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7. Nutraceutical Properties of Millets

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Abstract:

A long-term factor for health, development, and optimizing human genetic potential is nutritional well-being. As a result, it has been acknowledged that a community's nutritional state is a key predictor of its level of development.

Put another way, because it impedes on a country's ability to progress, malnutrition is considered a national issue. Dietary quality needs to be considered in order to address the issues of chronic food insecurity and malnutrition so Millets are considered a major grain in the world, however they are the least used. 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.

Keywords:

Millets, Health, Nutritional grain.

7.1 Introduction:

An ancient grain, millet is widely consumed in portions of Europe, Asia, and South America. This technically a seed but entire grain free of gluten is becoming more and more popular in the US as a substitute for quinoa or rice and as a component in some granola bars. As per the Whole Grains Council, millet ranks as the sixth most significant cereal grain globally. The Poaceae family of grasses includes the wide variety of millet varieties.

Due to its high nutritional content, the resilient crop is also widely consumed by humans in many parts of the world in addition to being planted for animal feed and bird seed. Furthermore, it can be processed into flour and utilized to make other goods, such as gluten-free bread.

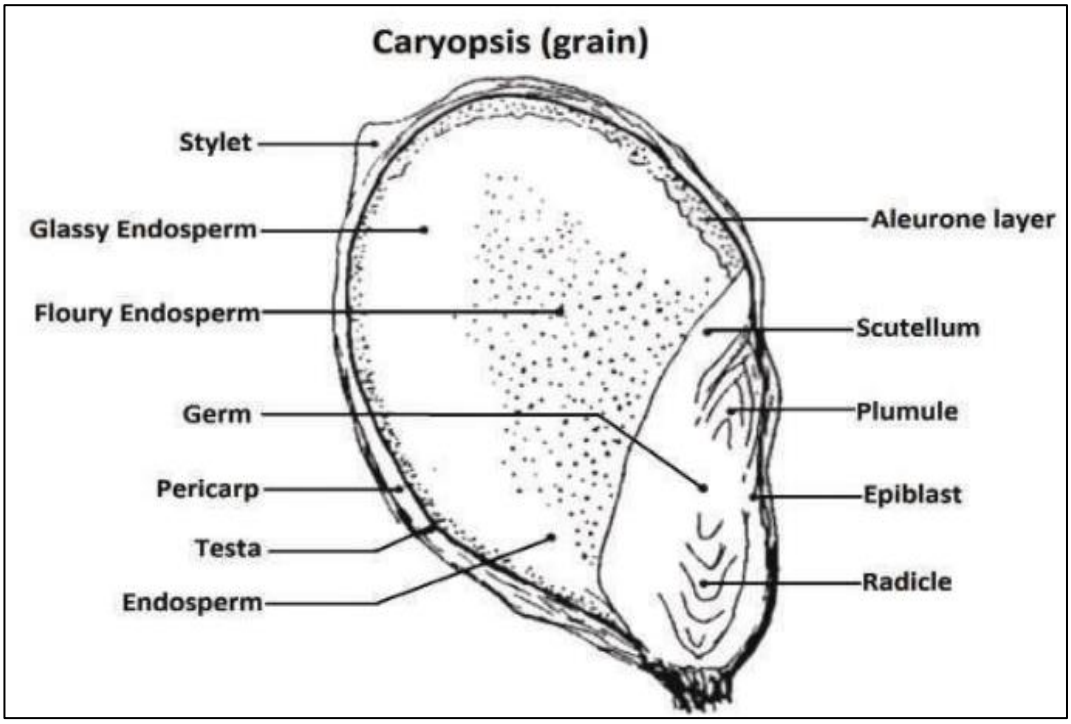

Figure 7.1: General Structure of Millet Grain

7.2 Types of Millets:

A. Sorghum:

One of the oldest cereal grains, sorghum is a major crop in both Africa and India. For patients with celiac disease and gluten sensitivity, it is regarded as a safe grain substitute. Based on molecular studies, sorghum grain is totally free of gluten and has several health benefits that make it a valuable complement to any diet. Grains like wheat, barley, and rye are frequently found to contain gluten, a protein that lends these grains their chewy, springy texture when baked into breads or pastas. Sorghum is substituted for wheat in baked goods like breads and pastas. It has also been proved that jowar, or sorghum, aids in weight loss.

