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EFFECT OF PARBOILING ON BIOCHEMICAL AND FUNCTIONAL PROPERTIES OF LITTLE MILLET (*Panicumsumatrense* L.)

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ABSTRACT

The purpose of this study was to determine the effect of parboiling process in biochemical and functional properties of the little millet (*Panicum*sumatrense L.).The biochemical and functional properties of parboiled and un-parboiled little millet was analyzed and compared. The obtained results showed that after parboiling process the total carbohydrate and crude fibre content was decreased from 62.50% to 45.78% and 1.47% to 0.97% was observed for the little millet. There was an increased ash content, calcium content, antioxidant value and colour value was observed for little millet after parboiling process from 5.566 to 6.061; 67.18mg/100g to 99.38mg/100g;59.9µg/g to 206.42µg/g and L^*- 95.38, a^*- 2.46, b^*- 6.23 to L^*-100.93, a^*-1.66, b^*-0.97, respectively. The functional properties such as Water Absorption Capacity (WAC), Water Solubility Index (WSI), Swelling Power (SP) were also increased in the little millet from 1.62 to 1.772;4.8 to 6.4;1.36 to 3.32, respectively after parboiling process. This investigation concluded that parboiled little millets contained great level of nutrition, biochemical and functional properties when compared to the un-parboiled little millet.

KEYWORDS: ***Panicumsumatrense L., parboiling, biochemical properties, functional properties***

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INTRODUCTION

Millets are a group of small-seeded grasses, widely grown around the world as cereal crops or grains. Millets differ from one another by their appearances and morphological features, maturity, grain type, etc .*Panicumsumatrense* L., known as little millet, belongs to the genus *Panicum* and the family *Poaceae*. It is an annual herbaceous plant, which grows straight or with folded blades to a height of 30 cm to 1 m. The leaves are linear, with the sometimes hairy laminae and membranous hairy ligules. The panicles are from 4 to 15cm in length with 2 to 3. 5mm long awn. The grain is round and smooth; 1.8 to 1.9mm long[1]. The nutritional quality of little millet grain is superior to many other major cereals. It is also contains B vitamins, especially niacin, B_6 and folic acid, calcium, iron, potassium, phosphorus, magnesium and zinc.[2] Little millet also playing the significant role in providing adequate amounts of antioxidants and phytochemicals in the diet.[3]Parboiling is an age-old process in parts of Asia, Africa and to a limited extent today, in some European countries and America and offers higher milling recovery, more translucent kernels and increased swelling when cooked to the desired softness. It is the hydrothermal treatment given in the grains before milling, leading to the gelatinization of the starch and disintegration of protein bodies in the endosperm, which expand and fill the internal air spaces in the grains.[4] It consists of three important steps- soaking of grains in water to increase its moisture, heat-treating wet grain by steam to complete the physical-chemical changes and finally drying the grains to a safe moisture level for milling.[5]Moreover, improvement of shelf-life and sensory properties has been observed after parboiling process.[6]The physico-chemical changes occurring during parboiling may also affect the nutritional properties of millets. Considering the growing awareness among the consumers regarding the health benefits an attempt was made to study and compare the effect of parboiling process in little millet forbio chemical and functional properties. In Table 1 Nutrient composition of the different millet grains and cereals were given.

Table 1
Nutrient composition of millets compared to fine cereals (per 100 g)
Source: Nutritive value of Indian foods, National Institute of Nutrition (2007)

Food	Protein (g)	Fat (g)	Ash (g)	Crude Fibre (g)	Carbo hydrate (g)	Energy (kcal)	Ca (mg)	Fe (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)
Rice	6.8	0.5	1.3	0.2	78.2	362	45	-	0.41	0.04	4.3
Wheat	11.6	2.0	1.6	2.0	71.0	348	30	3.5	0.41	0.10	5.1
Maize	9.20	4.6	1.2	2.8	73.0	358	26	2.7	0.38	0.20	3.6
Sorghum	10.4	3.1	1.6	2.0	70.7	329	25	5.4	0.38	0.15	4.3
Pearl millet	11.8	4.8	2.2	2.3	67.0	363	42	11.0	0.38	0.21	2.8
Finger millet	7.70	1.5	2.6	3.6	72.6	336	350	3.9	0.42	0.19	1.1
Foxtail millet	11.2	4.0	3.3	6.7	63.2	351	31	2.8	0.59	0.11	3.2
Common Millet	12.5	3.5	3.1	5.2	63.8	364	8	2.9	0.41	0.28	4.5
Little millet	**9.70**	**5.2**	**5.4**	**7.6**	**60.9**	**329**	**17**	**9.3**	**0.30**	**0.09**	**3.2**
Barnyard Millet	11.0	3.9	4.5	13.6	55.0	300	22	18.6	0.33	0.10	4.2

