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15. Emerging Trends and Current Scenario in Millet Processing

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Abstract:

Millets are significant grain for the global food production and nutrition industry as well as considered an important food grain for balanced diet. They play a major role in food security owing to the ability to grow under diverse adverse agro-climatic conditions. Millets have recently received a lot of attention due to their remarkable nutritional profile and easiness of intake in any effective form. Also, they contribute to national food security as well as have health benefits. One of the richest natural food sources, millets are filled with enough minerals, vitamins, fibre, proteins, carbs, and fats might therefore act as a natural cure for the promotion of improved health. However, the consumption of millets requires processing and value addition so that large populations can benefit from ready-to-eat and ready-to-cook products. The processing of millets and the establishment of their complete value addition chain could give greater potential for the development of rural livelihoods and entrepreneurship. In industries for the large-scale commercial processing of millets, each of these unit operations soaking, dehulling, grinding, roasting, puffing, germination, fermentation, malting, etc. is well-established. This chapter highlights about the current scenario in processing of millets, the need of processing of millets, the effect of processing *of millets on chemical composition of millets, the initiatives taken by government in processing of millets. Millets may be more effectively used to support the countries where the prospect of poverty, starvation, and economic crises is ever-present because of their short growth season and ability to withstand dry and hot environments. Thus, the processing of millets into diverse products can improve their value and will certainly contribute to farmer's income and nation's economy.*

Keywords:

Food security, Malnutrition, Millet processing, Puffing, Value addition.

15.1 Introduction:

Millets are widely distributed across the world. Millions of people who live in the dry and semi-arid tropics, Asia, Africa, and parts of Europe provide the majority of their nourishment. Little millets including finger millet, kodo millet, foxtail millet, proso millet, and tiny millet are produced in large quantities in India, which accounts for 20% of global output and 80% of that in Asia. Millets are chosen over other grains because they have a short life cycle, need little maintenance, and have resistance to abiotic and biotic stresses.

Promoting millets production and value addition helps achieve several of the Sustainable Development Goals (SDGs) (figure 15.1).

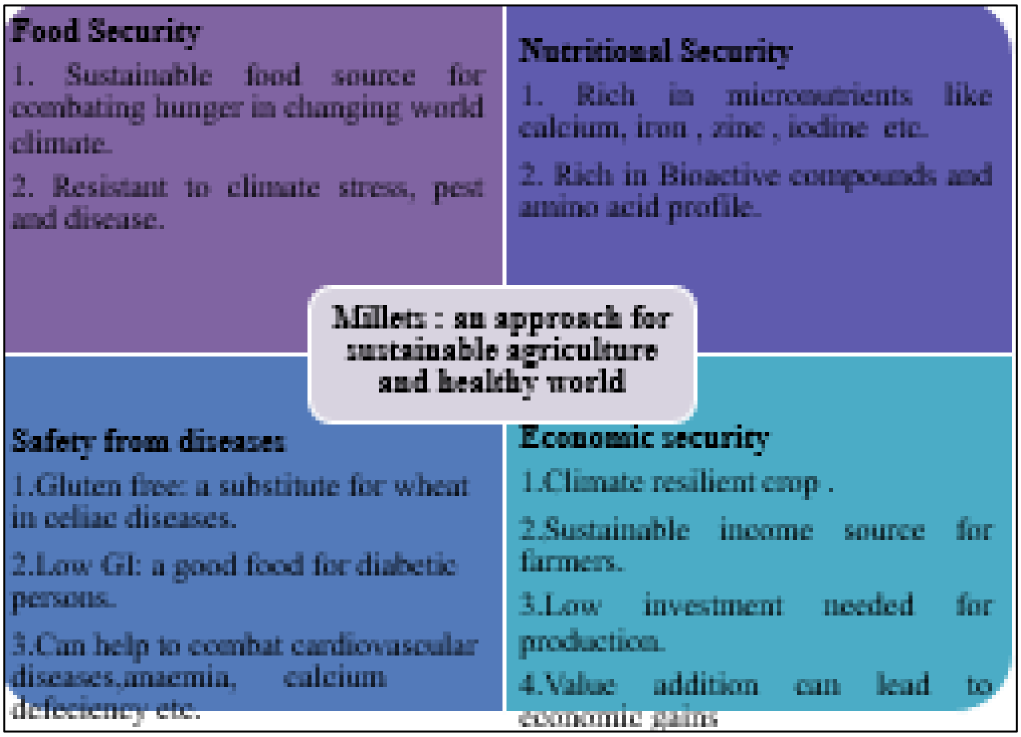

Figure 15.1: **Strategy for sustainable agriculture and healthy environment: Millets**

