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13. Products of Millets and Nutrient Content

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Abstract:

Millets are among the earliest meals that people have ever consumed, and they may have been the first cereal grain to be utilized in a household. Worldwide, millets are regarded as a significant grain, however, they are the least exploited. These nutri cereals are well-known for their high nutrient content, which includes minerals like calcium, iron, zinc, potassium, and magnesium as well as vital fatty acids, dietary fiber, protein, and B vitamins. They provide health benefits such as lowering blood sugar levels (diabetes), controlling blood pressure, and assisting with thyroid, cardiovascular, and celiac disease issues. Nonetheless, during the previous three decades, there has been a notable decrease in the direct intake of millets as food. Because millet grain is high in nutrients and phenolic compounds that are good for you, it may be used for both food and feed. The different nutritional and phenolic component contents of finger and pearl millet are strong indications that choosing the right variety of millet is crucial when using it for food or feed. Millets' phenolic qualities include flavonoids, tannins, and phenolic acids—all of which are good for human health. Millets are among the earliest foods that humans have ever consumed, and they may have been the first cereal grain to be used for cooking. For ages, people in the semi-arid tropical regions of Asia and Africa have relied mostly on millets as a food source, as other crops do not thrive there. Millet has been consumed frequently in Asia and India from ancient times. Ground millet seeds are used to make the Indian flatbread roti. The area used for millet cultivation has been declining over the past fifty years, especially after the green revolution, despite the remarkable traits and capacity of millet farming systems. This chapter focuses on its history, types, nutrient content and products of millets and nutrient content of different types of millets.

Keywords:

Millet, Nutrient, Health benefits, Sorghum, Proso, Foxtail, Barnyard, Extruded.

13.1 Introduction:

The beginning Millets are crops from the Poaceae grass family and are known as one of the oldest agricultural crops. Pearl millet (Pennisetum glaucum) and finger millet are the two most commonly used millets in food and feed. Millets are a cereal, in addition to wheat, rice, and maize. Millets are an important food source for millions of people, particularly those who live in hot, dry regions of the world. They are grown mostly in marginal areas under agricultural conditions in which major cereals fail to give substantial yields *(Adekunle, 2012).* Millets are classified with maize, sorghum, and Coix (Job's tears) in the grass sub-family Panicoideae *(Yang et al., 2012).* Millets are significant meals in many developing countries because of their capacity to grow in harsh environmental conditions such as low rainfall. Millet, on the other hand, provides millions of people in Africa with the majority of their energy and protein. According to reports, millet has numerous nutritional and medicinal properties *(Obilana and Manyasa, (2002).* It can be useful during a famine since it is a crop resistant to drought and can be kept for an extended period of time without being harmed by insects. There are differences in the literature on the classification of the millet family. While some sources include it in the Poaceae family, others refer to it as the Gramineae family. Millets come in an extensive variety. The four main varieties are Proso millet, also known as white millet (Panicum miliaceum), Foxtail millet (Setaria italica), Finger millet (Eleusine coracana), and Pearl millet (Pennisetum glaucum), which accounts for 40% of global production. Largest-seeded pearl millet is the kind most frequently utilized for human consumption *(Mariac et al., (2006).* Minor millets include Barnyard millet (Echinochloa spp.), Kodo millet (Paspalum scrobiculatum), Little millet (Panicum sumatrense), Guinea millet (Brachiaria deflexa - Urochloa deflexa), Browntop millet (Urochloa ramosa -Brachiaria ramosa -Panicum ramosum), Teff (Eragrostis tef) and fonio (Digitaria exilis) are also often called millets, as more rarely are sorghum (Sorghum spp.) *(ICRISAT, 2007; FAO, 2009).* In 2007, global millet production reached about 32 million tonnes with the top producing countries being: India (10,610,000), Nigeria (7,700,000), Niger (2,781,928), China (2,101,000), Burkina Faso (1,104,010), Mali (1,074,440), Sudan (792,000), Uganda (732,000), Chad (550,000) and Ethiopia (500,000) *(FAO, 2009).* According to FAO (2005), pearl millet production attained approximately 54% of the global production in 2004. Millets represent a unique biodiversity component in the agriculture and food security systems of millions of poor farmers in regions such as Sub-Saharan Africa. Pearl millet is an important food across the Sahel, although India is the largest producer of pearl millet *(Bhattacharjee et al., 2007).* Millets are often ground into flour, rolled into large balls, parboiled, and then consumed as porridge with milk; sometimes millets are prepared as beverages. Roti, made from pearl millet has been the primary food of farmers in Gujarat India *(FAO, 2009).* There is an emerging need for the world to feed its growing population, therefore, it is important to explore plants such as millets that are grown locally and consumed by low-income households in places like India and the Sahel zone *(Obiana, 2003).*

Cereals, in particular, millet-based foods and beverages are known worldwide and are still part of the major diet in most African countries *(Amadou et al., 2011).*

