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Nutritional properties of browntop millet (*Brachiaria ramosa*) based Khakhra

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Abstract
Browntop millet (*Brachiaria ramosa*) is an underutilized nutri-cereal recognized for its rich nutritional profile and health-promoting properties. The present study aimed to evaluate the nutritional properties of browntop millet-based khakhra developed using dehusked browntop millet flour. The product was analyzed for proximate composition, dietary fibre, antioxidant activity, antinutritional factors, and mineral content using standard analytical methods. The khakhra contained 12.21% protein, 8.08% crude fibre, 65.66% carbohydrates, 3.53% fat, 4.86% ash, and provided 344 kcal/100 g. Total dietary fibre was 5.40 g/100 g, comprising 2.86 g soluble and 2.54 g insoluble fibre. The product exhibited appreciable antioxidant properties, with total phenolic content of 188.05 mg GAE/100g, tannins of 813.68 mg GAE/100g, and 51.73% DPPH radical scavenging activity. Mineral analysis revealed the presence of calcium (89.25 mg), magnesium (122.47 mg), iron (3.97 mg), zinc (2.03 mg), manganese (1.38 mg), and copper (0.60 mg) per 100 g. The findings indicate that browntop millet khakhra is a nutrient-dense, fibre-rich functional snack with promising antioxidant potential and may contribute to the prevention and dietary management of lifestyle-related disorders, thereby promoting healthier food choices.

Keywords: Browntop millet Khakhra, proximate composition, total dietary fibre, antioxidant properties and minerals

Introduction
Millet refers to a collective group of small-seeded annual grasses that are grown as grain crops, in dry areas of temperate, subtropical and tropical regions. Millets grow under difficult ecological conditions and tolerate poor soils and a certain degree of drought better than any other cereal crop (Sade, 2009) [15]. Millets represented in the prehistoric world can be placed in to one of nine common genera, Brachiaria, Digitaria, Echinochloa, Eleusine, Panicum, Paspalum, Pennisetum, Setaria, Sorghum. The most prominent and well-known millets are the large or great millets of Africa, i.e., Sorghum and Pennisetum. The rest of the millets are often referred to as the small, or minor millets (Weber and Fuller, 2007) [22].
Browntop millet (Brachiaria ramosa), a minor millet is an annual/ perennial warm-season grass which is used in forage/pasture management systems that originated in Southeast Asia (Sheahan, 2014) [17]. It is cultivated in Africa, Western Asia, Arabia, China and Australia (Clayton, 2006) [8]. The Browntop millet is called “Korale” in Kannada and “Karlakki” in Mandya region and “Andukorralu” in Telangana and AP. It is specially grown in rainfed tracts of Tumakuru, Chitra Durga and Chikkaballapura districts of Karnataka state. The crop is popular in this region in terms of cultivation and consumption. The nutritional composition of Browntop millet is on par with the other millets and is reported to be a good source of zinc, iron and fibre. Color of the millet is also appealing and well accepted when compared to other minor millets (Roopa *et al*., 2016) [14]. Millet grains, before consumption are usually processed by commonly used traditional processing techniques such as decorticating, malting, fermentation, roasting, flaking, and grinding to improve their edible, nutritional, and sensory properties (Ahmed *et al*., 2013) [1]. An understanding of suitable processing, salubrious alternatives, are key factors in determining the usage of Browntop millet for domestic consumption or product development with optimum nutrients.
Browntop millet demonstrates versatility, serving as a potential nutri-cereal for human consumption, as well as fodder and game bird feed (Sheahan, 2014) [17]. Grains of non-

shattering 4 varieties of browntop millet can be utilized to make unleavened bread or porridge or cooked whole similar to rice. Traditionally, browntop millet is processed by polishing and cooking to produce rice-like dishes such as gruel, anna and kheer. Alternatively, it can be ground into flour for making flatbreads like roti and dosa. Additionally, browntop millet holds cultural significance in certain rituals and traditional ceremonies, which likely contributes to its continued cultivation in specific regions (Kimata *et al*., 2000) [10]. There are very few studies conducted on browntop millet based products. Hence, this study was conducted with the objective to analyze the nutritional properties of browntop millet based Khakhra.