Millets have drawn attention recently because of their remarkable nutritional profile and ease of consumption in any appropriate form. Millets have a low glycaemic index and are a good source of protein, fibre, minerals, iron, and calcium. Millets may be made into a number of different types of value-added products due to their high nutritional and functional characteristics [1].

Millets are used as a staple meal only by traditional consumers, despite their high nutritional content because of the absence of consumer-friendly and ready-to-eat food goods is the primary reason [2].

Millets low-quality characteristics and their typical pre-consumption form, such as flours, have restricted their utilisation. These qualities include dark, lifeless colour, coarse, grittier texture, high fibre content, astringent flavour, prolonged cooking time, antinutritional ingredients, and a short shelf life. However, the maximum limitations could be removed by more effectively utilising the right processing technology. Millets are potentially beneficial material for many traditional farmers and ready-to-eat health meals when processed properly. A variety of products have been made from millets, including composite flours, popped, flaked, puffed, extruded, roller dried, fermented, and weaning meals. Probiotic fermentation and germination of some millets improved the protein composition and increased the availability of minerals [3].

Millets' nutritional value may be further enhanced by using appropriate and efficient processing techniques. Worldwide availability of millets has increased, which has speed up production, processing, and value addition. To produce high-quality millet goods, modern processing companies employ higher milling, grading, and sorting (colour sorter) machinery.

15.2 Need of Processing of Millets:

Processing refers to a variety of methods used to transform raw millet grains into edible forms with improved quality. Before eating, millets are often processed to eliminate the undesirable parts, lengthen the shelf life, and enhance the nutritional and sensory qualities. To make millets appropriate for food, primary processing methods such dehulling, soaking, germination, roasting, drying, polishing, and milling (size reduction) are used. At the same time, millet-based value-added processed food items are created using modern or secondary processing techniques such fermentation, parboiling, frying, puffing, popping, malting, baking, flaking, extrusion, etc. The digestibility and nutritional bioavailability are intended to be improved by these processing methods, although substantial amounts of nutrients are lost during further processing [4].

The rapid urbanization, increased rice and wheat production, poor government supplies, lack of processing facilities, low investments and remuneration, poor demand and supply chain are some of the primary causes of low millet production. however, in this modern era of development and technologies and health and environment threats due to climate change consumer preferences are changing which is shifting the preferences from rice-wheat to millet-based diet. The products made of millets has more remunerative values than the most of the commercial crops (rice, wheat and maize).

Thus, the processing of millets could make the farmers self-reliant and self-sufficient. The millet-based products having more value can also increase the economy of the farmers and nation as well.

Millets production gradually decreased during the green revolution as a consequence of the increasing production of staple grains like rice and wheat under conditions of intensive cultivation and irrigation. Millets are difficult to process and reliably prepare because of their usual grain shape and robust seed coat. The main obstacles facing value-added or ready-to-eat items Lack of public knowledge and suitable processing techniques prevent cereals from having a larger range of food applications and better economic position than other cereals. The tough, fibrous seed coating, the colourful pigments, and the poor storage quality of the processed goods are the main obstacles to millet's widespread usage [5].

However, apart from that, millets have anti-nutritional substances that are a major challenge to its use. In particular, the multivalent cations of calcium, iron, zinc, magnesium, and the monovalent cation of potassium phytic acid quickly form complexes with each of these lowering their bioavailability and reducing their absorption [6].

In addition to phytic acid, goitrogenic polyphenols may also have a role in various health problems. Epidemiological studies suggested that a diet with millet as a main meal, such that have seen in rural villages in Africa and Asia, contributes to the appearance of endemic goitre in these regions [7].