Millets are among the earliest meals that people have ever consumed and may have been the first cereal grain to be utilized in a home. This plant is a cereal crop and is a member of the Graminae family of grasses. The word "millet" refers to a variety of small-seeded annual grasses that fall under the following five genera: Eleusine in the tribe Chlorideae, and Panicum, Setaria, Echinocloa, Pennisetum, and Paspalum in the tribe Paniceae. There are several different types of millet that originate in Asia and Africa. For ages, people in the semi-arid tropical regions of Asia and Africa have relied mostly on millets as a food source, as other crops do not thrive there. They have been raised since the beginning of time. About 6,000 different types of millet are cultivated. Millets are underutilized in many developed countries. There is an immense potential to process millet grains into value added foods *(Chandrasekara and shahidi, 2010).*

History:

It is believed that millet originated in Ethiopia, in North Africa, where people have been eating it since ancient times. The Bible even makes reference to millet as a component of unleavened bread. In Africa, where it is ground finely to form the traditional flatbread known as injera, millet remains a staple grain. Millet has been consumed frequently in Asia and India from ancient times. Ground millet seeds are used to make the Indian flatbread roti. Prior to the introduction of potatoes and corn during the Middle Ages, millet was a common grain throughout Europe, particularly in the nations of Eastern Europe. In the 1800s, the Seteria variety of millet was brought to the United States. While millet has historically been used mostly in Western Europe and North America as livestock feed and birdseed, it is currently becoming more and more well-known as a tasty and nutritious grain that can be appreciated for its own special qualities as well as being a gluten-free grain substitute for wheat. India, China, and Nigeria produce the majority of the millet crop used for commercial purposes worldwide *(Karuppasamy.,2015).*

13.2 Millet Production:

Top twenty millet producing countries include India, Nigeria, China, Burkina Faso, Niger Russian Federation, Mali, Sudan, Uganda, Nepal, Senegal, Chad, Tanzania, Ethiopia, USA, Pakistan, Myanmar, Ghana, Ukraine and Angola (Food and Agricultural Organization of United Nations).

Africa (16%), South and East Asia (about 60%), Eurasia and Central Asia (14%), and the rest of the globe (10%) share the world's millet production. Of the 28 million tonnes of product produced worldwide, India produces the most millet grains, accounting for 33–37 percent of the total. In India, 5 million tons of grains are produced by the cultivation of minor millets on 7 million hectares of land. The richness of millet varieties in the dry lands of southern India is similar to the diversity seen in Africa *(Phanikumar, 2010).* Finger millet alone accounts for 2.6 million hectares, producing 3 million tons and providing staple food for people in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Maharashtra and Bihar.

Finger millet constitutes about 81% of the minor millets produced in India and the rest by kodo millet, foxtail millet and little millet. *(Pradhan et al., 2010).* In recent years, millets have been recognized as important substitutes for major cereal crops to hope up with the world foods storage and to meet the demands of increasing population of both developing and developed countries. Millet grains which account for about one sixth of the total food grain production hold an important place in the food grain economy of India *(Shree et al., 2008).*

13.2.1 Different Types of Millets:

There are several millets types that you can find. Some of these are mentioned herein below:

1. Pearl Millet
2. Proso Millet
3. Sorghum Millet
4. Finger Millet
5. Foxtail Millet
6. Barnyard Millet
7. Browntop Millet
8. Buckwheat Millet
9. Little Millet
10. Kodo Millet
11. Amaranth Millet

Sorghum:

- Sorghum protein contains prolamin (kaffirin), which reduces digestion during cooking, perhaps benefiting specific diets.
- Sorghum proteins are much less digestible after cooking than those from other cereals, which may be advantageous for some dietary groups.
- It is rich in protein, fiber, thiamine, riboflavin, folic acid, and carotene.
- It has adequate levels of iron, zinc, and sodium along with a high concentration of potassium, phosphorus, and calcium.
- The best usage for sorghum is to replace wheat for creating bread, pasta, cookies, and other baked goods *(Mishra et al.,2021).*

Pearl Millet:

- Pearl millet has a remarkably high percentage of lipids (4-6%) and proteins (12-16%).
- The amount of dietary fiber in it is 11.5%. Food in the stomach takes longer to transit as a result. as a result, lower chance of inflammatory bowel illness.
- The niacin content in pearl millet is higher than all other cereals.
- Vitamins E and B complex, folate, iron, copper, and zinc are also present. In comparison to other millets, it contains a high energy level.
- It is also rich in calcium and unsaturated fats which are good for health.

