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Research Article

Physicochemical Properties of Brown top Millet and Evaluation of its Suitability in Product Formulation

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Abstract

The present study aims to investigate the physicochemical properties of Browntop millet, comparing it with refined wheat flour and evaluation of its suitability in product formulation. The proximate composition (moisture, ash, protein, fat and crude fiber) and functional properties (solubility, swelling power, water absorption capacity, oil absorption capacity and bulk density) were studied using AACC standard methods. The product bread was formulated by replacement of refined wheat flour of different levels of Browntop millet (10.20, 30%. The result were analysed the ash content of the Browntop millet and refine wheat flour are (2 ± 0.005) % and (1.00 ± 0.1) % respectively. The moisture content of the Browntop millet and refined wheat flour are (13.13 ± 0.11% and (14.00 ± 0.01) % respectively. The protein content of the Brown Top miller and refined wheat flour are (17.31 ± 0.05% and (11.06 ± 0.05% respectively. The far content of the Browntop millet flour and refined wheat flour are (6.23 ± 0.11) % and (4.02 ± 0.01% respectively. The carbohydrate content of Browntop millet flour and refined wheat flour are (61.63 ± 10.20) % and (79.87 ± 0.01) % respectively. The crude fiber content of Browntop millet flour and refined wheat flour are (3.53 ± 0.05) % and (0.36 ± 0.05) % respectively. The results of the functional properties of Browntop millet flour and refined wheat flour are analysed. The bulk density of the Browntop millet flour and refine wheat flour are (0.7 ± 0.04) g/ml and (0.82 ± 0.02) g/ml respectively. The water absorption capacity of the Browntop millet flour and refined wheat flour are (2.15 ± 0.02) g/g and (2.00 ± 0.01) g/g respectively. The oil absorption capacity of the Browntop millet flour and refined wheat flour are (2.30 ± 0.01) g/g and (2.59 ± 00.01) g/g respectively. The solubility percent of the Browntop millet flour and refined wheat flour are (11.06 ± 0.05) % and (13.22 ± 0.02% respectively. The solubility power of Browntop millet flour and refined wheat flour are (7.7 ± 0.04) g/g and (6.97 ± 0.02) g/g respectively. Sensory analysis of bread formulated seems to be reduced with increased level of fortification.

Keywords: Browntop Millet; Proximate Analysis; Functional Properties; Product Development; Sensory Analysis

Introduction

Millets are small seeded grains. They are grown on the marginal lands in dry areas in temperate, tropical and tropical regions as grain crops. Millets have good thriving capability. They've good yield indeed under adverse conditions (Gomashe., *et al*. 2017; Singh., *et al*. 2022) [1,2]. Small millets are grown in an area of 31.24 million hectare. India's millet production in 2017 is 11.56 million tons with an area of 9.1 million hectare (Nagaraju., *et al*. 2020) [3].

There are varieties of millets cultivated. They are Pearl millet which consists of 40% of the world production, Foxtail millet. Proso millet or white millet and Finger Millet. Pearl millet produces the largest seeds.

Millets contains high level of fiber and polyphenols. They reduce the rate of fat immersion also several non- communicable disease conditions like cardiovascular disease, diabetes and high blood pressure [2].

Browntop millet is small- seeded annual grass cultivated as grain crop, primarily on the borderline lands in dry areas in temperate, tropical and tropical regions [2]. It has great demand because of its high nutrient content. It has the capability to adopt climate change. In India, Browntop millets are grown in dry regions of Karnataka, Andhra Pradesh. Browntop millet are grown in the United States, Asia, Africa, Australia and China. These seeds contain high levels of proteins, healthy fats, carbohydrates, and dietary fiber content. Browntop millet is rich in essential nutrients which includes calci-

um, iron, phosphorus, potassium, magnesium, manganese and zinc. Daily consumption of the millets lowers the threat of developing cardiovascular diseases, diabetes, and digestive problems.

