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A REVIEW ON NUTRITIONAL AND HEALTH BENEFITS OF MILLETS

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1.ABSTRACT

Millets are traditional grains, grown and consumed in the Indian subcontinent from the past more than 5000 years. Millets are small - grained, annual, warm - weather cereals belonging to grass family. They are rain - fed, hardy grains which have low requirements of water and fertility when compared to other popular cereals. They are highly tolerant to drought and other extreme weather conditions. Millets are nutri cereals comprising of sorghum, pearl millet, finger millet (Major millets) foxtail, little, kodo, proso and barnyard millet (minor millets). These are one of the oldest foods known to humanity. These are one of the several species of coarse cereal grasses in the family poaceae, cultivated for their small edible seeds. Pseudo millets are so called because they are not part of the Poaceae botanical family, to which 'true' grains belong, however they are nutritionally similar and used in similar ways to 'true' grains. Millets are highly nutritious, non-glutinous and non acid forming foods. Millets have many nutraceutical and health promoting properties especially the high fibre content. Millets act as a probiotic feeding for micro - flora in our inner ecosystem. Millets hydrate our colon to keep us from being constipated. Niacin in millet can help lower cholesterol. Millets contain major and minor nutrients in good amount along with dietary fibre. Millets are gluten free and can be a substitute for wheat or gluten containing grains for celiac patients.

Keywords: Millets, nutrient food, agriculture





2.Introduction

Millets are resilient to climate change as they are adapted to a wide range of temperatures, and moisture regimes, and demand less input to grow. They are hardy crops that have low carbon & water footprints[1,2]. It can sustain drought and even 350-400 mm of rainfall is sufficient for millets. Millets grow faster, putting less stress on the environment .In rice production, temperature increases are predicted to reduce rice yields. So, there is a need to consider adaptive measures to cope with changing agricultural patterns. Due to climate change, there is a decline in yield leading to food insecurity, more attacks of pests and diseases, soil degradation, change in crop schedules, and desertification[3]. Considering, millets as an alternative crop is a better choice and we can say it is the future crop.

India is the highest producer of millets in the globe and the 5th largest exporter of millets. Its exports are increasing exponentially as the demand for millets is increasing at a fast rate[4].Millets are addressing the need for fuel and feeds. It has the potential to produce biofuel.As the demand for millets is increasing, it is creating more business opportunities for entrepreneurs. Millet Market size was over USD 9 billion in 2018 and will witness more than 4.5% CAGR during the forecast timespan(2018-2025) and the value projected is more than USD 12 billion.

3. Nutritional Composition of various types of Millets with their Local Name

Millets are high in nutrition and dietary fibre. They serve as good source of protein, micronutrients and phytochemicals[5]. The millets contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fibre. The essential amino acid profile of the millet protein is better than various cereals such as maize. Millets contain fewer cross-linked prolamins, which may be an additional factor contributing to higher digestibility of the millet proteins. Similar to cereal proteins, the millet proteins are poor sources of lysine, but they complement well with lysine - rich vegetables (leguminous) and animal proteins which form nutritionally balanced composites of high biological value[6]. Millets are more nutritious compared to fine cereals. Small millets are good source of phosphorous and iron. Millets contributes to antioxidant activity with phytates, polyphenols, tannins, anthocyanins, phytosterols and pinacosanol present in it having important role in aging and metabolic diseases. All millets possess high antioxidant activities[7].