- It is an excellent source of insoluble fiber, magnesium, and fat. Because of the lipase enzyme, its flour has a nutty flavor, poor keeping quality, and an odd flavor, but it also helps to reduce gallstones, migraines, and respiratory illnesses.
- Pearl millet contains insoluble fiber which helps in reduction of excessive bile system who leads gallstones *(Mishra et al.,2021).*

Finger Millet:

- It is an excellent source of insoluble fiber, magnesium, and fat. Because of the lipase enzyme, its flour has a nutty flavor, poor keeping quality, and an odd flavor, but it also helps to reduce gallstones, migraines, and respiratory illnesses.
- It is the richest source of calcium (300-350 mg/100g)
- Finger millet is the lower levels of protein (6-8%) and fat (1.5-2%)
- Finger millet proteins are unique because of the sulphur rich amino acid contents.
- The grains are well recognized for being used as weaning feeds and for their outstanding malting qualities.
- It has high antioxidant activity *(Mishra et al.,2021).*

Foxtail Millet:

- Foxtail millet also called as Italian or German millet. It thrives in both tropical and temperate climates with low rainfall. Foxtail millet's magnesium content aids to prevent diabetes by reducing blood glucose levels and supporting heart function.
- Foxtail millet is the high in carbohydrates.
- The amount of protein content in foxtail millet is double that of rice.
- It contains minerals such as copper & iron.
- This grain is high in nutrients, has a sweet and nutty flavor, and is easily digestible and allergy-free *(Reddy, 2017).*

Kodo Millet:

- It has high protein content (11%), low fat (4.2%) and very high fibre content (14.3%).
- Kodo millet has high levels of B vitamins (niacin, pyridoxin, and folic acid), as well as minerals like calcium, iron, potassium, magnesium, and zinc.
- It is great for fortifying the neurological system and has a high lecithin content.

Barnyard Millet:

- Barnyard millet is the richest source of crude fiber and iron.
- The grains contain GABA and beta-glucan, which act as antioxidants and reduce blood lipid levels.

Little Millet:

- Its nutritional value is referred to as "little but not less," because it includes vitamins, minerals, and fatty acids that are vital to life. Because little millet has a high fiber

content, it is a great substitute for rice for making pongal or kheer and can help prevent obesity *(Reddy, 2017).*

- Little millet is smaller than other millets.
- It is high in iron content.
- Little millet has high antioxidant activities.
- It has almost 38% of the daily required fiber.

Proso Millet:

- Proso millet contains the highest number of proteins (12.5%).
- The special qualities of proso millet contribute to its health benefits. It contains large levels of fat and carbohydrates.
- It is cheaper source of manganese as compared to other conventional sources like spices and nuts.
- It has a lot of calcium, which is necessary for the development and preservation of bones.
- It reduces cholesterol levels and also reduce the risk of heart diseases.
- Niacin (Vitamin B3), which is abundant in proso millet, aids in the prevention of pellegra. One skin condition is pellagra. Additionally, it has calcium to support strong bones and dental health as well as protein *(Mishra et al.,2021).*

Amaranth:

- A high percentage of protein (13–14%) and lysine, an amino acid that is either absent or very little in many other grains, are carried by this grain.
- Oil content ranges from 6 to 9%, more than most cereals. Amaranth oil contains around 77% unsaturated fatty acids and is high in linoleic acid.
- Amaranth is high in dietary fiber.
- Amaranth is a high in iron, magnesium, phosphorus, potassium and appreciable amounts of calcium.
- It is rich dietary source of phytosteriols, with cholesterol lowering properties.
- Contains a lunasin-like peptide and other bioactive peptides with cancer-prevention and antihypertensive effects.
- The genus Amaranthus, the family Amaranthaceae, the subfamily Amaranthoideae, and the order Caryophyllales are all home to grain amaranth *(Iftikhar and Khan.,2019).*

Buckwheat:

- In buckwheat contains protein 13-15% protein and rich in the amino acid lysine.
- Buckwheat rich in carbohydrates (mainly starch).
- High in linoleic acid and other important polyunsaturated fatty acids.
- Higher amounts of zinc, copper, and manganese compared to other cereal grains, with good bioavailability.
- High in soluble fiber.
- Buckwheat is a rich source of polyphenol compounds.

- Rutin, a bioflavonoid, has anti-inflammatory and anti-carcinogenic qualities and may help manage blood pressure.

13.3 Products of Millets and Nutrient Content:

Sorghum Puff:

Sorghum puffs are a product of explosive puffing or cannon puffing in which the sorghum grain is inflated to its utmost extent consistent with the grain identity. It is an RTE (ready-to-eat) snack created with a puff gun machine.

The puff gun machine loads deshelled sorghum grain into a spinning barrel, then roasts and fires the mixture to produce puffed sorghum.

Sorghum expands rapidly when treated to high temperature and short time (HTST) treatment. Popping imparts acceptable taste and desirable aroma to pop sorghum *(Sharma et al., 2014).*

Process flow chart for production of sorghum puff products.

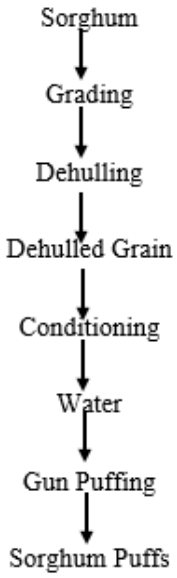

Figure 13.1: Process flow diagram for Sorghum puff product manufacturing

Sorghum Puff Yield and by Product: Puffs yield - 94%; By-product yield- 6%

Advantages of Sorghum Puff:

- Sorghum puffs are white and crunchy, comparable to puffed rice.