Browntop millet contains phytochemicals such as flavonoids, quinones, tannins, and resin (Singh., *et al*. 2022) [2]. There is a huge potential for development of value-added products made from Browntop millets similar as ready to eat foods and ready to cook foods like idli blend, poha and many more where millets are mixed with other cereal grains. (Singh et.al., 2022) [2]. Therefore, Browntop millet holds great potential in alleviating food and nutrition insecurity. It has good nutritive value. Browntop millet prevents numerous non- communicable diseases. It can be used in many forms such as forage and staple food.

Therefore, present study aimed to investigate the physiochemical properties of Browntop millet and evaluation of its suitability in bread formulation.

Browntop millet

Browntop millet is small-seeded annual grass cultivated as grain crop. Browntop millet (Urochloa ramose L) is also known as 'korale' or" karlakki' in Karnataka. It has the capability to adapt climate change.

The Browntop millet is grown in the districts of Tumakur, Chitradurga, Chikkaballapur and Mandya in Karnataka state and Ananthapur quarter in Andhra Pradesh state for the traditional food medications (Singh et.al., 2022) [2].

The chemical properties of Browntop millet changes when it is subjected to various processing methods that is soaking, germination, fermentation, dry heating, hydrothermal treatment and extrusion cooking. Samples were analysed and found to have moisture in the range of 1.92 ± 0.05 to 8.99 ± 0.06%, protein- 6.10 ± 0.06% to 17.31 ± 0.25%; ash - 1.06 ± 0.07% to 5.80 ± 0.15%; fat- 3.78 ± 0.12% to 7.08 ± 0.03%; crude fiber -2.22 ± 0.07% to 20.17 ± 0.09%; carbohydrate- 58.0 ± 1.06% to 76.33 ± 0.25%; energy- 306.8 ± 4.6 K Cal/100 g to 396.5 ± 0.8 K Cal/100 g. (Singh., *et al*. 2022) [2].

Germination leads to increase in Moisture content. Fermentation leads to decrease in fat and crude fiber content.

The moisture content of whole Browntop millet flour is (8.99 ± 0.06 %) while in dehulled Browntop millet flour is (8.97 ± 0.04%). In extruded whole Browntop millet flour it is (7.43 ± 0.27) and lastly in extruded dehulled Browntop millet flour it is (7.82 ± 0.8%).

The ash content of whole Browntop millet flour is (5.43 ± 0.27 %) while in dehulled Browntop millet flour is (2.36 ± 0.09%) . In extruded whole Browntop millet flour it is (3.54 ± 0.22%) and lastly in extruded dehulled Browntop millet flour it is (2.16 ± 0.17%).

The protein content of whole Browntop millet flour is (8.8 ± 0.23 %) while in dehulled Browntop millet flour is (17.31 ± 0.25%) . In extruded whole Browntop millet flour it is (7.74 ± 0.20%) and lastly in extruded dehulled Browntop millet flour it is (10.77 ± 0.11%).

The fat content of whole Browntop millet flour is (4.6 ± 0.27 %) while in dehulled Browntop millet flour is (6.27 ± 0.15%) . In extruded whole Browntop millet flour it is (3.78 ± 0.12%) and lastly in extruded dehulled Browntop millet flour it is (4.86 ± 0.8%).

Uses

In southern region of India the grains of Browntop millet from non-shattering kinds are consumed as boiled whole grain (like rice), porridge, kheer or unleavened bread and dosa (Nesbitt, 2005, Singh., *et al*. 2022). Browntop millet is generally base into flour and used to make roti or dosa or polished and boiled to make gruel.

Browntop millet is an effective crop, much like oats. Millets are principally C4 cereals which means it takes take further carbon dioxide (CO2) from the atmosphere and convert it to oxygen (O2),requires low input, have high efficiency of water use, and hence, they are environment friendly. They reduce carbon dioxide from atmosphere, and can contribute in modifying the climate change (Kumar., *et al*. 2018; Singh et.al., 2022) [2].