MATERIALS AND METHODS

Determination of Biochemical and Functional Properties for Parboiled and un-Parboiled Little Millet

The little millet was purchased from Ramasamy Chinnammal Trust, Coimbatore, Tamilnadu. In the parboiling process,100 kg of little millet along with the outer husk was soaked in the water for 4 hours, the soaked water was drained off. The soaked millet grain was steamed for 10-12 minutes afterwards the steamed millet grain will go for shade drying for 3 to 4 days. By using the de-huller the outer husk was removed from the Parboiled Little millet grain. For the un-Parboiled Little millet without Parboiling process the outer husk was removed by using the de-huller. Finally, the effect Parboiling process was studied by analyzing the various biochemical and functional properties of the Parboiled and un-Parboiled Little millet grain.

Determination of Total Carbohydrate Content (Phenol sulphuric acid Method)[7]:

Comment The sample was prepared where it was apipette out 0.2, 0.4, 0.6, 0.8 and 1ml of the working standard into a series of test tubes. Pipette out 0.1 and 0.2ml of the sample solution in two separate test tubes. Make up the volume in each tube to 1ml with water. Set a blank with 1ml water. Add 1ml of the phenol solution to each tube and then 5ml of 96% sulphuric acid to each tube and shake well. After 10min shake the contents of the tube and place in water bath at 25°C- 30°C for 20 min. Read the colour at 490mm.Calculate the amount of total carbohydrate content present in the sample solution using the standard graph. The formula used to calculate the total carbohydrate content was given in the Equation.1

$$\text{Absorbance corresponds to 0.1 ml of the test} = \text{x mg of glucose}$$
$$\text{100 ml of the sample solution contains} = \frac{x}{0.1} \text{x 100 mg of glucose=\% of total carbohydrate present} \quad \text{---(Eq.1)}$$

Determination of Ash Content (AOAC, 1999)[8]

Place the crucible and lid in the furnace at 550^{0}C overnight to ensure that impurities on the crucible on the surface of the crucible are burned off. Cool the crucible in the desiccators for 30min. Weigh the crucible and lid to 3 decimal places. Weigh about 5g of sample into the crucible. Heat over a low Bunsen flame with lid half covered. When fumes are no longer produced, place the crucible and lid in the furnace. Weigh the ash with crucible and lid. The ash content was determined by the following Equation 2

$$\text{Ash}(\%) = \frac{\text{weight of ash}}{\text{weight of sample}} x100 \text{----(Eq.2)}$$

Determination of Crude Fibre (AACC 1976)

Two grams of sample were digested with 200ml of 1.25 percent sulphuric acid for 30 min. After filtration through linen cloth, the residue was washed with boiled distilled water until it was free from acid. The acid free residue was then digested with 200ml of 1.25 percent sodium hydroxide for 30 min. The contents were filtered through a linen cloth. The residue was transferred to a crucible, and is washed with boiled distilled water until the residue was alkali free. Finally, the residue was washed with 15 ml of 95 percent ethyl alcohol. The content of the crucible was dried to a constant weight at 100°C. The dried residue was ignited in the muffle furnace at 550 ± 15°C for 30 min. The percent loss in weight was expressed as crude fibre. The crude fibre was determined by the formula given in the Equation 3.

$$\text{Percentage of crude fibre} = \frac{\text{Loss in weight}}{\text{weight of sample}} \text{x100 ---(Eq.3)}$$

Determination of Total Antioxidant activity (FRAP Method)