The bioavailability of minerals and carbohydrates is increased by technological advancements in processing (decortication, soaking, germination, fermentation, puffing, and boiling) that result in lower levels of anti-nutritional compounds like tannins and phenols. Thus, it is imperative to develop processing methods that are dependable as well as cost-effective in order to remove the challenges to the industrialization and use of millets flour for the manufacturing of products with added value.

15.3 Millet Processing by Using Machinery in Current Scenario:

Millets the yesterday’s coarse grains, today’s nutri-cereals, and tomorrow’s "superfoods" are abundant in minerals, phytochemicals, and other healthy substances for people. They are harvested manually or with the aid of a mechanised harvester-cum-thresher after the crop reaches the proper stage of maturity. Millet processing involved a series of post-harvest unit operations such as cleaning, drying, pre-treatment, decortication, polishing, grading and milling. The degree of moisture, type of variety, genotype, stage of maturity, location, agricultural techniques, and many other factors greatly affect how millets are processed.

Abrasive polishers and rubber roll shellers are typically used for millet decoration, which is a difficult operation. The increased demand for millets has encouraged improvements in production, processing, and value addition.

Small millet grains could be processed using main processing methods to create a wide range of foods that are edible, including flour, sprouts, salty ready-to-eat items, flaked, popped, porridge and fermented products.

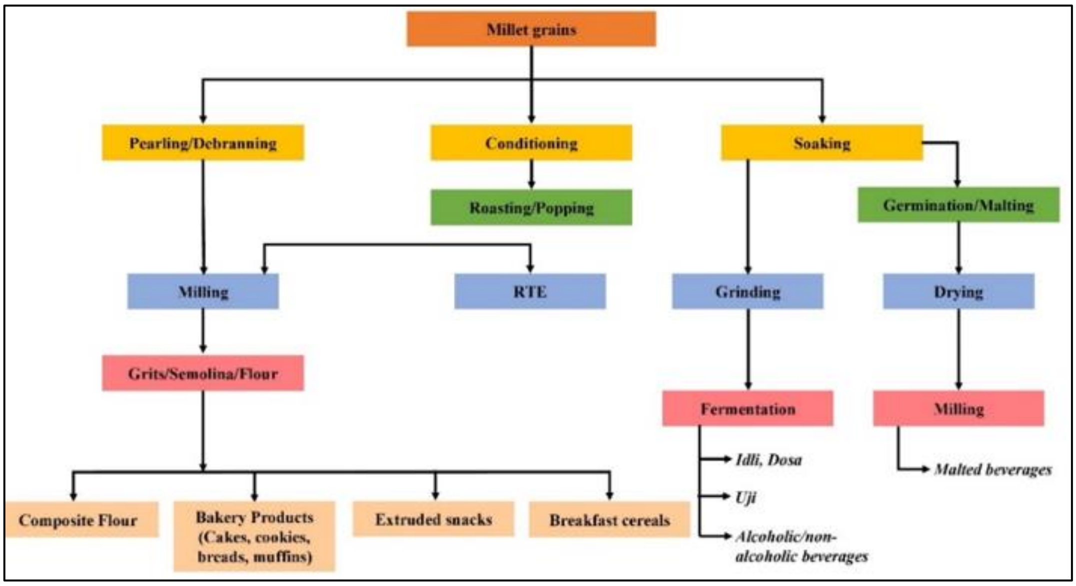

Figure 15.2: Schematic Diagram for Developing Millet Based Composite Foods

15.3.1 Grading:

The grader is used to separate millet grains from inert materials such as big stones, sticks, sand, grass and so on. To separate them, sieves of different sizes are used. The most common grader is a triple-deck grader with three sieves.

Large sticks, stones, and grasses are separated by the top sieve, good millet grains are separated by the middle sieve, and fine and coarse sand is separated by the bottom sieve. Dust and light particles are sent to the rear of the aspirator by a little fan. It is important to select the appropriate sieve size, and the operator must make sure the sieve's openings are not clogged. Brush should be used by the machine operator to prevent material clogging.

15.3.2 Destoner/Destoning:

The Destoner, which removes small stones and mud balls which are identical in size as the millet grains and destoner receives the material from the Grader. Destoner utilise the gravity concept to work.

Two sieves beneath the hopper of a destoner are used to grade the output material. The destoner bed receives the graded material, which is deposited with the lighter material falling to the front and the heavier material to the rear.

