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# Effect of Processing on the Nutritional and Organoleptic Characteristics in Proso Millet Flour

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## ABSTRACT

*Before consumption and for development of millet based food products, millet grains are usually processed by some traditional processing methods to improve their nutritional, organoleptic and edible characteristics. The processing techniques aim to increase the nutritional content and improve the sensory properties of proso millet flour. Thus, an attempt was made in the present research with an objective to study the effect of soaking, germination, roasting and grinding on nutritional and organoleptic characteristics of proso millet flour. Nutritional composition of both unprocessed and processed proso millet flour were analysed by using standard methods given by AOAC, 2000 while organoleptic characteristics were analyzed by using a nine-point hedonic scale. With respect to the nutritional assessment, this study revealed a significant ($p<0.05$) increase in ash, crude fiber, crude protein, iron, and zinc content while a significant decrease in moisture, fat, carbohydrate, energy, calcium and phosphorus with the progress in the germinating period. Both the nutritional and organoleptic assessment showed that the grains which were germinated for 72hrs were superior among all other processed proso millet flour.*

***Keywords:*** *Major and minor millet, Nutri-cereals, Proso millet flour, Nutritional properties, Organoleptic characteristics, Processing, Processed and unprocessed proso millet flour, Value added products.*

## INTRODUCTION

Millets are a group of highly variable small-grained, warm-weather, annual grasses belonging to the grass family *Graminaceae or Paniceae.* They are the oldest food grain known to humans and possibly the first cereal grain that is used for human consumption. Millets are also referred to as "Coarse grains" and "Poor man's crop". But after recognizing their nutrient composition now they are considered "Nutri-cereals". They are rich in nutrients and serve as a good source of many health-promoting components. Millet grains are rich in iron, calcium, potassium, zinc, phosphorus, dietary fiber, protein, and polyphenols, thus it makes unique from cereals [1]. Much research evidence suggests that regular consumption of millet results to a reduced risk of diseases like arteriosclerosis, Type-2 diabetes, and liver-related diseases [2] [3].

The millet family consists of major and minor millet as where proso millet is considered to be minor millet. Proso millet is known by various names such as "common millet", "broomcorn millet", "hog millet", etc. Compared to other cereal crops proso millet has one of the lowest water requirements and good production potential. It also possesses a wide range of adaptations to extreme climatic conditions. On a nutrition basis, proso millet is high in protein, dietary fiber, calcium, zinc, phosphorus and iron, B-complex vitamins, polyphenols, and essential amino acids like cysteine and methionine. It also has a low glycemic index, thus suitable for persons with Type-2 diabetes. In the present scenario, due to its high dietary fiber and mineral content, proso millet has been receiving attention from developing countries.

Before the consumption and development of millet-based food products, millet grains are usually processed by some traditional processing methods to improve their nutritional and organoleptic characteristics. The processing methods aim to increase the nutrient content, decrease the antinutrients, and improve the edible properties of the millet grains. Thus, an attempt was made in the present investigation with the objective to study the effect of processing (soaking, germination, roasting, and grinding) on nutrient composition and organoleptic characteristics of proso millet flours.

## METHODOLOGY

Proso millet grains were procured from the local market of Pusa, Samastipur district, Bihar, India. The grains were then subjected to different processing methods after thorough cleaning and washing.

### Processing of proso millet grains into flours

After cleaning and washing, the proso millet grains were soaked overnight and then the excess water was drained out. It was kept

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for germination for 24hrs, 48hrs, 72hrs, and 96hrs. Then the germinated grains were roasted, ground and sieved to fine flour. The flour obtained from 24hrs, 48hrs, 72hrs, and 96hrs germination was coded as Proso Millet Flour (PMF)-1, PMF-2, PMF-3, and PMF-4, respectively while unprocessed proso millet flour was taken as control (C). A schematic diagram of the preparation of proso millet flour is shown in Figure 1.

