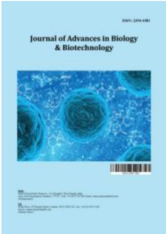

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The Power of Millets-transforming Bakery Products with a Revolutionary Approach to Nutrition: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Consumer preferences are increasingly shifting towards healthier food choices, prompting the food industry to develop nutritious alternatives to traditional snacks. Functional foods, offering health benefits beyond basic nutrition, are gaining popularity. Millets, resilient small-seeded grasses, have emerged as a promising ingredient due to their nutritional richness and adaptability. India, a leading

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producer of millets, has been promoting their cultivation and consumption to enhance food security and combat malnutrition. Millets are rich in proteins, fibers, vitamins, and minerals, and are gluten-free, making them suitable for individuals with specific dietary needs. Their incorporation into baked goods, enhances the nutritional profile and offers a healthier snack option. This article highlights the growing attention toward millets as a sustainable alternative for nutritional enhancement in bakery products. It reviews the incorporation of millets into commonly consumed bakery products, including cookies, bread, and cakes. The review reveals that millet-enriched bakery products exhibit improved nutritional profiles, notably higher fiber, protein, and mineral content. This exploration into millet-based products underscores their potential in promoting health and food security, aligning with modern consumer demands.

Keywords: Millets; food; bakery products; health benefits; nutrition; millet incorporation.

1. INTRODUCTION

In recent years, there has been a noticeable shift in consumer preferences towards healthier food choices. This trend has prompted the food industry to explore and develop nutritious alternatives to traditional snacks. The trend of consuming nutritious and high-quality foods i.e. "Functional Foods," or foods that contain ingredients that offer extra health benefits beyond meeting the requirements for minimum nutrition—is growing (Ndife, 2009). Therefore, creating a food product that satisfies consumers and has attributes like a longer shelf life, a satisfying taste and low calories while also being nutritionally superior and readily affordable presents a significant challenge. Millets have that ability to satisfy all these needs. Millets represent a diverse group of small-seeded grasses belonging to the *Poaceae* family and they encompass a variety of species such as sorghum, finger millet, pearl millet, foxtail millet and many more. Millets are highly adaptive to a wide range of ecological conditions and thrive well in rain-fed; arid climate. This characteristic resilience makes millets an attractive choice for sustainable agriculture (Anonymous, 2022a). India is one of the largest producers of millets with a production of 170 lakh tons i.e., 80% of Asia's and 19% of the world's and fifth largest exporter of millets (Anonymous.2023a). With a production of 5.15 million MT, Rajasthan leads all Indian states in millets production. Karnataka follows with 2.56 million MT, and Maharashtra is in third place with 2.51 million MT (Anonymous, 2022a). The Indian government is promoting millet production as part of its National Food Security Mission, hence millet production in India is expected to grow in the coming years (Anonymous, 2023a). Considering all of the advantages of millets, the United Nations last year proclaimed 2023 as the "International Year of Millets" in an effort to increase demand for the grain both domestically and internationally and to feed people a healthy diet (Anonymous, 2022c). This initiative came from the Indian government, and 72 other nations supported it, making India the proposed global centre for millets (Anonymous, 2022b).

In India, malnutrition remains a persistent and complex challenge, affecting a substantial portion of the population, especially among children and women. Despite economic progress, high levels of poverty, inadequate access to quality healthcare and insufficient dietary diversity contribute to the prevalence of malnutrition. With the highest alarming child wasting rate in the world i.e., 18.7%, India ranked 111th among 125 countries in the Global Hunger Index-2023 (Anonymous, 2023b). To tackle this problem, millet-based products can be a best option. In recent times, the nutritional richness of millets has been a focal point of research and dietary discussions. These grains are rich sources of essential nutrients, including protein, fiber, vitamins and minerals. Moreover, millets are gluten-free, making them a valuable dietary option for individuals with gluten sensitivities or celiac disease. Moreover, it has numerous other health advantages, including anti-oxidant, anti-cancer, anti-cholesterolemic and anti-hypertensive properties (Rao and Deepika, 2016). The carbohydrate content in millets consists mainly of complex carbohydrates with a low glycemic index, contributing to sustained energy release and better blood sugar control (Michaelraj and Shanmugam, 2013). According to Saleh *et al.* (2013), millets are suitable for use in food products like bakery goods and snack foods because they possess all the necessary nutritional and health-promoting factors. All age groups love baked goods like cookies, but kids especially adore them as they come in so many different flavors, textures, and aromas. Because of the gluten in refined wheat flour, it's an