The air adjustment hole may need to be carefully adjusted according to material. If there is no flow backward, we should open the slot and make modifications to allow the stones to flow backward. Destoner can be used to remove stones and other impurities from a variety of millets, including small millet, kodo millet, barnyard millet, proso millet, finger millet, and foxtail millet.

15.3.3 Dehulling:

Dehulling or dehusking of the millet crop is an important step in the post-harvest processing because it eliminates the outer, inedible layer (pericarp and testa) and makes the grains suitable for milling and consumption. Dehulling removes the pericarp (bran), which is high in fibre and anti-nutritional elements, and the testa, which promotes the digestion of the grains. The production of millet-based items is made easier by immediately milling the dehulled millet grain into flour. Dehulling is one of the crucial processing stages done to remove the husk from millets. The non-edible parts of millets are removed during dehulling, which also increase the bioavailability of the nutrients present, and decrease the amount of anti-nutritional components and increase consumer acceptability. For various kinds of millets, several decorticators and pearlers, dehullers are available.

A. Dehuller-Cum-Aspirator: Raw materials are transferred to the huller for husk removal after being properly cleaned. Nevertheless, depending on the millet type and hull hardness, several dehulling techniques may be used. For example, foxtail millet is dehulled using an abrasive process while being rolled from one side to the other by a large boulder-like stone [8]. There are two categories for dehullers under millet processing technologies that are centrifugal dehullers and abrasive dehuller.

- ***Centrifugal Dehullers:*** An impeller on a centrifugal dehuller removes the husk. The material is sent to the hopper, which sends it to the impeller, where it is flung into the impeller casing with a lot of centrifugal force. The millet grain separates from the husk as a result of the forceful impact and is then delivered to the aspirator, where the lighter husk is gathered at the back and the millet is gathered at the front.
- ***Abrasive Dehuller:*** Rubber rollers and Emery abrasives are the two categories into which they are classified. Both are working in abrasion principle. With the Emery type, there are two grinding stones. When the other stone rotates continuously, the first stone stays motionless. When using a roller mill, the pearling process typically involves passing the grain between a pair of steel rollers that are revolving inside a cylindrical chamber at equal or differing speeds in a cocurrent manner.

15.3.4 Soaking:

In order to eliminate potentially harmful chemicals and other substances from food, soaking is a safe method of processing. Soaking grains is a common method for increasing the bioavailability of minerals and lowering the amount of substances which are harmful for nutrition, such as phytic acid because phytic acid prevents the absorption of nutrients and minerals including calcium, iron, and zinc from diet. Phytase binds to minerals and nutrients, which makes it difficult for the stomach to absorb them Moreover, the human body cannot metabolise them. Soaking has an impact on the breakdown and leaching of substances like phytates, modifications in phytase activity and concentration of minerals like iron, zinc, etc.

When dehulled and milled grains were soaked, it was observed that the loss caused by this leaching is more severe. In contrast, a large proportion of nutritious constituents were seen to be leached from grains after they had been cooked by soaking them in water.

15.3.5 Grinding:

One of the beneficial unit operations for the secondary processing of millets is grinding. When being ground, the millet grains actually become smaller. The key features of the grinding process are particle size and fineness modulus. Based on the products, different types of particle sizes are chosen. The millets should be ground in a type of mills, including burr mills, hammer mills and attrition mills. For preserving the final size of output particles in the ground sample, such as flour, every grinding machine has a specific form of adjustment. The shelf life of millet is drastically shortened after grinding. Rancidity in millet flour is caused by an increase in free fatty acids (FFA), which is the main cause of shortened shelf life. The millets should be ground in a variety of mills, including burr mills, hammer mills and attrition mills and pulverizer.

15.3.6 Pulverize:

The most recent innovation for new flour mill entrepreneurs is the pulverizer because it requires no maintenance compared to traditional flour mills and can be installed with simply a plug and play setup. Pulverizing or grinding millets into powder to be utilized for making flour for human consumption and it is the secondary process for millets processing. Two chambers are used in double stage pulverizers for the purpose of grinding. Initial crushing takes place in the first chamber. Moreover, millets like jowar and bajra that have been partly ground are utilised as animal feed and the next chamber, grains are processed into a fine powder. Hence the functionality of pulverizer machine plays an important role and the pulveriser machine are suitable for all types of millets.

