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12. Millet's Processing and Value Addition

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Abstract:

Millet is a mainstay of a nutritious diet in many regions of the world. Millets are a grain that only the traditional and the poor eat, despite having a higher nutritious content than other grains. Millets are great source of calories, protein, dietary fiber, fat iron, and calcium. Additionally, they help stave off certain illnesses, such as diabetes, cataract development, and heart problems. Although the millets are potential health benefits but with the green revolution the production as well as consumption of the cereals has increased tremendously, whereas the consumption of millets has declined. So, with proper processing and using alternatives, value-added products can be prepared from the millets in order to end hunger and poverty which are the major problems of India and this in turn will result in improving the health status of the population.

Keywords: *Millets, processing, value addition, convenience foods, fermentation, weaning foods.*

12.1 Introduction:

Throughout ancient times, millets have been used as food, especially in rural regions where they are mostly utilized to prepare traditional dishes. Millets are most important in the Africa, Russia, China and Asian regions. There are many types of crops which are grown in India and these are pearl millet (Bajra), sorghum (Jowar), finger millet (Ragi/Mandua), and small millets such as barnyard millet (Sawa/Jhangora), lile millet (Kutki), kodo millet (Kodo), foxtail millet (Kangni/ Kakun), and proso millet (Cheena). Due to their high nutritional value, these are now referred to as "Nutri-cereals" (Birania *et al.*, 2020**)**. According to FAOSTAT's 2021 projection, 84.17 million metric tons of millet were produced worldwide in 2019–20 from an area of 70.75 million hectares, with 20.50 percent of the production occurring in India. Currently, 90 million people in Asia and Africa use millets in their diets.

The area covered by millets decreased from 74.6 million hectares to 72.3 million hectares between 2018 and 2020, resulting in a decrease in millets' output from 91.8 million metric tons to 89.2 million metric tons. ASSOCHAM (2021) revealed recent research that confirmed the decline in both area and productivity between 2010 and 2018. While India is the world's largest millet grower, over 40% of millet consumption has been reported in African countries, particularly in Niger, Mali, Nigeria, Burkina Faso, and Sudan. According to Research and Markets (2019), there is an anticipated rise in worldwide consumption between 2019 and 2024, following a 0.9% decline the year before.

When the green revolution began, cereal production increased dramatically. Grains are being consumed at higher rates as a result of the green movement. Increased grain consumption has increased the danger of many lifestyle ailments, which is a result of the green revolution and changes in people's living practices. High in vital amino acids, protein, lecithin, fiber, vitamin E, and other minerals are millets. Iron, magnesium, manganese, potassium, niacin, phosphorus, and manganese are also abundant in them.

Quick urbanization, changing consumer tastes and preferences brought on by rising per capita incomes, government policies that favor other crops (such as output price incentives and input subsidies), the introduction of Public Distribution System (PDS) rice and wheat at lower prices in non-traditional areas of fine cereals, low social status, and inconvenience in preparing these grains, particularly sorghum, The Indian Institute of Millet Research (2018) lists a few of the reasons for the loss in millets area and output, including poor compensation, short grain and flour shelf lives, and a lack of incentives for millet producers. Thus, in order to make use of these amazing millets, processing and value addition are necessary.

12.2 Processing of Millets:

Enhancing the grain's quality to make it into a section that can be eaten is called processing. Typically, millets are treated to increase their nutritional content, shelf life, and suitability for human consumption. Millets frequently have a hard seed coat. It's difficult to eat coarse grains as raw seeds (Hulse *et al.*, 1980). Millets undergo processing to improve their appropriateness for consumption, shelf life, and nutritional value (Rai *et al.*, 2012). Processing millet is an important step in using it as food. Because millets do not contain gluten, they cannot be utilized on their own like cereals; instead, they must be fortified in order to prepare ready to eat and ready to serve processed products. A wide range of goods, including porridges, flour, roasted, popping, salted, sprouting, and fermented dishes, may be made from millet. Cleaning, dehulling, sorting, polishing/pearling, grading, size reduction/grinding, drying, and storing are all included in the first processing.

Dehulling and Decortication: Historically, millets were decorticated at the home level using a manual pounding method. Yet thanks to advances in science and technology, they are now included into rice milling machinery. Due to their inability to be decorated like other cereals, finger millets can only be utilized in flour-based products. The endosperm texture was secured by the hydrothermal treatment of the millet, facilitating decortication. A soft texture akin to rice could not previously be achieved with decorticated millet in less than five minutes of cooking (Saleh *et al.* 2013). A centrifugal sheller can be used to dehull and adorn the little millets. In little millet, the husk content varied from 1.5 to 29.3%, Hadimani et al. (1993).

