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Millet a Nutri-cereal: Nutritional Value, Health Benefits and Value Addition in Dairy Products

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ABSTRACT: Millets valued for their nutritional value includes vitamins, minerals, carbohydrates and dietary fibres source and potential health benefits. This review highlights the potentials of millets as a source of dietary fibre, vitamins and minerals in dairy products, thereby improving the nutritive value of dairy products. Millets are a rich in dietary fibre, calcium, iron, zinc, lipids and high-quality proteins. Millets are loaded with phytochemicals that have been shown to reduce the risk of cardiovascular, diabetic, celiac and gastrointestinal diseases. Utilization of millets in dairy products in the form of millet milk powder, ice-cream, kheer, paneer and the novel technologies related processing of these products are discussed. The main challenge faced by the dairy products are the lack of fibre, especially dietary fibre. Blending millets with the dairy products can solve this problem to a greater extent.Various positive evidences of inclusion of millets in dairy products to enhances the nutritional and functional properties of dairy products, with potentials reduction of digestive disorder such as lactose intolerance because of its rich dietary fibre and phytochemical content. Overall, to increase awareness about production and consumption of millets address food security to millions of households and contributes to the economic efficiency of farming.

Keywords: Millets, health benefits, nutritional value, dietary fibre, dairy products.

INTRODUCTION

Millets, belongs to *Poaceae* family, were one of the first agricultural crops known to mankind (Tiwari *et al.,* 2023). A small-seeded grasses known as millets are frequently grown as cereal crops or grains for human nourishment and fodder around the world. The benefits of using the crop, such as productivity and a short growing season, have increased its appeal, making it a drought-resistant plant able to tolerate conditions of low rainfall (350–400 mm annually) and insufficient irrigation (Dey *et al*., 2022). They can endure harsh climatic conditions and are extremely drought-tolerant (Shalley *et al.,* 2022). Particularly in developing nations, millets are considered a staple food. It also features in the traditional diets of several more prosperous nations and is becoming more and more popular globally. It is an important dietary source of energy (Samtiya *et al.,* 2022). They can thrive without the use of pesticides since they are disease-resistant (Thakur and Tiwari 2019). There are three types of millets that are categorised based on grain size: major millets (sorghum, pearl millet, and finger millet), minor millets (foxtail, kodo, banyard, little, and porso millets), and pseudo millets (amaranth and buck wheat) (Sanjay *et al*., 2022). (Ahire *et al*., 2022). They are regarded as the nutri-cereals of today and the coarse grains of yesterday because of their excellent nutritional content (Gowda *et al*., 2021). China, India, Sri Lanka, Australia, and Malaysia are the countries that regularly grow millets (Nithiyananetham *et al*., 2019). In order to address the dietary requirements of the world's population, millets have seen a steady increase in production over the past few decades. All important constituents including protein, carbs, fat, minerals, vitamins, and bioactive substances, are abundant in millets, making them a great food source (Yousaf *et al.,* 2021). The information on different types of millets botanical name and origin is depicted in Table 1.

This review focuses on the nutritional value, dietary fibre content of millets to explores the possibilities of adding dietary fibre to dairy products. Both soluble and insoluble dietary fibres are abundant in millet. As a "prebiotic," the insoluble fibre in millet promotes the growth of healthy bacteria in your digestive system. This kind of fibre is essential for keeping stools bulky, which keeps you regular and lowers your chance of developing colon cancer (Sachdev, 2022). Bowl movement is enhanced by the pearl millet's high dietary fibre content, which ranges from 8% to 9%. Moreover, due to its slow digestion, it prolongs the transit time, slowing the absorption of glucose into the blood, which benefits non-insulin-dependent diabetic patients. Those who eat millet have a lower incidence of diabetes. Moreover, millet's fibre may improve good cholesterol while lowering bad cholesterol (Hassan *et al*., 2021).

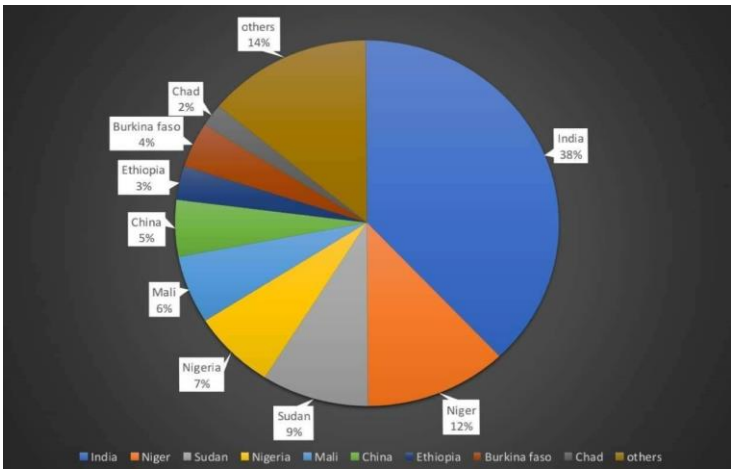
Table 1: Millets types, common name, botanical name and origin.

