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Effect of processing treatment on chemical and nutritional properties of millets

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Abstract
The goal of the current research was to examine how roasting affected the physico-chemical and nutritional properties of millets. Millets were roasted for 6-7 minutes at 70-80 °C. Amaranth and barnyard millet were comprehensively examined for chemical composition, mineral functionality, and antinutritional properties. The functional and phytochemical composition of amaranths and barnyard millet, such as moisture, fat, protein, phenols, and antinutritional compounds has been found to slightly decreased during roasting, whereas total carbohydrate content, ash, and fibre increased along with an increase in the bioavailability of minerals like calcium and iron. This study, therefore, concentrated on enhancing the nutritional content by roasting the millets for promoting amaranth and barnyard millet use in the future prospective.

Keywords: Amaranth and barnyard millet, roasting, nutritional properties, functional properties, anti-nutritional properties

Introduction
Millets are small seeded drought resistant cereals grown in arid and semi-arid region. They are nutritionally superior to wheat and rice in terms of proteins, vitamins, minerals and dietary fibre content. There are seven types of millets available in market *viz*. Pearl (*Pennisetum typhoideum*), Finger (*Eleusine coracana*), Foxtail (*Setaria italica*), Proso *Panicum miliaceum*), Kodo (*Paspalum scrobiculatum*), Little (*Panicum sumatrense*) and Barnyard millet (*Echinochloa frumentacea*) (Jaybhaye, Pardeshi, Vengaiah, & Srivastav, 2014) [8].
Millets are generally processed by traditional processing techniques such as decortication, malting, fermentation, roasting, flaking and grinding, to increase their palatability, sensory and nutritional properties (Saleh, 2013) [15]. Physicochemical and nutritional properties of major millets make them suitable for large-scale utilization and consumption in the world, by manufacturing a wide variety of value added food products, e.g. baby foods, dietary foods, and ready-to-eat (RTE) snacks. Particularly interesting is their application in extruded products in both grain and flour form (Subramanian and Viswanathan 2003) [20].
Whole grains are rich sources of fibre, vitamins, minerals and phytochemicals such as phenolic, lignans, b-glucan, inulin, resistant starch, sterols and phytates. The additive and synergistic effects of bioactive phytochemicals in plant-based foods have been suggested for their beneficial health out- comes (Duthie, & Kyle, 2000; Liu, 2007) [6, 9].
Amaranth grains contain a source of thiamine, niacin, riboflavin, and folate, and dietary minerals including calcium, iron, magnesium, phosphorus, zinc, copper, and manganese that are comparable to common grains such as wheat germ, oats and others; amaranth flour also has an unusually rich source of the essential amino acid lysine that is low in other grains (Myers & Putnam, 1988) [11].

Materials and Methods
Preparation of sample
Roasting of millets
The roasting process of whole millets occurred in a conventional oven at 70-80°C for 6.-7 min. In this study, 500 gram batch was used for each roasting process and three replication was applied for each roasting time.

Materials
Raw materials like amaranth and barnyard millet were procured from the local market of Parbhani. Chemical and reagents were obtained from the laboratory, Department of Food

Process Technology College of Food Technology, VNMKV, Parbhani.

Physical properties of millets

Bulk density

Twenty-five gram of sound grains was weighed on the digital weighing balance and filled into the measuring cylinder earlier filled with a reference solution of hexane. The increase in the level of liquid was measured after adding the grains. It is bulk density represented in g/L (Dutta *et al.*, 1988) [7].

$$\text{Bulk Density } (\rho') = \frac{\text{Weight of grains}}{\text{Volume displayed}}$$

Proximate composition of amaranth and barnyard millets

Raw materials such as amaranth and barnyard millets were analyzed for proximate composition including moisture, fat, protein, total carbohydrate, crude fiber, ash and mineral composition was carried out as per the methods given by AOAC, 2005 [1].

Determination of minerals composition of amaranth and barnyard millets

Two grams of defatted sample was weighed and heated at 550 °C. Then, the obtained ash were digested with concentrated Hydrochloric acid (HCL) on hot plate. The digested material was then filtered using whatman No. 42 filter paper and the final volume made to 100ml with distilled water that was further used for analysis with respects to iron, calcium, potassium, contents by using methods Ranganna (1986) [13].

Functional properties of amaranth and barnyard millets

Water absorption capacity (WAC)

Water Absorption Capacity was determined as outlined by Sowbhagya *et al.* (2007) [19]. Sample (1 g) was accurately weighed into a graduate test tube and 30 ml of distilled water was added. The content was allowed to hydrate for 18 hr at ambient temperature, centrifuged (4000 rpm, 20 min) and the suspended solution was removed. A portion of wet sample was removed, weighed and dried at 100 °C to get constant weight. The results were expressed as gm of water bound/ gm of sample.

$$\text{Water Absorption Capacity (g/g)} = \frac{\text{Residue hydrated weight} - \text{Residue dry weight (After centrifugation)}}{\text{Residue dry weight}}$$

Oil absorption capacity (OAC)

Oil Absorption Capacity was determined as outlined by Sangnark and Noomhorm (2004) [16] and was expressed as gram of oil held per gram of powder. Sample (1 g) was weighed into a pre-weighed centrifuge tube (W_1) and the weight noted (W_2), to which 25 ml of the groundnut oil was added and stirred. The content was allowed to stand for 18 hr. at ambient temperature, centrifuged (4000 rpm, 20 min) and the supernatant was decanted and the tubes were held in slant position to drain excess oil. The weight of the tube was noted (W_3). The difference in the weight of the centrifuged tubes with dry sample and after oil binding gives the amount of fat absorbed. The results were expressed as gm of oil bound/ gm of sample.