15.3.7 Sprouting:

Sprouting is the germination of grains under controlled conditions. The dormant embryo in the millet grain becomes active during sprouting under specific climatic and moisture conditions (temperature and humidity). The millets germinate about 48 to 72 hours at a temperature of 25 to 30º C. Sprouting millets significantly improve the availability of the vitamins and minerals present in them while significantly reducing the amount of tannin and phytic acid, which are anti-nutritional compounds. The dry weight of the source grain decreased after sprouting for longer than 48 hours with little to no nutritional benefit [9]. To maintain the necessary nutrition in sprouted millets, the process temperature and duration must be properly regulated. Millets were traditionally sprouted in atmospheric chambers, but presently there are specialised grain sprouters that provide the capacity of adjusting microclimate, such as the source of light, illumination, wavelength etc., to obtain a quality product with proper safety and storage stability.

15.3.8 Roasting:

A conductive heat medium is utilized in this traditional technique to expose millet grains with the proper quantity of moisture content to high temperatures (between 160 and 200°C) for varying times. By pre-soaking and shade drying, the necessary moisture in the grain is preserved. It is simpler to separate the husk from the cotyledon when the cotyledons of the grain that are roasted during the roasting process shrink more than the outer husk and form a gap between them. Husk removal during dehusking or pearling is made easier by this husk loosening. Also, by removing undesirable anti-nutritional and harmful components from millets, this heat treatment successfully provides a distinctive flavour. Different types of roasters specifically designed for millets are available depending on their mode of heat transfer operation. The performance of roasting equipment based on the conduction heating principle as better in terms of roasting strength and quality of the product. Nowadays, equipments which is equipped with suitable instrumentation for precise control of operating parameters (time, temperature) are trendy due to the uniform output quality and flexibility to utilise various types of commodities.

15.3.9 Puffing:

Puffing is a processing technique utilized to produce enlarged snacks and other items from any type of grain that are ready to eat. The millets were pre-soaked at the correct moisture content and subjected to hot sand in a ratio of 1:6 at high temperature (230-250 C) and brief duration for the process of popping or expansion (20–30s). When raw millet grains were heated to high temperatures and short time duration to create the appropriate enlarged shape, popping of the decorticated finger millet was relatively prevalent among millets Raw grains need to be flattened to the desired shape and kept at the desired moisture content before being exposed to a heating environment in order to achieve the highest expansion ratio [10].

The expansion properties of the grains are significantly improved by this popping process, in addition to their physical form and functional qualities. Moreover, the millet grains' availability of several anti-nutritional substances are reduced significantly [11].

Due to its puffing, the millet grains' physical and textural properties also undergo substantial transformation. According to their expansion and puffing abilities, common millets like sorghum, pearl millet, and finger millet are commonly utilized for puffing. Among Asian nations, puffing is a typical practise not just for millet but also for grains like maize, chickpeas, horse gram etc.

The equipment or machine required for puffing differs from a traditional individual home level system to a large industrial level system with varied capacity. These days, popping guns that use hot air are widely used because of their compact size, light weight, robust design, and desired output for domestic usage.

15.3.10 Malting:

The nutritional value, sensory qualities, and digestibility of millet grains are improved throughout the malting process, along with a substantial decrease in antinutrients, when processing conditions are appropriate. The process consists of three steps that are completed in the following order: (1) steeping (dipping grains in water), (2) germination (promoting the rise of sprouts and enzymatic activity), and (3) kilning (grain drying and stopping the enzymatic activity). The three processes might be carried out in separate equipment or in a single integrated system. These days, an integrated single system is highly common since it is quick, simple, and cost effective for manufacture. To maintain a uniform layer thickness in the integrated single malting unit, the grains are spread out on grain holding sieves [12].

The water spraying systems constructed at the top provide the water required for the grains to soak. Throughout the steeping process, this soaking water is changed three to four times through opening the bottom valve, which also allows freshwater to aerate the soaked grains. The bottom valve is opened to let all the water out after the steeping process is complete, and the grain is then left to germinate on sieves.