- When stored at room temperature in airtight MET pouches, the shelf life is four months.
- Sorghum puff is rich in protein and fiber.
- It can be used as an in-flight or night-time snack.

Table 13.1: Nutrient Composition for Sorghum Puff (Per 100 g)

Nutrient Content (100g)	Value
Protein (%)	11.9
Fat (%)	3.02
Dietary Fibre (g)	13.88

Source: Widowati and Luna (2022), **Reference:** Widowati, S., & Luna, P. (2022, May). Nutritional and functional properties of sorghum (Sorghum bicolor (L.) Moench)-based products and potential valorisation of Sorghum Bran. In IOP Conference Series: Earth and Environmental Science (Vol. 1024, No. 1, p. 012031). Foxtail Millet Puff:

The product known as "foxtail puffs" is the result of explosive or gun puffing, in which the foxtail grain expands to its maximum potential while maintaining its grain identity (same form). This food, which is ready to eat, is made with a puff gun machine. Puffed sorghum is produced by loading dehulled foxtail grain onto a revolving barrel in a puff gun machine, roasting it, and then firing it. Foxtail millet (setaria Italica) is one type of minor millet are popped by mechanical process and used for the production of different snack foods *(Gurupavithra et al., 2013).*

Process Flow Chart for Production of Foxtail Millet Product:

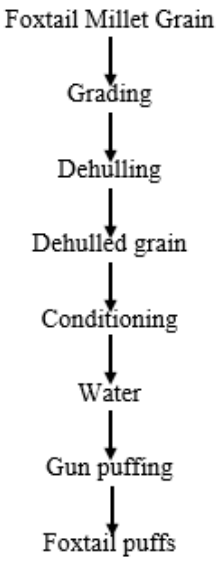

Figure 13.2: Process Flow Chart for Production of Foxtail Millet Puff

Product Yield and by Products of Foxtail Millet Puff:

Puffs yield – 92%; By-product yield – 82%

Advantages of Foxtail Millet Puff:

Foxtail puffs are white in appearance and crispy in texture, comparable to puffed rice. The shelf life is two months when packaged in airtight MET pouches at ambient temperatures, and the study is currently ongoing. They are high in protein and fiber. Available variants: masala-coated and fried. It can be used as an in-flight snack or a general evening snack.

Table 13.2: Nutrient Composition for Foxtail Millet (Per 100 g)

Nutrient Content (100g)	Value
Protein.	12.30 g.
Energy (Kcal).	331.
Carbohydrate.	60.9 g.
Crude Fibre.	14.0 mg.
Calcium.	31 mg.
Iron.	3.6 mg.

Source: Kalsi and Bhasin (2023), **Reference:** Kalsi, R., & Bhasin, J. K. (2023). Nutritional exploration of foxtail millet (Setaria italica) in addressing food security and its utilization trends in food system. eFood, 4(5), e111.

Pearl Millet Puff:

Pearl Millet (bajra) puffs are a product of explosive puffing or gun puffing in which the bajra grain is stretched to its utmost extent consistent with the grain identity. It is an RTE (ready-to-eat) snack created with a puff gun machine. The puff gun machine loads bajra grain into a spinning barrel, then roasts and fires the mixture to produce puffed Pearl Millet. It is one of the simplest and most cost-effective processing methods for ready-to-eat food. Popping fundamentally produces a crisp, aerated product with pleasing sensory properties. This is especially beneficial for pearl millet, which has a relatively short shelf life if it is not treated.s The popping not only improves the shelf life but also improves the nutritional quality with respect to bio availability of nutrients *s* It is one of the easy and economic processing method to prepare ready-to-eat products. Popping essentially creates a crisp, aerated product with desirable sensory qualities. It is one of the easy and economic processing method to prepare ready-to-eat products. Popping essentially creates a crisp, aerated product with desirable sensory qualities.

Product yield and by product of pearl millet: Puffs yield – 44%; By-product yield – 56% (small puffs and unpuffed grains) (Standardization is still in progress).

Process flow chart for production of pearl Puff products

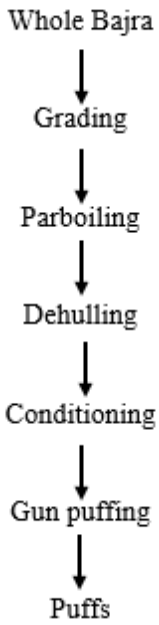

Figure 13.3: Process flow chart for production of Bajra Puff products

Advantages of Pearl Millet Puff:

1. Pearl millets are beneficial for diabetic diets as they include slow-digesting carbs that help maintain steady glucose levels over time. This makes them a good meal choice for diabetes.
2. Beneficial for heart health – Rich in dietary fibres and cholesterol-lowering properties of these grains are good for heart patients.
3. Pearl millet-based diets are ideal for people with celiac disease and gluten intolerance due to their gluten-free nature and ease of tolerance.
4. Therapeutic for those who experience frequent acidity and stomach ulcers: Pearl millets are among the few meals that lower stomach acidity, which prevents the development of ulcers and the discomfort associated with repeated acidity episodes.
5. Prevents Constipation: One of bajra's advantages is that it helps to maintain intestinal health. Put another way, eating the pearl millets will ensure that constipation stays at bay. The insoluble fiber found in bajra is the cause of this.
6. Lowers Blood Pressure: Potassium, which is essential for people with high blood pressure, is abundant in bajra. Increasing your intake of potassium-rich meals will aid in your body's sodium removal, lowering blood pressure.
7. Makes bone stronger – The high phosphorus content of bajra helps in making your bones stronger.
8. Helps in relieving constipation – A good amount of dietary fibres aid in the bulk formation and provide relief from constipation.
9. Lowers cholesterol: Pearl millet provides just the right amount of healthy fat, which is what people with high cholesterol want in their diet.

10. Ideal for weight management and obesity.

Millet Based Extruded Snacks:

Extrusion is a forming process (a sort of manufacturing process) in which a metal is confined in a closed chamber and then allowed to flow through a single aperture, causing the metal to take the shape of the opening. Extrusion processing reduces antinutrients while increasing the digestion of proteins and carbohydrates, making it ideal for millets. Extruded millets, with their lower fat content, can be promoted as healthy snacks/foods. Multigrain snacks can be either baked or fried. Extruded Snacks are ready-to-eat goods made by a twin-screw hot extruder, which combines heating and extrusion to produce a formed cooked product through circular, minus-shaped dies.

The majority of commercially available extruded snacks are produced from corn; however, this extruded snack is created from sorghum grits, rice, ragi, wheat, and corn flour. The mixture is blended and fed through a twin screw extruder, resulting in expanded nibbles that are ready to consume. The snack can be covered with any desired spices to change the taste and flavour. Extrusion cooking is an innovative method that enhances the nutritional value of food products through high temperatures and short cooking durations. It involves introducing moist grains into an extruder, where the necessary temperature and pressure are attained without the use of external heat, generated instead through shear and friction. The extrusion process was conducted with a twin-screw extruder *(Soni et al., 2024).*

Process flow chart of extruded product:

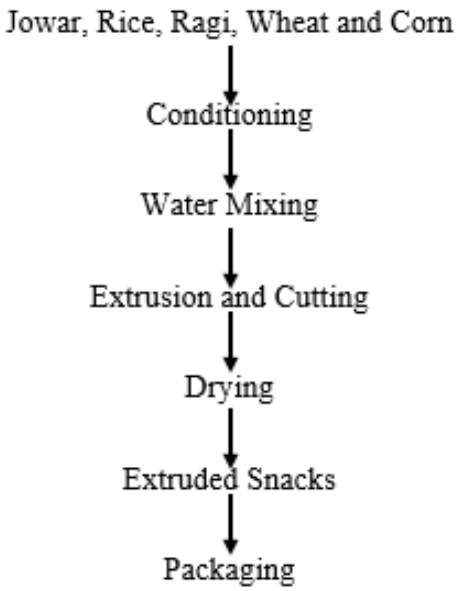

Figure 13.4: Process flow chart for production of ready-to-eat (Extruded snacks) products

Snack yield and by products yield:

snacks yield – 90%; By-product yield – 10%

Benefits of extruded snacks:

Extrusion allows the texture and shape of these foods to be controlled. Snacks with a wide variety of textures, such as crunchy, soft, fluffy or fibrous, can be obtained. In addition, specific shapes and uniform sizes can be created, which facilitates processing, packaging and consumption.

Table 13.3: Nutritive values of ready-to-eat extruded snack per 100 g

Nutrients (100 g)	Value
Protein (%)	12.90
Fat (%)	1.70
Dietary fibre (g)	12.88

Source: Soni et al.,(2024), **Reference:** Soni, N., Singh, M., & Jain, N. Development and quality evaluation of millet based extruded product, International Journal of Advanced Biochemistry Research 2024; 8(2): 102-104.

Millet based extruded flakes:

Extruded flakes differ from typical flakes in that the grit for flaking is created by extruding the blended components through a die hole. Then, snip out dough pellets to the desired size.

Extruded Flakes are ready-to-eat items made with a twin-screw hot extruder that combines heating and extrusion to produce a round-shaped product that is then flattened in a roller flaker machine. The extruded Flakes are prepared from sorghum grits, wheat, and corn flour. The snack can be covered with any desired spices to change the taste and flavour.