Crop	Common name	Botanical name	Origin	References
Pearl Millet	Bajra	*Pennisetum glaucum*	West Africa	(Satyavathi *et al.*, 2019)
Sorghum	Indian Millet	*Sorghum bicolor*	Africa	
Finger Millet	Ragi	*Eleusine coracana*	Uganda and Ethiopia	
Foxtail Millet	Kangni/ Kakum	*Sertaria italica*	North China	
Kodo Millet	Ditch Millet	*Paspalum scrobiculatum*	India	
Barnyard Millet	Prickly millet	*Echinochloa esculenta*	Japan	
Porso Millet	Broomcorn Millet	*Panicum miliaceum*	Manchuria (Japan)	
Little Millet	Kulki	*Panicum sumatrense*	India	

SCOPE OF STUDY

Dairy products plays an important role in human diet, but deficient in dietary fibers and minerals. Millets have potentials of incorporating into dairy products for improving nutritional quality and health benefits. Utilization of millets in dairy products suggest economic feasibility with better functionality. A review on this topic proved to be very effective as we were able to know about different millet-based dairy products. Further researches and development should focus to overcome technological and sensory properties of millet based dairy products. More products will be surely developed in future, because of the nutritive value and increased demand for Millet based dairy products.

Millet production statistics in India and the World. India is the world's largest millet producer, taking the top spot with a share of 41%. The major millets-growing states of India are Rajasthan, Uttar Pradesh, Haryana, Maharashtra, Karnataka, Andhra Pradesh, and Telangana. In terms of total millet production, three states Rajasthan, Uttar Pradesh, and Haryana accounted for more than 81% of the total (APEDA, 2022). Rajasthan, one of India's states, is the largest producer of millets (8.33 million metric tonnes) and has the most land dedicated to their cultivation (6.15 million hectares). The highest millet yield is found in Telangana (6563 kg/ha) (NABARD, 2022). Millets are grown in India on an area of 12.45 million hectares. A total of 12.45 million hectares are used for millet cultivation, yielding a total of 15.53 million metric tonnes at a rate of 1247 kg/ha. By area (3.84 million hectares) and production (4.3 million metric tonnes), sorghum ranks fourth on the list of the most important food grains in India. Over 50% of the nation's millet-growing acreage and productivity are contributed by bajra. In an area of 8.87 million ha, India produces the biggest amounts of barnyard (99.9%), finger (53.3%), kodo (100%), small millet (100%), and pearl millet (49.5%), totalling about 12.76 million metric tonnes. The FAO estimates that 74 million hectares will produce 89.97 million metric tonnes of millets worldwide in 2020. 90% of the world's millet production is made up of two millets: sorghum and pearl. Additionally, foxtail millet outperforms all other millets in terms of productivity (2166 kg/ha). Sorghum makes up over 65% of all millets farmed worldwide (ASSOCHAM, 2022).



Pie chart for millet production statistics around the World.

Millet a nutri-cereal. As nutri-cereals, millets is a great source of food, feed, and feeders. Nutritionist Dr. Khadar Vali, commonly known as '*the millet man of India*," suggests a diethigh in millet associated with positive health benefits. He has suggested the consumption of novel grains (barnyard, kodo, little, foxtail, and brown millets) in order to maintain excellent health. They are non-glutenous and have probiotic properties due to the high fibre content, which promotes good health. Fibres also function as a detoxifying agent, which aids in lowering the risk of inflammatory bowel disease (Sanjay *et al.*, 2022).

Millets are extremely nutrient-dense foods that contain a higher level of carbohydrate protein, diet fibre, essential fatty acids, potassium, iron, zinc,

phosphorous, calcium, and vitamins than rice and wheat (Poshadri *et al.,* 2023).

Each of the millets contains more fibre than wheat and rice, and some of them even have 50% more fibre than rice. Dietary fibre consumption decreases blood glucose levels, aids in maintaining normal levels, and supports type II diabetics' dietary management. Due to the colon's microflora's incomplete or slow fermentation of millet fibre, proper laxation is encouraged, preventing diverticulosis and diverticulitis as well as constipation. Consuming dietary products based on millet can help (Mounika and Uma Devi 2019).

Nutritive value of millets. In terms of nutrient value, protein content, and macronutrient composition, millets are like regular cereals. They significantly add to the diets of both humans and animals due to their high calorie, calcium, iron, zinc, lipid, and high-quality protein content. They are also abundant providers of vitamins and dietary fibre (Hasan *et al.,* 2021). Nutritive value of different millets is presented in Table 2.

