat, barley, and rice [4]. There is a growing interest in these crops because of the technological possibilities of its utilization in industrial applications as starch production and value addition in extruded products. Therefore, consequent on the large scale production and commercial exploitation of the crop is the need to study the physical and mechanical attributes of these crops, which are important in the design of equipment for handling, cleaning, storing and processing. The present study is therefore aimed to study the Physico-chemical, functional and antioxidant properties of selected millet flours.

2. MATERIALS AND METHODS

Finger millet (*Eleusine coracana*) grains were purchased from local market at Shimla (India). Pearl millet (*Pennisetum typhoides*, var. HHB-67) were obtained from Chaudhary Charan Singh Haryana Agricultural University, Hisar, (Haryana). Both millet grains were cleaned from soil particles and debris. The grains were ground directly using stone mill and passed through 60 mesh sieve to obtain fine flour. All the reagents used in the study were of analytical grade.

2.1. Physical properties

Bulk density of flours was measured by method of Wang and Kinsella, 1976) [5]. True density was determined by liquid displacement method (ASAE, 2001) [6]. Porosity of flour mixture was measured by method of (Thompson and Issac, 1967) [7].

2.2. Functional properties

WSI were determined by the method of Anderson (1982) [8]. Foaming Capacity (FC) and Foam Stability (FS) were determined by method of Narayana and Narasinga Rao (1982) [9]. Oil absorption capacity was determined with slight modification to the method of Wani et al., (2013) [10]. Color of flours was measured by using **…..** Antioxidant activity was measured utilizing 2, 2 diphenyl-1-1 picrylhydrazyl (DPPH) radical scavenging capacity, while as total phenolic of millet flour was measured by Folin–Ciocalteu reagent.

2.3. Statistical analysis

The data reported in all of the tables are the averages of triplicate observations. Statistical analysis of the results was done with Microsoft Excel 2007 (Microsoft Inc., USA) and Duncan's test was applied to determine the differences between means.

3. RESULTS AND DISCUSSION

3.1. Proximate analysis

The raw materials, finger millet flour, pearl millet flour were analyzed for proximate composition and shown in (Table 1). Moisture content of finger millet and pearl millet flour were 12.06%, 13.49% respectively. Ash content of finger millet and pearl millet flour are 2.2%, 0.73%. Pearl millet had highest fat content of 8.16% as compared to finger millet 2.73%. Protein content of pearl millet was 14.5%, finger millet 7.3%. Carbohydrate content of pearl millet were 70% and finger millet 68%.

3.2. Physical and functional properties

Table 1 showed the physio- chemical and functional properties of millet flours. The bulk density of pearl millet and finger millet flours ranged from 0.67g/ml to 0.54g/ml. The differences in the values of bulk density between these flours are likely due to varietal differences. Bulk density is a measure of heaviness of flour and is generally affected by the particle size and the density of the flour. It is very important in determining the packaging requirement, material handling and application in wet processing in the food industry. Krishnan *et al*., [11] found a bulk density of 0.5g/ml,0.50g/ml and 0.6g/ml in native, malted and hydrothermally treated finger millet seed coat. WSI of finger millet and pearl millet flour was significantly different 7.73% and 4.13%. This difference could be because of high content of starch, low contents of protein and fat in finger millet. Wang et *al.*, [12] have reported that amount of protein and fat could inhibit the starch granules swelling. The foaming capacity (FC) of a protein refers to the amount of interfacial area that can be created by the protein and foam stability (FS) refers to the ability of protein to stabilize against gravitational and mechanical stresses. Foaming capacity of finger and pearl millet flour was found to be 1.96% and 5.88%. Both finger and pearl millet flour is having low foaming stability of 0.98 ml and 0.97ml. In fact, the foam formed by the flour has no stability over time. This could be due to the protein denaturation caused by grinding. It has been reported that the native proteins provide high foam stability than denatured proteins [13]. Moreover, the low or absence of foaming capacity of certain meals could affect their stability during storage. Related to oil absorption capacity (OAC) of studied different millet flours, OAC of finger millet flour was found to be 1.93g/g and that of pearl millet flour is 1.60g/g. There is an advantage for best organoleptic characteristics of meal that high water and oil absorption capacity of the flour can positively influence the flavor, moisture and fat content in food [14]. Color is an important quality factor directly related to the acceptability of food products, and is an important physical property to report. Hunter color values (L*, a*, b*) of two millet flours are presented in Table 1. The lightness (L*) is an indication of the brightness. The L* value of finger and pearl millet flour were 80.73 and 80.50 respectively. Color parameter a* indicative of the redness of sample varied from 0.76, (-1.6). The yellowness value b* of flours varied from 9.63 to 11.06. Antioxidant activity and total phenolic content of finger and pearl millet flours varies from 26.40% -31.80% and 36.96 and 44.69 (mg/100g GAE). The concentration of antioxidants present in the grains and their antioxidant activities may vary depending on the species, cultivar, and growing location and environmental conditions, among others (15, 16, 17). Also dehulling decreased the TPC of whole grain millets and this change was essentially due to the removal of the outer layers of the grain, as phenolic compounds of cereal grains are mainly concentrated in the outer layers of the grain (18, 17).

Table 1: Physico-chemical and functional properties of selected millet flours

Parameters	Finger millet flour	Pearl millet flour
Moisture (%)	12.06 ±0.4b	13.49±0.17a
Fat (%)	2.73 ±1.00b	8.16±0.20a
Ash (%)	2.20 ± 0.12a	0.73±0.15b
Fiber (%)	3.03±0.05a	3.05±0.05a
Protein (%)	7.30 ±0.12b	14.5±0.14a
Carbohydrates (%)	68.00±0.57b	70.00±0.40a
Bulk density(g/ml)	0.67±0.02a	0.55±0.54a
True density(g/ml)	1.36±0.09a	1.69±0.29a
Porosity%	50.40±4.39b	67.11±5.26a
WSI (%)	7.73±1.80a	4.13±0.61b
FC (%)	1.96±0.00b	5.88±0.00a
FS (ml)	0.97±0.01a	0.98±0.00a
OAC(g/g)	1.93±0.03a	1.60±0.03b
Color (L*)	80.73a	80.50a
DPPH Activity (%)	26.40%b	31.80%a
TPC (mg/100g GAE)	36.96b	44.69a

Values are means ± SD of 3 replications. Means figures in a row followed by different superscripts indicate that they are significantly ($p < 0.05$) different with each other determined by Duncan's tests.

4. CONCLUSION

The results of the study revealed that both millet flours has a great potential to be used in food industry either for the purpose of formulating new products or for the replacement in food products made from various conventional flour sources. There is also tremendous opportunity to develop functional food from such millets.

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