Process flow chart of millet based Extruded flakess

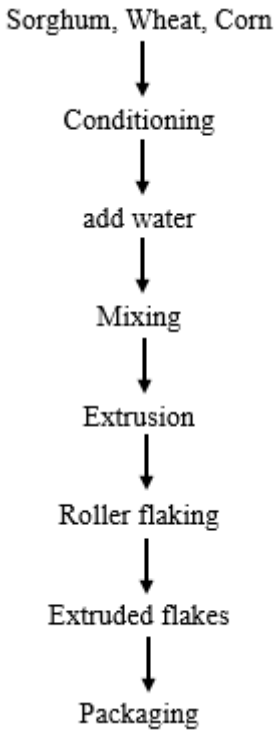

Figure 13.5: Process flow chart for production of Extruded flakes products

Table 13.4: Nutritive values of ready-to-eat extruded flakes (per 100 g)

Nutrients(100g)	Value
Protein (%).	13.90
Fat (%).	1.40
Dietary fibre (g).	14.88

Source: Takhellambam et al.,(2016), **Reference:** Takhellambam, R. D., Chimmad, B. V., & Prkasam, J. N. (2016). Ready-to-cook millet flakes based on minor millets for modern consumer. Journal of food science and technology, 53, 1312-1318.

Instant Mixes:

"Instant Foods" have become an indispensable part of everyone's daily routine in the fast-paced, time-sensitive world of today. In western countries, foods that are instantaneous and can be reconstituted have gained a solid reputation. The development of traditional foods into convenience foods is urgently needed, and IIMR has conducted research to create the instant mixes based on sorghum that are outlined below.

Instant Sorghum Idli Mix:

Idli is an indigenous traditional breakfast item in predominantly southern Indian cuisine. It is a steamed product made from rice semolina and crushed pulses and is usually eaten with a spiced vegetable filling or chutney. We attempted to make instant sorghum idli using sorghum fine semolina, black gram dhal, salt, and food grade additions, with citric acid and sodium bicarbonate as the key ingredients. A blender was used to mix all of the ingredients uniformly. The prepared mixture was placed in an MPET packing material.

Process flow chart of Instant Sorghum Idli Mix

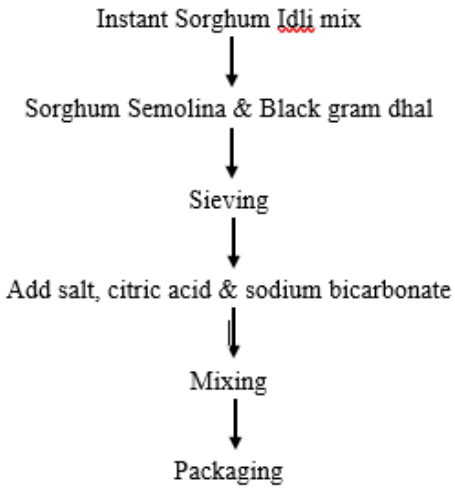

Figure 13.6: Process flow chart for production of Instant Idli Mix

Advantages of Instant Sorghum Idli Mix:

Sorghum idli may be prepared quickly, minimizing the time required for fermentation. It is high in phenolic compounds and promotes satiety, resulting in delayed digestion. Reduces oxidative stress (antioxidant). The shelf life of idli mix is three months. When compared to control idli, the instant idli mix contains a higher concentration of calcium, iron, zinc, and riboflavin.

Table 13.5: Nutritional Composition of Instant Idli 100 g.

Nutrients (100g)	Value
Energy (kcal)	364
Carbohydrates (g)	71.7
Protein (g)	12.4
Fat (g)	1.6
Riboflavin (mg)	1.5

Nutrients (100g)	Value
Folic acid (µg)	45.7
Calcium (mg)	10.2
Iron (mg)	7.2
Zinc (mg)	0.9
Magnesium (mg)	102.3

Source: Dayakar et al., (2016), Dayakar Rao B, Sangappa, Vishala A.D, Arlene Christina G.D and Tonapi V.A. 2016. Technologies of Millet Value Added Products. Centre of Excellence on Sorghum, ICAR-Indian institute of Millets Research. Rajendranagar, Hyderabad, India.

Instant Upma Mix:

Upma is an indigenous, traditional morning dish from predominantly southern Indian cuisine. It is made of cooked wheat or rice semolina with spices, condiments, and pulses added. We have attempted to make instant sorghum upma mix, sorghum semolina, and Bengal gram dal; the components included mustard seeds, curry leaves, dried green chilies, salt, and oil. Separate roastings were made of semolina, mustard seeds, and Bengal gram dal. Roasted mustard seeds, Bengal gram dal, dehydrated curry leaves, and salt were added to the semolina and combined. An MPET packing material was used to package the prepared mixture.

Process flow chart of Instant Upma Mix

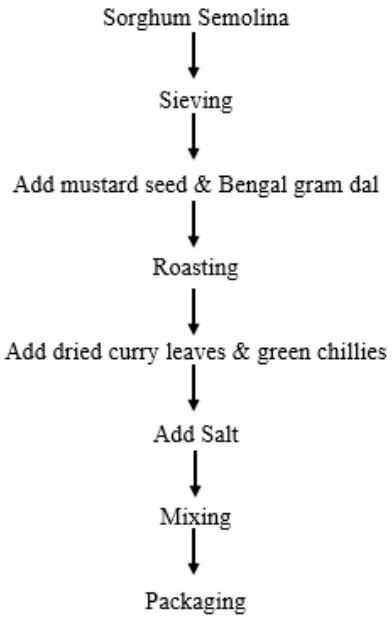

Figure 13.7: Process flow chart for production of Instant Upma Mix

Advantages of instant upma mix: It is possible to quickly create sorghum upma with extra flavor and taste. It is safe for celiac patients and free of gluten. Rich in phenolic compounds, which slows down digestion by causing satiety. lowers oxidative stress by using antioxidants Dietary fiber from a low-calorie diet helps to support good digestion. It takes six months for upma mix to become bad. Comparing the quick upma mix to the traditional upma, the former has less iron, protein, and fiber.