Total Antioxidant Capacity was determined chemically using FRAP method. FRAP method mainly depends upon the reduction in the low pH of ferric tripyridyltriazine complex to the formation of ferrous tripyridyltriazine by a reductant (antioxidant). For the preparation of calibration curve 0.5ml aliquots of 0.1, 0.2, 0.4 and 0.6 µm/ml aqueous Fe(II) as a Mohr salts solution (1mM) were mixed with 2.5 ml FRAP working solutions. The absorption was read after 30 minutes at 25°C and 593nm. All solutions were prepared using deionized water. For all the samples the determination was made in triplicate and the mean values were reported. Total antioxidant capacity in Fe (II) equivalents was calculated. Absorption determination for TAC (FRAP) was made using UV-VIS spectrophotometer.

Determination of Calcium

The 10ml of ash solution, 25ml of distilled water and 10 ml of saturated ammonium oxalate were taken in a beaker. To this, 2 drops of methyl red indicator were added and the pH of the contents was adjusted to 5.0 using diluted ammonia (1:1) and diluted acetic acid (1:4) solution. The contents were filtered through What man paper at room temperature for overnight. Next day, the residue thus obtained was washed with hot distilled water until it became oxalate free. The filter paper was broken by a pointed glass rod and washed with 10ml of hot dilute sulphuric acid (1:4) followed by distilled water. The contents were heated to 80°C and titrated against 0.01N Potassium permanganate to a stable pink colour. Finally, the filter paper was also dropped in the solution and titration was completed. Calcium content was calculated by the following formula given in the Equation 4.

$$\text{Calcium (mg/100g)} = \frac{\text{Titre value}\times\text{N of KMn4}\times 20\times\text{total volume of ash solution}}{\text{ml of ash solution taken for estimation}\times\text{Weight of sample taken for ash}} \times 100 \text{ ---(Eq. 4)}$$

Determination of Colour (TINTOMETER-LOVIBOND)

Colour measurements (L*, a* & b* values) of the Little millet were determined using a Lovibond Tintometer (Model # Lovibond RT 100) with the Lovibond RT Colour software (Version 3.0). Before measuring the colour of the samples, the instrument should be standardized by placing black and white standard plates and L*, a* and b* colour values are recorded. The deviation of the colour of the samples to standard were observed and recorded in the computed interface. L* values correspond to lightness/ darkness and extend from 0 (black) to 100 (white) with higher values corresponding to more lightness. The a*and b* values correspond to an object's colour, dimensions, with values describing a sample's red (+a) to greenness (-a), while b* values describe a sample's yellow (+b) to blueness (-b). Larger values indicate more redness and larger b* values indicate more yellowness.

Water Absorption Capacity (WAC)[9]

Water absorption capacity was measured by the centrifugation method.[10]The Parboiled and un-Parboiled Little millet sample (3.0 g) was dispersed in 25 ml of distilled water and placed in the centrifuge tubes. The dispersions were stirred for a few minutes, and then it was centrifuged at 3000 rpm for 25 minutes. The supernatant was decanted, sediment was dried at 50˚C for 25 minutes and the sample was weighed after cooling. The formula for calculating the water absorption capacity was given in the following equation.

$$\text{Water absorption Capacity} = \frac{\text{weight of the sediment}}{\text{weight of the sample}} \text{ ----- (Eq. 5)}$$

Water Solubility Index (WSI)

The Parboiled and un-Parboiled Little millet sample (2.5g) was dispersed in 30ml of distilled water, using a glass rod and cooked at 90˚C (i.e., kept in a water bath at90˚C for 15min). Then it was cooled to room temperature and transferred to centrifuge tubes and then centrifuged at 3,000 rpm for 10min. The supernatant was decanted and evaporated at 110^0C for 4hours. Water Solubility Index (g /100g) was calculated as per the Equation 6.

$$WSI = \frac{\text{weight of dissolved solids in the supernatant}}{\text{weight of the sample}} x100 \text{ ---(Eq.6)}$$

Swelling Power (SP)

Swelling power was determined using the method described by Thumrongchote (2012) with slight modifications.[11] According to this method, about 295.0 ±5 mg of parboiled and un-parboiled samples were weighed into centrifuge tubes in triplicates and 10 ml of distilled water were added. The suspensions were heated in thermostatic water bath at 80^0C for 30 minutes. Then they were centrifuged at 4,000 rpm for 20min. The supernatant was carefully poured into weight known aluminium dishes and dried at 105^0C until constant weight was achieved. The weight of the sediment gel and weight of the dried solids was taken. Swelling power was calculated using the following equation 7.

