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Effect of pre-treatments on the quality of browntop millet flour and development of cookies

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Abstract

Browntop millet (*Brachiaria ramose or Urochloa ramose*) is a rare and under utilised minor millet that grows in the remote parts of southern India. An attempt was made to study the effect of pre-treatments *viz.,* roasting (80^0 C for 10 minutes) and germination (germinate for 36 hours) on the nutrient and functional properties of browntop millet flour and to develop and evaluate the sensory properties of cookies, prepared from the pre-treated browntop millet flour. The browntop millet grains were washed, subjected to pre-treatments (roasting and germination) and further milled to fine flour. The results of the analysis of proximate and functional properties showed that there was a significant difference between the plain and pre-treated browntop millet flour. The study revealed that the pre-treatment significantly increased the nutrient content of browntop millet flour. The result of the proximate analysis of germinated sample showed highest amount of protein (11.55g/100g), crude fibre (12.56g/100g), and least amount of carbohydrate content (69.6g/100g). When subjected to sensory evaluation, the cookies made from germinated browntop millet flour scored the highest (7.9±0.93) for the overall acceptability thus making it a preferred food product. Thus, it could be concluded that roasting and germination enhanced the nutritional and sensory properties of browntop millet.

Keywords: Browntop millet, Germination, Minor millet, Roasting, Under utilised millet.

Introduction

Millets are consumed as staple food in the dry land regions. In India, millets are grown on about 17 million ha with annual production of 18 million tonnes and contribute 10 per cent to the country's grain basket. They are nutri cereals which are highly nutritious and are known to have high nutrient content which includes protein, essential fatty acids, dietary fibre, B-vitamins, minerals such as calcium, iron, zinc, potassium and magnesium. They provide various health benefits like reduction of blood sugar level (diabetes), blood pressure, thyroid, cardiovascular and celiac diseases. The direct consumption of millets has significantly declined over the past decades. Studies show that, processing methods like decortication, malting, soaking and cooking affect the anti-oxidant content and activity (Saleh et al., 2013).

The scientific name of browntop millet is *Brachiaria ramose* or *Urochloa ramose*, and are locally called as pedda-sama and korne. They have a limited cultivation largely confined to southern India. Domestic and wild/weedy forms of browntop millet are found in agricultural systems, often within the same field. They are not only used as food crop but also as a fodder. Although browntop millet is highly relict, its distribution is restricted to remote parts of Andhra Pradesh, Karnataka and Tamil Nadu in southern India (Kimata et al., 2000).

Browntop millet is both nutritious and delicious. They are gluten free and rich in nutrients. Comparing to other grains browntop millet is high in natural fibre. Since they have 12 per cent natural fibre, they are used to treat life style diseases. Regular consumption of millets lowers the incidence of cardiovascular diseases, duodenal ulcer and

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hyperglycemia (diabetes) (Reddy and Prasad, 2017). Cookies are ready to eat, convenient, and one of the most popular and widely consumed processed food products in India. Due to the limited studies on the product development of browntop millet, the concept of product development of cookies with browntop millet was initialized. With the increasing consumption of cookies and its acceptability among consumers, millets based cookies have proved as healthy alternative to refined flour based ready to eat foods.

Pre-treatments enhance nutritional quality, improve the digestibility and bioavailability of food nutrients by reducing anti-nutrients. Thus, an attempt was made to study the effect of pre-treatments *viz.,* roasting and germination on the nutrient and functional properties of browntop millet flour and to develop and evaluate the sensory properties of cookies prepared from the pre-treated browntop millet flour.

Materials and Methods

Selection and Procurement

For the preparation of cookies; sugar, butter, baking powder and vanilla essence, were procured from local market in Chennai. Browntop millet was procured from an organic store located at Kilpauk in Chennai.

Preparation of browntop millet flour (Plain, roasted and germinated flour)

Preparation of plain browntop millet flour

Browntop millet grains were washed under running tap water, sun dried till the moisture was removed from the grains and milled into fine flour.

Preparation of roasted browntop millet flour

Browntop millet grains were washed under running tap water and sun dried till the moisture was removed. The grains were dry roasted at 80° C for 10 minutes, cooled and milled to a fine flour.

Preparation of germinated browntop millet flour

Browntop millet grains were washed under running tap water and sun dried till the moisture was removed. The grains were spread evenly on a moist cloth and let to germinate for 36 hours by sprinkling water every 6 hours. The germinated grains were sun dried and milled into fine flour.