Table 1: Nutritional composition of Millets (mg/100 g)

Millets	Carbohydrates	Protein	Fat	Minerals	Fibre	References
Pearl millet	67.0	11.8	4.8	2.2	2.3	(Muthamilarasan <i>et al.</i> , 2016) [29]
Finger millet	72.05	7.3	1.3	2.7	11.5	(Shobana <i>et al.</i> , 2013) [45]
Foxtail millet	63.2	11.2	4.0	3.3	6.7	(Jaybhaye <i>et al.</i> , 2014) [22]
Kodo millet	66.6	9.8	3.6	3.3	5.2	(Saleh <i>et al.</i> , 2013) [38]
Proso millet	70.4	12.5	3.1	1.9	14.2	(Habiyaremye <i>et al.</i> , 2017) [17]
Little millet	65.55	8.92	2.55	1.72	6.39	(Dayakar Rao <i>et al.</i> , 2017) [10]
Barnyard millet	68.8	10.5	3.6	2.0	12.6	(Ugare <i>et al.</i> , 2011) [49]

Table 2: Mineral nutritional composition of Millets (mg/100 g)

Millets	Ca	P	Fe	Mg	K	Na	Mn	Cu	Zn	References
Pearl millet	46	379	8.0	137	442	12.0	1.8	1.06	3.1	(Himanshu <i>et al.</i> , 2018) [20]
Finger millet	137.33	158.43	1.46	6.38	35.19	3.70	2.85	0.06	0.48	(Sanusi <i>et al.</i> , 2019) [39]
Foxtail millet	23	310	3.2	130	270	10	2.2	0.9	2.1	(Serna-Saldivar <i>et al.</i> , 2019) [41]
Kodo millet	32.33	300	3.17	110	141	4.8	1.10	1.60	32.7	(Kumar <i>et al.</i> , 2018; Chandra <i>et al.</i> , 2016) [24, 8]
Proso millet	10	200	2.2	120	210	10	1.8	0.8	1.7	(Kumar <i>et al.</i> , 2018; (Serna-Saldivar <i>et al.</i> , 2019) [24, 41]
Little millet	30	260	20	133	370	8.1	20	4	11	(Himanshu <i>et al.</i> , 2018) [20]
Barnyard millet	22	280	18.6	82			0.96	0.60	3	(Chandra <i>et al.</i> , 2016) [8]

4. MILLETS PROCESSING TECHNOLOGIES

Millets processing technologies involve various methods and techniques to convert raw millet grains into more usable and marketable forms[8]. The specific processing steps can vary depending on the type of millet and the desired end product. Here are some common millet processing technologies:

- Cleaning and Grading:** The first step in millet processing involves cleaning the grains to remove impurities like dirt, stones, and other foreign particles[9]. Grading is also done to separate millets based on size and quality.
- Dehulling:** Millet grains are usually covered by a tough outer husk or hull, which needs to be removed to make the grain more edible and nutritious.
- Milling:** Milling is the process of breaking down millet grains into smaller particles. It can involve techniques such as grinding or crushing to produce millet flour or meal. Milling separates the grain into three components, germ, endosperm and seed coat[10]. Milling techniques practiced mostly depend on the end-use. Milling process starts with the cleaning of the grains, to remove unwanted impurities and broken grains, using vibratory sieves, aspirators and specific gravity separators[11]. The cleaned grains are conditioned, by addition of water, to soften the endosperm.
- Parboiling:** Parboiling is a heat treatment process where millet grains are soaked, steamed, and dried before milling[12]. This process enhances the nutritional value of the millets by improving their vitamin and mineral content. Parboiling could be an effective method to improve the decortication yield of millets as it has been one of the most valuable methods to increase rice yield. Parboiling process consists of three steps namely soaking, boiling/steaming, and drying.
- Decortication:** Decortication is a process similar to dehulling, where the outer husk of the millet is removed to obtain the edible kernel[13]. Decorticated finger millet is prepared by hardening the endosperm by hydrothermal processing and polishing the processed grains.