Table 2: Nutritive value of different millets.

Millets	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Ash (g)	Total dietary fibre (g)	Soluble dietary fibre (g)	Insoluble dietary fibre (g)
Sorghum	334	67.6	10.4	1.9	1.73	10.22	1.73	8.49
Pearl millet	363	67.0	11.6	4.8	2.20	11.49	2.34	9.14
Finger millet	336	72.0	7.3	1.3	2.60	11.18	1.67	9.51
Porso millet	341	70.4	12.5	3.1	1.90	8.47	-	-
Kodo millet	353	65.9	8.3	1.4	1.72	6.39	2.11	4.29
Little millet	329	67.0	8.7	4.7	5.40	6.39	2.27	5.45
Banyard millet	307	65.5	11.6	2.2	4.50	12.6	4.20	8.40
Foxtail millet	331	60.9	12.3	4.3	3.30	11.55	0.85	10.70

Sources: (Gowda *et al.,* 2021; Birania *et al.,* 2019; Gyawali, 2021; Rao *et al*., 2018; Doddamani *et al.,* 2018, Ugare *et al.,* 2014; Rana and Bhandari 2023)

Biological role of dietary fibre. Dietary fibres are indigestible polysaccharides or oligosaccharides that serve as roughage to sustain bowel motion and clean the digestive tract. They are unable to be digested by the human digestive system. If the gut microbiota in the colon breaks down dietary fibres to produce various short chain fatty acids (SCFA) like acetic acid, propionic acid, and butyric acid, then those substances are naturally prebiotics. These microbes include the Clostridium IV cluster members *Faecalibacterium*, *Roseburia*, *Anaerostipes,* and *Ruminococcus* as well as other *Lachnospiraceae* family members (Singh *et al.,* 2021). In colonic fermentation, the gut microbiota uses a unique collection of enzymes not found in humans to hydrolyse nondigestible food fibre into its component monosaccharides. Several enzymes make up the carbohydrate-active enzyme (CAZyme), which hydrolyses the complex fibre into the appropriate monosaccharides (Wardman *et al*., 2022).

The microorganisms continued to make use of these hydrolysed monosaccharides to produce various SCFAs via various routes (Fig. 1). For instance, acetyl-CoA, the succinate pathway, the acrylate pathway, and the propane diol pathway are all ways in which gut microorganisms might create acetate from pyruvate. Whereas butyryl-CoA is created by simultaneously reducing two acetyl-CoA molecules to butyryl-CoA, which is then transformed to butyric acid by the microbial enzymes phosphor transbutyrylase and butyrate kinase, butyric acid is created instead (Alexander *et al*., 2019). In the intestine, acetic, propionic, and butyric acids are frequently present in the molar ratios of 60:20:20. Due to their enhancement of tight junction proteins such claudin-2, claudin-7, zonula occludens-1 (ZO-1) and occludin, SCFAs also decrease gut permeability, which lowers the flow-through of toxins from the gut lumen to colonic tissues and the liver (Pohl *et al.,* 2022).

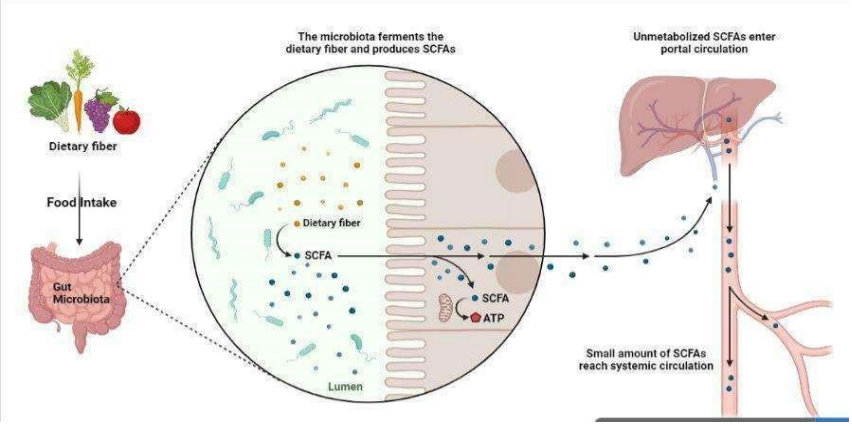


Fig. 1. Mechanism of production of SCFAs from dietary fibres.

Health benefits of millets. Millets are more than simply another type of basic cereal when it comes to potential health advantages. The grain is also rich in phytochemicals such phytic acid, which has been linked to a reduction in cholesterol, and phytate, which has been linked to a decreased risk of cancer. These health advantages have been partially linked to the wide range of phytochemicals, or potentially cancer-preventive compounds, including antioxidants, which are abundant in foods like millets (Amadou *et al*., 2011). Eating millets lowers your risk of cardiovascular disease, prevents diabetes, enhances digestion, detoxifies the body, improves immunity and respiratory health, gives you more energy, strengthens your muscles and nervous system, and guards against several degenerative diseases like metabolic syndrome and Parkinson's disease, according to epidemiological research (Dayakar *et al.*, 2017).