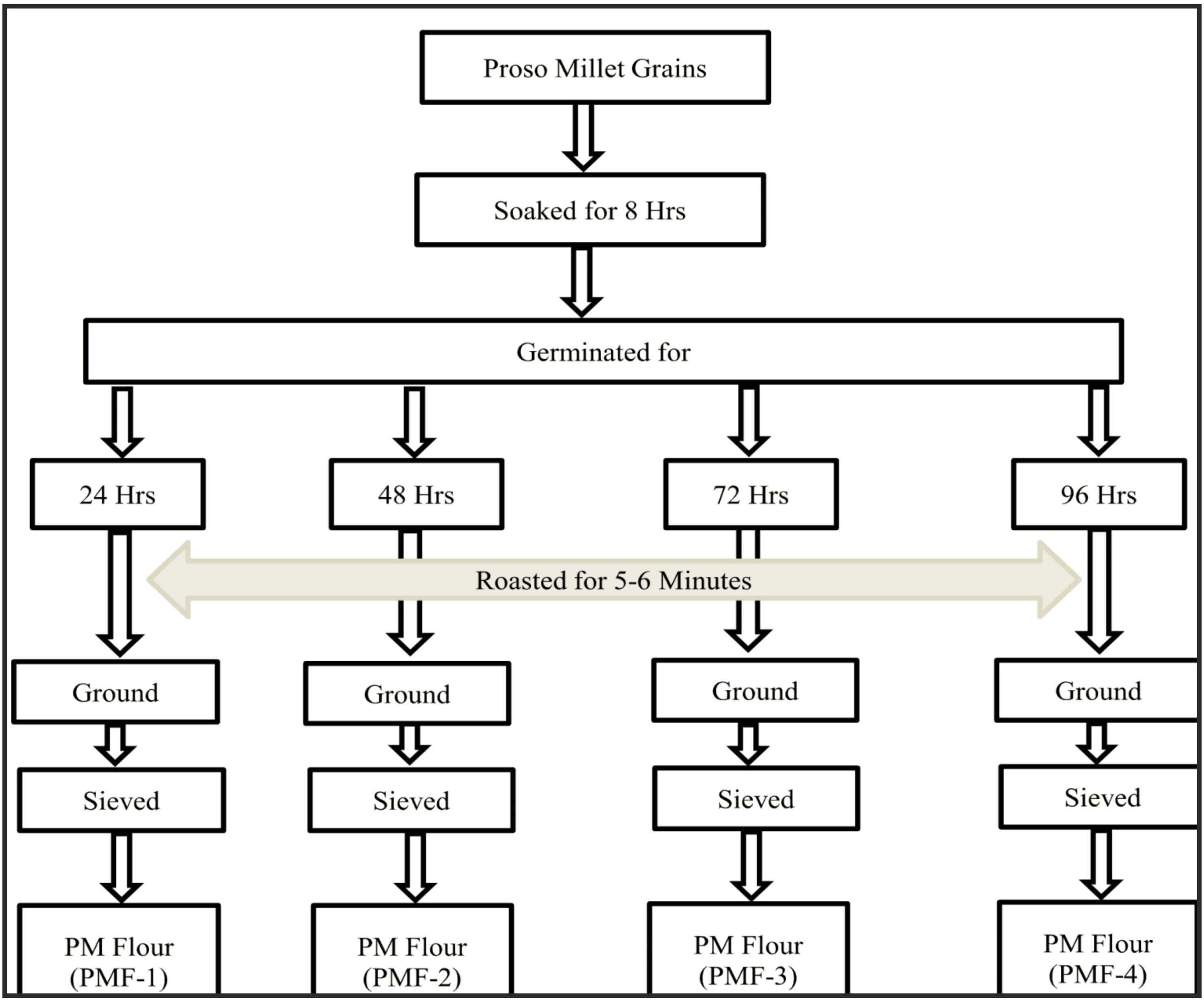


**Figure 1: Schematic diagram of the preparation of proso millet flour**

### Nutritional analysis of processed proso millet flour

The proximate composition such as moisture, ash, crude fiber, fat, crude protein, carbohydrate, energy and mineral composition like iron, zinc, calcium and phosphorus was determined for the processed proso millet flour by following the standard procedures (AOAC, 2000).

