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APPLICATION OF MILLETS IN MILK-MILLET BASED COMPOSITE FOOD: A REVIEW

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Abstract:

Millet is an important grain that has many health benefits, rich in minerals and phytochemicals. There are 70 varieties around the world and currently farmed in over 130 countries and are considered a traditional staple for over half a billion people in Asia and Africa. Worldwide, millets are regarded as a significant grain; however, they are the least exploited. Milk nutrients are effective in providing nutritional sufficiency, but they are connected with various health problems due to high levels of saturated fatty acids and a lack of dietary fibre in milk. Therefor fortifying milk with millets to be beneficial in augmenting dietary fibre and other micronutrients in the form of composite millet –milk dairy products. The objectives of this review is to give information on millet types, verities of milk-millet based composite products and its nutrition benefits, as well as innovative possibilities generated by employing millet in the area of composite dairy foods.

Keywords:**Health, Dairy product, Finger millet, probiotic, Nutritional composition, Pearl millet, Phenolic profile**

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1. INTRODUCTION

Millets are one of the world's oldest foods. Millets are now grown in over 130 countries and are a traditional food for a billion people in Asia and Africa. Millets are cereals that belong to the Poaceae grass family and were among the first crops to be domesticated, with evidence of their consumption period of the Indus Valley culture. Millets are largely a kharif crop in India, necessitating less water and agricultural inputs than other related staples. Millets were renamed as "Nutri Cereals" in April 2018, and the year 2018 was proclaimed the National Year of Millets, with the goal of increasing marketing and demand development. The government's initiatives have raised millet production from 14.52 million tonnes in 2015-16 to 17.96 million tonnes in 2020-21.India produces more than 170 lakh tonnes of millet, accounting for 80% of Asian production and 20% of global production. India's millet yield is 1239 kg/ha, compared to the global average of 1229 kg/ha (FAO Stat 2021). The Indian government proposed and the United Nations General Assembly accepted the International Year of Millets (IYM) 2023. India also revealed his goal to build IYM 2023 a 'People's Movement' alongside promoting India as the 'World Center for Millets'.

Millets are high in carbohydrates, protein, fats, vitamins, and minerals. Magnesium, manganese, and phosphorus are found in higher concentrations than in other grains. They also have a high concentration of important amino acids, notably sulphur-containing amino acids. It has a crude protein content of 6 to 13% and total mineral content of 1.9 to14% (Amadou et al., 2013).The use of enzymes in the manufacture of non-dairy drinks (rice milk and other cereal-based beverages) has been described (Deora and Deswal, 2018). Sorghum and pearl millet bran are good bulking agents that decrease cholesterol better than wheat bran (Kaur et al., 2012). Millet is utilized as a dietary medicine, according to Singh et al., 2016).

Consumer health concerns have influenced their food perception and preference in recent years. This resulted in the making of functional foods, which offer extra health advantages in addition to nutritional benefits. One such advancement is the manufacture of nondairy functional beverages, as milk based drinks can cause allergy, lactose intolerance, and hypercholesterolemia (ValenciaFlores et al., 2013). Millets are the less expensive raw material source for the production of non-dairy beverages. They have a distinct benefit in terms of health since they are high in micronutrients, particularly minerals and vitamin B, as well as nutraceutical(Ushakumari et al., 2004).

While milk is considered a complete food, it has been associated to several health problems due to high levels of

saturated fatty acids and a lack of dietary fibre in milk (Raju and Pal, 2014). Composite dairy foods are defined as the foods in which the milk, milk products or milk constituents are integral part of the final product. Milk-based desserts such as kheer, Paysam, tarhana (dried food based on a fermented mixture of grain and yoghurt, usually made into a thick soup), kishk (dried fermented cereal-milk mixture), and raabdi (sweet, condensed-milk-based dish) are examples of traditional composite dairy foods. In recent years, there has been a surge in interest in using millet crops and natural whey to produce composite dairy dishes and drinks through entrepreneurial programmes as a source of income for underprivileged populations. This review deals with the type of millets and possible applications of millets in making composite millet-milk products.

2. REVIEW OF LITRATURES

2.1 Types of Millets

The major millets are Pearl millet, Foxtail millet, Proso millet and Finger Millet. Minor millets include Barnyard millet, Kodo millet, little millet, Guinea millet and Browntop millet (hinchole et al., 2017, Nithiyanantham et al., 2019). The types of millets and its common & scientific namesareshown in Table 1.