Preparation of browntop millet cookies

The composition for the formulation of cookies with browntop millet flours has been shown in Table 2. Cookies made with refined flour was kept as control, and the variation were made with plain and pre-treated browntop millet flours. The cookies were coded as per Table 1. The method of preparation for both control and variation cookies are discussed below.

Preparation of cookies in variations (refined flour, plain flour, roasted flour and germinated flour)

All the ingredients were measured according to the composition given in the Table 2. Flour, baking powder and salt were sifted together. Sugar and butter were blended together using electric mixer at medium speed for 5 minutes. The flour mixture and vanilla essence were added to butter and sugar mixture and mixed. The mixture was blended

Table 1. Codes assigned for samples of browntop millet flours and cookies

Sl. No.	Samples	Code
1	Plain browntop millet flour	PBT
2	Roasted browntop millet flour	RBT
3	Germinated browntop millet flour	GBT
4	Refined flour cookies	SCC
5	Plain browntop millet cookies	PBTC
6	Roasted browntop millet cookies	RBTC
7	Germinated browntop millet cookies	GBTC

Table 2. Composition for the formulation of cookies

Ingredients	SCC	PBTC	RBTC	GBTC
Flour	100gms	100gms	100gms	100gms
Sugar	25gms	25gms	25gms	25gms
Butter	25gms	25gms	25gms	25gms
Salt	1g	1g	1g	1g
Vanilla essence	1 tsp	1 tsp	1 tsp	1 tsp
Baking powder	1g	1g	1g	1g

together until stiff dough is formed. The cookies were moulded and baked at 180^0 C for 20 minutes.

Proximate composition of plain and pre-treated browntop millet flour

Proximate composition such as moisture content, protein, fat, crude fibre, ash, total carbohydrate, iron and calcium were determined for the plain and pre-treated browntop millet flour using standard procedures (AOAC 2000) in triplicates.

Functional properties of plain and pre-treated browntop millet flour

Functional properties such as bulk density, oil absorption, water absorption, swelling power and emulsion capacity were analysed using standard procedure (AOAC 2006) in triplicates.

Physical properties of browntop millet cookies

Physical parameters such as diameter, thickness, spread ratio, weight, volume, density and specific volume were analysed for the cookies using standard procedures (Gaines, 1991) in triplicates.

Sensory evaluation of the developed cookies

Sensory evaluation is a scientific discipline that analyses and measures human responses to the composition of food and drink. Thus, sensory evaluation was carried out for all the 3 variations of browntop millet cookies on a 9-point hedonic scale rating by 25 untrained panellists. Each panellist was given a sensory evaluation sheet and the cookies were rated for the parameters such as colour, flavour, texture, taste, crunchiness, breakability, mouthfeel, after taste and overall acceptability. One way ANOVA was used to test the significant difference between the sensory parameters of the experimental cookies.

Processing and analysis of data

The analysis was carried out in triplicates and the results were expressed as mean ± standard error. The results were obtained using data analysis toolpak software. Two tailed t test was carried out to test the significant difference between the experimental samples. One way ANOVA was used to test the significant difference between the sensory parameters of the experimental cookies.

Results and Discussion

Proximate composition of plain and pre-treated browntop millet flour

Table 3 shows the results of the proximate composition of browntop millet flour samples. Cereals and millets are characterised by low moisture contents. Whole grains designed for long-term storage for development of value added products with pre-treatments like germination are dried to a final moisture content of 10-12% (Verma and Patel, 2013). The moisture content of PBT, RBT and GBT was 11.55 ± 0.04%, 9.88 ± 0.03% and 10.34 ± 0.02% respectively. The moisture content decreased with pre-treatments.

Table 3. Proximate composition of browntop millet flour samples

Parameters	PBT	RBT	GBT
Moisture content (%)	11.55±0.04	9.88±0.03*(-14.45)^1	10.34±0.02**(-10.47)^1(4.65)^2
Protein (g/100g)	11.37±0.02	11.16±0.01*(-1.84)^1	11.55±0.04**(1.58)^1(3.49)^2
Fat (%)	4.88±0.02	4.65±0.02^{NS}(1.43)^1	4.96±0.02^{NS}(0.40)^1(6.66)^2
Crude fibre (g/100g)	12.25±0.03	12.37±0.01*(0.98)^1	12.56±0.02**(2.53)^1(1.54)^2
Ash (%)	0.81±0.01	0.97±0.01*(19.75)^1	0.97±0.01**(19.75)^1
Total carbohydrates (g/100g)	71.6±0.08	75.4±0.05*(5.63)^1	69.6±0.05**(-2.82)^1(-7.69)^2
Iron (mg/g)	0.60±0.01	0.55±0.01*(-8.33)^1	0.46±0.01**(-23.33)^1(-16.36)^2
Calcium (mg/g)	0.02±0	0.02±0^{NS}	0.01±0^{NS}(-50)^2