Table 13.6: Nutritional Composition of Instant Upma Mix (per 100 g.)

Nutrients (100 g)	Value
Energy (kcal)	374
Carbohydrates (g)	78.7
Protein (g)	13.4
Fat (g)	1.8
Fibre (g)	1.5

Source: Dayakar et al., (2016), Dayakar Rao B, Sangappa, Vishala A.D, Arlene Christina G.D and Tonapi V.A. 2016. Technologies of Millet Value Added Products. Centre of Excellence on Sorghum, ICAR-Indian institute of Millets Research. Rajendranagar, Hyderabad, India.

Instant Dosa Mix:

A dosa is an indigenous, traditional breakfast dish from predominantly southern Indian cuisine. It is a pancake made with ground pulses and rice semolina that is usually eaten with chutney or a spiced vegetable filling. We tried making instant sorghum dosa mix using sorghum flour, salt, and black gram dhal (2:1). The primary ingredients were blended together with sodium bicarbonate and citric acid. An MPET packing material was used to package the prepared mixture.

Process flow chart of instant dosa mix

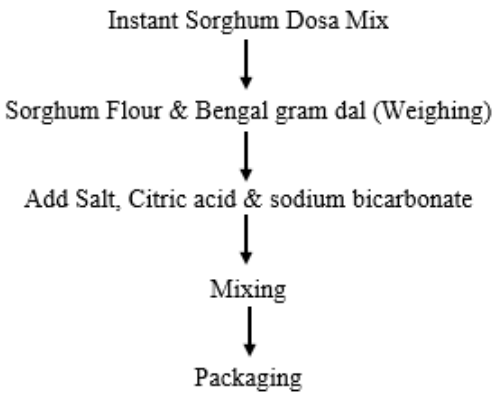

Figure 13.8: Process flow chart for production of Instant Dosa Mix

Advantages of instant dosa mix:

Instantly create sorghum dosa with increased flavor & taste. It is gluten-free and suitable for celiac patients. Rich in phenolic compounds, which promotes fullness and slows digestion. Reduces oxidative stress (antioxidant). A low-calorie diet (with dietary fiber) improves healthy digestion.

The shelf life of dosa mix is six months. When compared to conventional dosa, the quick dosa mix contains a higher concentration of fiber and protein.

Table 13.7: Nutritional Composition of Instant Dosa Mix (per 100 g.)

Nutrients	Value
Energy (kcal)	364
Carbohydrates (g)	71.7
Protein (g)	12.4
Fat (g)	1.9
Riboflavin (mg)	1.5
Folic acid (µg)	45.7
Calcium (mg)	10.2
Iron (mg)	7.2
Zinc (mg)	0.9
Magnesium (mg)	102.3

Source: Dayakar et al., (2016), Dayakar Rao B, Sangappa, Vishala A.D, Arlene Christina G.D and Tonapi V.A. 2016. Technologies of Millet Value Added Products. Centre of Excellence on Sorghum, ICAR-Indian institute of Millets Research. Rajendranagar, Hyderabad, India.

Millet Based Instant Laddu Mix:

Laddu is an Indian dessert made of flour/semolina, powdered low-calorie sugar, and shortening that is formed into a ball.

Millet laddu mix is made with roasted sorghum fine rawa, finger millet flour, and pearl millet flour, and then powdered low-calorie sugar, dry fruits, and cardamom are added. Before serving, combine the mixture with ghee or milk to form spherical balls.

The prepared mixture was placed in an MPET packing material.

The millet ladoo mix with many health benefits is the emerging need for the people who wants to incorporate millets in their normal diet and also the individuals to lead a healthy life; to restore the calcium level post pregnancy, lactation and menopause and calcium deficient population **(Pavitra *et al.*,2022).**