Jowar has a higher calcium content than major cereals like wheat and rice. It is also a great source of fiber, protein, and iron. Studies have discovered that policosanols, which lower cholesterol, are abundant in ordinary sorghum wax. Because it is a gluten-free grain, people who are intolerant to wheat-based items also really appreciate it.

B. Finger Millet:

One of the healthiest grains is finger millet, which also has a good amount of natural calcium that protects bones and lowers the risk of bone fractures. Additionally, it is a good natural iron source that helps with anemia. Finger millet is regarded as a wholesome food that can take the place of wheat or rice. It is regarded as a nutritional storehouse that is high in minerals, vitamins, proteins, and amino acids. It is a good laxative and helps to avoid constipation because of its high fiber content.

Finger millet's high calcium amount makes it beneficial for young children, the elderly, and pregnant women. Because it helps in the production of enough breast milk, it is also particularly beneficial for breastfeeding mothers. Finger millet is an excellent diet for diabetics since it slows down the breakdown of carbohydrates in the blood and helps improve heart problems, blood pressure, asthma, and other medical conditions.

C. Pearl Millet:

Magnesium, which occurs in pearl millet, help patients with asthma with their breathing issues and reduces the effects of headaches. Pearl millet's fiber content contributes to a lower risk for gallstones. Because gall stones are caused by an excess of bile in the body, the insoluble fiber found in pearl millet aids in reducing this bile.

D. Kado Millet:

Kodo millet is a traditional grain that help with weight loss and tastes a lot like rice. It is highly digested and full of antioxidants and phytochemicals that help prevent a variety of problems linked to a certain lifestyle. In addition to treating knee and pain in the joints, kodo millet also helps women's menstruation to become regular.

E. Proso Millet:

Because Pellagra is a disorder brought due to niacin, or vitamin B3, Proso millet helps prevent it. Niacin is high in Proso millet. Skin becomes rough, scaly, and dry when suffering from pellagra. Protein and niacin, or vitamin B3, are found in Proso millet. It has long been utilized as a healing food, particularly after childbirth or sickness.

F. Foxtail Millet:

Since little millet is considered very small, its nutritious value does not decrease. It is a good source of calcium, iron, zinc, potassium, and B vitamins, among other minerals. Additionally, it gives the body sufficient fats to help in weight loss. An additional advantage is its high fiber content, which makes it good for kheer also or food in place of rice.

Foxtail millet facilitates the continuous release of glucose without affecting with the body's metabolism. Because foxtail millet is an excellent source of magnesium, it is also widely recognized as a heart-healthy diet and helps lower the prevalence of diabetes in humans.

G. Little Millet:

Since little millet is considered very small, its nutritious value does not decrease. It is a good source of calcium, iron, zinc, potassium, and B vitamins, among other minerals. Additionally, it gives the body sufficient fats to help in weight loss. An additional advantage is its high fiber content, which makes it good for kheer also or food in place of rice.

7.3 Nutraceutical Properties of Millet:

Similar to medications, the word "nutraceuticals" refers to these food-based bioactive substances that, when isolated, have a preventive impact against degenerative diseases. Millions of people worldwide utilize sorghum and millets, specifically Pearl, Finger, Kodo, Proso, Foxtail, Little, and Barnyard millets, as key staples.

These are typically rain-fed crops that are cultivated in low-lying regions, which makes them even more crucial to the sustainability of agriculture and food security.

In developed nations, the majority of millet is used for animal feed, but in most developing countries, almost all of it is consumed by humans. Millets are a good source of protein, minerals, and phytochemicals and are rich in nutrients sufficient to be compared to major cereals.

Methods of preparation like as heating, decortication, soaking, and malting impact the amount and activity of antioxidants. Finger millet has 12–16% protein and 2-5% lipids, compared to sorghum and most other millets' 10% protein and 3.5% lipid content. Millets and sorghum are excellent providers of micronutrients like vitamins and minerals. Prolamin, also known as kaffirin, makes up the majority of the protein in sorghum and has the unusual property of being less digestible when cooked.

In contrast, millets have a better amino acid profile. Sorghum proteins are reportedly much less digestible when cooked than those from other cereals, which may be advantageous for some dietary groups. However, millets have a lower concentration of cross-linked prolamins, which could be another reason for the millet proteins' increased digestibility.