Oil Absorption Capacity (g/g) = Initial wt. of sample – Final wt. of sample after oil uptake

Ant nutritional properties of amaranth and barnyard millets

Tannin

Finely grounded sample was weighed (0.2 g) into a 50 ml sample bottle. Ten of 70% aqueous acetone was added and properly covered. The bottle was put in an ice bath shaker and shaken for 2 hrs at 30 °C. The solution was then centrifuge and the supernatant stored in ice, 0.2 ml of the solution was pipette into the test tube and 0.8 ml of distilled water was added. Standard tannin acid solution was prepared from a 0.5 mg/ml of the stock and the solution made up to 1 ml with distilled water, 0.5 ml of Folin-ciocalteu reagent was added to the sample and standard followed by 2.5 ml of 20% Na_2CO_3 the solution was then vortexed and allowed to incubate for 40 min at room temperature, its absorbance was read at 725 nm against a reagent blank concentration of the same solution from a standard tannic acid curve prepared (Markkar and Good child, 1996) [10].

Estimation of saponins (mg/100 g)

Two gram of the finely grinded sample was weighed into a 250 ml beaker and 100 ml of Isobutyl alcohol was added. Shaker was used to shake the mixture for 5 h to ensure uniform mixing. The mixture was filtered using No 1 Whatman filter paper into 100 ml beaker containing 20 ml of 40% saturated solution of magnesium carbonate. The mixture obtained again was filtered using Whatman filter paper No 1 to obtain a clean colourless solution. 1 ml was added into 50 ml volumetric flask using pipette, 2 ml of 5% iron (iii) chloride ($FeCl_3$) solution was added and made up to the mark with distilled water. It was allowed to stand for 30 min for the colour to develop. The absorbance was read against the blank at 380 nm (Bruneton, 1999) [5].

$$\text{Saponin} = \frac{\text{Absorbance of sample x concentration of standard}}{\text{Absorbance of standard}}$$

Results and Discussion

Effect of processing treatments on chemical and mineral composition amaranth and barnyard millet flour

The data penetrating the effect of the roasting treatment on various chemical and mineral compositions such as moisture, fat, carbohydrate, protein, ash and crude fiber were determined and results obtained and illustrated are table.1 and table 2.

Table 1: Proximate composition of raw and roasted millet flour

Chemical properties	Mean Value (%)			
	Amaranth		Barnyard	
	Raw	Roasted	Raw	Roasted
Moisture	8.98	4.26	10.2	6.2
Ash	2.10	1.89	2.9	2.6
Protein	13.12	12.14	7.4	7.20
Fat	6.89	4.59	8.9	4.6
Carbohydrate	35.40	37.40	62.3	55.4
Fiber	5.36	4.31	2.6	4.5

*Each value represents the average of three determinations

The data presented in Table 1 depict the chemical composition roasted amaranth and barnyard millets flour. It was observed that moisture content was reduced in roast sting process of millets flour i.e. 4.26 and 6.2 percent comparatively native amaranth and barnyard millets flour. This may be due more losses of water due to heat treatment in roasting. The protein content of roasted amaranth and barnyard millets flour was observed 12.14 and 7.2 per cent. The decrease in protein contents of roasted amaranth flour might be due to protein denaturation during roasting. The crude fat content of roasted amaranth flour decreased as compared to native amaranth flour. The values for crude fat content were 4.59 and 4.6 per cent in roasted amaranth and barnyard flour and the decreased fat content is due to the destruction of fat during the thermal process of roasting of millets. The highest ash content was observed in roasted amaranth and barnyard flour i.e. 1.89 and 2.6 percent respectively. Minerals are more heat resistant and can sustain up to 600 °C and they have a low volatility as compared to other nutrients. The crude fiber content of roasted amaranth flour was observed decreased i.e. 4.31 percent this may be due to loss of moisture content in the roasted amaranth flour.

The carbohydrate content of the roasted flour samples was observed 37.40 percent. The decrease in the carbohydrate content of roasted amaranth flour is due to increased hydrolysis of some of fat because of thermal process. These results are in agreement with Sushma *et al.* (2019) [21], Shanmugapriya A. and Nazni P (2020) [17] and Beniwal *et al.* (2019) [4].

Effect of processing treatments of mineral composition of amaranth and barnyard millets flour

Minerals are inorganic elements essential to the body as structural component and act as regulators of body process. Raw and roasted amaranth and barnyard millets were estimated for their mineral composition and findings pertaining to the same are reported in Table 2.