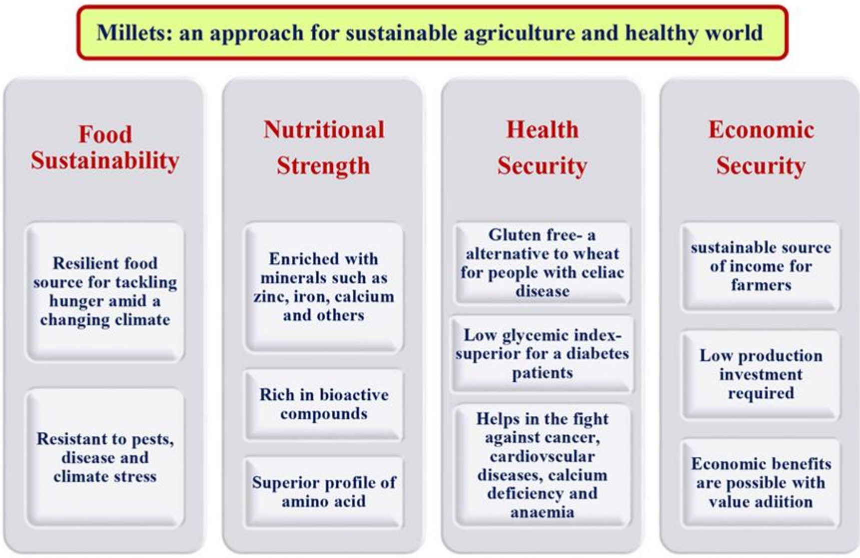

Fig. 1. Millet Benefits at a Glance (Kumar *et al*., 2018)

essential ingredient for making any bakery product. Refined wheat flour is a byproduct of refining and has a higher proportion of starch, low dietary fiber, and minerals. As a result, cookies made with refined wheat flour have a lower protein, fat, and mineral content (Ali, 2013). As a result, to increase the nutritional value of bakery product, refined wheat flour needs to be replaced with another flour that is of higher quality. The production of millet-based products represents a creative approach to leveraging the inherent benefits of millets in a convenient and appetizing form. By combining various millet grains, such as sorghum, finger millet, pearl millet and foxtail millet, in the cookie-making process, manufacturers aim to create a snack that not only meets the modern consumer's taste expectations but also aligns with their nutritional aspirations. This article delves into all the different aspects of millet-based baked products, examining the nutritional advantages that render them an appealing option for consumers who prioritize their health.

2. NUTRITIONAL AND MEDICINAL BENEFITS OF MILLETS

Despite years of execution, the global hunger index indicates that the fight against hunger is still essentially at a standstill. Malnutrition and hunger are among the serious problems that an increasing number of people are facing as a result of the crisis's multiplicity and intensity (Anonymous, 2023b). The majority of illnesses are caused by an unbalanced diet. The Food and Agriculture Organization of the United Nations estimates that in 2020-2022, approximately 16.6 % of the India's population was undernourished, 74.1 % of Indians are unable to afford a healthy diet (FAO, 2023). The WHO has classified obesity-related complications like diabetes and cardiovascular diseases as an epidemic. Global reports from 2022 state that, about 2.5 billion (43 %) adults were overweight. Of these, 890 million (16 %) were living with obesity, i.e.,1 in 8 people living with obesity (Anonymous, 2024a). In 2022, 70 million adults in India suffered from obesity; women accounted for nearly twice as many cases as men, at 44 million and 26 million, respectively. The obesity rate increased from 1.2 % (1990) to 9.8 % (2022) for women and 0.5 % (1990) to 5.4 % (2022) for men (NCD-Risk Factor Collaboration, 2024). In India, 11.4 % of country's population (about 101 million people) are living with diabetes and 15.3 % population dealing with prediabetic, around 35.5 % have hypertension and 81.2 % have dyslipidemia (Anjana *et al*., 2023). The WHO has classified obesity-related complications like diabetes and cardiovascular diseases as an epidemic.