Table 1: Millet varieties, its common & scientific names.

S.	Types of Millets	Common Name	Scientific Name
1	Finger millet	Ragi/Mandua	Eleusine coracana
2	Kodo millet	Varagu/ kodo	Paspalum scrobiculatum
3	Barnyard mille	Sawa/Sanwa/Jhangora	Echinochloa esculenta
4	Foxtail millet	Kakun/Thinai/ Kangani	Setariaitalica
5	Proso millet	Cheena	Panicum miliaceum
6	Little millet	Kutki /Samai	Panicum sumatrense
7	Sorghum	Jowar	Sorghum bicolor
8	Pearl millet	Bajra	Panicum miliaceum
9	Buck-wheat	Kuttu	Fagopyrun esculentum

Pearl millet is a significant grain in the world, ranking sixth in production after maize, wheat, rice, barley, and sorghum (FAOSTAT, 2020). It is the most widely grown millet, which are a top crop in India and many parts of Africa. Among millets, pearl millet (Bajra) has the highest level of macronutrients such as iron, Zn, Mg, P, folic acid, and riboflavin, as well as starch, soluble and insoluble dietary fibers (Antony et al., 2006). It is also regarded as one of the crops capable of providing good nutrition and money to small-scale farmers, so contributing to livelihoods and food availability (Patel et al., 2015).

Finger (Ragi) millet originated in Africa and ranked fourth in the millet production (Shukla & Srivastava, 2014). It is rich in fibre, minerals, and vitamins, and has eight times the calcium (344 mg/100 gm) of other cereals (Verma and Patel, 2013). Ragi has gain popularity due to its slowly digesting and resistant starch (Wadikar et al., 2007), as well as its low glycemic index, making it acceptable for diabetic patients. Ragi flour, both malted and fermented, is widely utilized in the production of weaning foods, quick mixes, drinks, and medicinal product (Rao and Muralikrishna, 2001). Ragi porridge is an excellent low-calorie food for individuals of all ages, particularly developing infants, pregnant women, and the elderly(Gari, 2020).

Proso Millet isanother ancient crop and Romans were familiar with it, and it eventually became the common millet. (Sheahan, 2014). Foxtail millet is mostly a sub-tropical and temperate zone crop. The majority of production orders come from Japan, China, India, and Eastern Europe (Doust et al., 2009).Little Milletis found in the wild in northern India and Southeast Asia. It will produce some grain and is beneficial in very adverse circumstances (Vijayalakshmi & Radha, 2006).

Barnyard millet was domesticated in India, where it is still a popular cereal in some places. It was also covered in the Central African Republic, Tanzania, and Malawi. The wild form is a common tropical weed (Rao, 1994). Kodo millet is solely farmed as a grain in India, despite the fact that the wild grass is a common tropical weed. In all of the traits tested, wild weeds and cultivated varieties merged. Kodo millet is known to be harmful after rain, clean, nutritious grain appears to offer no health risks (Hegde & Chandra, 2005).The highest amount of free radical activity (DPPH) is seen in kodo millet, followed by sorghum and finger millet (Deshpande et al., 2015).

2.2 Nutrition values of millets

Millets are nutritionally better than wheat and rice due to increased protein levels and a more balanced amino acid composition. Similarly, millet has a higher amount of dietaryfiber than other of the main grains. Millets also include a variety of phytochemicals that, due to their anti-inflammatory and anti-oxidative capabilities, have medicinal benefits. Millets contain a lot of important amino acids, especially sulphur-containing amino acids like methionine and cysteine (Devi & Sangeetha, 2013).

2.3 Government support for milk- millet based composite food developments

India grows all nine generally familiar millets and is the world's largest producer and fifth-largest exporter of millets,

according to 2020 data, with exports continuously increasing at around 3% CAGR in the last five years ending with 2020. Most Indian states cultivate one or more millet crop species. The largest millets produced in India are pearl millet (60%) followed by sorghum (27%), finger millet (11%), and small millets (2%). (as per the 4th Advance estimate 2021-22). According to millet output in 2021-22, the principal millet-growing states in India are Rajasthan (39%), Uttar Pradesh (20%), Haryana (12%), Gujarat (11%), and Madhya Pradesh (9%).