### Organoleptic assessment of processed proso millet flour

Organoleptic characteristics of the processed proso millet flour were analyzed with the help of a semi-trained panel of 30 judges [4]. A sensory score card was made where the sensory attributes like flavor, appearance, color, taste, overall acceptability, and texture were considered. In the present study, a nine-point hedonic scale was used to score the sensory attributes in which the product liked extremely was scored as 9 and those disliked extremely were scored as 0. The mean scores regarding each attribute were calculated to see the extent of acceptability.

### Statistical analysis

The final data were compiled and analyzed using suitable statistical methods. The results obtained were represented as descriptive statistics such as mean, standard deviation, and one-way ANOVA. p values less than 0.05 were considered significant. ANOVA was used to test the differences among different processed proso millet flours. The data shown in the tables are an average of triplicate observations.

## RESULTS AND DISCUSSION

### Nutritional analysis of processed proso millet flour

The proximate composition such as moisture, ash, crude fiber, fat, crude protein, carbohydrate, energy and mineral composition like iron, zinc, calcium, and phosphorus analyzed for the processed proso millet flours is discussed below.

### Proximate composition of processed proso millet flour

The proximate composition of unprocessed and processed proso millet flour is tabulated in Table 1. The highest moisture content was found in unprocessed proso millet flour (C) having 10.56%. Among the processed proso millet flour, the moisture content of PMF-1, PMF-2, PMF-3 and PMF-4 were 8.41%, 8.34%, 8.01%, and 8.00% respectively. A significant ($p<0.05$) decrease in the moisture concentration in flour was observed which may be attributed due to the roasting of the grains during processing. The ash content in food samples is the reflection of mineral composition. Among the processed proso millet flours, the highest ash content was in PMF-3 (1.91±0.09%) and PMF-4 (1.93±0.81%) flour which was statistically non-significant ($P>0.05$) to each other. The lowest ash content was recorded in the unprocessed flour (1.22±0.07%) among all the flour samples, while PMF-1 and PMF-2 had 1.30±0.06% and 1.62±0.01% ash content, respectively. Except PMF-1, a significant ($p<0.05$) difference in ash content among all the processed PM flours was found when compared to control flour. The significant increase in ash content may be due to a reduction in fat and carbohydrate content during the germination process [5].

In the case of fat content, unprocessed proso millet flour had the highest fat content (1.03g) when compared to other processed flour and it was followed by PMF-1 (0.74±0.02g), PMF-2 (0.64±0.32g), PMF-3 (0.52±0.01g) and PMF-4 (0.51±0.01g), respectively. The carbohydrate content of control was 78.93±0.03g whereas of PMF-1 was 80.89±0.09g, PMF-2 was 80.39±0.03g, PMF-3 was 79.63±0.84g and PMF-4 was 79.58±1.02g per 100g. Among all PM flours, PMF-1 had the highest carbohydrate content while the control had the lowest value. PMF-3 and PMF-4 were non-significant to each other in fat and carbohydrate content. The significant ($p<0.05$) decrease in the fat and carbohydrate content in the processed flour samples is due to the use of fat and carbohydrate for metabolism during germination.

The crude fiber content of PMF-1, PMF-2, PMF-3, and PMF-4 was to be found 0.71±1.37g, 0.91±0.40g, 1.29±0.02g, and 1.30±0.04g, respectively whereas control flour had 0.64±0.03g. All the processed PM flour samples were to be found significantly ($p<0.05$) different when compared to the control. PMF-3 and PMF-4 were statistically similar to each other in fiber content. A significant increase ($p<0.05$) in fiber content among all the flour may be due to a decrease in fat and carbohydrate content [6] [7].

The highest protein was observed in PMF-3 (8.64±0.33g) and PMF-4 (8.68±0.01g) flours whereas PMF-1 and PMF-2 had 7.95±0.01g and 8.10±0.65g, respectively. The lowest protein content was recorded in unprocessed proso millet flour (7.62±0.02g). A significant increase in the protein concentration among processed proso millet flours may be attributed to enzymatic protein synthesis during germination [8]. A non-significant ($p>0.05$) difference was found between PMF-3 and PMF-4 flour in their protein content. The release of amino acids may also have led to an increase in crude protein in germinated grains [9].