After the germination process is complete, the side valve is opened for the last malting step, or drying. Hot air of the proper temperature comes from the side and travels through the sieves so that it distributes evenly across all sieves and the grain is dried. We obtain malt following the removal of sieves from the apparatus. Malt is obtained once sieves are removed from the apparatus.

15.3.11 Fermentation:

One of the oldest methods of food preservation, that has been practised for ages is fermentation. Millets are used to make a number of traditional dishes across the world. The physiochemical properties of millet grains and the final fermented product are significantly altered during the fermentation process.

The fermentation process has a number of benefits, including a decrease in antinutrients, an increase in protein availability, enhanced protein digestibility, and an overall improvement in nutritional profile. There was a noticeable decrease in the proportion of anti-nutritional elements in pearl millet grains after fermentation [13].

This method also significantly increased the amount of starch and protein that was available for processing at the same time. Although some specific flavonoids and past behaviour were discovered to diminish after the fermentation of millet grain, some vitamins were also found to rise in addition to the amino acids [14].

Due to certain fermentation circumstances for a particular type of millet, some nutrients were found to be increasing at the same time as others were reported to be decreasing. During the pearl millet grain fermentation, observable changes in the macronutrients such as fibre, protein, and fat as well as the micronutrients such as Mg, Fe, K, Cu, Na, Mn and Zn were noticed. When some of the millets were fermenting, particularly after 16 hours, an increase in amount of crude proteins and crude fibres was being noted. Phytic acid was shown to decrease and zinc availability to rise during the finger millet's 24-hour fermentation [15].

According to the properties of the raw material and the desired processing of foods product, the suitable microbe’s population for the processing of different types of millets may be chosen [16]. The literature claims that millet-based end products with high nutritional value may be produced using fermentation separately or in conjunction with other methods. Moreover, only a small number of unique millet products have been developed using these processes on a large scale, and the majority of them are used in households to create traditional foods. Thus, for industrial manufacture of thus products, the establishment of present technology and careful optimisation of mechanical and physical properties are vital and essential.

Figure 15.3: Diverse Millet-Based Food Products

15.3.12 Flaking:

One of the special food products of millets is flaked millets. Millets need a particular machine for processing, such as flaking, because they have different physical features than the primary cereals like rice and wheat. Up until now, millets have been flaked using rice flaking machines; however, millets have not been given their own unique design. Flaking machine developed by CIAE is a small machine that presses conditioned millet between two textured stainless-steel rollers is powered by a 2 hp single phase electric motor to produce millet flakes. It is appropriate for use with various sizes of millets/cereals and other food/feed products to produce flakes of varying thickness due to the movable spacing between the rollers. The mounted acrylic inspection window facilitates machine maintenance and operation monitoring. For safe food manufacturing, all machine parts that come into touch with food products are constructed of food grade 304 stainless steel. The machine can produce 100 kilogramme per hour.

15.4 Effect of Processing on Nutritional Properties of Millets:

Proteins- Millets are a popular food among vegans and are a great source of protein. They are regarded as a superior plant protein and contain fewer saturated fats than animal proteins. Reducing the quantity of antinutrients is crucial since their presence prevents protein digestion. Dehulling, grinding, soaking, and heating are easy methods that reduce antinutrient levels and improve in vitro protein digestibility. Foxtail millet's protein quality was increased by fermentation, germination (for 40 hours at 25 degrees Celsius), popping, and alkaline cooking. Kodo millet was puffed or "popped," which raised the protein percentage from 7.92 to 8.12% [17].

The protein content of pearl millet may be greatly increased by spontaneous fermentation [18]. Due to the microflora's production of proteolytic enzymes, antinutritional components like phytate are broken down during fermentation and the insoluble protein is transformed to soluble protein [19]. Due to the mobilization of stored nitrogen, the straightforward method of soaking pearl millet for 24 hours led to an increase in protein [20].

Decortication reduces the considerable loss of proteins and amino acids like histidine, lysine, and arginine by removing around 12% to 30% of the outer husk, bran, and germ component of grains.