Health benefits

Browntop millet rich in fiber that is it contains 12.5 g fiber per 100g (Indian Institute of Millets Research (IIMS) 2012). Fiber helps in detoxification of the body by removing the waste from the intestine. Fiber act as a prebiotic in the colon as it gets fermented (lei., *et al*. 2006). Browntop millet is gluten free. Browntop millet contain 276 mg per 100 g phosphorous (Kishore., *et al*. 2021). It is also a good source of minerals. Sufficient amount of magnesium is present which is 94.5 mg/100g (Kishore., *et al*. 2021). Magnesium is a vital mineral which increases the effectiveness of insulin and glucose receptors by supporting numerous carbohydrates digesting enzymes which manages insulin action (Hemamalini., *et al*. 2011) and it also helps to reduce the pressure on blood vessels (Ashoka and Sunita 2020) which make it able of reducing the effects of myocardium infarction and migraine (Sarita and Singh, 2016).

Product developed earlier using browntop millet flour

According to study by Tikare., *et al*. (2021) [4] the biscuits prepared from 50% Browntop millet and 50% refined wheat flour were packed in LDPE and PP and were stored at (30 ± 4°C) for 90 days to check their storage feasibility. Chemical composition of the fresh biscuits were moisture content was 4.05 %, protein 11.40%, crude fat 24.76 %, crude fiber 4.36 %, carbohydrates 59.03 %, calcium 24.84 mg/100g, iron 5.77 mg/100g and 176.48 µg/100g beta carotene. Monthly sensory evaluation was carried out during the storage of three months.

The results indicated that the overall acceptability of the control sample decreased from 8.01 to.73 in LDPE and in PP 8.30 to 7.92 during the storage span of 90 days. Storage study showed that there were minimum losses in sensory, nutritional and textural characteristics in the biscuits that were stored in LDPE than in PP. There were changes in the level of protein, crude fiber, calcium, beta carotene and iron content with increase in the storage period of three months [4-14].

Material and Methods

Procurement of raw materials

Browntop millet was purchased from Nutrelis, Noida located in Rajasthan. All the chemicals and reagents used during the research work of analytical grade.

Proximate analysis

Moisture content

Moisture content of the sample was tested with the help of the standard protocol (AACC, 2000). For the analysis, 5g of precisely weighed sample was placed inside the already weighed petri plate and then kept inside a hot air oven (110 ± 1°C) for 1h. The moisture content was estimated from the average of triplicate reading using the following formula.

Moisture content (%) = $(W_1 - W_2) \times 100\%$

$(W_1\text{-}W)$

Where, W= Empty petri plate weight, W1 = Petri plate ± sample weight prior to drying, W2 = Weight of petri plate ± sample after drying.

Ash content

The ash percentage was calculated using the standard protocol as given by AACC (2000). The powdered sample (3g) was weighed and transferred into an already weighed silica crucible. The sample along with the crucible was burned using gas flame till the period where smoke ceases. Thereafter the crucible was kept in the muffle furnace 550°C and was incinerated for 4-5 h in the muffle furnace only overnight. The percentage ash content was estimated as described below

Ash % = $(W_3 - W_1) \times 100\%$ $(W_2\text{-}W_1)$

Where, W = Sample weight, W1 = Empty crucible weight, W2 = Weight of crucible

Crude fat content

Fat percentage was calculated with the help of Soxhlet extractor as given in the method of AACC (2000). About 5g of precisely weight sample was kept in a thimble and placed inside the fat extraction tube of the Soxhlet assembly. About 250 ml of hexane was passed through the sample in a Soxhlet apparatus and refluxed for about 10 h. After the completion of the extraction time, the thimble was recovered from the apparatus and most of the ether was distilled off by collecting it in the Soxhlet apparatus. The crude fat content was determined using the equation as under, Crude fat (%) = Weight of ether soluble material (g) × 100 Weight of sample taken (g).

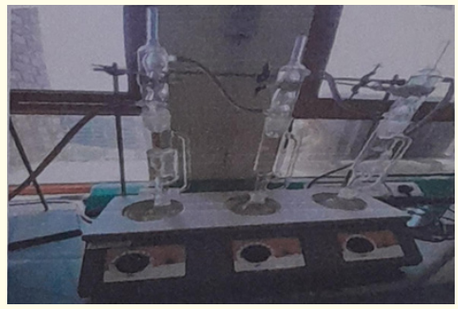

Figure 1: Soxhlet apparatus for fat estimation.

