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A REVIEW

Millets, processing and its value addition

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Abstract : Due to its high concentration of macro and micronutrients like protein, dietary fibre, essential fatty acids, minerals, and vitamins, millets are small-seeded crops that have been widely embraced globally. The United Nations has designated 2023 as the International Year of Millets because to their climatically resilient nature and potential contribution to food and health security. Millets being a rich source of all essential nutrients among cereals it can be a great alternative to other cereals that are allergic and are difficult to cultivate. This review emphasis the millets, importance of millets, processing and its value addition into broad sectors of food industries such as baking, flaking, extrusion and other sectors. Therefore, this review will be helpful for the researchers as well as food industries for considering millets as an ingredient in novel food product development.

Key Words : Millet, Nutri- cereal, Processing, Value addition, Extrusion, Flaking, Baking

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INTRODUCTION

Millets are termed as small seeded grasses that are drought and temperature resistant crops. It is termed as "Nutri-cereal" having all the essential macro and micro nutrients in it. Millets have been a staple crop in the regions of arid and semi-arid regions of Asia and Africa. In 2009, the FAO reported that 33.6 million hectares of land were used to produce 26.7 million metric tonnes of millets. From an area of 33.3 million hectares, millets were only produced in the world in 23.3 million metric tonnes in 2002. In 2009, Africa produced 20.6 million metric tonnes of millet, which was followed by Asia (12.4 million metric tonnes) and India (10.5 million metric tonnes) (Rao *et al*., 2017). Based on their cultivation and availability millets are classified into two categories major and minor millets. Major millets include Sorghum, Pearl millet, and Finger millet. Minor millets include Kodo millet, little millet, Barnyard millet, Proso millet, Foxtail millet, and Brown top millet. From 32.8 million tonnes in 2010 to 28.4 million tonnes in 2014, the world's production of pearl millets decreased. The world's entire output of pearl millets is mostly produced in Asia and Africa, accounting for more than 98% of the overall production (Rao *et al*., 2017). African countries' proportion to the world's millets output decreased from 49.22% in 2010 to 43.72% in 2014, while Asian countries' contribution rose to 52.25% from 48.72% in 2010. According to FAO production data from 2016, sorghum [*Sorghum bicolor* (L.) Moench] is the world's fifth-largest crop after maize, rice, wheat, and barley. After a sharp decline in

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production in 2011 to 57 million tonnes, the global sorghum output considerably increased in 2014 to 68.9 million tonnes. In 2014, Africa was the world's top producer of sorghum, accounting for around 42% of total production, followed by the Americas (39.75%) and Asia (14.04%).

The 65% of the millet grain that is made up of carbohydrates is primarily made up of starchless polysaccharides, which lower blood cholesterol, prevent constipation, and inhibit the release of glucose into the bloodstream after digestion. The majority of India's population considers rice as their staple food in many parts of the country. To prevent the national food security from high rice consumption, there should be alternative non-rice-based food sort of analog rice. Analog rice is a replica of conventional paddy rice that is prepared from non-rice ingredients and has the capability to deliver similarity in both appearance and nutrition content to natural rice and can be fortified with essential nutrients such as vitamins and minerals. Analog rice products are expected to help the national food stability program by reducing rice consumption levels, as well as satisfying the people need for carbohydrates (Sumardiono *et al.,* 2021). Rice is a good source of carbohydrates and doesn't provide any protein, dietary fiber, fat, and minerals. So, the consumption of rice is declined due to the change in consumer shift towards the other nutritionally rich rice substitutes which contains a deficient and similar function to rice such as pulses, meat, millets, dairy, fruits, and vegetables. It is high GI food and glycaemic load (GL) supports the development of chronic diseases, particularly CVDs and diabetes, foods with higher GI, such as white rice, can cause a quick postprandial increase in insulin secretion and blood glucose level and have increased risk of type 2 diabetes (Khosravi-Boroujeni *et al*., 2013).

While the millet grain contains about 65% carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fiber which help in the prevention of constipation, lowering of blood cholesterol, and slow release of glucose to the bloodstream during digestion (Rao *et al.,* 2017). So, to eradicate these problems millets are used as a better substitute for rice. Millets are small-seeded grasses grown around the world as cereal crops. Nine are divided into two types: major and minor millets based on their cultivation and usage. Major millets include sorghum, pearl millet, and finger millet. Minor millets include foxtail millet, Kodo millet, barnyard millet, proso millet, little millet and brown top millet.