PBT-plain browntop millet flour, RBT-roasted browntop millet flour, GBT-germinated browntop millet flour

^{1} Depicts the per cent increase or decrease between PBT and RBT and between PBT and GBT

^{2} Depicts the per cent increase or decrease between RBT and GBT

* Significant difference on dry roasting (p<0.05): two tailed t test for paired sample

** Significant difference on germination (p<0.05): two tailed t test for paired sample

NS depicts no significant difference on pre-treatments

The protein content of GBT was found to be highest as germination has increased the protein content of the flour sample. On dry roasting a significant ($p<0.05$) decrease of 1.84 per cent was recorded in comparison with PBT. A decrease in protein content of the roasted flour sample could be due to protein degradation. On germinating there was a significant ($p<0.05$) increase of 1.58 per cent on comparison with PBT. The increase in protein content of the germinated millet flour may be as a result of the formation of enzymes or an encompassing change following degradation of other constituents (Steve, 2012).

The fat content was found to be reduced on roasting and increased upon germination. Both the pre-treatments (roasting and germination) had no significant ($p>0.05$) difference on the fat content of the browntop millet flour. However, there was a decrease of 1.43 per cent on the fat content of the roasted flour. This result confirms with the report of Aremu and Audu (2011) where groundnut and cranberry bean upon roasting were shown to reduce crude fat content thus increasing shelf life due to decrease in rancidity.

Both the pre-treatments (roasting and germination) have significantly increased the mineral content by 19.75 per cent. This increase in the mineral content may be attributed to reduction in phytic acid that might increase the bioavailability of minerals. In a study by Chauhan et al. (2015) the germinated amaranth flour shows higher ash content when compared with raw amaranth flour. Germination activates its natural enzymes, improves its vitamin status and soften the grain. Several nutritive factors such as vitamin concentration and bioavailability of trace elements and minerals increase during germination Bhathal et al. (2015).

The crude fibre content was increased upon germination with GBT having the highest value followed by RBT and PBT. There was a significant increase of 0.98 per cent ($p<0.05$) in roasted sample (RBT). In a study carried out by Hamed et al. (2008) roasting of the pumpkin seeds significantly increased crude fibre and carbohydrate contents to 3.80 and 18.68 per cent respectively. It is generally accepted that the consumption of food naturally rich in dietary fibre is beneficial to the maintenance of health (Champ et al., 2003). There was a significant ($p<0.05$) increase ($p<0.05$) of 2.53 per cent in germinated sample (GBT). The germinated flour sample has the highest amount of crude fibre of 12.56 g/100g. It may be attributed to the fact that germination stimulates the starch breakdown (Ocheme and Chinma, 2008).

The total carbohydrate content of the flour samples revealed that RBT has the highest value followed by PBT and GBT. There was a significant increase of 5.63 per cent ($p<0.05$) in total carbohydrate content on roasting. There was a significant ($p<0.05$) decrease of 2.82 per cent in total carbohydrate content on germination. These results were in agreement with Mubarak, 2005, who reported that germinated samples showed a significant reduction in the total carbohydrate. Among all these treatments, the highest reduction in total carbohydrate content was noticed in the germination treatment. This could primarily be due to the utilisation of carbohydrate as a source of energy for embryonic growth Vidal-Valverde et al. (2002). The iron content of the flour sample decreased with pre-treatments. There was a significant decrease ($p<0.05$) of 8.33 per cent ($p<0.05$) in iron content upon roasting. Iron content was decreased when grains were roasted (Adawy and Taha, 2001). This statement was in agreement with the current study findings which revealed that roasted browntop millet flour exhibited less iron content (0.55 mg) than other processing technique. There was a significant ($p<0.05$) decrease of 23.33 per cent of iron content in germinated flour sample. Baranwal and Bhatnagar (2013) found that the iron content decreased after soaking and germination. Nagaprabha and Jamuna (2009) reported that a 12.6 per cent decrease in the iron content on germination of green gram.