The NFSM-Nutri Cereals initiative is being implemented in 212 districts throughout 14 states as part of the National Food Security Mission (NFMS). There are around 500 start-ups in India operating in the millet value-added chain, and the Indian Institute of Millets Research has incubated 250 under the Rashtriya Krishi Vikas Yojana - Raftar. The millets and milk integration (MMI) has been found to generate the best nutritional synergy. A lot of technology related to composite dairy foods has already been developed under National Agricultural Innovation Project of Indian Council of Agricultural Research and attempts are being made to transfer the technology to potential buyers like industry, SHG, entrepreneurs etc.

2.4 Application of millets in dairy based Composite Dairy Foods

The presently upward trend of the Indian food industry and new potential for the making of health foods by the careful combination of millets with milk or milk products. A variety of traditional foods is made by mixing millets with milk or milk products.It increases not just the palatability of these goods, but also their nutritional content. Malted milk foods are a typical example of 'Composite Dairy Foods' based on milk and grains that have been enjoyed by people of all ages, particularly youngsters. There is potential for producing milk-millet-based composite dairy foodsat a lower cost.

2.4.1 Plant-Based (Dairy-Free) Beverages

A rising number of customers choice plant-based milk/beverage replacements for health concerns, such as lactose intolerance and cow's milk allergies, which affect 80% of the world's population (Pinal et al., 2015).Millets may be used to make milk. Millet milk is an example of one. Ragi milk is quite popular. Ragi grains that have been sprouted are utilized to get milk from Ragi. Foxtail millet and Proso millet are two more millets that are used to manufacture millet milk. Both of these millets are used to produce millet milk, which is then utilised to manufacture a variety of vegan treats. Furthermore, the dairy industry is one of the greatest sources of greenhouse gas emissions, consumers are seeking plant-based foods in order to hold sustainable diet patterns (e.g., vegan) and lessen the negative environmental effect (Hass et al., 2019).Barnyard millet, little millet, kodo millet and finger millet based millet milk can be a substitute for dairy beverage and can be consumed by all age group of people.

Though current plant-based milk on the market contains significantly less protein (1% w/v) than cow's milk, growing research on milk/beverage extraction utilizing grains has demonstrated to give a protein level that nutritionally equals as dairy drinks(Manassero et al., 2020). Quinoa milk has 5.66 times more protein than rice milk and half the protein level of cow's milk. Quinoa, rice, and cow's milk had protein contents of 1.7%, 0.3%, and 3.2%, respectively (Pineli et al., 2015). Quinoa milk has much lower cholesterol and salt levels than cow's milk. High-protein low-calorie amaranth beverage with a protein content equivalent to cow's milk and calcium content higher than other plant-based milk (Manassero et al., 2020). The millet milk products are manufactured industrially (Shunmugapriya et al., 2020).

A study of qualities of dairy-free millet beverage by fermentation of a lactobacillus delbrueckii subsp. bulgaricus and streptococcus thermophiles was done. The completed product was free of dairy allergens such as milk protein and lactose, and it had sensory properties that vegetarian and lactose-free customers would like (Ziarno et al., 2019). The study of quinoa fermentation with three distinct strains of lactic acid bacteria in order to create a yogurt-like beverage. During 20-hour fermentation, the study discovered an increase in key amino acids and protein digestibility of 10-20% (Lorusso et al., 2018).

Compared a traditional Nigerian beverage called 'kunu' made from sorghum to amaranth kunu. The study found that amaranth kunu had more protein and less antinutrients such oxalates, tannins, and saponins than sorghum kunu (Isaac-Bamgboye et al., 2019). The fermented quinoa beverage made using Lactobacillus plantarum Q823 from quinoa flour. They founded beverage containing live microorganisms (10^9 CFU/ml) that could be stored for up to 28 days. Although the unflavored product in their testing received negative comments owing to its unpleasant taste, the chocolate and bilberry tastes received good feedback (Urquizo et al., 2017).

2.4.2. Millet- Milk based Beverage

The number of people suffering from celiac disease is rapidly increasing, and removing wheat from their diets is only conceivable with millets. Nonetheless, gluten-free product production is a significant issue for food formulators, and

interventions such as the inclusion of milk proteins or enzymes might be beneficial.

Bajra lassi, created by the National Dairy Research Center in Karnal, combines the nutritional superiority of pearl millet with beneficial lactic bacteria (NDRI, 2008). Millet-based product is madua, a famous finger millet-based beverage in India. Moreover, millet is used to make Oshikundu, a traditional Namibian alcoholic or non-alcoholic drink (Kumar et al, 2018).

