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18. Post Harvest Processing and Management of Millets

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Abstract:

Millets have been cultivated since ancient civilizations by people across the globe. They have been around for 10,000 years in East Asia. A significant crop in the semi-arid tropics of Asia and Africa, particularly in India and Nigeria, millet is produced in 97% of the world's developing countries. Millets have a similar amount of energy as other cereals. Due to their rich fibre, mineral, vitamin, macro- and micronutrient, and phytochemical content, they also offer more substantial health advantages and can be used to treat chronic diseases. Millets can be a cheap, satisfying, and healthful addition to a normal diet. The nutritional fibre, mineral, and vitamin content of the majority of millets were shown to increase after germination and fermentation. By enhancing the protein digestibility and mineral bioavailability, straightforward processing methods like soaking,

germination/malting, and fermentation can assist address the issue of protein-energy deficiency. The total proteins, total dietary fibre, and micronutrients were shown to be decreased as a result of decortication, dehulling, milling, and extrusion. Millets can be made into flour, porridge, popped grains with salt that are ready to eat, cereals with sprouts, roasted, and malted delicacies. The first step in processing millet grains is to remove the husk, which has a tough seed covering. For further processing traditional methods are used. Cracked or broken grains, coarse meal, grits and fine flour are the products of dry-milled whole grain.

Keywords:

Biofortification, Millets, Micro nutrients, Nutrition security.

18.1 Introduction on Millets and History:

Millets are a family of small-seeded grasses that are widely cultivated as cereal grains for human and animal nourishment around the world. They comprise a functional or agronomic group rather than a taxonomic one. In practically every nation, millets are naturally grown or farmed for human consumption as food grains and as animal fodder. There are coolers of millet in cream, brown, red, and black because of the diversity of crops. From ancient times, millets have been grown by people all over the world. They have been around for 10,000 years in East Asia.

A significant crop in the semi-arid tropics of Asia and Africa, particularly in India and Nigeria, millet is produced in 97% of the world's developing countries. Because of its productivity and quick growth season in hot, dry conditions, the crop is recommended. Millets native to many regions of the world; its thought that their evolutionary history began in western Africa because that region has the most wild and domesticated varieties of millets.

Millions of the most vulnerable people in these regions still primarily rely on millet grains for their calories, protein, vitamins, and minerals. They are grown in hard conditions when other crops produce significantly less, which is noteworthy. A large number of small-holder farmers cultivate them using scarce water resources and typically without the use of any fertilizers or other inputs. They are sometimes referred to as "coarse grain" or "poor people's crop" since they are primarily consumed by underprivileged communities. In many nations, they are not typically traded on local or even international marketplaces. Because of this, farmers rarely have a guaranteed market in the case of a production surplus.

Figure 18.1: Types of Millets

A. **SORGHUM:** It is thought that sorghum, also known as "**JOWAR**" cereal, is a significant coarse-grained food crop. In addition to Rajasthan, it is commonly grown in Maharashtra, MP, UP, Telangana, Haryana, and AP. The traditional main food of the arid regions of the world is sorghum. It is a warm-season crop that is intolerant of cold temperatures, resilient to pests and diseases, highly nutritive, and climatically adaptable. It comes in fourth in India and fifth overall in terms of cereal production. Millions of people, particularly in semiarid regions, Major sources of minerals vitamins, and protein can be found in sorghum grains.

B. **BAJRA (Pearl millet):** (PENNISETUM GLAUCUM) is the millet that is grown the most far and wide. Bulrush millet, babala, bajra, cumbu, dukhn, sajje, souna are other names for it. Since ancient times, it has been grown on the African and Indian subcontinents. It is grown in Rajasthan, Gujarat, and Haryana in India and is known as "bird feed" because of its ability to thrive in nutrient-poor, sandy soils in low-rainfall regions. The plant develops a brownish flower with a thick panicle resembling a spike. It is well known that this millet has phytochemicals that decrease cholesterol. Folate, iron, magnesium, and vit. E and B are also present. When compared to other millets, pearl millet contains a lot of energy. Unsaturated fats and calcium are also abundant in it.

C. **FINGER MILLET: FINGER MILLET** (*ELEUSINE CORACANA*), known as ragi in India, is another significant staple food in Asia and Eastern Africa (India, Nepal). It grows in cooler, higher elevations up to 2000 metres above sea level and has a slightly higher water requirement than most other millets. Many spikes or "fingers" protrude from the plant's stem at the top. The grains are tiny. Finger millet is rich in calcium, protein with a balanced composition of key amino acids, vitamin A, vitamin B, and phosphorus. It also has a lot of calcium in it. In Karnataka, ragi flour is typically formed into balls, or "ragi mudde," which are then used to make flatbreads, leavened dosa, and thinner, unleavened rotis. Due to its high fibre content, it also prevents bowel cancer, high blood cholesterol, and constipation.