There was no difference in the calcium content of the roasted flour sample (RBT). But there was a significant ($p<0.05$) decrease of 50 per cent in calcium content upon germination. This was in agreement with the study findings by Nagaprabha and Jamuna (2009) that revealed a decrease in calcium content upon germination.

Functional properties of plain and pre-treated browntop millet flour

Table 4 shows the result of functional properties of experimental samples – plain flour, roasted flour, and germinated flour. In the analysis of the functional properties, the bulk density of RBT was found to be the highest followed by GBT and PBT. Germination significantly ($p<0.05$) decreased the bulk density by 12.35 per cent. Similar observations of lowered bulk density on germination are reported by Ocheme et al. (2008) for sorghum flour, Ghavidel and Prakash (2006) for green gram, cowpea, lentil and bengal gram. It may be expected that decreased bulk density would be an advantage in the preparation of weaning food formulations. Among the various traditional technologies which could be followed for the preparation of low-bulk weaning food, germination has been reported to be very useful (Khatun et al., 2013).

The oil absorption capacity of the flour samples increased on pre-treatment. The increase in the oil absorption capacity could be due to change in the quality of protein during dry roasting. Germinated sample exhibited highest oil absorption capacity**.** Ocheme et al. (2008) also reported an increase in oil absorption capacity for germinated millet flour. Germination increased the capacities of cowpea, green gram, lentil and bengal gram to bind oil as observed by Ghavidel and Prakash (2006). Oil absorption capacity has been attributed to the physical entrapment of oil.

The water absorption capacity of the flour samples increased on pre-treatment. Germination significantly increased ($p<0.05$) the water absorption capacity of browntop millet flour by 9.26 per cent. This result was in agreement with a few studies on sorghum and pulses which reported that such flours are useful in baking (Ocheme et al., 2008; Ghavidel and Prakash, 2006). An increase of water absorption capacity on germination could be attributed to an increase in protein content and change in the quality of protein upon germination and also breakdown of polysaccharide molecules, hence the sites for interaction with water and holding water would be increased (Gamel et al., 2006).

The swelling power of the flour samples decreased on pre-treatment. There was a significant ($p<0.05$) decrease of 22.4 per cent on dry roasting and 29.25 per cent on germination respectively. Obasi et al., (2014) reported that there was a significant decrease in swelling capacity of the brown beans on roasting which might be due to protein denaturation and starch gelatinisation. The presence of carbohydrates weakens the intra granular binding forces of the starch granules thereby results in minimum restriction to swelling power of the flour (Wang et al., 2011).

The Pre-treatment also increased the emulsion capacity of the flour samples. There was a significant ($p<0.05$) increase of 4.64 per cent and

Table 4. Functional properties of experimental samples – plain flour, roasted flour, and germinated flour

Parameters	PBT	RBT	GBT
Bulk density (g/ml)	0.81±0.01	0.85±0.01*(4.94)[1]	0.71±0.005**(-12.35)[1](-16.47)[2]
Oil absorption (ml/g)	8.11±0.005	8.72±0.01*(7.52)[1]	8.83±0.02**(8.88)[1](1.26)[2]
Water absorption (ml/g)	8.10±0.01	8.65±0.04*(6.79)[1]	8.85±0.04**(9.26)[1](2.31)[2]
Swelling power (%)	4.41±0.01	3.42±0.02*(-22.4)[1]	3.12±0.01**(-29.25)[1](-8.77)[2]
Emulsion capacity (%)	4.32±0.01	4.52±0.02*(4.64)[1]	4.9±0.01**(13.42)[1](8.41)[2]

[1] Depicts the per cent increase or decrease between PBT and RBT and between PBT and GBT [2] Depicts the per cent increase or decrease between RBT and GBT *Significant difference on dry roasting ($p<0.05$: two tailed t test for paired samples) ** Significant difference on germination ($p<0.05$: two tailed t test for paired samples) [NS] Depicts no significant difference on pre-treatments.

13.42 per cent on dry roasting and germination respectively. Ghavidel and Prakash (2006) reported that germination increased the emulsion capacity of green gram flour by 3–10 per cent and emulsion stability by 5–7 per cent compared to control samples. The increase in emulsion capacity could be due to an increase in the area of stabilized oil droplet at interface which could be a function of the food components (Imtiaz et al., 2011). The emulsification of food materials may be due to soluble and insoluble proteins and polysaccharides,

Physical properties of browntop millet cookies

Table 5 shows the result of physical properties of browntop millet cookies There is no significant difference in the spread ratio, diameter, thickness, volume, specific volume and density of the cookies. However, the weight of the cookies showed a significant difference. There was a significant increase of 5.04 per cent ($p<0.05$) in weight on plain flour, and a significant increase of 2.92 per cent ($p<0.05$) on dry roasting and a significant ($p<0.05$) increase of 7.43 per cent on germination.