However, iron, zinc, and calcium's bio accessibility increases by 26, 24, and 15g/100g, respectively, after decortication, which lowers the total mineral concentrations (Krishnan *et al.* 2014). It increases the process of protein digestion while concurrently drastically lowering the number of tannins, total phytic acid, polyphenols, and dietary fiber. Millet-based food products undergo decoration before to ingestion in order to enhance their appearance and improve their sensory and edible attributes.

It has been demonstrated, meanwhile, that decortication depletes a number of nutrients, including minerals and fiber. As to Hoseney *et al.* (1994), the first stage of milling is the process of separating the edible parts of the grain from its anatomical components.

12.3 Milling:

Nucellar epidermis, pericarp, seed coat, and aleurone layer are the components of bran, and their separation is the primary goal of milling. The techniques employed for rice and wheat are also used to the grinding of the small millets. Meals are prepared with whole meal and finger millet seed flour. But screening removes the majority of the bran and yields a fairly white flour after crushing. According to Kurien *et al.* (1962), bran may be toughened and its friability reduced by tempering it for 30 minutes with 3–5% moisture. This process preserves the endosperm's qualities. For this purpose, roller flour mill can be used to get millet flour that has been fully refined. Dehusking and debranning still involve the use of the denki method, a hand-operated pestle.

The same rice-hulling equipment used for bigger grains, such as centrifugal shellers and disc hullers, may also be used effectively to mill small millets (Desichakar *et al.*, 1975). In a plate mill, millets may also be dehusked by changing the plate clearance. Grind the polished grains to make semolina or flour. As an alternative, the grains can be processed into flake or cooked like rice. Small millets can be processed and mixed with wheat and other cereals to make composite flours, according to Crabtree and Dendy (1977).

Because millet bran contains 15–25% oil, rice bran may use the bran from milling the millets as an extended to extract oil. Moreover, it hastens the rancidity of the product, reducing its palatability. Correspondingly, while milling may reduce the mineral and vitamin content of cereal grains, whole grains could include physiologically unavailable forms of these elements (Roderuck *et al.*, 1987).

Multigrain flour: It is made from combined millet flours; multigrain flour is often referred to as composite flour. Although they are highly nutrient-dense, millet is not a grain that is used very often. Combining them with other cereals is the best way to use them and get them more accepted.

Vitamins, minerals, protein, and dietary fiber are among the many nutrients that pulses are high in. Also, they satisfy the escalating dietary requirements of those who choose contemporary, nutritious eating habits for communal meals and mass feeding. According to Rao *et al.* (2014), the use of multigrain flour high in sorghum can improve the flavor and nutritional value of sorghum roti". Multigrain flour, created by blending finger millet and wheat in a 3:7 ratios, can be used to make finger millet flour chapatti. The recommended blend significantly reduced the gluten content and somewhat darkened the color of the chapatti. In addition to improving the taste of chapattis, finger millet fortification lowers blood sugar levels in diabetics (Ravinder *et al.*, 2008). Kamaraddi and Shanthakumar (2003) blended tiny millet flours with commercial wheat flour to investigate the effects of adding refined millet flours on chemical, rheological, and baking qualities.

It became out that millet flour may be used to substitute wheat flour to the tune of 10% to 20%. Add twenty percent to the proso millet and fifteen percent to the barnyard. Finger millet, foxtail millet, and small millet should all be added in an optimum proportion of 10%. As the quantity of millets increased in the mixtures, the percentage of starch and protein damaged the ash content, the gluten and sedimentation value, and the bread volume declined. Although the hue and shape of the bread crust remained the same, the crumb's colour changed from creamish white to dismal brown.

