



# MILLETS: NUTRITIONAL COMPOSITION- A REVIEW

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## Abstract-

Millets are a group of small-grained cereals belonging to the grass family Graminae that are drought-resistant and resistant to other extreme weather conditions. They are grown with low chemical inputs such as fertilizers and pesticides. They are categorized as major and minor millets, including sorghum, pearl, and finger millet, while proso, barnyard, kodo, little, and foxtail millets come under minor millets. These are good sources of food for poor and normal people from ancient times. Millets are necessary to add to our diet because of their rich source of minerals and nutrients and their health benefits. They are rich in protein and, most importantly, gluten-free. They are a rich source of phytochemicals. Among these, proso millet has the highest protein (12.5 g/100 g), followed by foxtail (12.3 g/100 g) and bajra (11.6 g/100 g). The fat content is higher in little millet (4.7 g), followed by foxtail (4.3 g). Barnyard millet has 9.8 g of crude fiber, which is higher than any other millet like kodo (9.0 g) and foxtail (8.0 g). They have good sources of energy, ranging from 310 to 360 kcal.

**Key words:** Graminae, Phytochemicals, Millets, Dietary fibers, Amylose, Amylopectin

## 1. Introduction-

Millets are cereal crops belonging to the grass family *Graminae* (Karuppasamy 2015), small in size, and are used as food, feed and fodder (Bhat *et al.*, 2017). Millet is one of the oldest foods and possibly the first grain used for domestic use. These crops required a dry, high temperature, and short growing seasons (Rao *et al.* 2017). It is being able to go from planted seeds to mature, harvest-ready plants in as little as 65 days (Michaelraj and Shanmugam 2013). These are better adapted to dry, barren soils than most other crops. Millet is an important crop for dry land farmers and is traditionally grown in India in arid and semi-arid regions in areas of low rainfall (< 450 mm) (Bhat *et al.*, 2018). Chemical fertilizers are not necessary for millet production. Millets considered

as poor man crop i.e., it is a cheap crop which can be affordable by low-income group people (Himanshu, *et al.*, 2018). As a group, millets are C<sub>4</sub> plants, and the enhanced water and nitrogen usage efficiency of C<sub>4</sub> plants is a factor in grain productivity (Diwevedi S. *et al.* 2012). According to Chhangmei and Jaganathan (2014), pearl millets, foxtail millets, proso millets, and finger millets are four major millets cultivated on large scale.

In India, Millet comes under coarse cereals type. According to size and grown area, the millets are classified into two categories i.e. major millets and minor millets (Rao *et al.*, 2016; Bhat *et al.*, 2018). Sorghum (sorghum bicolor L. Moench /*jowar*), finger millet (Eleusine coracana (L.) Gaertn./*ragi/mandua*) and pearl millet (Pennisetum glaucum (L.) R. Br./*bajra*) fall under major millets category while foxtail millet (Setaria italic Beauv./*kangni/Italian millet*), little millet (Panicum miliare Lam./ *kutki*), kodo millet (Paniculam serobiculatum L./Kodo), barnyard millet (Echinochloa frumentacea (Roxb.) L./*sanwa*), proso millet (Panicum miliaceum L./*cheena/common millet*) and brown top (Brachinria ramosa (L.) Stapf; Panicum ramosum L.) millets fall under minor millets category (Verma and Khurana 2019). Buck-wheat (Fagopyrum esulentum L. and F. tatarium L./*ugal/Kuttu*) and amaranth (Amaranthus hypochondriacus L./ *ramdana/Chaulai*) included as pseudo millets (Verma and Khurana 2019, Khulbe RK *et al.* 2014, Dwivedi *et al.* 2012 and Bhat *et al.*, 2018).

Millets are highly rich in nutrients, that's why is called Nutri-cereals (Bhat *et al.*, 2017). They have high nutritional values and nutraceuticals properties. The millets are rich source of protein, essential fatty acids, dietary fiber, vitamins, and minerals and have a low glycemic index (Rao *et al.* 2016). These are also rich in antioxidants in the form of phytochemicals such as phenolic acids, flavonoids, catechins, phytic acid, and phytosterols (Himanshu *et al.*, 2018). These grains are gluten free and good for gluten intolerant persons (Verma and Khurana 2019).