Protein Content

Crude protein estimation was done through the Kjeldahl method by Kjeldahl apparatus (Buchi- Kjel Digester K-449 and Kjel Flex K-360). About 1g powdered sample was placed in a macro digestion tube and 1 g mixture of K2SO4: CuSO4.5H2O and concentrated sulphuric acid (20 ml) was added to it. The tubes were further kept at 389°C in a digestion unit till light green colour solution started appearing. A blank sample was also run only with sulphuric acid and K2SO4: CuSO4 mixture. After digestion, tubes were allowed to cool and thereafter distillation was carried out by semi-automatic distillation unit. After the addition of 40% NaOH (90 ml), distillation was done for 3 minutes. The distillate was recovered inside the flask having 4% boric acid solution (50 ml) along with two drops of indicator. It was titrated against 0.1 N H_2SO4, and the percent nitrogen was determined using the following formula

%Nitrogen =14.01 × (ml titre-ml blank) × N × 100/ Sample weight (g) × 1000.

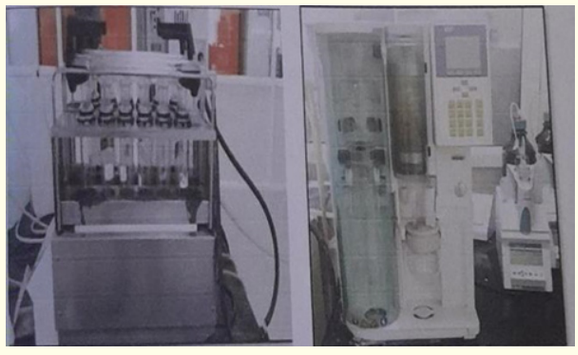

Figure 2: Protein estimation unit.

Crude fiber content

The crude fiber was estimated by the standard AACC protocol 2000.Precisely ,5g fat free sample was kept into a conical flask treated and refluxed for 30 minutes after the addition of 200ml of 1.25% H2SO4. After that the flask was removed and the content of the flask was filtered using an ash free filter paper and then treated with boiled water. The remaining residue after washing transferred back into the flask and digested again with 1.25 % NaOH (200ml) for about 30 minutes. After that the residue was collected through

filtration and treated with boiled water several times. The residue remaining after washing was transferred to a silica crucible and dried in hot air oven (105 ± 1°C) till constant weight was achieved. The weight of dried crucible with residue was recorded after cooling in a desiccator for 30 minutes. The crucible was then kept inside the muffle furnace at 550 ± 5°C to burn all the carbonaceous matter. Thereafter, the crucible was cooled in a desiccator and reweighed.

Percent Crude fiber was estimated using the following formula

Crude fiber (%) = W1-W2 × 100/W

Where, W = Sample weight. W1 = Crucible ± treated sample weight after oven drying. W2 = Crucible ± sample weight after ashing.

Carbohydrate percentage

It was calculated using the method suggested by Yadav., *et al*. (2014), by the difference method (100-moisture ± ash ± protein ± fiber ± fat).

Functional analysis

Bulk density

Bulk Density of the sample that is Browntop millet and Refined Wheat Flour was measured through Mass/Volume Ratio with the help of an empty 100ml graduated cylinder of pre- determined weight and volume as given in (Wan., *et al*. 2016). Each sample of 4g, 5g, 6g was measured in the cylinder and measured further content in the cylinder was tapped on 20 times over the surface until the sample settled and readings were taken and applied to the given formula to obtain the Bulk Density.

Bulk Density (g/ml) = Mass of the sample (g)/Volume of the sample (ml)

Water absorption capacity

Brown Top Millet Flour and Refined Wheat Flour of 1 g was taken in a beaker.10 ml of distilled water was added. It is mixed properly for 30 minutes. Then it is transferred into a dry empty centrifuge tube whose weight was noted down earlier. It is then centrifuge for 20 minutes at 3000 rpm for 20 minutes Then the volume of the supernatant and Weight of the supernatant was recorded.