Owing to the millets significant potential and ability to guarantee enhanced food and nutrition security, genetic diversity in the food culture can be expanded (Mal, 2010). When it comes to nutritional parameters, millets are far superior to wheat and rice. With 56.88 to 72.97 % carbohydrates (Saleh *et al*., 2013; Leder, 2004), 6-13% proteins (Baebeau and Hilu, 1993; Panghal *et al*., 2006; Singh and Raghuvanshi, 2012), 1.43-6% fat (Leder, 2004; Nirmala and Muralikrishna, 2000; Singh and Raghuvanshi, 2012), and 1 to 10% crude fiber (Saleh *et al*., 2013), millets are a good source of iron, manganese, phosphorus, magnesium, antioxidants, and vitamin B. All of the millets are superior than wheat and rice in terms of fiber, with some having more than fifty times the fiber content of rice (Gull *et al.*, 2014). One of the biggest public health concerns in the developing world, especially India, is the concealed epidemic of micronutrient deficiencies (Chaudhary *et al*., 2022). Millets have a mineral content of 2.5 to 3.5%, which is significantly higher than that of staple grains like wheat (1.5%) and rice (0.6%) (Eugenia *et al*., 2021).As finger millet contains the highest concentration of calcium (348 mg/100 g), it can help prevent osteoporosis and has a calcium content approximately eight times higher than wheat and thirty times the calcium content of rice, while all other millets have at least twice the calcium content of rice (Gull *et al.*, 2014). Pregnant women who suffer from anemia can meet their iron requirements by consuming rich sources of iron, such as pearl mist and barnyard millet. Only 10 mg less than the recommended daily intake of iron is found in barnyard millet i.e., 17.47 mg/100 g. Of all millets, foxtail millet has the highest concentration of zinc i.e., 4.1 mg/100 g (Chandel *et al*., 2014). These nutrients i.e., iron and zinc, are crucial for strengthening the immune system. β-carotene and B vitamins, particularly riboflavin, niacin, and folic acid, are also abundant in millets. They also contain a good amount of essential amino acids, with the exception of lysine and threonine, which are relatively high in sulfur-containing amino acids like methionine and cysteine (Singh *et al.,* 2012).

A number of studies have demonstrated the numerous potential health benefits of millets, including a decreased risk of heart disease, protection against diabetes, improvement of the digestive system, a lower risk of cancer, detoxification of the body, increased immunity in respiratory health, increased energy, and protection against a number of chronic illnesses like metabolic syndrome and Parkinson's disease (Manach *et al*., 2005; Scalbert *et al*., 2005; Chandrasekara and Shahidi, 2012).Millets contain high levels of phosphorus and essential B vitamins, including riboflavin, niacin, thiamine, and folacin, which are essential for the synthesis of energy in body(Sarita and Singh, 2016).Millets contain flavonoids, which are powerful antioxidants that have a variety of functions in the immune system (Shobana *et al*., 2009). By encouraging appropriate excretion and reducing enzymatic activity in specific organs, antioxidants like quercetin, curcumin, ellagic acid, and numerous other advantageous catechins which are present in millets can assist in clearing your system of any foreign substances and toxins (Reddy, 2017).Millets contain phenolic compounds such as pancreatic amylase and alpha-glucosidase, which partially inhibit the enzymatic hydrolysis of complex carbohydrates, thereby reducing postprandial hyperglycemia (Shobana *et al*., 2009). Studies on millets revealed that they are high in antinutrients called phenolic acids, phytates, and tannins, which help lower the risk of breast and colon cancer. Millets' phenolics have been demonstrated to be useful in halting the development and spread of cancer in vitro (Chandrasekara and Shahidi, 2011). A number of inhibitors found in millet grains, such as aldose reductase, prevent sorbitol from building up and reduce the risk of diabetes-related cataract disease (Chethan *et al*., 2008). Magnesium is abundant in millets and helps lower the risk of type-II diabetes, heart attacks and migraines. Magnesium is a vital mineral that produces a large number of enzymes that break down carbohydrates, which controls the action of insulin. This helps to increase the effectiveness of glucose and insulin receptors (Reddy, 2017). Millets are an excellent source of phytochemicals that include phytic acid, which decreases the body's cholesterol levels (Coulibaly *et al*., 2011). In 2010, the National Institute of Nutrition (ICMR) evaluated the Glycemic Index (GI) of foods based on sorghum jointly with the Indian Institute of Millets Research, Hyderabad, as part of the National Agricultural Innovation Project (NAIP). The findings demonstrated the low GI and reduction in postprandial blood glucose levels of foods based on sorghum. Due to the high fiber content, finger millet diets demonstrated a low glycemic response. Additionally, they support the process of dermal wound healing (Ambati and Sucharitha, 2019). It is difficult for genetically susceptible people to tolerate even trace amounts of gluten in their diets due to celiac disease, an immune-mediated enteropathy brought on by gluten ingestion. Since millets are free of gluten, they are a great option for those with celiac disease and other gluten-sensitive patients who frequently experience side effects from eating wheat and others more widely consumed cereal grains (Saleh *et al*., 2013). Hence, the integration of millets into our daily diets offers a sustainable approach to combat malnutrition and other health issues. Their rich nutritional profile not only supports better health but also contributes to food security, making them a valuable addition to our food systems.