Materials and Methods

Materials and Methods The present investigation was conducted at the Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences Dharwad, Karnataka. Dehusked browntop millet grains were procured from Green Organics.

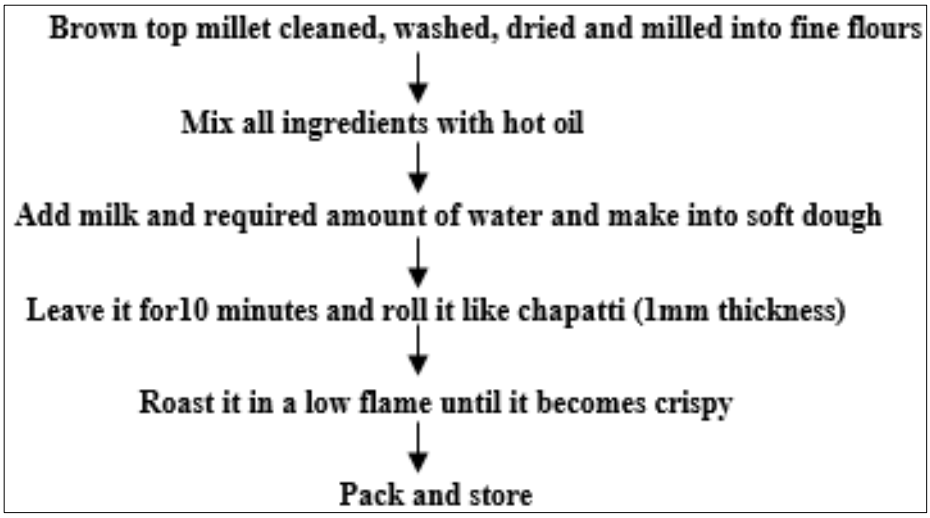
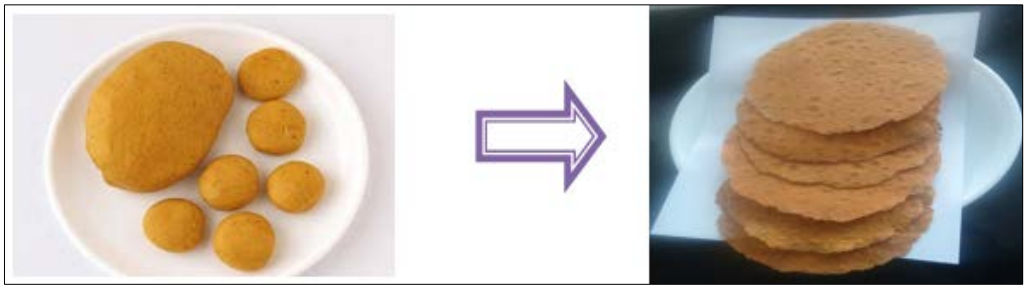


Fig 1: Flowchart for preparation of brown top millet Khakhra



The proximate of browntop millet khakhra: The proximate properties like moisture, protein, crude fat, total ash, crude fibre, carbohydrates, energy of browntop millet khakhra were analysed according to Anon, 2019[2].

Dietary fibre (%) of browntop millet khakhra: The soluble, insoluble and total dietary fibre of browntop millet ribbons was estimated by using α-amyl glucosidase method (Asp *et al*., 1983) [3]. Antioxidant properties of browntop millet khakhra: The antioxidant properties like antioxidants-tannin, total phenolics content and DPPH radical scavenging activity. antinutrients- phytic acid and oxalic acid.

The mineral content of browntop millet khakhra Minerals (mg/100 g): The minerals (calcium, iron, zinc, copper, manganese and magnesium) were estimated by wet digestion using triacid mixture. A known aliquot of browntop millet khakhra sample was diluted and micro minerals in the test sample (Ca, Cu, Mn, Mg, Zn and Fe) were determined using atomic absorption spectrophotometer (Anon., 2019) [2]. Calibration of measurements was performed using commercial standards.