Figure 7.2: Source pristineorganic.com

Table 7.1 provides an overview of the average nutritious profile of various grains, including millet. Table 7.2 lists the various millets' amino acid compositions.

Table 7.1: Proximate Composition and Dietary Fiber (per 100 g)

Millets and Cereals		Moisture (g)	Protein (g)	Ash (g)	Total Fat (g)	Dietary Fibre (g)			Carbo hydrates (g)	Energy (KJ)
						Total	Insoluble	Soluble		
Bajra (*Pennisetum typhoideum*)		08.97 ± 0.60	10.96 ± 0.26	1.37 ± 0.17	5.43 ± 0.64	11.49 ± 0.62	9.14 ± 0.58	2.34 ± 0.42	61.78 ± 0.85	1456 ± 18
Sorghum (*Sorghum vulgare*)		09.01 ± 0.77	09.97 ± 0.43	1.39 ± 0.34	1.73±0.31	10.22± 0.49	8.49 ± 0.40	1.73 ± 0.40	67.68 ± 1.03	1398 ± 13
Ragi (*Eleusine coracana*)		10.89 ± 0.61	07.16 ± 0.63	2.04 ± 0.34	1.92 ± 0.14	11.18 ± 1.14	9.51 ± 0.65	1.67 ± 0.55	66.82 ± 0.73	1342 ± 10
Little Millet (*Panicum miliare*)		14.23 ± 0.45	08.92 ± 1.09	1.72 ± 0.27	2.55± 0.13	06.39 ± 0.60	5.45 ± 0.48	2.27 ± 0.52	65.55 ± 1.29	1449 ± 19
Kodo Millet (*Setaria italica*)		14.23 ± 0.45	08.92 ± 1.09	1.72 ± 0.27	2.55 ± 0.13	06.39 ± 0.60	4.29 ± 0.82	2.11 ± 0.34	66.19 ± 1.19	1388 ± 10
Foxtail Millet *		-	12.30	-	4.30	-	-	-	60.09	331
Barnyard Millet *		-	06.20	-	2.20	-	-	-	65.55	307
Proso Millet *		-	12.50	-	1.10	-	-	-	70.04	341
Wheat	Whole	10.58 ± 1.11	10.59 ± 0.60	1.42 ± 0.19	1.47 ± 0.05	11.23 ± 0.77	9.63 ± 0.19	1.60 ± 075	64.72 ± 1.74	1347 ± 23
	Refined flour	11.34 ± 0.93	10.36 ± 0.29	0.51 ± 0.07	0.76± 0.07	02.76 ± 0.29	2.14 ± 0.30	0.62 ± 0.14	74.27 ± 0.92	1472 ± 16
	Atita	11.10 ± 0.35	10.57 ± 0.37	1.28 ± 0.19	1.53 ± 0.12	11.36 ± 0.29	9.73 ± 0.47	1.63 ± 0.64	64.17 ± 0.32	1340 ± 07
	Semolina	08.94 ± 0.68	11.38 ± 0.37	0.80 ± 0.17	0.74 ± 0.10	09.72 ± 0.74	8.16 ± 0.58	1.55 ± 0.18	68.43 ± 0.99	1396 ± 18
Rice	Raw Brown	09.33 ± 0.39	09.16 ± 0.75	1.04 ± 0.18	1.24 ± 0.08	04.43 ± 0.54	3.60 ± 0.55	0.82 ± 0.15	74.80 ± 0.85	1480 ± 10
	Raw milled	09.93 ± 0.75	07.94 ± 0.58	0.56 ± 0.08	0.52 ± 0.05	02.81 ± 0.42	1.99 ± 0.39	0.82 ± 0.22	78.24 ± 0.68	1491 ± 15
	Parboiled	10.09 ±.0.43	07.89 ± 0.63	0.65 ± 0.8	0.55 ± 0.08	03.74 ± 0.36	2.98 ± 0.35	0.76 ± 0.09	77.16 ± 0.76	1471 ± 8
Quinoa (*Cheno podium quinoa*)		10.43	13.11	02.65	5.50	14.66	10.21	4.46	53.65	1374
Amaranth Seed	Black	09.89	14.59	02.78	5.74	07.02	5.76	1.26	59.98	1490
	Pale Brown	09.20 ± 0.40	13.27 ± 0.34	3.05 ± 0.30	5.56 ± 0.3	07.47 ± 0.09	5.80 ± 0.17	1.67 ± 0.21	61.46 ± 0.60	1489 ± 10
Maize	Dry	09.26 ± 0.55	08.80 ± 0.49	1.17 ± 0.16	3.77 ± 0.48	12.24 ± 0.93	11.29 ± 0.85	0.94 ± 0.18	64.77 ± 1.58	1398 ± 25