Table 1. The Medicinal Value of Millets: Curative Compounds and Health Impacts (Eduru *et al*., 2021; Rao *et al*., 2017)

Health Problem	Curative Millet Crops	Curative Compounds	Functions	References
Obesity	Sorghum	High dietary fiber content	Lowering appetite and consumption is achieved by slowing down the digestion and absorption of food by prolonging its transit time from the stomach to the intestine	(Ali *et al*.,1982; Schneeman and Tietyen, 1994)
	Finger millet	Tryptophan	Reduces appetite	(Rao *et al*., 2017)
Celiac disease	Sorghum, Pearl millet	Gluten free	After prolonged consumption, the amount of anti-transglutaminase antibodies cannot be altered by grain content	(Carolina *et al*., 2007)
Detoxification	Sorghum, Finger millet, Kodo millet, Little millet, Foxtail millet, Barnyard millet	Antioxidants (Quercetin, Curcumin, Ellagic acid)	Utilize radical cation scavenging to neutralize free radicals and stop cell disruption	(Dykes and Rooney, 2006; Choi *et al*., 2007)
Diabetes	Sorghum, Pearl millet, Finger millet	Fiber, Magnesium, Vitamins, Tannins	Prolonged fiber digestion resulting in a delayed blood glucose release	(Montonen *et al*., 2003)
Cancer	Sorghum	Polyphenols, Tannins	Exhibits a positive melanotic activity while acting against human melanoma cells	(Gomez-Cordoves *et al*., 2001)
Gastrointestinal illness	Finger millet	Fiber	Get rid of cramps, bloating, excessive gas, and constipation	(Rao *et al*., 2017)
	Pearl millet	Alkaline nature of millets	Keeps the pH of the stomach maintained by neutralizing the acidity	(Rao *et al*., 2017)
Cardiovascular disease (High level of cholesterol)	Finger millet, Proso millet, Barnyard millet	Lignin	Serve as antioxidants that lower triglycerides in plasma	(Lee *et al*., 2010)
	Sorghum	Sterol	Decrease absorption and prevent the body from producing cholesterol on its own	(Carr *et al*., 2005)
	Finger millet	Lecithin, Methionine	Eliminate extra fat from the liver and reduce cholesterol	(Rao *et al*., 2017)

Table 2. Nutritional profile of millets per 100 g (Chandel *et al*., 2014; Leder, 2004; Panghal *et al*., 2006; Rao *et* al., 2017; Saleh *et al*., 2013)

Crop	Protein (g)	Fat (g)	Carbo-hydrate (g)	Crude fiber (g)	Ash (g)	Energy (Kcal)	Calcium (mg)	Iron (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)
Sorghum	10.82±2.5	3.2±1.6	72.9±2.3	1.9±0.4	1.7±0.7	349.0±1.6	35.2±7.4	5.3±1.3	0.35±0.04	0.14±0.01	2.10±0.09
Finger millet	7.4±0.9	1.4±0.1	71.5±3.6	3.6±0.7	2.63±0.1	334.0±2.8	348.0±3.5	4.3±0.6	0.37±0.04	0.17±0.01	1.34±0.02
Pearl millet	11.4±0.8	4.8±0.1	69.1±1.5	2.0±0.5	2.1±0.2	363.0±3.1	35.0±8.9	10.3±7.0	0.25±0.04	0.20±0.04	0.86±0.10
Foxtail millet	11.3±0.9	3.3±0.8	67.3±5.7	8.2±1.7	3.4±0.1	352.0±1.4	31.0±1.1	3.5±1.2	0.59±0.02	3.20±0.03	0.11±0.04
Proso millet	11.7±0.9	3.1±1.2	67.1±4.8	8.5±3.4	2.7±0.7	352.5±1.6	10±3.5	2.2±1.2	0.41±0.05	0.10±0.02	4.20±0.03
Barnyard millet	10.7±1.1	3.5±1.2	56.8±6.8	12.8±2.4	4.3±0.3	341.0±2.8	18.3±6.0	17.5±2.0	0.33±0.03	0.28±0.03	4.50±0.05
Kodo millet	9.9±1.6	3.0±1.0	63.8±7.9	8.2±2.3	2.8±0.4	349.5±4.9	32.3±4.6	3.2±1.3	0.29±0.05	0.20±0.02	1.49±0.08