Results and Discussion

Table 1: Proximate composition of browntop millet khakhra

Parameters	Mean±SD
Moisture (%)	**5.66±0.19**
Fat (%)	**3.53±0.02**
Crude protein (%)	**12.21±0.08**
Ash (%)	**4.86±0.02**
Crude fibre (%)	**8.08±0.25**
Carbohydrate (%)	**65.66±2.72**
Energy(Kcal)	**344±3.72**

Note: Values are expressed as mean ± standard deviation of three replications

Table 2: Carbohydrate profile of browntop millet khakhra

Carbohydrate profile		Browntop millet *khakhra* (g/100g)
Starch	Total starch	52.45±1.70
	Amylose	17.59±0.08
	Amylopectin	34.86±0.15
Dietary fibre	Total dietary fibre	5.40±0.19
	Soluble dietary fibre	2.86±0.01
	Insoluble dietary fibre	2.54±0.27

Note: Values are expressed as mean ± standard deviation of three replications

Table 3: Antioxidants and antinutrients of browntop millet *khakhra*

Parameters		Mean ± SD
Antioxidants	Tannin (mg TAE/100g)	813.68±23.47
	Total phenolics content(mgGAE/100g)	188.05±3.89
	DPPH radical scavenging activity (%)	51.73±1.35
Antinutrients	Phytic acid(mg/100g)	135.56±1.58
	Oxalic acid(mg/100g)	3.50±0.10

Note: Values are expressed as mean ± standard deviation of three replications

Table 4: Mineral content of browntop millet *khakhra*

Mineral (mg/100g)	Mean ± SD
Iron	3.97±0.13
Zinc	2.03±0.04
Calcium	89.25±2.81
Manganese	1.38±0.01
Copper	0.60±0.01
Magnesium	122.47±4.08

Note: Values are expressed as mean ± standard deviation of three replications

Table 1 presents the chemical composition of browntop millet khakhra was analyzed and the results of moisture content was found to be 5.66 ± 0.19 per cent, while the fat content was 3.53 ± 0.02 per cent. The crude protein content was 12.21 ± 0.08 per cent and the ash content was 4.86 ± 0.02 per cent. The crude fiber content was 8.08 ± 0.25 per cent and the carbohydrate content was 65.66 ± 2.72 per cent. The energy value of the khakhra was determined to be 344 ± 3.72 Kcal.

Table 2 presents the carbohydrate profile of browntop millet khakhra was determined and the total starch content was found to be 52.45 ± 1.70 g per 100 g which was further classified into amylose 17.59 ± 0.08 g and amylopectin 34.86 ± 0.15 g. The total dietary fiber content was 5.40 ± 0.19 g, with soluble dietary fiber accounting for 2.86 ± 0.01 g and insoluble dietary fiber making up 2.54 ± 0.27 g per 100 g of the khakhra.

The antioxidants and antinutrients of browntop millet khakhra were evaluated and the results are the tannin content was found to be 813.68 ± 23.47 mg TAE per 100 g, while the total phenolic content was 188.05 ± 3.89 mg GAE per 100 g. The DPPH radical scavenging activity, a measure of antioxidant potential, was determined to be 51.73 ± 1.35 per cent. Regarding antinutrients, the phytic acid content was 135.56 ± 1.58 mg per 100 g and the oxalic acid content was 3.50 ± 0.10 mg per 100 g (Table 3).

Table 4 presents the mineral content of browntop millet khakhra was assessed and the results of the iron content was found to be 3.97±0.13 mg per 100 g, while zinc content was 2.03± 0.04 mg per 100 g. The calcium content was 89.25 ± 2.81 mg per 100 g and the manganese content was 1.38 ± 0.01 mg per 100 g. Copper was present at 0.60 ± 0.01 mg per 100 g and magnesium content was 122.47 ± 4.08 mg per 100 g.

Discussion

The proximate composition of browntop millet Khakhra revealed that it was a rich source of protein, with a content of 12.21% (Table 1). Similar findings were reported by Vernekar *et al*., 2018[16]; Sharavathi and Usha Devi, 2022 [21]. Khakhra, including Kariyele Khakhra (13.47%), spinach leaves Khakhra (5.2%), millet-based Khakhra (11.05-17.54%), fibre-enriched Khakhra (14.7%), value-added Khakhra with garden cress seeds (8.32-11.49%), kodo millet Khakhra (12.33%), multigrain Khakhra (15.34%) and 162 fenugreek-enriched Khakhra (19.56%). The moisture content of browntop millet Khakhra was found to be 5.66%, which was relatively low due to the evaporation of moisture during the roasting process, leading to a reduction in the high initial moisture content (Sruthi *et al*., 2021) [19]. The ash content (4.86%), crude fibre (8.08%) and total carbohydrate (65.66%) were comparable to those found in various other Khakhra varieties developed by Solanke *et al*. (2018) [18] and Mahalaxmi and Pattan (2021) [12].