Urbanization has had a big impact on Indian consumption, with some cereals like millets becoming less popular and more people turning to animal products, refined sugar, fat, and alcohol. Regarding non-communicable diseases, which account for roughly 71 percent of all fatalities worldwide, this consumption pattern has increased the burden on society. Additionally, the current pattern of consumption is a significant factor in the development of oxidative stress (Mishra *et al.*, 2022). Numerous in vitro scientific reports point to millets' beneficial effects in lowering oxidative stress and controlling blood glucose levels in diabetic patients (Kaur *et al.*, 2019).

Millets provide a variety of nutritional benefits that can be used to prevent a wide range of health problems, for example, bringing down the blood pressure, risk of heart infections, forestalling malignant growth and cardiovascular illnesses, diminishing cancer cases and so on. Other health advantages include lengthening the time it takes for the stomach to empty and providing nutrients to the digestive tract (Sarita and Ekta 2016).

Besides this millet have numerous health benefits and played an important role in curing cardiovascular diseases, anti-ageing, diabetes, cancer, celiacdisease and obesity. Furthermore, millets have both anti-inflammatory and antimicrobial activity in our body and helps in digestion as well. Data on health benefits of millets are given in Table 3.

Table 3: Data on health benefits of millets.

Diseases	Health promoting properties	References
Cancer	• Millets are one of many dietary supplements that can help prevent cancer in addition to medical treatments. • Linoleic acid in millets has anti-tumour properties. • Sorghum includes polyphenols and tannins with anti-cancer and antimutagenic effects. • Foxtail millet has strong inhibitory effects on the proliferation of human colon cancer cells.	(Dhaka *et al*., 2021; Mishra *et al.*, 2021; Stephenson, 2019)
Cardiovascular	• Due to excellent dietary sources millets can inhibit cardiovascular health risks. • Magnesium in millets may prevent heart attacks and migraines • Phytic acid known to lower cholesterol. • Potassium helps to lower blood pressure. • Millets fiber has potential to decrease cholesterol by removing LDL and boosting the HDL.	(Bachate *et al.*, 2022, Dayakar *et al*., 2017; Ambati and Sucharitha 2019)
Diabetes	• High-fiber, low-GI weight loss reducing cholesterol and blood sugar fluctuations. • Magnesium content in millets prevents diabetes by regulating insulin action	(Watson, 2022; Ambati and Sucharitha 2019)
Celiac	• Millets are gluten-free, help to decrease the prevalence of celiac disease by easing the discomfort that gluten-containing common cereal grains cause • Gluten free property of millet prevent immune reaction and genetic predisposition that triggers CD.	(Caeiro *et al.*, 2022; Rondla *et al.*, 2022)
Obesity	• Millet is a great source of dietary fibre that promotes digestion, nutrient absorption and lowers the risk of chronic illnesses, obesity and encourages good bowel health.	(Aishik and Udit 2023)
Inflammation	• Millet shows anti-inflammatory properties due to their tannins, flavonoids, and phenolic acids, peptides, and fibers. • Lipophilic antioxidants like carotenoids and vitamin E are also found in millet	(Liang and Liang 2019)
Ageing	• Phytochemicals plays significant role as anti-aging and promote health benefits. • Millets are good source of iron, fibre, polyphenols, calcium, methionine, and secondary metabolites known to promote health and potentially slow ageing.	(Kumar *et al.*, 2022)

Utilisation of Millets in Dairy Products. A variety of products based on millets, including extruded flakes, vermicelli, ready to eat snacks, quick mixes and baked items, have been developed thanks to the nutrient content of millets and its ability to promote human health. Millets were initially eaten as cooked rice, but

throughout time, eating habits changed. Ancient millet processing methods include dehulling, crushing, sprouting, fermenting, roasting, and malting, according to FAO (2019). They improve the pleasant qualities of millet products while reducing the antinutrient qualities. Millet grains that have been parboiled are ground into flour, which is then used to make milk-based pottage and rolled sweets called laddus. Millets are also used to prepare a variety of regional dishes, such as dosa, porridge, chapatti, bread, biscuits, and spaghetti (Adebiyi *et al*., 2017). Most of the countries in Africa consume foods and beverages made from millet to a greater extent (Amadou *et al.,* 2013).

Millet milk. Millets can be processed to produce milk. In the preparation ofragi milk, sprouted grains are used. Additionally, milk can be extracted from foxtail millet and proso millet. Proso millet can be used to make popsicles, kheer, smoothies, and more (Vijaya Venkatesh, 2018).