3. UTILIZATION OF MILLETS IN BAKED PRODUCTS AND ITS NUTRITIONAL ENRICHMENT

Because of the affordable prices, wide range of tastes, appealing packaging, and extended shelf lives for convenient marketing, bakery goods are widely consumed worldwide and their production has increased significantly (Patel and Rao, 1996). According to Market Intelligence Report for Biscuit (2019), "The market is being led by the wheat segment, but the multi-grain segment is predicted to grow significantly" (Anonymous, 2019). Numerous research organizations worldwide have taken notice of the nutritious qualities and attributes of millet that support a healthy lifestyle, leading to a greater emphasis on utilizing them in processed food products. This section briefly discusses few of the research works that has been carried out regarding millets use in baked goods.

Not only will millets provide superior fiber and micronutrient content in baked goods, but their use will also open up new opportunities for millets to be used in a variety of value-added products (Verma and Patel, 2013). When millet flour blend is added, the nutrient density of the composite flour increases and its properties are altered to the point where it can be used to make cookies, crackers, toast, pasta, and other foods (Vijayakumar and Mohankumar, 2009).

Cookies: Composite millet flour cookies offer a nutritious and innovative twist to traditional baked goods. This fusion not only promotes food sustainability but also diversifies dietary options, showcasing the versatility and benefits of millets in cookies development (Anonymous, 2024b). By incorporating millets into cookies bakers can develop delicious, wholesome treats that support both consumer well-being and environmental health.

Sudha *et al*. (2019), formulated nutritious millet cookies using various varieties of ragi such as VR-900, VR-988 and VR-1076. For the preparation of cookies, wheat-millet composite flour used in the ratio of 00:100, 20:80, 30:70, 40:60. High amounts of protein (4.10–5.80%), fat (19.74–21.74%), digestible carbs (50.11–70.11%), and fiber (2.20–4.73%) are found in baked cookies. Sensory evaluation determined that cookies of variety VR-988 with a blend ratio of 260:760g were acceptable. Shanmugapriya *et al.* (2022) investigated the sensory attributes of cookies prepared with various kinds of millet i.e., pearl millet, finger millet, sorghum (100 % millet flour). In comparison to sorghum (7.92) and finger millet (7.82), the author reported that cookies made with 100% pearl millet flour were highly acceptable, receiving a sensory score of 8.11 on a 9.0 hedonic scale. The possibility of utilizing little millet, an untapped nutritious grain, in cookies was investigated by Biradar *et al*. (2021). The researcher utilized a blend of wheat and millet flour, varying the proportion from 0% to 100%, to create the cookies for the initial investigation. Cookies prepared with 20:80 wheat-little millet ratio was deemed appropriate for further storage study among the developed cookies based on sensory evaluations. On the first day, cookies made with 80% less millet flour have higher levels of iron (7.24 mg), fat (29 g), and crude fiber (6.37 g) than the control sample cookies (100 % wheat flour), i.e., 1.77 g, 26.39 g, and 2.62 mg, respectively. Author concluded that cookies with 80 % little millet flour had better acceptability till 90th day. A composite flour blend made up of pearl millet flour and wheat flour in proportions of 20, 40, 60, 80, and 100% was utilized by Kulkarni *et al*. (2021) to develop a low-gluten cookie. According to this study, when the percentage of PMF in composite flour rises, the prepared cookies exhibit an increasing trend in terms of nutritional quality parameters like fat, fiber, calcium, phosphorous, and iron. The highest score for overall acceptability was found in sensory trials for cookies made with 60% PMF. These cookies also showed good nutritional properties, including fat (24.9 g), fiber (0.74 g), calcium (21.0 mg), phosphorous (153.3 mg), and iron (3.8 mg). By adding various millets such as finger millet, foxtail millet, kodo millet, and little millet to wheat flour at varying percentages (20 to 80%), Subbulakshmi and Malathi (2017) standardized the multi-millet cookies. According to the results of the sensory trial, cookies made with 20% of each millet were found to be highly acceptable and it also contains high concentration of nutrients (20.57 % fat, 1.92% fiber, 65.59 % carbohydrate, 13.15% protein, 31.42 mg calcium, and 1.74 mg iron) in comparison to the control sample (20.12%, 0.46 %, 66.54 %, 13.65%, 11.62 mg, and 15.52 mg, respectively).The author also assessed the hypoglycemic impact of multi-millet cookies on the rats, and the results of this investigation showed that the rats given multi-millet cookies had a higher blood glucose reduction than the rats given control cookies. By utilizing composite flour (sorghum flour substituted with refined wheat flour at different levels, i.e., 5%, 10%, 15%, 20%, and 25%), At 0,25,50,75, and 100%