It is expressed in g/g.

Water Absorption Capacity = Weight of the Sediment(g)/ Initial Sample Weight (g)

Oil absorption capacity

Brown Top Millet Flour and Refined Wheat Flour of 1 g was taken in a centrifuge tube. 15 ml of oil is added. It is then mixed for 30 minutes. It is kept in the water bath at 30°C for 30 minutes. It is then cooled down. The sample is then centrifuge for 20 minutes at 3000 rpm. Volume of the supernatant and Weight of the Sediment was then noted.

It is expressed in g/g.

Oil Absorption Capacity = Weight of the Sediment(g)/ Initial Sample Weight (g)

Solubility

Browntop millet Flour and Refined Wheat Flour sample of 0.5 g were taken in centrifuge tube 20 ml of distilled water is added. It is then mixed properly. Then it is heated at 90°C for 1 hour and mixed periodically. It is then cooled. Centrifugation is done at 5000 rpm for 10 minutes. In a test tube separate the aliquot. Dry pre weighed petri dish was taken and the aliquot sample was transferred to it. It is kept in the hot air oven for 110°C .After complete drying, the weight of the petri dish was recorded .

It is expressed in %.

Solubility = Weight of dried residue/ Weight of Initial Sample × 100

Swelling power

Top Brown Millet Flour and Refined Wheat Flour sample of 0.5 g were taken in centrifuge tube 20 ml of distilled water is added. It is then mixed properly. Then it is heated at 90°C for 1 hour and mixed periodically. It is then cooled. Centrifugation is done at 5000 rpm for 10 minutes. Volume of the supernatant and Weight of the Sediment was then noted.

It is expressed in g/g.

Swelling Power = Weight of the Sediment (g)/Initial Sample Weight (g)

Product development on browntop millet

Preparation of browntop millet bread

Ingredients	F1 (Control)	F2 (10%)	F3 (20%)	F4 (30%)
Refined wheat flour	100g	90g	80g	70g
Browntop millet flour	0g	10g	20g	30g
Salt	1.3g	1.3g	1.3g	1.3g
Sugar	5.3g	5.3g	5.3g	5.3g
Yeast	5.3g	5.3g	5.3g	5.3g
Butter	5.3g	5.3g	5.3g	5.3g
Water	As per the requirement	As per the requirement	As per the requirement	As per the requirement

Table 1: Ingredients used for the preparation of Browntop millet bread.

Procedure

Take 5.3g yeast along with 5.3g sugar and keep in warm water (40°C) for 20 minutes.

Dough was produced by blending flour in which 1.3g salt and 5.3g butter was present with fermented yeast and sugar mixture.

Dough was kneaded properly till the gluten activates.

It was then covered with wet clean muslin cloth and rested for 45 minutes at room temperature (30 ± 2°C) after which it was kneaded again

The dough was shaped into loaf size portion kept in pre- oiled baking pan, rested again for proofing at room temperature for 2hours.

The baking oven was pre heated at 180°C for 15 minutes.

The dough was baked at 180°C for 30 minutes.

Bread was then cooled in a cooling rack at room temperature for 1 hour.

Results and Discussion

Proximate analysis of Browntop millet and refined wheat flour

Result for the proximate analysis of Browntop millet and refined wheat flour are determined. It is found that the ash content of refined wheat flour and Browntop millet flour are 1% and 2% respectively. The moisture content of refined wheat flour and Browntop millet flour are 14% and 13.13% respectively. The protein content of refined wheat flour and Browntop millet flour are 11.06% and 17.31% respectively. The fat content of refined wheat flour and Browntop millet flour are 4.02% and 6.23% respectively. The carbohydrate content of refined wheat flour and Browntop millet flour are 79.87% and 61.63% respectively. The crude fiber content of refined wheat flour and Browntop millet flour are 0.36% and 3.53% respectively.