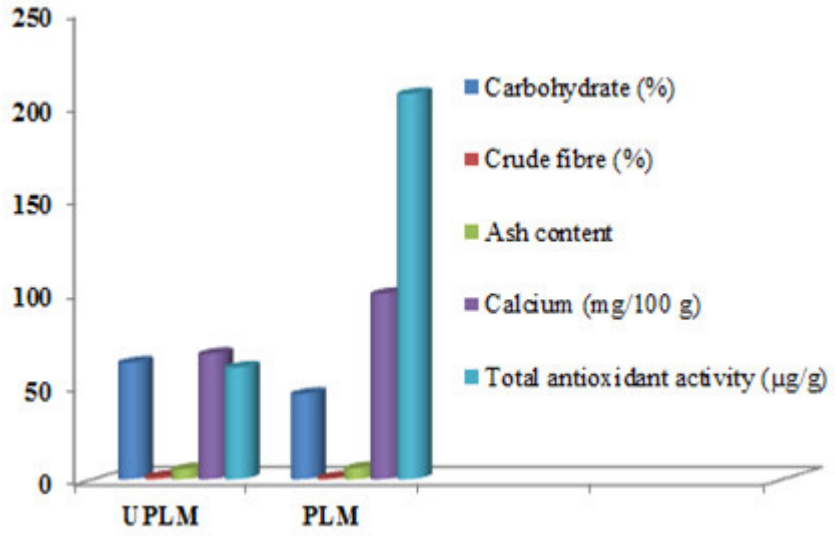
$$\text{Swelling Power} = \frac{\text{weight of the sediment}}{\text{weight of the sample} - \text{weight of dried solids in supernatant}} \text{ ---(Eq:7)}$$

RESULTS AND DISCUSSION

Biochemical analysis done for both Parboiled(PLM) and un-Parboiled (UPLM) Little Millet. The parameters analyzed are total carbohydrate content, ash content, crude fibre, total antioxidant activity, calcium and colour value.

Total Carbohydrate Content (Phenol sulphuric acid Method)

For the un-Parboiled and Parboiled sample the total carbohydrate content were calculated as per Phenol sulphuric acid method and the result was given in the Graph 1.The Total carbohydrate content of un-Parboiled (UPLM) and Parboiled Little millet (PLM) were 62.50% and 45.78%respectively. The Total carbohydrate content percentage of UPLM was high when compared to the PLM. Because, parboiling process decreases the Carbohydrate content of the Parboiled Little millet. The obtained result was coincided with the result given by Dubois and Krishnaveni.[12]



Graph 1
Comparing the Biochemical properties of UPLM with PLM

Ash Content

Ash content was analyzed using AOAC method (2000), the results obtained for un-Parboiled(UPLM) and Parboiled Little Millet (PLM)were 5.566% and 6.1% respectively(Graph 1). Ash content value was higher in Parboiled Little Millet (PLM). The result obtained was being in agreement with the result obtained from Parboiled rice by Shiela.[13]

Crude Fibre (AACC, 1976)