According to Nair *et al*. (2020) when compared to dairy milk, the millet milk provides more calories (383 kcal) and a similar percentage of carbs (78%). Although coconut milk (2.26%) has greater fibre, millet milk (0.9%) contains more crude fibre than dairy milk (0.73%). Due to its mineral content, millet milk has a high ash percentage (0.35%). Low temperature processing reduced the protein level from 9.1% to 8.7–8.8% and the fat content from 1.21.1% to 0.64– 0.6%, although even after processing, the protein content was still significantly higher than that of dairy milk (2.4–1.8% protein and 1.2-1.1% fat). A decrease in viscosity and a rise in TSS were also seen at lower temperatures. Malted milk's protein, fibre and ash contents rose. The malting process results in a product with a high protein and low fat content, making it very beneficial (Nair *et al.,* 2020).

Another study conducted by Akshaya *et al.* (2020) suggested that there was great acceptance among the people for their Millet milk prepared by using kodo, Barnyard, foxtail and proso millets. Besides this they also found that the dietary fibre in the milk was 4.8mg/100g, Calcium 16.3mg/100g and Iron content 7.1mg/100g. The shelf life of the Millet milk was found to be 5 days which is more than the cow milk that we consume. Overall, millet milk acts as a good substitute to milk and other soft drinks (Akshaya *et al*., 2020**).**

Millet Ice-cream. According to Amritha *et al*. (2021) the millet-based ice cream had significant amounts of calcium, phosphorus, protein, and fat. The sensory evaluation revealed that the ice cream made with coconut, sesame, and banana extracts had a higher acceptance score than the ice cream made with different amounts of banana, sesame, and coconut extracts. The developed plant-based, non-dairy ice cream can be ingested by people who are lactose intolerant, allergic to cow's milk proteins, and future vegan dieters. There is also a chance that this ice cream will be sold commercially in the future. Thus, this study's conclusions will help in the design and optimisation of a suitable millet-based food (Amritha *et al.,* 2021).

Another researcher Sivakumar (2017) used foxtail millet, which is nutrient-rich to prepare sugar-free ice cream. He concluded that the addition of stevia at a level of 3 percent and foxtail millet at a level of 4 percent to ice cream was deemed to be acceptable by sensory evaluation. The addition of millet enhanced the ice cream's flavour and overall acceptance. Further, dietary fibre was found to be high in the prepared foxtail millet ice-cream (Sivakumar, 2017).

Patel *et al.* (2015) made millet ice-cream by using different flavours. His studies tells that the typical compositional values, acidity, and pH of ragi ice creams made with various flavourings, including chocolate (CH), mango (MG), vanilla (VA), and caramel (CR). When cocoa was added as a flavouring agent, the mix's total solids content increased; however, adding mango as a flavouring agent caused the mix's total solid and protein contents to fall. Mango addition also caused the mixtures' pH to fall and their acidity to rise. The total solids of the mixture were unaffected by the addition of vanilla or caramel flavour. Protein levels in CH, CR, and VA were comparable to one another ($P > 0.05$). MG had much less protein and total solids than all the other foods (Patel *et al*., 2015).

Cerelac. By the age of six months, a child needs foods high in energy, also referred to as weaning or complementary foods, in their diet. Cereal malt made from grains like wheat and barley are rich sources of vital micronutrients, but they are frequently lacking in milk. Ready-to-eat foods are typically blends of cereal malt and milk solids around the world. The typical complementary food made at home as a soft porridge for infants is wheat gruel. Malted foxtail millet flour, wheat flour, skim milk powder, whey protein concentrate (WPC), ghee, and sugar can be used to prepare Cerelac (Kaur *et al.,* 2018). Murthy's preparation of a complementary food, which was then contrasted with commercially available cereal and milk solid-based complementary foods (Cerelac) (Murthy *et al.,* 2016).

In contrast to the commercial sample, his report found that malted foxtail millet had the highest overall acceptability: wheat flour (30:40), skim milk powder (30%), ghee (7%), WPC (2%) and sugar (12%) (Cerelac). Due to its direct composition and beneficial nutritional qualities, the product can be stored up to 45 to 60 days and can be produced at both industrial and domestic levels (Murthy *et al.,* 2016). Ragi is a cereal that is very nutrient-dense and supports a baby's general growth and development, due to ragi being a significant source of fibre. Large amounts of calcium and iron are present. It has little fat. As it is easily digestible, it is regarded as the ideal weaning food for newborns after the completion of the fifth month **(**Patel, 2021).