It was evident from Table 1 that, the energy content of PMF-1 was highest i.e. (362.02±0.75Kcal/100g) which was followed by PMF-2 (359.72±0.32Kcal/100g), PMF-3 (357.76±0.49Kcal/100g), PMF-4 (357.63±0.58Kcal/100g) and the lowest energy value was noted in control flour (355.47±0.31Kcal/100g). The one-way analysis of variance between the samples revealed a significant difference ($p<0.05$) between the processed and control flour samples while PMF-3 and PMF-4 were statistically similar in their energy values.

**Table 1: Proximate composition of processed proso millet flour**

| Flour | Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Moisture (%) | Ash (%) | Fat (g) | Fiber (g) | Protein (g) | Carbohydrate (g) | Energy (Kcal) |
| C | 10.56±1.10 | 1.22±0.07 | 1.03±0.04 | 0.64±0.03 | 7.62±0.02 | 78.93±0.03 | 355.47±0.31 |
| PMF-1 | 8.41±0.02 | 1.30±0.06 | 0.74±0.02 | 0.71±1.37 | 7.95±0.01 | 80.89±0.09 | 362.02±0.75 |
| PMF-2 | 8.34±0.21 | 1.62±0.01 | 0.64±0.32 | 0.91±0.40 | 8.10±0.65 | 80.39±0.03 | 359.72±0.32 |
| PMF-3 | 8.01±0.57 | 1.91±0.09 | 0.52±0.01 | 1.29±0.02 | 8.64±0.33 | 79.63±0.84 | 357.76±0.49 |
| PMF-4 | 8.00±1.61 | 1.93±0.81 | 0.51±0.01 | 1.30±0.04 | 8.68±0.01 | 79.58±1.02 | 357.63±0.58 |

Values are expressed as the Mean of three replicates ± SD and the sample is compared using one-way ANOVA at 5% probability.

### Mineral composition of processed proso millet flour

The mineral composition of processed proso millet flour is shown in Table 2. From the data, it was found that PMF-4 had the highest iron content (2.86±1.32mg) and was followed by PMF-3 (2.85±1.55mg), PMF-2 (2.59±0.02mg), PMF-1 (2.25±0.23mg) and control (1.91±1.06mg). The iron content significantly ($p<0.05$) increased among the flours as the germination period of flour samples progressed. The results confirm the report of Nnam [10]. The zinc content of processed proso millet flour was significantly increased compared to the unprocessed proso millet flour. PMF-4 had the highest zinc content (3.66±0.09mg) followed by PMF-3 (3.55±0.04mg). The zinc content of unprocessed proso millet flour was 3.07±0.06mg, which was found to be the lowest among all the flour samples. The results are in agreement with Obizoba and Atii [11].

With respect to calcium present in PM flour samples, the highest content was found in the control sample (13.73±0.03mg/100g) while the lowest concentration was observed in the PMF-4 sample (11.84±0.03mg/100g). The calcium content of PMF-1, PMF-2 and PMF-3 was to be found 13.03±0.03mg, 12.67±0.02, and 11.95±0.02mg, respectively per 100g. The calcium levels significantly ($p<0.05$) decreased as the germination period increased. This decrease may be attributed due to leaching loss during germination of the proso millet grains.

Among all the flour, the phosphorus content of the control (198.17±0.57mg/100g) was higher while that of PMF-4 (170.19±0.07mg/100g) was lower. The data from the Table 2 also revealed that the phosphorus content of PMF-1 was 179.97±0.02mg/100g, PMF-2 was 174.18±0.12mg/100g and PMF-3 was 170.21±0.48mg/100g. The decrease in phosphorus content is due to increased phytase enzyme activity during sprouting [12]. Similar results were also observed by Kindiki et al in germinated and roasted pearl millet grains [13].