Flaked and Puffed Millets: It has long been a tradition to cook cereals to make them stand alone or to add extra sugars, spices, or salt for a snack or meal. During the puffing or popping process, the starch or starch-protein matrix expands due to structural changes in the millet grain or preconditioned pasta. This results in a puffed product with high crisp and other textural properties. The high temperature short time (HTST) method, which capitalizes on the thermo-physical properties of starch, is used to create expanded grains or flakes (Jaybhaye *et al.,* 2014). During this process, the sugars in the aleurone layer react with the amino acids in the millet to give the puffed product a desirable and sought-after aroma. This is known as Millard reaction, in which sugars combines with the millet's amino acids to give the product a pleasing and highly sought scent. Furthermore, it lowers anti-nutrients like tannins and phytates, raises the bioavailability of minerals, adds a pleasant texture to the food, and facilitates better digestion of carbs and proteins (Nirmala *et al.,* 2000). The cereal processing technologies may be utilized to efficiently process foxtail millet to produce ready-to-eat products such as flaked, extruded, roller dried, decorticated, and popped grains by subjecting the native grains (12% mc) to HTST treatment at 230+/- 5^{o}C (Ushakumari *et al.,* 2004). The highest degree of starch gelatinization was found in roller-dried millet, which was followed by popped, flaked, and extruded products. The microstructure of puffed starch granules becomes spherical, whereas the microstructure of popped and extruded products has a honeycomb-like appearance (Fujita *et al.,* 1996). Expanded flakes can be made by forming dough, extruding it with a manual extruder, flaking it to a thickness of 0.6 mm, and then roasting it at 90–110^{o}C for 5–15 minutes. Finger millet and foxtail millet flour are cooked at 80–100^{o}C with varying amounts of water (100–130 ml) and time (1-3 min) (Viswanathan *et al.,* 2009).

12.4 Fermented Foods:

The fermentation process increases the amount of protein, calcium, and fiber while reducing the amount of ant nutrients and enhancing flavor. Fermented dishes like dosa and idli are commonly offered for both morning and evening meals in southern India. When preparing idli and dosa, millets can be utilized in place of rice (Desikachar, 1975). Black gram and millets are mixed in a 1:3 ratios, ground moist, and left to ferment for the entire night. To create idli and dosa, or wet pancakes, prepared batter is steamed and baked. Enjera is a popular meal in Euthopia that is made similarly to dosa by baking the batter on a hot pan (Gebrekidan *et al.,* 1982).

Onyango et al. (2004) made fermented uji with high energy density by using extrusion and alpha amylase to combine several types of cassava, sorghum, finger millet, and maize.

The study revealed that incorporating 0.1–2.1 ml/100 ml alpha-amylase into the fermented slurry or extruding the dried and fermented flour at 150–180^{o}C and 200 rpm screw speed could decrease the viscosity of uji from 6000–7000 to 1000–2000 cp, while maintaining energy densities (0.6–0.8 kcal/g) appropriate for child feeding.

12.5 Millet Parboiling:

A traditional technique for modifying the hardness of rice endosperm to minimize milling losses is parboiling. Parboiling finger millet hardens the endosperm, reduces the mudde's sliminess, and allows for the formation of grits, according to Desikachar (1975). Shreshta (1972) found that parboiling improved the quality of milling kodo millet. Rice that has been parboiled is known to improve the quality of the milling process and reduce thiamine loss.

12.5.1 Papad:

Finger millet flour is combined with up to 15-20% of extra ingredients, such as rice, black gram, and spices, to make this classic South Indian dish. Begum (2007) states that in Karnataka, finger millet flour is blended up to 60%. Papad requires the finger millet flour to be gelatinized by boiling it in water. After the dough is gelatinized, it is shaped and sized into thin sheets, dried, and allowed to attain a moisture content of 7. The papad's slightly deeper color is caused by the pericarp of the finger millet plant. Cooking causes the papad's dark hue to fade (Varma *et al.,* 2012).

Vidyavati et al. (2004) prepared millet papad (rolled, circular, thin sheets) by substituting 50% of the black gram dhal flour and sago flour combination with finger millet flour. The outcomes were then compared with black gram (Phaseolus mungo) dhal papad. With a higher sensory score of 4.7 on a five-point hedonic scale, finger millet flour papad was shown to have more calcium (102 mg % in roasted and 109 mg% in fried) than black gram dhal papad (82 mg% in roasted and 99.6 mg% in fried). Although the amount of nutrients decreased somewhat, the inclusion of millet and pulse proteins improved the quality of the proteins.

12.6 Malting and Weaning Food:

Sangita and Srivastav (2000) state that malting improves the nutritional composition, fiber content, crude fat content, availability of vitamins B and C, minerals, and the bioavailability of nutrients in addition to improving the sensory attributes of the grains. Malting barley and sorghum is a prerequisite for industrial brewing in African countries. Many Indian regions have a long-standing custom of finger millet malting. Finger millet has more amylase than sorghum and other millets (Senappa, 1988). It has been observed by Malleshi and Desikachar (1986) that finger millet malt tastes quite well when starch hydrolyzing enzymes are present in healthy proportions. Peak amylase activity occurs 4-5 days after germination. Because of its high calcium and Sulphur amino acid content, it is a great base for weaning meal compositions. Moreover, infant meals and beverages that may be produced with milk or warm water and sugar added are created using millet malt.

Malted finger millet grains are superior in terms of quality, digestibility, and sensory nutrition. Furthermore, there is a discernible decrease in antinutrients (Desai *et al.,* 2010).