Table 2: Mineral composition of raw and roasted millet flour

Minerals (mg/100 g)	Mean Value (Mg/100 gm)			
	Amaranth		Barnyard	
	Raw	Roasted	Raw	Roasted
Calcium	75.16	50.60	22.5	40.2
Phosphorus	524.5	410.2	289	240
Potassium	508	389	124.1	390.5
Iron	14.75	10.25	6.0	4.28

The data presented in Table 2 showed the effects of roasting on mineral composition of amaranth and barnyard millets flour. The calcium contents of roasted millets flour was 50.60 and 40.2 mg/100 g respectively. The phosphorus contents of roasted amaranth and barnyard flour was 410.2 and 240 mg/100 g. These losses in the minerals content may be due roasting treatment ionization of minerals takes place. The contents of calcium and phosphorus are highlighted (Sharma V. *et al.* (2015) [18]. The potassium content of roasted amaranth and barnyard flour was 389 and 390.5 mg/100 g. Potassium is the key intracellular fluid cation and functions in acid-base equilibrium, osmotic pressure control, and nerve impulse conduction, muscle contraction, particularly the cardiac muscle, function of the cell membrane. The iron contents of roasted amaranth and barnyard flour were 10.25 and 4.28 mg/100 g respectively. The results of minerals content of millets were found to be similar with the data published by Nazni P and Shobana Devi R. (2016) [12].

Effect of processing treatment on functional properties of roasted amaranth millet flour

The data related to impact of roasting on functional quality of amaranth and barnyard millets flour is presented in table 3.

Table 3: Functional properties of roasted amaranth and barnyard millet flour

Functional Properties	Amaranth		Barnyard	
	Raw	Roasted	Raw	Roasted
Bulk density (g/ml)	0.72	0.12	0.81	0.92
Water Absorption capacity (ml/g)	1.49	4.59	1.15	1.45
Oil Absorption capacity (ml/g)	1.37	2.69	1.09	1.15

The data presented in Table 3 revealed the effects of roasting on the functional quality of amaranth and barnyard millets flour. The roasting of millets resulted in increasing the water holding capacity of roasted millet flour. The water holding capacity of roasted amaranth flour was 4.59 ml/g whereas water holding capacity of native amaranth flour was 1.49 ml/g and the water holding capacity of roasted amaranth flour was 1.45 g/g whereas water holding capacity of native barnyard flour was 1.15 g/g. Saharan K, *et al.* (2002) [14] reported that functional properties of flour such as lower water absorption capacity were due to less availability of polar amino acids.

The oil absorption capacity of native and roasted amaranth and barnyard flour were 1.37 and 2.69 g/g/ and 1.09 and 1.15 g/g/ respectively. The high oil absorption capacity enables the powder suitable in aid in improvement and development of flavor and mouth feel when utilized in food (Appiah *et al.*, 2011) [3]. The bulk density of native and roasted amaranth and barnyard flour were 0.72 and 0.12 ml/g nad were 0.81 to 0.92 ml/g respectively respectively. The roasted amaranth flour was found significantly superior over native amaranth flour with respect to water holding capacity, oil absorption capacity and bulk density.

Effect of processing treatment on ant nutritional factors of amaranth and barnyard millet.

The raw and roasted of millets were evaluated for their anti-nutritional factor and the findings pertaining to the same are comparatively summarized in table 4.

Table 4: Effect of processing treatment on ant nutritional factors of amaranth and barnyard millet

	Antinational factor			
	Amaranth		Barnyard	
	Saponin (g /100 gm)	Tannin (mg/100 gm)	Tannin (mg/100 gm)	Phenolic Compound (mg/100 gm)
Raw	2.52	1.51	1.36	4.31
Roasted	1.49	0.75	1.02	3.2

Table-4 revealed that the roasting of amaranth and barnyard millets resulted in a significant reduction in the ant nutritional factors. The anti-nutritional factors were analyzed to investigate influence of processing treatment on their level. Tannin, saponin and phenolic content were affected by processing treatment and least values for these were attained by the roasting process of amaranth and barnyard millet. It was found that values of Saponin content and tannin content of non-roasted and roasted amaranth were varied from 2.52 to 1.49 (g/100 g) and 1.51 to 0.75 (mg/g) respectively. It was found that values of phenolic compound and tannin content of non-roasted and roasted barnyard millets were varied from 4.31 to 3.2 (g/100 g) and 1.36 to 1.02 (mg/g) respectively. Results reported are in close agreement with these findings Alvarez *et al.* (2010) [2].

Conclusion
In the current investigation, roasted millets were produced in a temperature-controlled setting. According to the investigation, roasting had a significant impact on the chemical, mineral, functional, and anti-nutritional qualities. Cereals' nutritional value and functionality are improved, while antinutritional. The factors are decreased by roasting a simple and inexpensive processing technique. The nutritional composition of millets as well as slight enhancements in the end product.

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