levels, wheat flour was substituted for millet flour to create cookies with reduced or no gluten by Hussain *et al.* (2019). The cookies' antioxidant activity, as determined by DPPH, ABTS, or FRAP methods, rose as the millet flour content increased. The cookies' DPPH activity (%) varied from 10.39±0.26 (control sample) to 16.39±0.34 (100 % millet flour). It has been reported that adding flours such as millet, sorghum, chenopodium, and amaranth enhanced the antioxidant potential and total polyphenol content of various cookie recipes (Chauhan *et al*., 2015; Jan *et al*., 2016; Pasha *et al*., 2015). Despite the fact that cookies with 50% or less millet flour were deemed to be acceptable from a sensory perspective. Three types of millets, foxtail, barnyard, and Kodo were germinated and used to make gluten-free cookies using a combination of flours, as reported by Sharma et al. (2016). Millets flours were combined in the following ratios to make flour blends- 80:15:5, 70:20:10, 60:25:15, 50:30:20, 40:35:25, and 35:35:30. According to the sensory score, cookies made with a 70:20:10 ratio that included either raw or germinated millets were deemed to be excellent and having acceptance ability. Additionally, these cookies were said to have the highest nutritional content. Dietary fiber (29.7 g/100 g), protein (9.72 g/100 g), fat (6.72 g/100 g), phenolic content (32.23 mg/100 g), and DPPH activity (60.24%) are the nutritional characteristics of raw millet flour cookies. Florence *et al*. (2014), investigated the possibility of substituting refined wheat flour at 100 % level for two distinct pearl millet varieties, K & MRB (K and Maharashtra Rabi Bajra, respectively), while making cookies. Nutritional attribute study of pearl millet cookies with both the K and MRB variety showed that, per 100 gm, the protein (8.63 and 8.50 g), iron (6.39 and 6.71 mg), calcium (25.70 and 29.36 mg), and phosphorus (208.1 and 190 mg) contents were higher than those of the control (Maida) cookies, which was 6.80 g, 2.48 mg, 18.26 mg, and 86.7 mg, respectively. Furthermore, compared to the control sample (473 Kcal), cookies made with pearl millet flour had slightly higher energy values, i.e., K (492 Kcal) and MRB (485 Kcal). The cookies containing pearl millet had a superior sensory profile than the control, according to the Quantitative Descriptive Analysis (QDA) method used to evaluate the cookies' sensory quality.

Bread: Millet flour is highly nutritious and has viscoelastic properties that make it suitable to incorporate into bread recipes (Siroha and Bangar, 2024). As addition of millets transforms the ordinary bread into a powerhouse of nutrition, appealing to health-conscious consumers. This approach aligns with the growing demand for nutritious and eco-friendly food products, making millet-based breads is a promising innovation in the realm of sustainable baking.