Carbohydrates- The millets' carbohydrate contents range from 60 to 75 percent, with small millet having the highest carbohydrate content and foxtail millet having the lowest. Like other cereals, the main source of carbohydrates in millets is starch. Several home processing and cooking techniques, like as soaking, sprouting, pressure cooking, autoclaving, and others, have an impact on the amount of readily accessible carbohydrates in dietary grains. Parboiling considerably reduced the total starch by 5–10% as a result of starch leaching out during the soaking and boiling processes, according to a thorough research [21] on the starch digestibility of pearl and proso millet. In addition, they noted that parboiled proso and pearl millet had a lower readily digested starch percentage (18.2-19.1% to 17.4-18.3%), resulting in a 1.6-3.9% lower glycemic index. According to these findings, parboiling can considerably decrease the starch's ability to be digested, which makes it a useful technique for creating products to treat metabolic illnesses like diabetes and obesity.

Dietary Fiber- Dietary fibre is classified as complex polysaccharides that are not easily accessible, and the millet bran fraction is a significant and plentiful source of this type of fibre. Thus, the fibre component is significantly reduced as a result of the removal of the bran portion during decortication and dehulling. According to a research, millet grains may be dehulled between 12% and 30% to remove the kernel without suffering a major loss in fibre. Dehulling grains more than 30%, however, causes a significant loss of nutritional fibre [22]. Controlling the amount of dehulling in order to increase the fibre content is crucial because the majority of millets are ingested in their decorticated condition. While high temperature extrusion methods result in the thermal destruction of dietary fibre, dehulling and milling (debranning) activities diminish dietary fibre. Dietary fibre is essential for lowering type 2 diabetes and constipation, especially the fibre found in the outer bran layer. It is crucial to educate customers to choose entire (unpolished) millets and their byproducts for a healthy millet diet and to dissuade millers from polishing millets.

Minerals- Millets are a rich source of vitamins that are mostly deposited in the aleurone, germ, and pericarp, as well as minerals including K, Mg, Fe, Ca, and Zn [23]. Prior to cooking, soaking millet grains helps to minimise antinutrients and increases the bioavailability of minerals. Minerals may have leached into the soaking water as evidenced by the lower Zn and Fe content of millet grains after being soaked in water [24]. The "in vitro solubility" of minerals like Fe and Zn increases by 2-23% when millet grains are soaked. The bioavailability of the millet grains significantly increased and phytic acid levels were decreased when they were soaked in hot water (45 to 65 °C, pH 5–6) [25]. The antinutrients, which prevent mineral bioavailability by forming complexes, are lessened during the decortication process. The bioavailability of minerals improves as antinutrient levels are reduced.

Vitamins- As the bran and germ components of refined millet flour are removed, vitamins are lost, which results in a lower nutritional value of polished/debranned millets. Regarding the amount of vitamins and other elements, such as lipids, proteins, and minerals, millets are regarded as being superior to wheat, sorghum, and maize. In the aleurone, germ, and pericarp, vitamins and minerals naturally accumulate. Vitamins including riboflavin, thiamine, niacin, and folic acid are abundant in millet grains [26]. A 67% decrease in vitamin E was seen in little millet that had decortication [27]. The milling process alters the millet grains' bran, which lowers the amount of vitamins that have mostly gathered there. The bulk of vitamins are concentrated in the outer layer of millets, hence research on milling or dehulling imply that vitamins are lost during these processing activities. By germinating the millets and creating byproducts from germinated millets, the availability of essential vitamins can be increased. *Fats*- Fats are important for the body to absorb and transport the vitamins A, D, E, and K as well as to produce calories and the development of the brain. The amount of fat depends on the germination period. In contrast to the non-germinated sample, the raw and optimized flour of germinated foxtail millet exhibited fat contents of 4.4% and 3.6%, respectively. This is because the decline occurs after germination since the fat is utilized as an energy source during the germination process [28]. The investigations offer significant proof of fat denaturation or degradation during high temperature processing (cooking and popping), as well as fat content reduction during milling, malting, and fermentation procedures. Manufacturers may find that using straightforward processing methods like soaking, germination, and malting will enable them to create millets-based low-fat food items. The high temperature processing would diminish the flavor and taste of the processed meals and harm the fat quality.

15.5 Initiatives Taken by Government of India for Production and Processing of Millets:

In India, there are several Organizations and government programs in place to increase the area, output, and productivity of millets farming.