12.6.1 Pasta, Vermicelli Noodles, and Other Goods:

Extrusion technology is transforming ingredients into value-added products. Extruded meals, which are RTE goods, are now a healthy snack alternative due to changes in eating habits (Varma *et al.*, 2012). As dietary habits have changed, there has been an increase in the demand for noodles both locally in India and globally. More individuals are becoming aware of finger millet's nutritional advantages as a result of its rising popularity. Noodles are another term for convenient meals that are made using cold extrusion. Noodles prepared from a blend of millet and legume flours provide a nutritionally balanced meal that may be used as supplemental feeding or as weaning food. After being soaked in water for 24 to 48 hours, the pearled grains are wet crushed, boiled, extruded, and dried to produce a superbly crispy end product when fried. Since the equipment needed to make these goods is very simple, there is also less capital investment needed (Kumate *et al.*, 1983).

Kanagini, also known as foxtail millet (Setaria italica), was used by Punia et al. (2003) to make shankarpara (a dough shaped into flakes) and ladoo (sweet balls) by substituting 50% of the kangini flour for the maida. The study revealed that kangini ladoo had 13.13% protein, 4.92% ash, and 13.83 and 2.35 mg/100 g of iron and zinc, each. Furthermore, the two manufactured things were found to be satisfactory, and the product's appearance, flavor, and texture were all rated as "liked very much." Jowar crunch, developed by Suhendro et al. (1998), is a light-crunch snack meal prepared by deep-frying dried kernels (pellets) of whole sorghum that has been boiled alkaline. Jowar crunch, developed by Suhendro et al. (1998), is a light-crunch snack meal prepared by deep-frying dried kernels (pellets) of whole sorghum that has been boiled alkaline. For optimal results, sorghum should be autoclaved for 60 minutes at 120^{o}C, rinsed, then dried to 9% moisture content at room temperature before being deep-fried at 220^{o}C.

12.6.2 Bakery Items:

A few products manufactured using millet flour include nankhatai, biscuits, bread, and muffins. Since gluten is necessary to give the dough its extensible and elastic properties, low gluten millet grains are challenging to work with when producing pure millet solid food items, particularly bread or noodle products. For those with greater fiber and vitamin contents, the advent of millets into the baking sector offers a promising future. There has been a surge in interest in finger millet flour in recent years, and there have been initiatives to provide it to consumers in convenient forms (Singh *et al.*, 2012).

As per Singh et al. (2012), bread produced using a composite flour based on millet tastes equally well as bread prepared with wheat flour. Eneche (1999) used different millet/pea blending ratios to make biscuits from blends of millet and pigeon pea flour. All of the biscuit recipes received high sensory evaluations, according to the results of the sensory test, with the 35% pea/65% millet blend recipe scoring highest for texture, flavor, and acceptance overall.

According to Saha et al. (2010), finger millet: wheat flour composites containing 60:40 and 70:30 (w/w) were used to make biscuits. They found that the 60:40 mixture yielded a biscuit batter that was tougher than the 70:30 level. The adhesiveness and resilience of the biscuit dough increased with the amount of wheat flour added; nevertheless, the 70:30 composite biscuit dough expanded more and broke more strongly after baking than the 60:40 composite. The wheat composite flour (40 g/100 g) has a higher water absorption capacity than the composite (30 g/100 g).

12.6.3 Roti/ Chapatti:

Millets can be used for the preparation of chapatti but due to the color of the millets these are not generally acceptable. So, millets can be blended with wheat in different proportions in order to prepare chapattis. A 7:3 ratio of finger millet to wheat works nicely for creating roti. This proposed mix, while containing less gluten, nonetheless results in highly appealing chapattis. It also gets a little deeper in hue for the chapatti. Apart from adding taste to chapattis, adding finger millet to them helps diabetics control their blood sugar levels. Due to delayed digestion and the bulkiness of the fibers, we feel fuller on less calories.

12.6 Conclusion:

Since millets contain more nutrients than other grains, processing and using them in products has unquestionable potential in terms of quality, nutrition, and health advantages. Although it is not yet widely accepted by the populace, it can also serve as an alternative to other cereals like wheat and rice. Millets are less expensive; they are less practical to utilize since they are not widely consumed and are only used by the underprivileged and traditional people. There are several procedures and techniques for making goods solely from millets and for combining millets with other ingredients; these procedures and methods can be the same as those for making wheat and rice or they can differ depending on the physical and chemical characteristics of the millets. With the processing various value- added products can be prepared by using millets which can be a boon for the people who are suffering from starvation and malnutrition.

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