A product comparable to raabdi was made utilising pearl millet and shorgum, widely known as bajra and Jowar respectively, combined with conveniently accessible skim milk instead of sour buttermilk for increase the applicability of industrial production of bajra/jowar lassi (Modha and Pal, 2011).

The optimized a procedure for the manufacture of a functional beverage based on finger millet, oats, and double toned milk. For the manufacture of functional beverage, a 60:40 ratio of malt drink and double toned milk was used. The produced beverage demonstrated a sensory acceptance equivalent to cow milk. The product had a low fat, cholesterol, and lactose content. Millets fortification increased the milk's dietary fiber content, as well as its total phenols and antioxidant activity (Kumar et al., 2020).

2.4.3 Probiotic Milk-Millet Beverages

Lactic acid bacteria (LAB) fermentation produces probiotic dairy products that promote gut health, improve protein digestibility and nutrient bioaccessibility, and reduce antinutritional factors (Lorusso et al., 2018, Balakrishnan and Agrawal, 2014). It is better opportunity into the field of functional food is the addition of millet to milk or milk-products. Millets serve as a dietary substrate for probiotics, improving flavour, texture, and overall acceptability (Charalampopoulos et al., 2002). To make a millet-based probiotic beverage, 800 mL of milk was mixed with 152 g of millet flour and cooked for 15 minutes while continually stirring. The mixture was chilled before being injected with bacterial culture for 9 and 12 hours. After fermentation, the population of L. rhamnosus GR-1 increased by two log cycles, whereas S. thermophiles increased by three log cycles (Stefano et al., 2017).

The beverage was made from cooked finger millet inoculated with Lactobacillus casei431®, sugar, fresh cow milk, and cocoa powder, and incubated at 37°C for 2 hours, 4 hours, and 6 hours. Sensory study revealed that fermentation for 4 hours resulted in the best acceptance (Fasreen, 2017).

The growth of Lactobacillus acidophilus NCDC14, Lactobacillus casei NCDC297, and Lactobacillus rhamnosus NCDC347 in nutri-cereals-based beverages with or without co-culture Streptococcus thermophilus NCDC74. The beverage was inoculated with 1% and 5% culture, with a 6-hour incubation time producing the most desirable beverage. After 6 hours of fermentation, the cell viable count increased by three log cycles. L. acidophilus produced the maximum sensory properties among the strains investigated (Kumar, 2017).

2.4.4. Milk and millet based Snacks

According to many scientific research, include whey proteins in daily snacks is responsible for lowering hypertension, cholesterol, dental difficulties, and cardiovascular disease, among other things. Whey protein supplemented bajra biscuits having a shelf life of 6 months for celiac disease patients (Gayathri, 2011). Whey derived from cheese is used in the creation of snack meals to boost the nutritional content of standard snack foods (Onwulata, 2001).

The snacks are made using Whey proteins, SMP, and pearl millet. She also found that extruded snacks based on whey nutrition and millets with reduced fat and moisture proportions might be promoted as protein-rich healthy snack food (Meena, 2016). Skim milk powder, little millet flour and green gram dhal in combination can be used effectively to develop protein rich mix (Srilekha and Bharati, 2022).

2.4.5 Composite milk-millet sweets and desserts

Traditional milk sweets, such as rasmalai, jalebi, gulabjamun, and khoa sweets, are popular throughout South Asia. Composite milk sweets include a wide range of components such as raw or roasted nuts, various types of flour, milk and milk solids, seasonal fruits and dried fruits.

South India now offers India's first 100% vegan millet milk ice cream parlour. An ice cream parlour in Trichy, Tamil Nadu, offers millet milk ice cream that is completely vegan. Burfi was made by substituting 57% of Bengalgram flour with foxtail millet flour, and the inclusion of foxtail millet flour significantly reduced blood glucose and cholesterol levels (Mamtha et al., 2003).

Sorghum bran peda was preparation with Sorghum bran powder, sugar, ghee, milk powder, and cardamom are the major components in these thick, semi-soft chunks. The sorghum bran is roasted and ground to a fine powder before being blended with powdered sugar, milk powder, and cardamom powder. Ghee is carefully poured to the flour and formed into little balls. Almond or cashew nuts are used to adorn the balls. In certain regions of Africa, millet is cooked into porridge with a thin or thick consistency, and in others, it is prepared into couscous (Obiana, 2003).