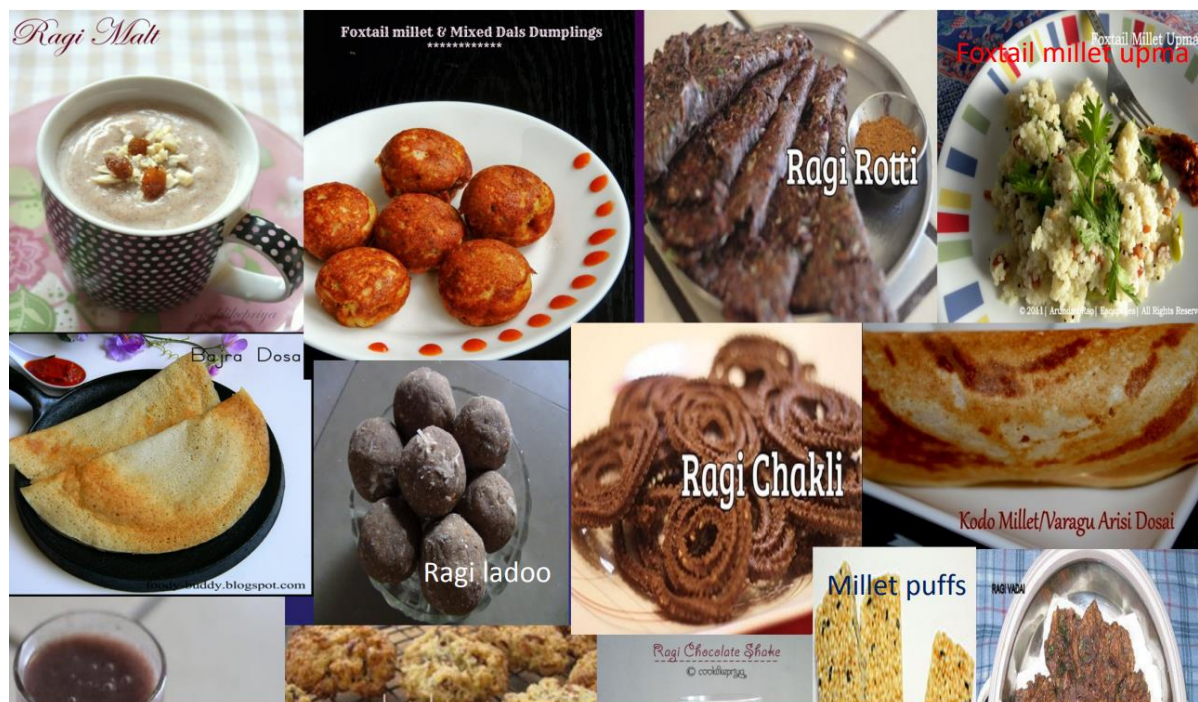
6. **Pearling:** Pearling is a polishing process that removes the bran layer from millet grains, producing polished millet[14]. This process is commonly used to produce pearl millet (bajra) for human consumption. In traditional pearling practices, the conditioning of finger millet grains are done by mixing grains with water and allowed to stand for 5 min[15]. Afterward, it pound with a wooden pestle for 10–15 min to detach the husk from the grains