Parameter studied (%)	Refined Wheat Flour	Browntop millet Flour
Ash Content	1.00 ± 0.01	2.00 ± 0.005
Moisture Content	14.00 ± 0.01	13.13 ± 0.11
Protein (%)	11.06 ± 0.05	17.31 ± 0.05
Fat (%)	4.02 ± 0.01	6.23 ± 0.11
Carbohydrate (%)	79.87 ± 0.01	61.63 ± 0.20
Crude Fiber (%)	0.36 ± 0.005	3.53 ± 0.05

Table 2: Proximate analysis of Browntop millet flour and refined wheat flour sample.

Values are expressed as the mean ± standard deviation of three independent readings (n = 3).

Functional properties of Browntop millet and refined wheat flour

Result for the functional properties of Browntop millet and refined wheat flour are determined. The bulk density of refined wheat flour and Browntop millet flour are 0.82g/ml and 0.70g/ml respectively. The water absorption capacity of refined wheat flour and Browntop millet flour are 2g/g and 2.45g/g respectively. The oil absorption capacity of refined wheat flour and Browntop millet flour are 2.59g/g and 2.3g/g respectively. The solubility of refined wheat flour and Browntop millet flour are 13.22% and 11.06% respectively. The swelling power of refined wheat flour and Browntop millet flour are 6.97g/g and 7.7g/g respectively.

Parameter studied	Refined Wheat Flour	Brown Top Millet Flour
Bulk Density (g/ml)	0.82 ± 0.02	0.70 ± 0.04
Water Absorption Capacity (g/g)	2.00 ± 0.01	2.45 ± 0.02
Oil Absorption Capacity (g/g)	2.59 ± 0.01	2.30 ± 0.01
Solubility (%)	13.2 2± 0.02	11.06 ± 0.05
Swelling Power (g/g)	6.97 ± 0.02	7.7 ± 0.04

Table 3: Functional properties of Browntop millet flour and refined wheat flour sample.

Values are expressed as the mean ± standard deviation of three independent readings (n = 3).

Scale Used for Sensory Analysis

After preparation of various samples of different flavour sensory analysis was done by various respected faculties using 0 to 9 hedonic scale. Hedonic scale : Hedonic Scale is a scale that indicates the extent of respondents' overall liking or disliking for something. Sample Performa used for sensory analysis (0-9 hedonic scale).

Attributes	F1 (Control)	F2 (10%)	F3 (20%)	F4 (30%)
Colour	7.90 ± 0.73	8.30 ± 0.65	6.40 ± 0.96	6.40 ± 0.48
Taste	8.00 ± 0.63	7.81 ± 0.42	6.21 ± 1.81	6.81 ± 0.74
Texture	8.01 ± 0.66	8.40 ± 0.51	5.60 ± 0.51	5.60 ± 0.51
Appearance	8.21 ± 0.78	8.40 ± 0.51	7.00 ± 0.84	6.20 ± 0.78
Aftertaste	8.00 ± 0.66	8.21 ± 0.42	5.60 ± 0.51	5.81 ± 0.78
Overall acceptability	8.61 ± 0.48	8.40 ± 0.51	5.81 ± 0.78	5.60 ± 1.07

Table 4: Sensory Analysis of Bread.

Figure 3: Bread made with refined wheat.

Figure 4: Bread preparation with 10% brown flour top millet

Figure 5: Bread prepared with 20% Browntop millet millet flour.

Figure 6: Bread prepared with 30% Brown Top.

Conclusion

The study was aimed to analyse the physicochemical properties of Browntop millet and evaluation of its suitability in bread formulation. According to sensory analysis, sample F2 that is the bread prepared with 10% millet formulation was preferred and recorded the highest score in sensory analysis. Bread with 30% formulation was hard in texture, darker in colour in comparison to other bread formulation. Results of sensory analysis showed a significant decrease in acceptability with increase in the fortification. It can be concluded from the results of functional analysis of Browntop millet flour and refined wheat flour that the water absorption capacity and the swelling power is greater than refined wheat flour. Whereas, the oil absorption capacity, solubility, bulk density is more in refined wheat flour than that of the Browntop millet flour. From the results of proximate analysis it can be stated that Browntop millet is highly nutritious because of the high protein, fat and crude fiber content.

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