The total dietary fibre content of browntop millet Khakhra was 5.40%, with 2.86% soluble and 2.54% insoluble fibre in the present study (Table 2). This demonstrated that the fibre content in grain-based products depends on the natural fibre present in the grains. High fibre diets were linked to a reduced risk of cancers, coronary heart disease and obesity, with fibre's bulking action decreasing calorie density and increasing satiety (Buttriss and Stokes, 2008) [5]. Soluble fibre also served as a prebiotic, supporting beneficial bacteria and overall health (Chawla and Patil, 2010) [7]. Furthermore, fibre intake improved glucose and insulin metabolism in Type 2 diabetes, reducing glucose absorption and promoting continuous glucose release. Balanced nutrition often recommended high fibre intake (Brennan, 2005) [4].

The study presents the total phenolic content of browntop millet Khakhra and it was was found to be 188.05 mg GAE/100g (Table 3). The World Health Organization (WHO) recognizes the importance of antioxidants in maintaining health and preventing diseases. Antioxidants play a crucial role in protecting cells from oxidative damage caused by free radicals, which can contribute to the development of chronic diseases such as cardiovascular disease, cancer and neurological disorders (Yao *et al*., 2004) [23]. Polyphenolic compounds, known for their antioxidant properties have gained significant attention due to their potential health benefits.

The DPPH radical scavenging activity of browntop millet Khakhra was found to be 51.73% (Table 3). Buckwheat's antioxidant activity was influenced by both the specific antioxidant properties of certain phenolic compounds and the overall phenolic concentration (Lee *et al*., 2016) [11]. Browntop millet was found to contain tannins at a concentration of 813.68 g TAE/100g. In the study of, Umraji and Vijayalaxmi (2020) [20] reported very low antioxidant activity in kodo millet masala Khakhra. Additionally, found a positive correlation between the levels of phenolic compounds, such as phenolic acids, tannins and antioxidant activity (Cai *et al*. 2004) [6]. The phytic acid content of browntop millet Khakhra was found to be 135.56 163 mg/100g, which was similar to the findings of McKenzie-Parnell and Davies (1986) [13]. They reported higher phytate content in ready-to-eat barley grain (0.85%) and millet whole grain flakes (0.81%), while barley whole-grain flakes had a lower phytate content of 0.42%.

The study presents the mineral composition of browntop millet Khakhra was analyzed, revealing 89.25 mg of calcium, 3.97 mg of iron, 2.03 mg of zinc, 0.60 mg of copper, 1.38 mg of manganese and 122.47 mg of magnesium per 100g (Table 4). These results were similar with those reported by Divakar and Prakash (2020) [9], who prepared Khakhras in four variations using different millets, including pearl millet (bajra), finger millet (ragi), sorghum

and foxtail millet. They found that sorghum Khakhra was richer in minerals such as iron (12.15 mg), zinc (3.90 mg) and magnesium (199 mg/100g), while finger millet Khakhra had the highest calcium content (188 mg/100g). Ragi Khakhra contained the least iron (7.53 mg/100g). Additionally, the use of malted sorghum and soy flour in the preparation of Khakhra resulted in an increase in minerals such as iron, calcium and zinc when substituted at various levels.

Conclusion

In the present study, analysis was conducted on the proximate composition, dietary fibre, and antioxidant and minerals properties of browntop millet khakhra. The results revealed that browntop millet khakhra were rich in protein, crude fibre and dietary fibre content. These findings highlight the potential of browntop millet as a valuable nutri-cereal. Given its high protein and high fibre content, it can be utilized for value added products aimed at improving overall health. The inclusion of browntop millet khakhra in the diet may play a significant role in the prevention and management of various lifestyle-related diseases, such as diabetes, obesity and cardiovascular diseases.

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