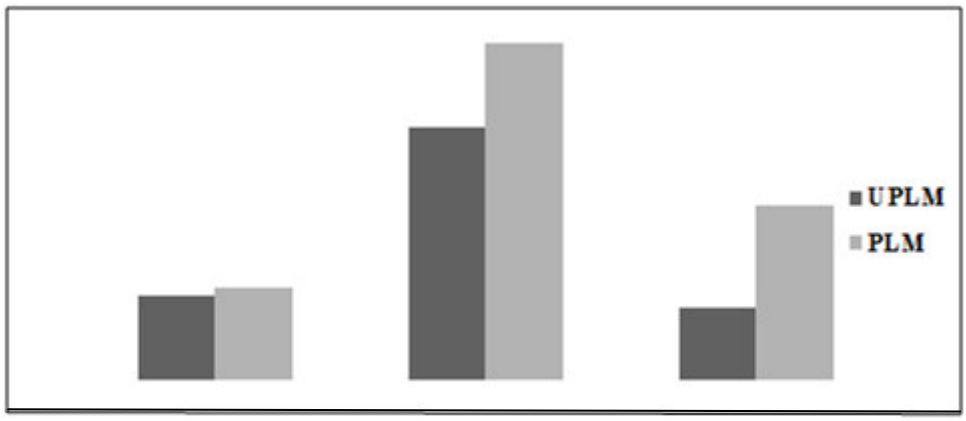
Crude fibre value was analyzed by the AACC method for UPLM and PLM. The results obtained were 1.47%and0.97% (Graph 1). Crude fibre (%) was also high (1.47%) in UPLM compared to 0.97% in Parboiled Little Millet (PLM). Because, parboiling process decreases the crude fibre content.

Total Antioxidant activity (FRAP method)
Total Antioxidant Capacity was determined chemically using FRAP method. The value observed for un-Parboiled Little millet (UPLM) was 59.86µg/g and 206.42 µg/gfor Parboiled Little Millet (PLM) it was given in Graph1. The results obtained for PLM was high when compared to the UPLM.

Calcium
Calcium value of un-Parboiled Little millet(UPLM) was 67.18mg/100g and in Parboiled Little Millet (PLM) it was 99.38mg/100g (Graph:1). Calcium value was higher in Parboiled Little Millet (PLM), this shows that Parboiled tend to be have higher calcium retention capacity than un-Parboiled Little millet (UPLM)

Colour value
Colour value is determined using TINTOMETER-LOVIBOND results obtained were, for un-Parboiled Little Millet (UPLM) was L*- 95.38, a*- 2.46, b*- 6.23 whereas it was L*-100.93, a*-1.66, b*-0.97 for Parboiled Little Millet (PLM) (Graph: 1). Parboiled Little Millet having dark colour values compared to un-Parboiled Little Millet this was due to the parboiling process where the whole grain was steeped to gelatinize starch, the presence of hull during parboiling which gives a distinct colour to the grains, after milling colour was retained in the grain.

Water Absorption Capacity
Water Absorption Capacity (WAC) was measured by the centrifugation method described by Sosulski.[14]The WAC value of PLM was 1.772, it was little high when compared to the result obtained for UPLM (1.62).



Graph 2
Comparing the functional properties of PLM with UPLM

Water solubility Index (WSI)
The Water solubility index was studied by the method.[15]The Water solubility index (WSI) of UPLM and PLM was 4.8 and 6.4 respectively. In this WSI of PLM was more when compared to the UPLM.

Swelling Power (SP)
The Swelling Power of Parboiled Little millet was more when compared to the Un-Parboiled Little millet(Graph:2). The result obtained was coincided with the result of Desikachar and Subramanian.[16] The swelling Power was determined for both the Parboiled and Un-Parboiled millet, compared to the Parboiled Little millet the value was lower for the Un-Parboiled Little millet because it was partially cooked, the starch present in the Little millet will be gelatinized partially when it was parboiled.

CONCLUSION

This investigation concluded that Parboiled milled millets contained good sources of nutrition, bio-chemical contents and functional properties when compared to the un-Parboiled Little millet. The Parboiled Little millet showed a great potential as well as a positive correlation between nutritional qualities, so these types of millets can be used in food industry either for the purpose of formulating new products or for the replacement in food products made from various conventional sources. Hence, various innovative products may be developed to suit the consumer needs and also to achieve nutrition security. There is also tremendous opportunity to develop functional food from these types of millets. The functional properties of the parboiled little millet such as their water absorption capacities, water solubility index and their swelling power, supported their future use as convenient products for infant complementary foods.

CONFLICT OF INTEREST

Conflict of interest declared none

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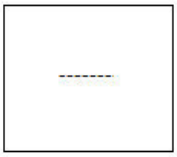

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