**Table 2: Mineral composition of processed proso millet flour**

| Flour | Parameters | | | |
|---|---|---|---|---|
| | Iron (mg) | Zinc (mg) | Calcium (mg) | Phosphorus (mg) |
| C | 1.91±1.06 | 3.07±0.06 | 13.73±0.03 | 198.17±0.57 |

 

| | | | | |
|---|---|---|---|---|
| PMF-1 | 2.25±0.23 | 3.17±0.01 | 13.03±0.03 | 179.97±0.02 |
| PMF-2 | 2.59±0.02 | 3.27±0.03 | 12.67±0.02 | 174.18±0.12 |
| PMF-3 | 2.85±1.55 | 3.55±0.04 | 11.95±0.02 | 170.21±0.48 |
| PMF-4 | 2.86±1.32 | 3.66±0.09 | 11.84±0.03 | 170.19±0.07 |

Values are expressed as the Mean of three replicates ± SD and the sample is compared using one-way ANOVA at 5% probability.

### Organoleptic assessment of processed proso millet flour

Chapatti was developed from the processed proso millet flour to assess the sensory attributes of the flour. The organoleptic assessment of the flour samples has been shown in Table 3.

The chapatti prepared from PMF-3 recorded the highest score in appearance (7.89±0.65), color (7.03±0.48), taste (7.53±0.83), texture (7.87±0.88), flavor (7.51±1.38) and overall acceptability score (7.56±1.01) thus, revealing that this flour was highly acceptable by the panel members. While the lowest scores in all the sensory attributes were observed in control flour. The scores of control in appearance, color, taste, texture, flavor, and overall acceptability were to be found 6.26±0.63, 6.03±0.54, 6.00±1.69, 6.58±2.12, 6.35±1.40 and 6.24±1.82, respectively. The overall acceptability score in PMF-1 was 6.64±1.43, PMF-2 was 6.85±0.85 and PMF-4 was 7.49±0.83. A significant ($p<0.05$) difference was recorded in all the processed PM flour when compared to the control.

**Table 3: Organoleptic assessment of processed proso millet flour**

| Treatment sample | Appearance | Color | Taste | Texture | Flavor | Overall acceptability |
|---|---|---|---|---|---|---|
| C | 6.26±0.63 | 6.03±0.54 | 6.00±1.69 | 6.58±2.12 | 6.35±1.40 | 6.24±1.82 |
| PMF-1 | 7.35±0.66 | 6.09±0.59 | 6.54±1.98 | 6.78±1.87 | 6.45±1.08 | 6.64±1.43 |
| PMF-2 | 7.48±0.62 | 6.22±0.71 | 6.86±1.36 | 7.09±1.35 | 6.60±0.85 | 6.85±0.85 |
| PMF-3 | 7.89±0.65 | 7.03±0.48 | 7.53±0.83 | 7.87±0.88 | 7.51±1.38 | 7.56±1.01 |
| PMF-4 | 7.87±0.60 | 6.90±0.53 | 7.41±1.25 | 7.81±0.66 | 7.39±0.84 | 7.49±0.83 |

Values are expressed as the Mean of three replicates ± SD and the sample is compared using one-way ANOVA at 5% probability.

## CONCLUSION

There was a significant variation with respect to the nutritional and organoleptic characteristics of proso millet flour. The processing significantly increased the ash, crude fiber, crude protein, iron, and zinc content while decreasing the moisture, fat, carbohydrate, energy, calcium, and phosphorus content in processed proso millet flours. Among the proso millet flour, PMF-3 and PMF-4 were superior and were significantly similar to each other in all the nutrient compositions. The organoleptic assessment of the flours revealed that PMF-3 was most acceptable to the panel members. Thus, the flour developed from proso millet grains germinated for 72hrs (PMF-3) was found to be superior nutritionally and organoleptically.

## FUTURE SCOPE OF THE STUDY

Considering the present research results, it is recommended that proso millet can be germinated for 72hrs to get nutrient-rich proso millet flour. The processed proso millet flour can also be incorporated with other major or minor millet flour like finger millet, sorghum, etc in further studies. The selected proso millet flour is suggested to carry forward to develop various value-added products like cookies, soup, biscuit, ladoo, etc

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