Source: *Indian Food Composition Tables, NIN – 2017 and *Nutritive value of Indian foods, NIN – 2007*

Table 7.2: Mineral and Trace Elements compared to fine cereals (mg/g of N)

Millets and Cereals		Aluminium (mg)	Arsenic (mg)	Cadmium (mg)	Calcium (mg)	Chromium (mg)	Cobalt (mg)	Copper (mg)	Iron (mg)	Lead (mg)	Lithium (mg)
Bajra (*Pennisetum typhoideum*)		2.21 ± 0.78	0.97 ± 0.24	0.003 ± 0.001	27.35 ± 2.16	0.025 ± 0.006	0.030 ± 0.015	0.54 ± 0.11	6.42 ± 1.04	0.008 ± 0.002	0..003 ± 0..001
Sorghum (*Sorghum vulgare*)		2.56 ± 0.59	1.53 ± 0.04	0.002 ± 0.002	27.60 ± 3.71	0.010 ± 0.003	0.012 ± 0.007	0.45 ± 0.11	3.95± 0.94	0.008 ± 0..003	0.001 ± 0.001
Ragi (*Eleusine coracana*)		3.64 ± 0.69	-	0.004 ± 0.004	364 ± 58	0.032 ± 0.019	0.022 ± 0.009	0.67± 0.22	4.62 ± 0.36	0.005 ± 0.002	0.003 ± 0.003
Little Millet (*Panicum miliare*)		-	0.49 ± 0.15	0.001 ± 0.000	16.06 ± 154	0.016 ± 0.006	0.001 ± 0.00	0.34± 0.08	1.26± 0.44	-	-
Kodo Millet (*Setaria italica*)		1.07 ± 0.83	-	-	15.27 ± 1.28	0.021 ± 0.027	0.005± 0.003	0.26± 0.05	2.34 ± 0.46	-	0.027 ± 0.003
Foxtail Millet *		-	-	-	-	0.030	-	1.40			
Barnyard Millet *		-	-	-	-	0.090	-	0.60			
Proso Millet *		-	-	-	-	0.020	-	1.60			
Wheat	Whole	0.55 ± 0.23	-	0.002 ± 0.001	39.36 ± 5.65	0.006 ± 0.003	0.003 ± 0.002	0.49 ± 0.12	3.97 ± 0.78	-	0.005 ± 0.004
	Refined flour	0.94 ± 0.33	-	0.001 ± 0.000	20.40 ± 2.46	0.005 ± 0.002	0.001 ± 0.001	0.17 ± 0.02	1.77 ± 0.38	0.004 ± 0.002	0.003 ± 0.003
	Atta	1.54 ± 0.53	-	0.01 ± 0.001	30.94± 3.65	0.006 ± 0.005	0.006 ± 0.003	0.48 ± 0.11	4.10 ± 0.67	0.006 ± 0.003	0.002 ± 0.001
	Semolina	0.64 ± 0.19	-	0.002 ± 0.001	29.38 ± 2.11	0.006 ± 0.003	0.003 ± 0.002	0.46 ± 0.11	2.98 ± 0.34	0.004 ± 0.000	0.002 ± 0.002
Rice	Raw Brown	0.60 ± 0.18	-	0.002 ± 0.001	10.93 ± 1.79	0.005 ± 0..002	0.011 ± 0.003	0.37 ± 0.14	1.02 ± 0.35	0.002 ± 0.001	-
	Raw milled	0.44 ± 0.30	-	0.002 ± 0..002	7.49 ± 1.26	0.005 ± 0..003	0.003 ± 0.002	0.23 ± 0.06	0.002 ± 0.66	0.002 ± 0.66	0.002 ± 0.66
	Parboiled	0.20 ± 0.06	-	0.002 ± 0.003	8.11 ± 1.01	0.005 ± 0..002	0.003 ± 0.001	0.27 ± 0.12	0.72 ± 0.20	0.006 ± 0..002	0.005 ± 0.002
Quinoa (*Chenopodium quinoa*)		-	0.03	0.002	198	0.004	-	0.48	751	-	-
Ama-ranth Seed	Black	3.32	-	-	181	1.227	0.059	0.81	9.33	0.013	0.028
	Pale Brown	2.73 ± 0.47	-	0.001 ± 0.000	162 ± 15.7	0.092 ± 0.045	0.021 ± 0.005	0.56 ± 0.09	8.02 ± 0.93	0.018 ± 0.012	0.008 ± 0.008
Maize, Dry		2.82±0.16	-	-	8.94 ± 0.61	0.010 ± 0.006	0..010 ±0.003	0.45 ± 0.23	2.49 ± 0.32	-	0.002 ± 0.001