D. **FOXTAIL MILLET:** The gluten-free grain known as "Italian millet" or "foxtail millet" is also one of the oldest varieties still growing today. Also suited to temperate areas is **FOXTAIL MILLET (SETARIA ITALICA).** It results in lengthy, bristly, compact, cylindrical or lobed panicles. Foxtail millet production in the globe is dominated by China. There, it is farmed for both food and animal feed. The crop is also grown in several regions of southern Europe, Indonesia, Korea, and India. Outside of the eastern highlands, it isn't grown in any significant quantity in Africa. Before sorghum-sudangrass forage hybrids were accessible, foxtail millet was a significant species for short-term pastures.

E. **KODO MILLET:** Kodo millet was first domesticated almost 3,000 years ago in India. It is a tufted grass that is annual and reaches a height of 90 cm. Hard, corneous, persistent husks that are challenging to remove surround the grain. The colour of the grain can range from light red to dark grey. Of all millets, it has the most dietary fibre. Kodo millet has a high lecithin content, is very simple to digest, and is highly good for boosting the neurological system. It contains a lot of minerals like calcium, iron, potassium, zinc, and B vitamins like niacin, B6, and folic acid.

F. **BARNYARD MILLET:** In India's tropics and subtropics, barnyard millet (Echinochloa crusgalli, E. colona), is a significant crop. Barnyard millet is an excellent source of dietary fibre with a fair amount of soluble and insoluble fractions. It is also a strong source of highly digested protein. Barnyard millet is a natural gift from nature

for modern individuals who spend their days sitting still because of its low carbohydrate content and slow digestion. Linoleic acid, followed by palmitic and oleic acids, is the main fatty acid in this millet. Moreover, it exhibits a strong retrogradation of amylase, which promotes the creation of more resistant starches.

G. **LITTLE MILLET:** (*Panicum sumatrense*) the traditional crops of Karnataka and is also farmed in India, Nepal, Sri Lanka, eastern Indonesia, and Burma. Little millet mostly mix cropped with other millets, pulses and oilseeds Millet is typically eaten as rice, and any recipe that calls for staple rice can be made with a small amount of millet. With the exception of the smaller grain, this cereal's habit is identical to that of proso millet. It is an annual herbaceous plant that can reach heights of 30 cm to 1 m and grows either straight or with folded blades. The leaves are linear and can have membranous hairy ligules and hairy lamina. Small millet is said to have the largest amount of dietary fibre among cereals—between 37% and 38%—and is referred to as a nutraceutical. As a result, it is a complete food ingredient that can be used on a big scale in processed goods, snacks, baby foods, and many other products. It also significantly promotes global food security.

H. **PROSO MILLET:** A short-season crop that flourishes in regions with little rainfall is proso millet. You can grow this millet alongside red gramme, maize, and sorghum. Because the seeds are encased in the hulls and are challenging to remove using traditional milling techniques, the grain has a relatively high percentage fibre.

18.2 Nutritional Profile of Millets:

Nutritive value of food has a significant role in the good and maintenance of the metabolism of the human body. For the genetic potential of humans to be developed and maximized, the food content is essential. Although millet is a plentiful source of carbs, protein, dietary fiber, minerals, vitamins, and phytochemicals, its nutrition is similar to main staple grains rice, wheat, and maize. High dietary fiber millets have a multitude of medical advantages, including improving plasma lipids, blood glucose clearance, and gastrointestinal health. Millets with low glycemic index and minimal gluten content are beneficial for people with diabetes and celiac disease. According to a study, millets contain over 50 distinct phenolic groups and their derivations, including ferulic acid, flavones, flavanols, and flavononols, which have strong antioxidant properties.

A. Millets Processing:

Millets find it challenging to eat the coarse cereals as entire, uncooked seeds. (Hulse et al., 1980). Originally, we come to know that millets have calorie and energy contributions and good for us; then we find that millets are rich source of fibres too, and we want to importance right now that millets are a fantastic resource of phytochemicals as well. Millets' 3 main parts—their starch-containing endosperm, protective pericarp, and germ—are partially separated or altered through processing. Offal consists of the pericarp and, occasionally, the germ. Offal removal is often referred to as dehulling or decortication. Millets' tough outer coat, distinctive flavor, and absence of processed millets products that are similar to rice and wheat are the main causes of their lower appeal among wheat and rice eaters. Much equipment is available for the process of grains, but there is no well-established procedure or method for producing white products from colored millets.

The loss of minerals was quite minimal. Moreover, decortication increases nutrient availability and customer appeal. Millets, whether in the form of processed or unprocessed grain, can be cooked decorously or whole and can be turned into flour using modern or conventional techniques. Therefore, it is necessary to identify alternative use scenarios. Unlike other flours like wheat flour and rice flour, millet flours are unable to produce elastic, cohesive, and expansive dough when combined with water because they lack gluten. Due to the lack of these features in millet flours, fortification is a method for employing millets to create processed foods that are prepared to eat.