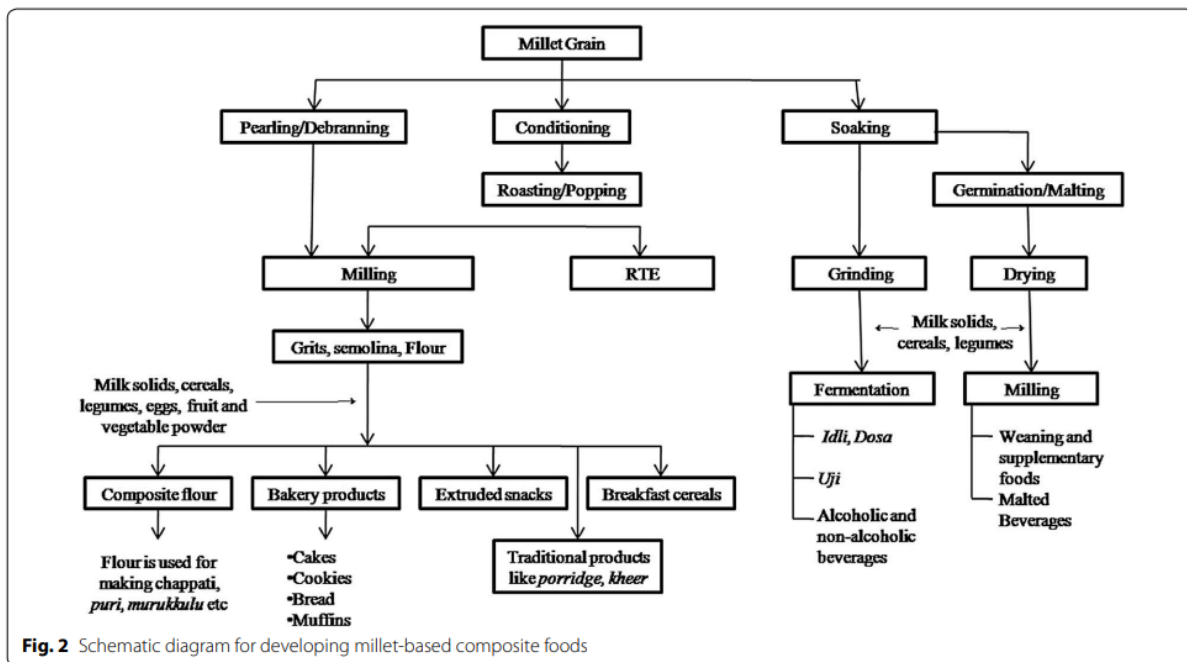
7. **Flaking:** Flaking involves pressing millet grains between rollers to produce flattened flakes, which can be used in various food products like breakfast cereals.
8. **Roasting:** Roasting millet grains can enhance their flavor and aroma, and it is a common practice in some traditional millet-based dishes[16].
9. **Malting:** Malting is a process that involves soaking and germinating millet grains to convert their starches into sugars[17]. The malted millet is then dried and used in the production of alcoholic beverages or other food products. Ragi or Finger Millet is cleaned, washed thoroughly and left to soak for 20-24 hours[18]. It is then sprouted over the next 24 hours in clean cotton cloths, further sun-dried and milled in stone grinders[19]. The sprouted ragi flour is then passed through a cotton cloth sieve to get fine sprouted-ragi malt.
10. **Extrusion:** Extrusion technology is used to produce millet-based snacks and ready-to-eat food products. Millet flours or blends are processed under high temperature and pressure to create various shapes and textures[20]. The flour is fed through the inlet opening into the screw barrel and is conveyed forwards. As a result of the backup ahead of the appropriate screw elements of die, a pressure is built up which leads to a compaction of the material.
11. **Fermentation:** Fermentation is used in some traditional millet-based food preparation to improve digestibility, enhance nutritional content, and add unique flavors to the final products [21]. The millet is soaked in water for about 72 h to ferment, it is strained, and the flour is mixed with water to form the dough. The dough ferments for about 2–4 days before it is used to prepare porridge.

5. USES OF MILLETS

Millets are a group of small-seeded grasses that have been cultivated and used as staple crops in various parts of the world for thousands of years. They are known for their resilience, nutritional value, and adaptability to different climates[22]. The primary uses of millets include:



1. **Human Consumption:** Millets are highly nutritious and are used as a staple food in many regions, especially in parts of Asia and Africa[23]. They are rich in protein, fiber, vitamins, and minerals, making them a valuable dietary source. Common millet varieties used for human consumption include pearl millet (bajra), foxtail millet, finger millet (ragi), and little millet.
2. **Animal Feed:** Millets are also used as fodder for livestock due to their high nutritional content and easy cultivation[24]. They serve as a valuable feed option for animals, especially in areas where other feed sources may be limited.
3. **Brewing:** Certain types of millets, such as finger millet (ragi), are used in the production of alcoholic beverages, including beer and traditional spirits.
4. **Traditional Medicine:** Millets have been used in traditional medicine systems in some cultures for their health benefits[25]. For example, finger millet is believed to have medicinal properties and is used in some traditional remedies.
5. **Gluten-Free Products:** Millets are naturally gluten-free, making them an excellent alternative grain for individuals with gluten sensitivity or celiac disease[26]. They are used to produce gluten-free flours, cereals, and other food products.
6. **Nutritional Supplements:** Millet-based products, such as millet flakes or millet-based energy bars, are becoming popular as nutritious and healthy alternatives to conventional processed foods.
7. **Soil Improvement:** Millets, like other cereal crops, contribute to soil improvement by adding organic matter and nutrients to the soil through crop residue after harvesting.