Sensory evaluation of the developed cookies

Table 6 shows the result of sensory analysis of the cookies. The sensory evaluation was carried out for the plain and pre-treated browntop millet cookies on a 9-point hedonic scale rated by 25 untrained panellists**.** Cookies made with refined flour was kept as control, and the variation were made with plain and pre-treated browntop millet flours.

The analysis was carried out in triplicates and the results were expressed as mean ± standard error. The results were obtained using data analysis toolpak software. One way ANOVA was used to test the significant difference between the sensory parameters of the experimental cookies**.**

On pre-treatment there was no significant difference on the colour, flavour, texture, taste, crunchiness, breakability, mouthfeel and aftertaste of the experimental cookies ($p>0.05$). There was significant ($p<0.05$) difference on the breakability and overall acceptability of the experimental cookies. The samples of the sensory analysis of the

Table 5. Physical properties of the cookies

Parameters	SCC	PBTC	RBTC	GBTC
Spread ratio	2.4±0	2.31±0^{NS}(-2.49)[1]	2.05±0^{NS}(-10.32)[1]	2.0±0^{NS}(3.56)[1]
Diameter (cm)	3.6±0	3.7±0^{NS}(2.78)[1]	3.5±0^{NS}(-2.78)[1]	3.6±0^{NS}
Thickness (cm)	1.5±0	1.6±0^{NS}(6.67)[1]	1.7±0^{NS}(13.33)[1]	1.8±0^{NS}(20)[1]
Weight (g)	7.54±0.01	7.92±0.005*(5.04)[1]	7.76±0.05**(2.92)[1]	8.10±0.01***(7.43)[1]
Volume (cm^{3})	31.20±0	31.20±0^{NS}	31.20±0^{NS}	31.20±0^{NS}
Specific volume (m^3/kg)	4.13±0	3.93±0(-3.5)[1]	4.02±0(-1.97)[1]	3.85±0(-3.5)[1]
Density (kg/m^3)	0.24±0	0.25±0^{NS}(5.26)[1]	0.24±0^{NS}(5.26)[1]	0.25±0^{NS}(5.26)[1]

[1] Depicts the per cent increase or decrease between SCC and PBTC, SCC and RBTC and between SCC and GBTC.
*Significant difference on plain flour ($p<0.05$: two tailed t test for paired sample)
**Significant difference on dry roasting ($p<0.05$: two tailed t test for paired sample)
***Significant difference on germination ($p<0.05$: two tailed t test for paired sample)
^{NS} Depicts no significant difference on pre-treatments

Table 6. Sensory analysis of the cookies

Attributes	SCC	PBTC	RBTC	GBTC
Colour	7.4±0.69	7.5±0.82	7.5±0.81	7.6±0.9
Flavour	7.6±1.11	7.4±0.90	7.1±0.68	7.5±0.96
Appearance	7.8±0.59	7.6±0.78	7.3±0.67	7.9±0.80
Texture	7.7±0.98	7.7±0.93	7.3±0.70	7.5±0.81
Taste	7.8±1.03	7.7±1.01	7.4±0.62	7.9±0.72
Crunchiness	7.3±0.92	7.6±0.89	7.4±0.73	7.7±0.87
Breakability	8.1±0.60	7.8±0.80	7.3±0.72	7.4 ±0.89
Mouthfeel	7.8±0.72	7.6±0.96	7.6±0.72	7.8±0.77
Aftert aste	7.8±0.73	7.7±0.77	7.4±0.73	7.9±0.93
Overall acceptability	7.4±0.70	7.7±0.7	7.1±0.83	7.9±0.93

cookies ranked similar for all the attributes. However, GBTC scored more for the overall acceptability than the other samples.

Millets are unique among the cereals because of their richness in dietary fibre, polyphenols and protein. Millets have potential health benefits and epidemiological studies have showed that consumption of millets reduces risk of heart disease, protects from diabetes. The incorporation of browntop millet flour in the formulation of cookies can be justified as it has high nutritional properties and are rich in fibre.

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