The characteristics of bread made from blended flours containing different levels of wheat and pearl millet (10, 20, 30, & 40%) were investigated by Nehra et al. (2021). A satisfactory sensory score was found for bread formulations containing up to 30% pearl millet flour to wheat flour. A range of 19.75 to 21.93% was noted for the bread's antioxidant properties. For the bread sample with 20% PM flour, the highest value was reported. Chavan *et al*. (2016) looked into the effects of incorporating 0,10,20,30,40, and 50% sorghum flour with refined wheat flour on the nutritional value and organoleptic qualities of bread and cookies. The cookies and bread with highest proportion of millet (50:50) found to be having highest fiber content i.e., 1.95 % and 2.24 % respectively as compared to the control sample (100 % refined wheat flour). According to the sensory scores, bread with 20% incorporation and cookies with 30% incorporation having acceptable results. In the ratios of 30:70, 40:60, 50:50, 60:40, and 70:30, Sharma et al. (2018) blended wheat and kodo millet flour to make bread. on the basis of sensory scores, ratio of 50:50 considered as standard for further evaluation. This multigrain bread was found to be significantly higher in proteins (9.7 g) and fibres (21 g), as well as antioxidants such as flavonoids (2.2 µg/ml) and total phenol (6.13 mg/ml) when compared to commercial wheat bread. Padmaiah et al. (2024) investigated the use of millet blend (a 1:1 mixture of pearl millet and finger millet flours) in place of whole wheat flour at percentages of 0%, 25%, 50%, 75%, and 100% when making pizza bases. According to the sensory assessment, a pizza base with up to 50% millet blend incorporation was deemed acceptable, receiving a score of 7.5. A substantial increase in dietary fibre (9.40–11.19%), protein (4.96–6.88%), ash (2.01-2.73%), and in-vitro protein digestibility (41.77–49.80%) was observed in the nutritional investigation's findings. Khating et al. (2014) prepared the bread. The nutritional parameters, such as calcium (72.35-74.75%), iron (2.50-3.15%), fat (2.95-4.46%), and crude fibre (1.80-2.27%), exhibited an increasing trend as the percentage of sorghum flour increased. overall study revealed that, up to 15 % alteration of wheat flour by sorghum flour is giving positively acceptable bread quality. Karuppasamy et al. (2013) proposed the study for standardization of breads by incorporating millet flour viz., Foxtail millet, kodo millet and little millet at 10-70 % levels. In comparison to the control bread (0.36g), the fibre content of the millet bread was 1.31g, 1.46g, and 1.53g for kodo, little, and foxtail millet bread, respectively. The amount of tannin in bread bred with foxtail millet was found to be significantly higher (73.22 mg) than in bread made with refined wheat flour (54.71 mg). By adding little millet flour (LMF) to wheat flour in different proportions (10, 30, 50%), Mannuramath et al. (2015) looked into the possibility of creating a fibre-enriched functional bread. Compared to other millet breads, the 50% millet-incorporated bread scored slightly lower sensory scores, while bread with 30% millet incorporation has shown non-significant difference. The percentage of micronutrients such as iron (94%), zinc (29%), copper (70%), phosphorus (28%) and fibre (19%) increased when little millet flour was substituted for wheat bread, improving the nutritional value of the bread. Author further concluded that, for the management of diet-related metabolic disorders, bread containing 30% millet can be regarded as a sustainable and nutritious food option.

Cakes and Muffins: Introducing millet flour into cakes and muffins revolutionizes baking with its health benefits and unique flavour.by replacing traditional flours with millet flour, bakers can enhance the nutritional profile of their recipes while providing moist, tender crumb and subtly nutty taste. This approach not only meets the growing demand for gluten free options but it also makes it a forward-thinking choice for modern baking.