Manufacturing a dairy dessert based on pearl millet the best formulation with 18.49% dairy whitener and 6.0% pearl millet

and a process temperature of 87.5 °C yielded 46.76% of the product on the basis of the dairy whitener used.(Jha et al., 2013). Burfi developed by blending of10% roasted foxtail millet powder by weight of khoa with 30% sugar (Sujith et al., 2021).

2.4.6 Weaning or complimentary foods by millets addition

At the age of six months, a child's diet must include energy-dense meals known as weaning or complementary foods. Ready-to-eat complementary meals are generally mixes of cereal malt and milk solids all over the world because malt made from cereals like wheat and barley is a good source of key micronutrients that are often lacking in milk. Wheat gruel is a popular complementary food made at home as soft porridge for toddlers.

It has been observed that weaning combinations made up of 45 percent precooked pearl millet flour, SMP, groundnut oil, and sugar can help with energy deficiency (Guiro, et al. 1987). Weaning mixtures containing pearl millet (raw/malted/blanched), cow pea or mung bean, SMP, sugar, and ghee were well tolerated and had a long shelf life (Archana, 1997). A supplementary meal made from malted foxtail millet flour, wheat flour, skim milk powder, whey protein concentrate (WPC), ghee, and sugar and compared to commercially available cereal and milk solid based supplemental foods (Cerelac). According to his findings, the malted foxtail millet had the highest overall acceptance when combined with wheat flour in ratio of 30% to 40%. The storage investigations demonstrated that the product is suitable for 45 to 60 days and may be manufactured at both the industrial and domestic levels due to its simple formulation and has strong nutritional qualities (Murthy, 2015). Germinated, popped, and roasted millet flours, together with milk solids; legume flour, and other cereals, have been utilised to make low-cost weaning and supplementary meals (Singh et al., 2011).

Spray dried supplemental food made from whey, skim milk, germinated barley malt, pearl millet, and corn flour mixes. The optimised product was cooked for 15 minutes at 80°C by combining germinated and roasted pearl millet flour at 20%, barley malt extract at 15%, maltodextrin at 5.69%, maize flour at 5%, and whey-skim milk blend (in ratio of 4:1). The new technology is fairly simple, and the decreased processing and raw material costs make it appropriate for industrial manufacturing (Modi, 2009).The weaning blends were formulated with 42% sorghum, 20% legumes, 10% oil seeds, and 28% additives including skim milk powder (Asma et al., 2006).

Pearl millet baby food made from 70% flour, 13% malt, and 17% milk powder enhanced digestibility, decreased viscosity, and supplied enough protein and calorie levels for one-year-old children (Badi et al., 1990).

2.4.7. Millet- milk based Extrusion products

The extrusion procedure improves the iron availability of extruded weaning meals based on pearl millet, cowpea, peanut, or milk powder by 3.5 to 6.5 times that of roasted weaning foods (Cisse et al., 1998). The extruded precooked RTE weaning meal from sorghum, pearl millet, finger millet flour (60%) combined with roasted mung bean flour (30%) and nonfat dry milk (10%) had a decreased cooked (hot) paste viscosity and a high (cold) paste viscosity (Malleshi et al., 1996).Extrusion of baby food manufactured from 70% pearl millet and 30% cow pea contributed 17% of the daily protein, 72% lysine, and 110% threonine requirements of two-year-old children (Almeida-Dominguez et al., 1990).Iron and zinc supplemented pearl millet nutrimix made by extruding cleaned, soaked, germinated, and pearled pearl millet (Shuddhodhan, 2012). The preparing of composite millets milk powder with the combination of finger millet and pearl millet to prepare RTC extruded product from millet powder and maida (50:50) within acceptable ranges in terms of nutrient content, colour, texture, cooking quality, and sensory (Devi and Narayanasamy, 2013).

3. CONCLUSIONS

Millets are cereals that belong to the Poaceae grass family and were among the first crops to be domesticated. Millets are high in carbohydrates, protein, fats, vitamins; minerals as well as magnesium, manganese, and phosphorus are found in much higher concentrations than in other grains. Milk is considered a complete food, but it has been linked to several health problems due to high levels of saturated fatty acids and a lack of dietary fibre in milk. In recent years, there has been a surge in interest in using combination of millet and milk or milk product or unprocessed whey to produce composite dairy foods likes beverage, lassi, probiotic food, snacks, complementary foods, extruded foods and different types of sweets.. This review deals with the type of millets and possible applications of millets based composite millet-milk products development.

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