The feasibility of combining high energy density and low viscosity green gram with malted finger millet weaning meal. For the important operation as food, inedible grains are converted into fresh form and also civilizing its value by the processing. Millets can be made into flour, porridge, popped grains with salt that are ready to eat, cereals with sprouts, roasted, and malted delicacies. The first step in processing millet grains is to remove the husk, which has a tough seed covering. For further processing traditional methods are used.

Dry-milled whole grains produce coarse meal, grits, cracked or broken grains, and fine flour. The flour can be used by addition with other flour to produce simple to complex food products like soft and stiff porridges.

B. Primary Operations of Millets:

Operations farm which improves grain quality / transforms the grain into more useful form.

A. CLEANING OF MILLTES
B. DEHULLING OF MILLTES
C. SORTING OF MILLTES
D. POLISHING / PEARLING OF MILLTES
E. GRADING OF MILLTES
F. SIZE REDUCTION /GRINDING OF MILLTES
G. DRYING OF MILLTES
H. STORAGE OF MILLTES

C. Millets Dehulling/ Decortication:

Traditionally, millets were decorticating by hand pounding at domestic level. These days, with slight modification of the process these are milled in rice milling machinery. Decortication of finger millets similar to other cereals is not possible, so its use is confined to flour based products. The endosperm texture hardened by hydrothermal treatment of millet and enabled its decortication. For soft texture like rice in 5 min, decorticated millet can be cooked which was not possible before (Saleh et al. 2013). Centrifugal sheller can be used to dehull/decorticate the small millets. The fractions of husk in small millet varied from 1.5 to 29.3% (Hadimani et al. 1993). With corresponding increase in protein digestibility it significantly decreases dietary fibre, polyphenols, total phytic acid, and the amount of tannins. To increase the appearance of millet grains food products and to improve their edible and sensory properties they are decorticated before consumption though some nutrients such as fiber and minerals were found to be reduced due to decortcstion.

D. Milling of Millets:

The little millets are ground using both rice milling and wheat milling procedures. The friable and soft endosperm of the finger millet is securely linked to the seed coat. The finger millet coloured pigments. Use of abrasive type milling machinery to debran finger millet are found ineffective. Flour of finger millet seed and whole meal is used for food yield. Nevertheless, adding together 2 to 5 percent moisture, tempering for 30 minutes (which will toughen the bran and reduce friability without compromising the endosperm properties), and screening after crushing produce fairly white flour and separate the majority of the bran. (Kurien et al., 1962). The fully refined millet flour can be made using a roller mill.

18.3 Secondary Post Harvest Operations:

Unit procedures on grains that turn them into goods typically for immediate consumption, either before or after primary processing. Often, they take place outside of farms, either in disorganized or organized sectors. Puffing, Milling, Baking, Flaking and Value Added Products of Millets.

Machines for Post-Harvest Handling of Millets:

For Primary Processing

A. GRAIN PRE-CLEANERS
B. DESTONER – GRAIN CLEANER
C. JOWAR POLISHER
D. RAGI PEARLER
E. MILLET RICE POLISHER
F. FLOUR MILLS
G. DEHULLER
H. SEPERATOR
I. SORTER

For Secondary Processing

A. TWIN SCREW EXTRUDER MACHINE
B. FLAKING MACHINE
C. GRAIN ROASTER
D. PASTA MACHINE
E. FOOD BLENDER

18.3 Conventional Food Products:

A. Roti (unleavened pan cake): The main food products of millets are roti, porridge and mudde as stated by (Devi et al., 2014). Millet as a sole material for bakery products is unsuitable as millet protein lacks gluten. Millet flour is combined with hot water to partially gelatinize the starch that gives dough its binding qualitie. Dough flattened into

thin sheet and baked on hot metal plate. Roti be similar to maize tortilla or chapatti of wheat flour. By shaping the dough into balls and heating it, mudde is made.