Source: *Indian Food Composition Tables, NIN – 2017 and *Nutritive value of Indian foods, NIN – 2007*

Finger millet has approx. 5-8% protein, 65-75% carbs, 15-20% dietary fiber, and 2.5–3.5% minerals. When it comes to nutritional characteristics, millets are not only on par with main cereals but also excellent providers of vitamins, carbs, and phytochemicals with nutraceutical properties. Millets are composed of 7–12% protein, 2-5% fat, 65–75 percent carbs, and 15-20 percent dietary fiber. Of these, finger millet has lower levels of fat (1.5-2%) and protein (6-8%) than pearl millet, which has a significantly higher proportion of lipids (4-6%) and proteins (12-16%). Millet protein has superior essential amino acid profiles than maize protein. Pearl millet has more niacin than any other cereal, however finger millet proteins are special due to their high sulfur concentration of amino acids. Millet proteins, like those from cereals, are not rich in lysine. However, they combine well with vegetable (leguminous) and animal proteins to create nutrient-rich composites with high biological value. Fine cereals are less nutrient-dense than small millets. The best source of calcium is finger millet (300–350 mg/100 g), while other little grains are an excellent source of iron and phosphorus.

7.4 Nutritional Characteristics:

A. Carbs:

Sorghum has three primary types of carbs: starch, soluble sugar, and fiber (which includes cellulose, hemicellulose, and pentasons).

The carbohydrates from millet are categorized as either structural (cellulose, hemicelluloses, and pectin compounds) or non-structural (sugars, starch, and fructosans). Starch is the main type of non-structural carbohydrate (NSC). The primary component of regular sorghum is amylopectin. The most prevalent changes have high amylose starch and waxy (only containing amylopectin).

B. Starch:

Amylase and amylopectin molecules are glued together by hydrogen bonds and severely arranged in spherical granules to form the highly ordered structure of starches. During germination, starch serves as the primary energy source. It consists of linear glucose chains linked by α-1, 4-glycosidic linkages, also known as amylopectin.

The polymer amylopectin is significantly bigger and branched. Sometimes the starch is discolored by the pigments in the pericarp of millet grains, giving it shades of a light pink, green, and yellow.

C. Soluble Sugar:

Caryopses' soluble sugar concentration varies during development, obtaining a high of 5.2%. The average soluble sugar concentration at maturity was 1.3% (0.8-4.2%), with sucrose accounting for 75% of the total sugars. 2.2 to 3.8% soluble sugars, 0.9 to 2.5% free reducing sugars, and 1.3 to 1.4% non-reducing sugars are present in mature caryopses.

The ranges for fructose and glucose were 0.3 to 0.7% and 0.6 to 1.8%, respectively. More soluble sugars are present in millets that are sweet and high in lysine.

D. Dietary Fiber:

Iron, magnesium, and zinc, decreasing their bioavailability. Dietary fibre also generates short-chain fatty acids like butyrate, propionate, and acetate during fermentation in the colon, which is the second method by which it has therapeutic benefits. By acting as a source of energy, butyrate promotes the regeneration of colon mucosal cells and lowers the risk of inflammatory bowel disease and colon cancer.

The resulting short-chain fatty acids—propionate and acetate in particular—are absorbed into the splenic circulation and moved to the liver, where they are known to prevent hepatocytes from synthesizing cholesterol and to release glucose from the liver. This action of the fatty acids is partially responsible for the hypocholesterolemia and hypoglycemic effects of dietary fiber.