Three distinct millet flours—Amaranth flour, Proso millet flour, and Barnyard millet flour were used by Paneria and Agarwal (2023) to make three muffin samples and the amounts of other ingredients were the same for each sample. Based on the nutritional analysis, the amaranth millet-based muffin had higher moisture (23.2%), fat/oil (20.4 gm%), and calcium (166 mg%) contents. Furthermore, the muffin made with barnyard millet had a higher ash content (2.66 gm%) and crude fiber content (3.33%). The panelists preferred the proso millet-based muffin, which had a higher iron content of 4.06 mg%. With the goal of enhancing the product's sensory and nutritional qualities, the Emmanuel *et al*. (2013), developed ten distinctive cake formulations with varying ratios of millet to wheat flour (0 %–100 %). The proximate analysis generally revealed a mean rise of 2.08±0.36% for ash and 33.41±3.32% for fat against the control sample of 1.53% and 30.96%, respectively, indicating an improvement in the nutritional value (ash and fat) of the formulations. Nonetheless, the carbohydrate content decreased by 71.41±5.38% compared to the control sample's 77.43%. According to a panel's evaluation of the products' overall acceptability, acceptance increased as the percentage of millet flour to wheat flour increased (from 0% to 40% incorporation in the sample). According to the evaluation, Sample with 40 % substitution was the most preferred. Nevertheless, the acceptability decreased as the millet proportion rose above 50%. Eke-Ejiofor and Allen (2019), used 0 to 40% millet flour (pearl millet and finger millet flour, both used separately) in place of wheat flour while baking the cake. According to the author's analysis, the nutritional qualities of the cake made from pearl millet, such as its fat, fiber, protein, and carbohydrate content, increased from 18.0 to 18.67%, 1.67 to 2.0%, 5.75 to 13.16%, and 46.36 to 51.72%, respectively. Regarding the finger millet-based cake, the percentages of protein, carbohydrates, and fiber went up from 5.75 to 11.85%, 46.36 to 49.55%, and 1.67 to 2.66, respectively. According to sensory trials, substitution up to 40% millet flour were considered as acceptable for the preparation of cakes. In order to develop the cake blends, Sharoba *et al*. (2021) substituted pearl millet flour for wheat flour at different levels, i.e., 90:10, 80:20, 70:30, and 0:100 (WF:PMF). Comparing the millet-based cake to the control sample, the results of the nutritional quality evaluation revealed a distinct and appreciable improvement in every characteristic, including the amount of ash, protein, carbohydrates, fat, and fiber which ranged as 0.99-1.99 %, 11.39-13.19 %,46.48-47.04 %, 16.39-18.19 and 0.57-1.89 % respectively. The obtained sensory test results showed that up until 30% millet flour incorporation, pearl millet flour significantly improved the overall quality of the cake; however, acceptability was observed to decrease after that. The impact of partially substituting 10% and 15% of wheat flour with sorghum flour on the quality attributes of sponge cakes and biscuits was investigated by Rizk *et al*. (2015). In case of biscuit sample, the percentages of crude fiber (0.82-1.12%), fat (18.68-19.03%), and ash (0.55-0.75%) increased gradually as the proportion of sorghum flour increased. However, a non-significant increasing trend was observed in case of cake with increasing proportion of sorghum flour, viz., 1.52-1.72 %, 3.66-3.92 %, and 0.84-1.02%, respectively. In accordance with sensory trials, color, flavor, and texture of the cake and biscuit made with 10% sorghum-incorporated flour and the control sample did not significantly differ from one another.

These finding highlight the importance of formulating millet-based products. Incorporation of millets into baked products significantly boosts their nutritional value while preserving desirable sensory qualities. Studies indicate that millet blends enhance fiber, protein, and mineral content, making them an excellent choice for health-conscious consumers. As interest in nutritious and diverse food options grows, millets stand out as a valuable ingredient for creating innovative and wholesome baked goods.

4. CONCLUSION

Millets represent a versatile and highly nutritious option for enhancing the nutritional profile of baked goods. The nutritional richness of millets, including their high protein, fibre, mineral, and antioxidant content, makes them an ideal choice for addressing global health challenges such as malnutrition, obesity, and chronic diseases. By promoting the cultivation and consumption of millets, we can not only address micronutrient deficiencies but also mitigate the risks associated with chronic diseases such as diabetes and heart disease. Incorporating millets into baked products not only increases their nutritional value but also enhances their sensory appeal, as evidenced by various studies. The utilization of millets in bakery products offers a sustainable solution to improve dietary diversity and promote food security, especially in regions where malnutrition is prevalent. Moreover, the gluten-free nature of millets makes them suitable for individuals with celiac disease or gluten sensitivities, thereby widening the consumer base for these products. As global attention shifts towards healthier food choices, the incorporation of millets into mainstream bakery products provides an opportunity for food manufacturers to satisfy the consumer demands regarding nutritious, functional foods. Furthermore, government initiatives such as the “International Year of Millets” underscore the importance of promoting millet consumption globally, encouraging sustainable agricultural practices and fostering economic opportunities for millet-producing regions.

Looking ahead, continued research and collaboration among scientists, nutritionists, farmers, and policymakers are crucial to furthering the integration of millets into global food systems. Efforts should focus on optimizing processing technologies to preserve nutritional integrity, and promoting consumer awareness and acceptance through education campaigns. Additionally, exploring new product innovations and market strategies can help increase the accessibility and affordability of millet-based bakery goods, ensuring that their nutritional benefits reach diverse populations worldwide. By harnessing the nutritional potential and sustainability of millets, we can advance towards a more resilient and equitable food future, where health, environment, and economic prosperity are harmoniously balanced. Ultimately, by prioritizing millets within global food security agendas, we can foster a more inclusive and sustainable food system thatmeets the nutritional needs of all while safeguarding our planet's resources for future generations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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