Paneer Kheer. Indian dessert known as kheer is made by cooking whole milk partially over a direct flame in a pan with sugar, rice, and occasionally semolina (Bhosale *et al.,* 2021). The chemical make-up of paneer kheer was made from a blend of Foxtail and Finger millet flours at optimal levels. The total solids, protein, fat, and ash levels of millets-blend products were observed to be slightly higher. While the control sample had no crude fibre content, millets blended samples had. The blended sample's crude fibre content

of finger millet and foxtail was much greater, at 0.174 and 0.046%, respectively (Kumar *et al.*, 2014).

For the preparation of the kheer, Bhosale *et al.* (2021) used 8% constant rate sugar and 8% constant proportion of paneer shreds were combined with the various concentrations of finger millet flour: T0 (2.5%), T1 (1% finger millet flour kheer blended with paneer), T2 (1.5% finger millet flour kheer blended with paneer), and T3 (2% finger millet flour kheer blended with paneer). The product's moisture, fat, and protein content, as well as its acidity, total solids, carbs, crude fibre, and ash, were all measured. The findings showed that using more finger millet flour causes a considerable reduction in the amount of moisture and fat. However, the concentration of lactic acidity, protein, ash, carbs, total solids, and crude fibre altered as the amount of finger millet flour changed (Bhosale *et al*., 2021)**.**

Millet milk powder. The quick millet milk powder that the current invention refers to is prepared with millet, fresh milk, sucrose, and honey as the main ingredients (Anonymous).The main advantages of this powder include higher calorie (383 kcal) and comparable (78%) carbohydrate content to dairy milk. Compared to dairy milk, crude fibre is higher (0.9%), while coconut milk has a lower concentration of fibre. High quantity of fat (0.74-0.6%) and protein (8.7–7.8%). The TSS increases and the viscosity decreases at lower temperatures. Malted milk has high levels of protein and fibre and low levels of fat. Drum dry millet milk has a high protein level (8.57%). The hue of spray- and tray-dried millet milk powder is slightly pale, while drum-dried powder is brown (Nair *et al.*, 2020).

At various moisture concentrations, the physical and flow characteristics of milk-blended foxtail and barnyard millet powders were assessed. As moisture level rose, particle-size distribution and span significantly shrank. Both millet powders were found to be hygroscopic in the dynamic flow and shear experiments, where it was discovered that particle size and moisture had an impact on flow ability. Due to agglomeration and a decrease in the particles' surface area of contact and the strength of their interactions, the fundamental flow energy and shear tests demonstrated that both millet powders flowed more readily at 9% moisture content than at 3%. Because to its greater particle size and shorter span than milk-barnyard millet, the former had better flow ability when compared to the latter.

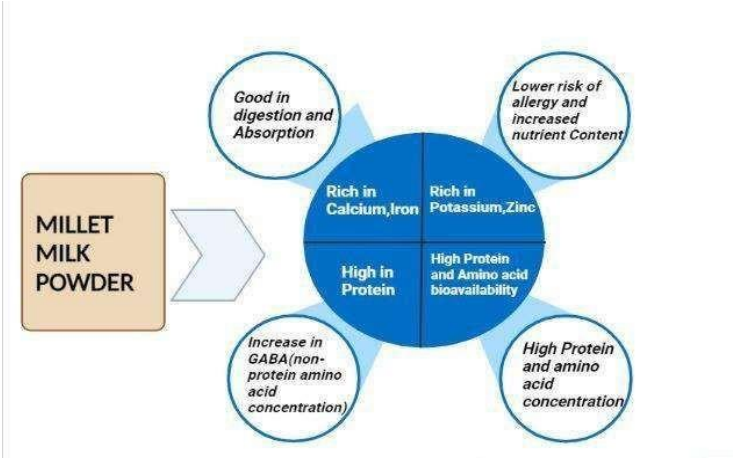


Fig. 2. Nutritive value of Millet Milk Powder.

Novel processing Technology

Fermented millet sprout Milk beverage. Sudha *et al.* (2015) made Fermented Millet Sprout Milk Beverage, in three different ratios (25:75, 50:50, and 75:25), skim milk was blended with millet milk made from separately soaked millets and sprouts. The mixture was then inoculated with starter culture based on 2% for the entire milk and incubated at 37° C for 12 hours. For a full 12 hours, it was left alone to ensure that the milk curdled effectively. After the curd had formed, it was thoroughly mixed in an electric mixer. The blending process included the addition of salt and spices. The sensory qualities of a beverage made from various combinations of skim milk and millet milk were assessed (Sudha *et al.*, 2015). In a recent experiment, the produced milk from millet without malting. The physical, nutritional, and organoleptic properties of the millet milk were evaluated. The milk beverage made from kodo millet has TSS (15 o brix), acidity (0.86), starch (5.73 g%), total sugar (3.26 g%), reducing sugar (1.79 g%), and protein (1.75 g%) concentrations per 100 g. Millet sprouting boosted milk production while reducing viscosity and sedimentation.