Process flow chart of millet instant laddu mix

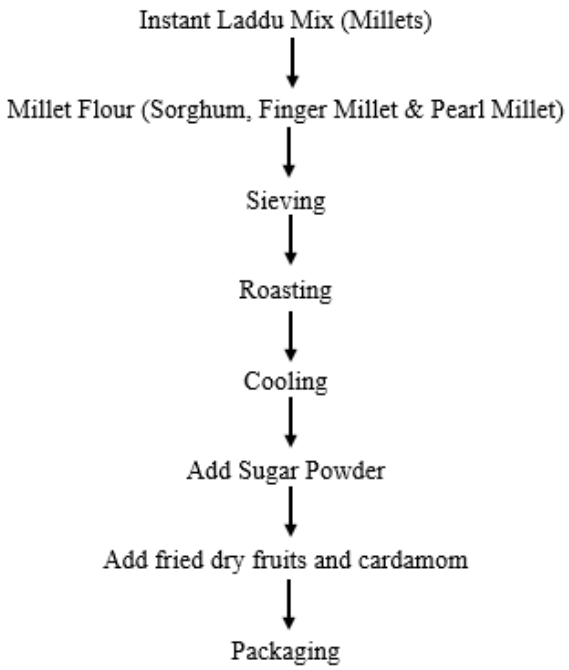

Figure 13.9: Process Flow Chart for Production of Instant Laddu Mix

Advantages of millet instant laddu mix:

Instant laddus can be made with enhanced flavor and taste. It is gluten-free and suitable for celiac patients. Rich in phenolic compounds, which promotes fullness and slows digestion. Reduces oxidative stress (antioxidant). Contains low-calorie sugar and aids good digestion through the presence of dietary fiber. It fights arthritis and rheumatism. The shelf life was three months when stored at room temperature.

Table 13.8: Nutritional composition of millet instant laddu mix

Nutrients	Value
Protien	5.41 g
Carbohydrates	71.30 g
Energy	456.9 Kcal
Iron	4.71 mg
Zinc	2.06 mg

Source: Pavitra et al.,(2022), Pavitra. K, Usha Devi C, Navaneetha, R, Development of Millet Ladoo Mix, International Journal of Science and Research (IJSR) ISSN: 2319-7064.

Millet Pasta:

Pasta is made through cold extrusion. This is particularly beneficial because of its low cost and continuous processing capability, and it has recently been recognized as one of the most useful technologies in the field of food processing. Sorghum/Finger millet/Foxtail millet/Pearl millet semolina and refined wheat semolina are combined in the vermicelli-making machine's mixing compartment, mixed with water for 30 minutes, then extruded using a pasta die. Wheat is added because the low gluten content of millets necessitates a minimum amount of wheat for pasta production. The worldwide acceptance of pasta is attributed to its low cost, ease of preparation, versatility, good sensory quality and long shelf life *(Sarojani et al., 2021).*

Process flow chart of Millet Pasta:

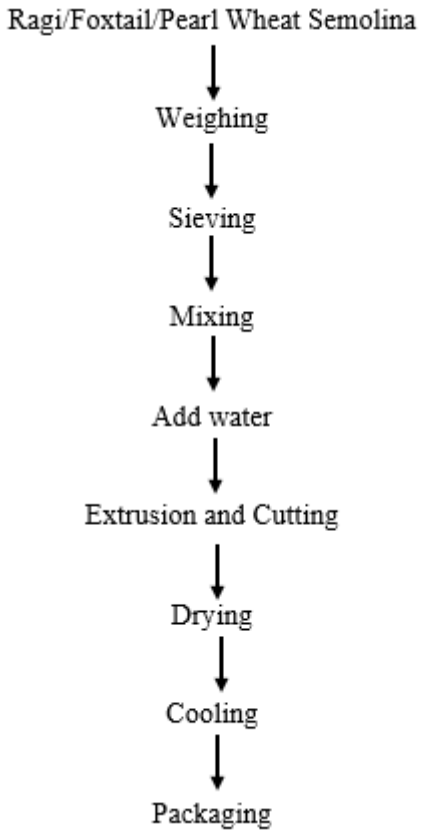

Figure 13.10: Process flow chart for production of Millet pasta

Advantages of millet pasta:

- Millet pasta stored for three months at ambient temperature; Finger millet /Foxtail millet /Pearl millet vermicelli shelf-life studies are still in progress.

- Millet can boost immunity, improve digestion, and manage blood sugar levels. Millet is also high in antioxidants, which may help prevent chronic diseases including cancer, heart disease, and diabetes.
- They can help to improve digestion, boost energy levels, and support the immune system *(Dwivedi., 2023).*

Table 13.9: Nutrient composition for Millet pasta (per 100 g)

Nutrients	Values/100g
Moisture (%)	8.31
Protein (g)	10.50
Fat (g)	1.29
Crude fiber (g)	1.25
Ash (g)	0.94
Carbohydrate (g)	78.96
Energy (kcal)	369
Iron (mg)	1.55
Zinc (mg)	) 2.35
Calcium (mg)	28.65

Source: (Sarojani et al., 2021).

13.4 Conclusion:

Nutrient compositions of most millet-based food products are inadequate to meet the nutrient requirement for all age groups. The millets are considered as nutraceutical due to its amazing nutritive value and health benefits over other cereals. Millets based pasta, biscuits, cakes, weaning food, fermented food and traditional products are available in market with reasonable price. The aim of this chapter is to awake the people to reorganize the importance of millets as nutritious food and full-fill the nutritional need of population and also increase demand and consumption of millets in daily meal. Millets are nutritionally effective and can reduce the problem of malnutrition and other health related problems.

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