1.7 HEALTH BENEFITS OF MILLETS

Nutrient Content of Various Millets vs Rice and Wheat					
Crops	Protein (g)	Crude Fibre (g)	Total Minerals(g)	Iron (mg)	Calcium (mg)
Rice	6.8	0.2	0.6	0.7	10
Wheat	11.8	1.2	1.5	5.3	41
Finger millet	7.3	3.6	2.7	3.9	344
Pearl millet	10.6	1.3	2.3	16.9	38
Foxtail millet	12.3	8	3.3	2.8	31
Kodo millet	8.3	9	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17

Millets have a wide range of health benefits due to their nutritional composition and properties. Here are some of the key health benefits of consuming millets:

- High Nutritional Value:** Millets are rich in essential nutrients, including complex carbohydrates, dietary fiber, proteins, vitamins (such as B-complex vitamins), and minerals (such as iron, magnesium, phosphorus, and potassium) [27]. These nutrients are crucial for various bodily functions and overall health.
- Heart Health:** Certain millet varieties, like pearl millet (bajra), have been shown to have cardio-protective properties. The presence of antioxidants, fiber, and phytochemicals in millets can help reduce cholesterol levels, lower blood pressure, and support cardiovascular health.
- Blood Sugar Regulation:** Millets have a low glycemic index, which means they are digested slowly, leading to a gradual increase in blood sugar levels[28]. This characteristic makes millets a favorable choice for individuals with diabetes or those aiming to manage their blood sugar levels.

4. **Weight Management:** The high fiber content in millets promotes satiety, helping individuals feel fuller for longer and potentially aiding in weight management by reducing overall food intake.
5. **Digestive Health:** Millets are an excellent source of dietary fiber, which supports healthy digestion and helps prevent constipation. The fiber content also promotes a healthy gut microbiome.
6. **Antioxidant Properties:** Some millet varieties, like finger millet (ragi), are rich in antioxidants, such as phenolic compounds and flavonoids[29]. These antioxidants help combat oxidative stress and reduce the risk of chronic diseases.
7. **Bone Health:** Millets contain important minerals like calcium and phosphorus, which are vital for maintaining strong bones and preventing conditions like osteoporosis[30].
8. **Improved Immunity:** The vitamins and minerals present in millets, along with their antioxidant properties, contribute to enhancing the immune system's function and overall immune response[31].
9. **Energy Boost:** Millets are a good source of complex carbohydrates, providing sustained energy, making them a valuable choice for maintaining energy levels throughout the day[32].
10. **Gluten-Free Baby Food:** Some millets, such as finger millet (ragi), are used to make nutritious and easily digestible baby food in many cultures[33].

Remember that incorporating millets into a balanced and varied diet can contribute to these health benefits[34]. However, individual nutritional needs may vary, so it's always a good idea to consult with a healthcare professional or a registered dietitian for personalized dietary advice and recommendations.

11. **Erosion Control:** Millets can be grown as cover crops to prevent soil erosion, especially in hilly or sloping areas[35].
12. **Ethanol Production:** Some millet varieties have potential for use in biofuel production due to their high starch content, which can be converted into ethanol.
13. **High Nutritional Value:** Millets are rich in essential nutrients, including complex carbohydrates, dietary fiber, proteins, vitamins (such as B-complex vitamins), and minerals (such as iron, magnesium, phosphorus, and potassium) [36]. These nutrients are crucial for various bodily functions and overall health.
14. **Gluten-Free:** Millets are naturally gluten-free, making them a safe and nutritious grain option for people with celiac disease, gluten sensitivity, or those choosing a gluten-free diet.

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