Millet Lassi. A delicious summer beverage can be made by combining yoghurt and finger millet. It is nourishing, hydrating, and works well to cool the body. (Anonymous, 2015). According to Pardhi *et al.* (2014) more nutritious and value added lassi can be prepared by the addition of finger millet flour (Pardhi *et al.*, 2014).

The control lassi samples from standardised whey-germinated pearl millet slurry lassi showed noticeably high moisture and fat levels. Control lassi samples were found to have comparable protein and total fibre levels to the experimental sample. The amount of ash was enormous. The control beverage's pH value was comparable to that of the lassi made from whey-germinated pearl millet. Results for titrable acidity revealed a pH-reverse trend. They observed a considerable drop in pH with corresponding increase in

titrable acidity in germinated + autoclaved + fermented food mixes as compared to non-germinated food mixtures, whereas titrable acidity values were at par in case of whey-germinated pearl millet based lassi and control sample.

The results of the physico-chemical analysis of different flavours of lassi show that acidity of the product rises when pH of the product falls, fat content falls when water is added, and ash content depends on the amount of inorganic residue left in completely burned sample at particular high temperature during manufacturing. The results of the sensory evaluation analysis of the various lassi flavours with the controls show that the mango lassi has the highest overall acceptance, flavour score, and body and texture score (Sabavath *et al.*, 2022).

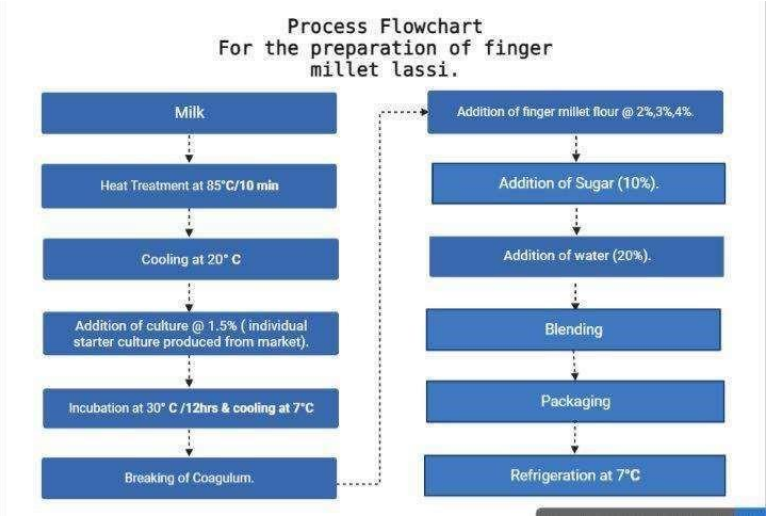


Fig. 3. Process flow chart for the preparation of Finger millet lassi.

Fermented millet milk-based curd. Moorthy *et al.* (2018) in study prepared a fermented curd-like product made from millet milk. Their studies found this product to have a pH between 3.5 and 4.5 and to have 0.74 to 1.2% acidity. Based on a sensory analysis, the final manufactured product's general acceptability for millet milk-based curd was extremely acceptable. Processing techniques like as soaking and germination are used to boost nutritious value while reducing anti-nutritional elements. As a result, a novel millet-based fermented product rich in readily available nutrients was created. However, validation and confirmation require further standardisation and analysis (Moorthy *et al.*, 2018**).**

Balli *et al.* (2023) investigated fermentation as a straightforward and inexpensive method for creating new millet-based products with enhanced nutritional characteristics. One of the three lactobacilli and yeast mixtures evaluated in the study, in particular, was able to provide more nutraceutical and nutritional value than the unfermented grain. In addition to enhancing the nutritional value of food for those who already eat millet as a staple, the ability to prepare ingredients and foods with greater nutritional properties quickly and cheaply may also encourage the use of millet more widely in nations where it is not currently a common food source (Balli *et al.*, 2023).

Development of burfi Incorporated with Millets. Sujith *et al.* (2021) study found that the average moisture content of the control burfi was 13.10%, while the burfi with foxtail millet was 11.30%. The total solids content of foxtail millet-infused burfi is 89.10%, compared to 87% for the control burfi. This is a sign of longer shelf life. In another study, the protein content of the burfi made using foxtail millet was 18.38%andthat of the control was 19.46%. The inclusion of millet, whose protein level is substantially lower than that of foxtail millet, may be the source of the lower figure. Moreover, fibre helps lower cholesterol and blood sugar levels, and can help avoid several diseases like diabetes, heart disease, and bowel cancer (Sujith *et al.*, 2021).