Millets are termed Nutri-cereal due to their nutr itive value. Millets were found to have high nutritive value and are comparable to that of major cereals such as wheat and rice (Saleh *et al.,* 2013). It has also been reported that millet proteins are good sources of essential amino acids except for lysine and threonine but are relatively high in methionine. Millets are also rich sources of phytochemicals and micronutrients (Saleh *et al.,* 2013). Being non-glutinous, millets are safe for people suffering from gluten allergy and celiac disease. They are non-acid forming, easy to digest, and non-allergenic (Saleh *et al.,* 2013). Millets are also rich in health-promoting phytochemicals like polyphenols, lignans, phytosterols, phytoestrogens, and phytocyanin. These function as antioxidants, immune modulators, detoxifying agents, etc., and hence protect against age-related degenerative diseases like cardiovascular diseases (CVD), diabetes, cancer, etc. (Rao *et al.,* 2017).

Millets have the potential for protection against age-onset degenerative diseases. Consumption of millets reduces the risk of heart disease, protects from diabetes, improves the digestive system, lowers the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels and improves muscular and neural systems, and protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease (Rao *et al.,* 2017).

Processing technologies :

Millet processing technologies typically used to improve the quality of food grains through processing them into edible form and lowering the antinutrients that compose them. Millet value addition technologies include pre-processing technologies such as soaking, germination. Primary processing technologies such as cleaning, grading, sorting, dehulling, and milling. Secondary processing technologies include extrusion, flaking, baking, bar processing, fermentation, and plant-based technologies.

Soaking and thermal treatment :

Soaking is the most commonly used approach for lowering antinutrients in food. Millets are soaked for 10 to 12 hours at room temperature reduces the polyphenol, tannins, phytates, saponins, and trypsin inhibitors (Rathore *et al.,* 2019). Soaking enhanced the levels of protein, ash, water absorption, hygroscopic and swelling power of millet also reduced the levels of phytates, fat, gelation capacity, and viscosity of flour samples (Chinma *et al.*, 2008). Soaking of finger millet in NaOH or distilled water for 8 hours reduced the levels of phytate content. It also helps reduce phytic acid level by 39.47 to 24.17% (Kakade and Hathan *et al*., 2015). As with soaking, cooking with boiling water or steam inactivates heat labile antinutrients in finger millet (Kakade and Hathan *et al.*, 2015). High pressure soaking of foxtail millet showed that the high-pressure soaking of germinated foxtail millet grains improved water uptake significantly, enhancing the degree of starch gelatinization of the flour to a maximum value of 64.93% (Sharma *et al*., 2018). Soaking, pressure cooking and germination reduced the levels of phytate phosphorous by 13-19% during soaking, 27-30% during cooking, and 32-56% during germination as stated by (Tarafdar *et al.,* 2008), Pearl millet was soaked. Steamed and decorticated to obtain two fractions. Fractions obtained are rich in zinc, flavonoids, phytic acid and other compounds.Soaking for short duration (3 hours) didn't result much change. Acidic soaking of fractions reduced the levels of flavonoid content by 62.7% in endosperm fraction (Jha *et al*., 2015).

Germination :

Finger millet was germinated for 0, 12, 24, 36, 48, 96 hours and milled into flour, the milled flour was examined to phenolic, tannins, anti-oxidant activity, and flavonoids tests. Germination of finger millet resulted in reduction of total phenolic content and levels of tannins and anti-nutrient factors in the germinated finger millet flour and enhanced the amounts of antioxidant activity and flavonoid contents significantly (VF *et al.,* 2018). Fura a cereal food of Nigeria prepared from germinated pearl millet. Fura prepared from germinated pearl millet resulted in increase in nutritional levels of Fura such as protein, ash, fibre, calcium, phosphorous, iron levels, and overall acceptability. It was observed that the levels of phytic acid reduced significantly with germination (Inyang and Zakari, 2008). Proso millet was germinated for 12, 48, and 96 hours at room temperature. There was significant increase in the levels of protein, ash, crude fiber with the increase in germination time. Also, with the increase in the germination time there was a significant reduction in the levels of fat, available carbohydrate, cyanides, and oxalates. With the decrease in the phytates level during germination resulted in enhanced bioavailability of protein and other nutritional elements (Morah *et al*., 2017).