- millets were designated as nutri-cereals by the government in April 2018 because of their nutritious content.
- As part of the National Food Security Mission (NFSM)-Nutri Cereals Sub Mission, the government is educating farmers about nutri cereals (millets) such ragi, sorghum, bajra, and micro millets through demonstrations and training.
- Incentives are given to farmers through the state governments under NFSM-Nutri Cereals for crop production and protection technologies, cropping system-based demonstrations, production and distribution of seeds for recently released varieties and hybrids, Integrated Nutrient and Pest Management techniques, improved farm implements/tools/resource conservation machinery, water saving devices, etc. The creation of Farmer Producer Organizations (FPOs) for Nutri Cereals, Centers of Excellence (CoE), and Nutri Cereals seed hubs are just a few of the efforts in which the NFSM has been instrumental.
- The Government is making people aware of nutri-cereals by funding for Research & Development. Also, support is provided to startups and entrepreneurs that create recipes and value-added items that encourage the use of millets. During 2018 up till the present, eight bio-fortified Bajra types and hybrids have been made available for cultivation.

- Under the All India Coordinated Research Project (AICRP) on small millets, sorghum, and pearl millet, the Indian Council of Agricultural Research (ICAR) supports 45 collaborating Centers located in various State Agricultural Universities (SAUs) and ICAR Institutes for the development of new varieties and hybrids of millets.
- A Memorandum of Understanding (MoU) was signed by ICAR-Indian Institute of Millet Research (ICAR-IIMR) and Agricultural and Processed Food Products Export Development Authority (APEDA) to increase exports through quality production and processing, which is expected to increase value addition and farmers' income. The primary objective of the Agreement is to promote the commercial cultivation of export-oriented processable varieties developed by ICAR-IIMR, which is anticipated to boost millets production and add value. The Agreement also encourages the development of links between farmer-producer associations and farmers' markets.
- To market millets and millet value-added products, APEDA is preparing programmes for the UAE, Indonesia, USA, Japan, UK, Germany, Australia, Republic of Korea, South Africa, and Saudi Arabia. The promotion campaign will include BuyerSeller Meetings, Road Shows, and participation in key international events to promote millets and value-added products of millets.
- On December 20, 2021, The United Nations World Food Program (WFP) and NITI Aayog signed a Statement of Intent (SoI), By utilising the potential of 2023 as an International Year of Millets, the cooperation is focused on mainstreaming millets and aiding India in taking the lead globally in knowledge exchange. With a strategic and technical cooperation between NITI Aayog and WFP, the Project's main objective is to build climate resilient agriculture for increased food and nutrition security in India.
- The Department of Agriculture & Farmers Welfare also provides aid to the States for a number of extension initiatives and agricultural breakthroughs that might help develop millet farming through a centrally funded programme called "Support to State Extension Programme for Extension Reforms." Moreover, the States can encourage millets under the Rashtriya Krishi Vikas Yojana (RKVY), Paramparagat Krishi Vikas Yojana (PKVY), and Mission Organic Value Chain Development for North Eastern Region (MOVCDNER).

15.5.1 Manufacturers of Millet Processing Technologies in India:

- Perfura Technologies (India) Pvt. Ltd
- Small Millet Foundation (Division of DHAN Foundation)
- AVM Engineering Industries
- Agromech Engineers
- KMS Industries
- Borne Technologies Private Ltd.

15.7 Conclusion

Millets the foods of twentieth century are given prime importance in this era of climate change. These are the foods with enormous amounts of nutrients, requiring minimal resources for cultivation and generating higher returns through the proper processing and marketing. Their antinutritional substances, off flavours and off tastes are all minimized when the proper processing method and instruments are used.

This transformation enhances the nutritional value of these smart foods while also allows farmers to improve their agricultural income. The development of millets' processing technology provides possibilities and will help millets become a more competitive source of staple food. Millet-based products with added value can support the economically poor masses and fight hidden hunger. There is still a need to concentrate on improving the processing methods for minor millets to make them more palatable without sacrificing the health advantages, given the variety of the influence of processing on the nutritional characteristics of millets. Also, in order to fight food poverty and malnutrition, information must be spread at the commercial and household levels about how processing affects the nutritional value and health advantages of millets.

15.8 References

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