Both milk and burfi are lacking in nutritional fibre. The fibre content of the foxtail millet-infused burfi was 0.89%, compared to the control burfi's 0.11%. The development of the product's fibre content is enhanced by the addition of millet, which helps to improve digestive health (Sujith *et al.*, 2021). Burfi made with kodo millet tended to retain more moisture, and attempts to further desiccate it resulted in a product that was crumbly, dry, and hard-bodied with a coarse texture. Kodo millet was added, which resulted in a considerable rise in moisture, crude fibre, and iron content from 14.54 to 17.4, 0 to 0.59, and 0.60 to 0.69, respectively.

However, since the availability of these nutrients in khoa is higher per gram than it is in millets, a considerable decline in the values of fat, protein, ash, and energy was seen (Sahana and Vijayalaxmi 2022).

Vegan Milk Made from Sprouted Millets. A plant-based dairy start-up "alt foods" has introduced the first plant-based milk of its kind manufactured with components like sprouted sorghum, sprouted finger millets, amaranth, and oats. Plant-based milk, an alternative to milk derived from animals, promotes health and wellbeing while also being good for the environment. Smart protein, which is produced through food science rather than industrial animal agriculture, is a crucial component of the worldwide effort to combat climate change, food insecurity, and public health issues like upcoming pandemics.

Over $3.1 billion was invested in these regenerative foods globally in 2020. Customers are aware of the potential environmental effects of these goods and give plant-based milks high marks for distinctive qualities like sustainability. The demand for plant-based foods has never been greater, according to the policy of NITI Aayog of the Indian government. It has been determined that climate resilience is a necessity for the nation to survive (Anonymous, 2021).

Significance of millets in dairy products:

Improve the nutritional value of dairy products. Millets can enhance dairy products' nutritional profiles and increase their nutrient density. For general health and wellbeing, millets are a wonderful source of vital nutrients like iron, magnesium, phosphorus, and zinc. According to a study by Kothari *et al.* (2018), adding finger millet flour to yoghurt boosted the amount of calcium, zinc, and iron, three crucial micronutrients for human health.

Improve the functional properties of dairy products. The functional qualities of millets are also well-known for improving the texture, flavour, and shelf-life of dairy products. Dietary fibre from millets can enhance the mouthfeel and texture of dairy products. Antioxidants found in them help extend the stability and shelf life of dairy products. According to a 2016 study by Mandeep *et al.* (2016) paneer's texture and sensory qualities were enhanced by the inclusion of finger millet flour (Mandeep *et al.*, 2016).

Millets can reduce lactose intolerance. Lactose intolerance is a common digestive disorder that affects a significant portion of the population. Due to a lack of the enzyme lactase, people with lactose intolerance are unable to digest lactose, a sugar found in milk and dairy products. Dietary fibre, which is abundant in millets, can aid to enhance digestive health and lessen lactose intolerance. According to a 2018 study by Dhiman *et al.* (2018) lactose intolerant people experienced fewer symptoms of lactose intolerance when finger millet flour was added to ice cream (Dhiman *et al.*, 2018).

Improve the quality of dairy products. Low-fat dairy products are frequently linked to a loss of sensory qualities like flavor and texture. The addition of millets to low-fat dairy products can improve their sensory properties and enhance their nutritional value. In a 2016 study, Aggarwal *et al.* (2016) discovered that the texture, sensory qualities, and nutritional value of low-fat paneer were all enhanced by the inclusion of foxtail millet flour (Aggarwal *et al.*, 2016).

CONCLUSIONS

Millet is crucial for a flexible and diverse modern agricultural system that meets nutritional needs sustainably. Millet benefits health and provides income. Increased millet production and consumption in India will impact dairy industry. Although millet has health benefits, taste is crucial in determining if people eat it. This indicates that health awareness alone won't encourage the consumption of millet. Therefore, there is a need for appetizing millet dairy products and other recipes. Adding millet to packaged foods benefits farmers and promotes mechanization to ease traditional processing. Government should incentivize millet cultivation with specific policy measures. Millet is a staple food for millions in poverty-stricken Asia and Africa. Millets are filling, high in carbs and can compensate for a lack of lysine in other protein sources. Expanding millet use depends on improving its characteristics. Millet consumption in industrialized countries will likely contribute to an industrial revolution.

FUTURE SCOPE

Millets' MSP was raised by the government, giving farmers a large financial incentive. To guarantee a consistent market for the produce, the government has incorporated millets into the public distribution system. In order to boost consumer demand for Nutri-cereals, the Ministry of Women and Child Development has been constructing Nutri-gardens, encouraging research on the relationships between crop diversity and dietary diversity, and sponsoring behaviour change campaigns (The Times of India, 2022).

Increased public awareness of millets' health advantages and their adaptability for production in challenging conditions brought on by climate change is driving India to design out a plan to rank among the top three exporters by 2025. Exports may be greatly boosted by working together to expand the regions under millets and by constructing a productive millet value chain ecosystem with end-to-end solutions for producing demand (Trade Promotion Council of India, 2022).

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