Dehulling and milling :

Dehulling is the process of removal of outer husk from the grain. Major millets such as sorghum, pearl millet, and finger millet does not compose of outer husk. Minor millets having an outer husk so dehulled before consumption. The whole grain after dehulling used as consumable rice as a staple food rich in macro and micro nutrients. For the value addition of millet dehulling is the major step to use whole grain into dehulled and value added. The ash concentration of the bran rich fraction, by product of flour milling, was substantially higher. Pearl millet flour, semi-refined flour, and bran rich fraction were milled and tested for nutrients, antinutrients, and bio accessible mineral content. The bran-rich fraction had an increased proportions of fat and ash. Minerals such as calcium and phosphorus, as well as antinutrients such as phytate, were abundant in the bran rich fraction (Suma and Urooj, 2014).

Baking :

A gluten-free cookies was prepared by using pearl millet flour and wheat flour. wheat flour was replaced with pearl millet flour and cookies was prepared. With the increase in the pearl millet flour there was significant reduction in the diameter, spreading factor of cookies. It was observed that substitution with pearl millet flour resulted in increase in the hardness, breaking strength, and cutting strength, and nutritional values. With the addition of pearl millet to 60% resulted in good sensory acceptance (Kulkarni *et al.*, 2021). Cookies formulated with addition of malted little millet flour and malted Kodo millet flour resulted in improvement of nutritional composition of developed of cookies (Himabindu and Devanna, 2017). Pearl millet flour was fermented and prepared cookies, bread that improved the nutritional profile of the products and reduced the phytic acid levels significantly, with the increase the pearl millet flour there is an increase in the hardness of bread, reduced loaf volume was decreased as observed by (Ranasalva and Visvanathan, 2014). Millet bread prepared with the combination of pearl millet and sorghum millet has shown significant increase in the nutritional composition such as protein, fibre, ash than refined wheat flour bread as observed by (Guttapalam *et al.,* 2021).

Extrusion :

One of the modern food processing techniques used to prepare a range of low-cost snacks, speciality, and supplemental foods is extrusion cooking (Harper and Jansen,1985). According to Nibedita and Sukumar (2003), it lowers the antinutritional factors, makes the product microbiologically safe, and increases consumer acceptability. Additionally, it enhances the digestion of proteins and carbohydrates and lessens the loss of minerals. Indian diets have traditionally included millet, but for a variety of reasons, individuals have started switching to cereals in recent years. Nonetheless, there has been a renewed interest in millets' nutritional and practical worth. Protein from soy/pulse or milk would improve the quantity and quality of protein in millet products, as millets lack high-quality protein. If extrusion technology were used to create such a food, it would be rich in other useful features, high in protein and fiber, and low in fat. Keeping all of these benefits of extrusion we can develop various extruded products from millet that could serve us with many nutritional and health benefits.We can develop products like-Millet pasta, Millet noodle, millet vermicelli and millet extruded puffs using extrusion technology.

Flaking :

A significant advancement in grain processing, flaking is recognized for producing crispy, flavorful, and delicious products that enhance both the nutritional and functional qualities as well as the palatability of the final product. Flaking has found commercial application in the production of breakfast cereals, snacks, and other ready-to-eat and ready-to-cook items (Mujoo, 1997). The hydrothermally treated grains, grits, or pellets from grains are fed through two sizable heavy-duty rollers or edge runners that rotate counter-clockwise during the traditional flaking process. This compresses the grains, grits, or pellets from grains into flattened products of various sizes and shapes (Ananthachar *et al.*, 1982 and Mujoo, 1997). This flaking technique is now used to create millet based flakes using various millets like-sorghum millet flakes, kodo millet flakes, pear millet flakes etc which are highly nutritious and flavourful and a very good alternative to traditionally available rice or other cereal based flakes.

Conclusion :

The presence of dietary fibre, minerals and polyphenols in millets can provide a variety of health benefits such as diabetes prevention, hypocholesterolaemia prevention, prevention of diet-related chronic diseases, antioxidant and antibacterial properties. With the addition if millets in diet of people and processing technologies can be used to improve micronutrient bioavailability. Millet consumption can be increased by proper processing and value addition. Millets may be useful in the formulation of various value-added food items due to its well-balanced protein profile and gluten-free status. Millets' physico-chemical and nutritional properties make them an effective component for foods developed for specific uses, and millets can be utilised to develop functional foods and easily substitute traditional flours in several rapidly evolving foods with significant value-addition that promote millet consumer demand. Leads from this review will be used to develop plans to fill current gaps in millet manufacturing and to guarantee that farmers receive the necessary advances in technology.Millets are similar to rice in many aspects, and farmers would choose to cultivate millets if the machinery for processing millets was established in the same manner that it exists for rice, and meals for public consumption based on millets were made available on a commercial scale.

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