Sorghum has a high concentration and diversity of phytochemicals, however research on this crop's potential as a source of beneficial substances for health is still behind that of other commodities (such fruits and vegetables). Therefore, there is very little use of sorghum fractions in food to enhance nutrition. Given their agronomic qualities and the mounting knowledge regarding the biological impacts of the phytochemicals found in millets, millets have a lot of potential.

The range of free lipids in pearl millet is 5.6-7.1%, while the range of bound lipids is 0.57-0.90%.Hydrocarbons, triglycerides, mono- and di-glycerides, and free fatty acids make up the free lipid fraction, whereas lecithin and other substances make up the bound lipid fraction, which lacks free fatty acids. Unsaturated fatty acids, which make up 70.3% of the total free lipid content in pearl millet, are abundant in the free lipid content. Linoleic, oleic, and palmitic acids are the primary fatty acids present in free lipids.

Pearl millet was thought to have a higher lipid content than other cereals. Estimated that the free lipids' polar and nonpolar fractions ranged from 0.17 to 0.31% and from 2.6 to 4.1%, respectively. The nonpolar and polar percentages for bound lipids ranged from 0.09 to 0.16% and from 0.23 to 0.29%, respectively. Because of its high ratio of nonpolar to polar fractions of total lipid (5.9 to 7.8%), millets are not as appropriate for manufacturing bread. The same components, in varying ratios, are present in the nonpolar fraction of both bound and free lipids. Triglycerides were the main component, with the presence of hydrocarbons, easterly esters, sterols, fatty acids, and partial glycerides.

It was discovered that lecithin constituted the majority of the polar lipids. Linoleic, oleic, palmitic, and stearic acids were the main fatty acids found in pearl millet. On average, the unsaturated acids accounted for 52% of the bound and 70% of the free lipid fractions.

Kodo millet is high in minerals including calcium, iron, potassium, magnesium, and zinc as well as B vitamins like niacin, pyridoxine, and folic acid. It has a low fat level and is high in fiber. It is a great way to fortify the neurological system and has a high lecithin content.

Additionally rich in key amino acids such as arginine, lysine, methionine, lecithin, etc., finger millet serves several vital health-promoting roles, including: 1. Acts as a precursor for the generation of nitric oxide. 2. Growth hormone release is stimulated. 3. Enhances the capacity for reproduction and the immune system. 4. Shortens the time it takes for injuries (especially bone) to heal. 5. Reduces time needed for damaged tissue to heal. 6. Lowers the danger of adipose tissue body fat and heart disease. 7. Promotes better blood circulation and muscle mass. 8. Increase insulin sensitivity and aid in memory formation, among other things. 9. Lower your blood pressure. 10. Enhances sperm motility and production, reducing male infertility.

Good concentrations of phospholipids, which include cephalism and lecithins, have additional benefits. Other cereals' phospholipids, such as those found in rice, wheat, corn, etc., are extracted and dissolved in oils, making them unavailable to consumers. These substances play a significant role in overall metabolism and, due to their concentration in the brain, are beneficial for stress management, behavioral disorders, and brain function. They safeguard the gastrointestinal tract, kidneys, liver, and lungs in addition to aiding in membrane regeneration. It is well known that these substances increase the bioavailability of other nutrients and medications.

7.5 Conclusion:

Millets are a valuable crop in tropical and semiarid regions of the world because of their short growing season, tolerance to pests and diseases, and productivity in hot and dry conditions when main cereals aren't dependable for yields that are sustainable. Approximately 90% of the millets produced worldwide are used in underdeveloped nations, and the remaining 2/3 are eaten as food. Traditionally, the impoverished people has consumed them as foods that promote health and vigor. The nutritional potential of millets is similar to that of famous cereals like rice, wheat, and barley in terms of protein, carbs, and energy contents. The majority of the health advantages linked to millets are mostly attributed to the high concentration of certain minerals, vitamins, and trace elements as well as phytochemicals such dietary fiber, polyphenols, and tocopherols. Millets are said to provide many health benefits, some of which have greater scientific backing. Millets are still seen as an essential for the underprivileged. To ensure that consumers receive the right advantages, many processed items must be optimized. There is potential for using millet to prepare nutritious meals. Due to their health benefits that are these grains do require significant promotion in order to move ahead of the major cereals in terms of consumption.

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