B. **Multigrain flour:** Multigrain flour/composite flour is made from blended flours of millets, and pulses are rich in nutrients such as protein, minerals, vitamins, and dietary fiber and meet the changing dietary requirements of the population in light of the choice for contemporary, healthy eating habits for mass feeding and social programmes. Sorghum roti's flavour and nutritional value can be enhanced by using multigrain flour rich in sorghum. (Rao et al., 2014).
C. **Fermented foods:** Fermentation improves the taste and lowers the antinutrients but increases the value of food in terms of calcium fiber and protein. Idli and Dosa are fermented food, commonly used in breakfast and also in evening meals in southern states of India. Idli and Dosa are prepared by rice which can be completely substitute by millets (Desikachar, 1975).
D. **Parboiling of millets:** Parboiling is a traditional process used for hardness of endosperm of rice to lower the losses during milling. When finger millet is parboiled, the endosperm becomes harder, the mudde becomes less slimy, and grits can be made as reported by Desikachar (1976). Milling quality of kodo millet improved by parboiling as reported by Shreshta (1972). It is well known that parboiling of rice reduces the loss of thiamine during milling and improves milling quality. Precooked ready to eat product of rice is also prepared by parboiled rice.
E. **Papad:** Papad is a traditional food in south India that is produced by combining finger millet flour, up to 15-20%, with additional ingredients like spices, rice, and black gramme. Up to 55-60% of the flour in Karnataka is made from finger millet as reported by Begum, (2007).
F. **Non-conventional food products:** According to many research, processing millets leads to the use of traditional health foods. Several scientists have worked to create processed foods including weaning foods, puffed, popped, extruded, roller-dried, flaked products, malted, composite flours, etc.
G. **Millet flakes:** Millets should be used to make quick-cooking cereals since they cook softly in five to ten minutes when placed in boiling water. Pearled grains are boiled at high pressure to completely gelatinize the starch before being dried to a moisture percentage of 16-18% and pressed between heavy-duty rollers to create flakes. (Rao et al., 2016) Millets' small size makes them ideal for making flakes. Flakes hydrate quickly when milk or water is added to them.
H. **Puffing or popping:** For preparing the ready to eat products puffing or popping is a simple processing technique. Popped grain is a porous, precooked and crunchy product and also has a good taste by adding flavor. On popping, a highly acceptable flavor is developed by finger millet. Popping temperature of about 250° C and 19 % grain moisture content is maintained then that to obtained expanded millets as reported by Malleshi and Desikachar (1986). For preparing expanded millet decorticated finger millet required a hightemperature short-time treatment. For maximum expansion ratio the two factors play an important role first is flattening the grains to the desired shape and second is the moisture content.(Ushakumari et al., 2007).
I. **Weaning/Malting food:** On an industrial scale for brewing, malting of barley and sorghum is done in African nations. Finger millet malting is a traditional practice in some regions of India. In terms of amylase activity, finger millet is superior to sorghum and other millets. (Senappa, 1988). Malleshi and Desikachar (1986) It is said that finger millet malt has a very pleasant flavour when starch hydrolyzing enzymes are present in

sufficient amounts. At 4 to 6 days of germination, amylase activity reaches its peak. It makes an excellent base for weaning food formulations since it is high in calcium and sulphur amino acids. With the addition of sugar, millet malt is used to make beverages with milk or lukewarm water as well as baby food. The sensory nutritional quality of finger millet grains is enhanced by malting, which also has a noticeable impact on reducing the ant nutrients. (Desai et al., 2010).

J. **Noodles-vermicelli:** The best application of extrusion technique is Kurkure. Ingredients are being transformed into products with value added using extrusion technology. With the shift in eating habits, extruded foods, which are RTE goods, have become a good option for snack foods. (Varma et al., 2012). Noodle demand has grown both domestically and internationally as a result of changes in eating patterns. The demand for finger millet is increasing as more people become aware of its nutritional benefits. Noodles are manufactured through a cold extrusion and are often known as handy foods. The nutritionally balanced noodles made from a blend of millet and bean flour can be used as a weaning food or as a supplement. The pearled grains are boiled, extruded, and dried after being soaked in water for between 24 and 48 hours. This gives the grains their great crispiness when fried. The equipment needed is fairly basic, thus small capital expenditure is also needed to make these goods at a reasonable cost. (Kumate et al., 1983).

K. **Bakery products:** For the creation of bakery goods including nankhatai, biscuits, bread, and muffins, millet flour is frequently utilized. Gluten is crucial for giving the dough extensibility and elastic qualities, however millet grains weak in gluten render them unsuitable for simple handling of pure millet solid food products, especially noodles or baked goods. Millets with superior fibre and micronutrient contents now have a better chance of entering the bakery market. In recent years, finger millet flour has gained popularity, and efforts have been made to offer it to customers in practical forms. (Singh et al., 2012). Breads made using millet-based composite flour have the same acceptance as bread made with wheat flour (Singh et al., 2012). Eneche, (1999) made biscuits from pigeon pea and millet flour blends with various millet/pea blending ratios.

18.4 Conclusion:

Since millets are more nutrient-dense than other grains, there is little question that developing products employing millets will have positive effects on health, nutrition, and quality. Although not yet widely accepted by the public, it can be a substitute for other cereals like rice and wheat. Millets are less expensive but less convenient to utilize because they are exclusively used in food by the impoverished and the traditionally dressed. There are various techniques and procedures for making products solely from millet and combining it with other ingredients. These techniques can be similar to those for making products from wheat and rice or they may differ because millet has different physical and chemical characteristics than the other cereal grains.

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