## 2. Nutritional composition of millets-

Millets are a storehouse of nutrients contained macro and micro nutrients. Sorghum and other millets are well renowned for being highly nutritious and having a minimal carbon footprint (Seetha A. *et al.*, 2021). Millets have a similar energy content as regular cereals (Gowda *et al.*, 2022). In terms of protein, minerals, and vitamins, each millet is three to five times more nutritionally superior to the frequently marketed rice and wheat (Kalaiselvi *et al.*, 2016).

**Table-1: Comparative Nutrients Profile of Millets with Rice and Wheat**

Nutrients	Food grains									
	Sorghum	Pearl millet	Finger millet	Kodo millet	Proso millet	Foxtail millet	Little millet	Barnyard millet	Wheat	Rice
Carbo-hydrates (g)	67.7	61.8	66.8	66.2	70.4	60.9	65.5	65.5	64.7	78.2
Protein (g)	09.9	10.9	07.2	08.9	12.5	12.3	10.1	06.2	10.6	07.9
Fat (g)	1.73	5.43	1.92	2.55	1.10	4.30	3.89	2.2	1.47	0.52
Energy (kcal)	334	347	320	332	341	331	346	307	322	356
Dietary Fiber (g)	10.2	11.5	11.2	06.4	2.2	8.0	7.7	9.8	11.2	02.8
Ca (mg)	27.6	27.4	364.0	15.3	14.0	31.0	16.1	20.0	39.4	07.5
P (mg)	274	289	210	101	2.06	290	130	280	315	96
Mg (mg)	133	124	146	122	153	81	91	82	125	19
Zn (mg)	1.9	2.7	2.5	1.6	1.4	2.4	1.8	3.0	2.8	1.2
Fe (mg)	3.9	6.4	4.6	2.3	0.8	2.8	1.2	5.0	3.9	0.6
Thiamin (mg)	0.35	0.25	0.37	0.29	0.41	0.59	0.26	0.33	0.46	0.05
Riboflavin (mg)	0.14	0.20	0.17	0.20	0.28	0.11	0.05	0.10	0.15	0.05
Niacin (mg)	2.1	0.9	1.3	1.5	4.5	3.2	1.3	4.2	2.7	1.7
Folic acid (µg)	39.4	36.1	34.7	39.5	-	15.0	36.2	-	30.1	9.32

(Longvah *et al.* (2017), Bhat *et al.*, 2018; Gopalan C. *et.al.* 2018).

Karuppasamy, (2015) reviewed that the millets contained higher amounts of vitamins especially vitamin B (niacin, thiamine, riboflavin, pyridoxine, and folic acid), and minerals (calcium, iron, potassium, magnesium, phosphorous, and zinc). Bhat *et al.*, (2017) studied that millets are rich in calcium, dietary fiber, polyphenol and protein contents. The amino acids such as methionine and cystine present in the millets in significant amount.

## 2.1 Carbohydrate

The proso millet contains higher carbohydrate content (70.4g) than foxtail millets (60.1g) (Table-1). Himanshu *et al.*, (2018) reported that carbohydrate in milled millet present in the form of free sugars (2–3%), non-starchy polysaccharides (15–20%), and starch (60–75%). Free sugar consists of glucose, fructose, and sucrose; non-starchy polysaccharides regarded as dietary fibers that are cellulose, hemicellulose, and pectinaceous material while starch present in millets as amylose and amylopectin in the ratio of 25:75. Nazni and Shobana D. (2016) found that even under hot conditions (boiled and pressure cooked) the starch of barnyard millet flour and foxtail millet flour was stable with low breakdown viscosity.

## 2.2 Fat

Millets contain around 2% to 5% fat (Verma and Khurana 2019). The proso millet has lower in fat (1.2 g/100g) compared to the foxtail millet varieties (Devisetti *et.al.* 2014). Table -1 shows that lowest fat present in finger and proso millet, around (1-2%) and highest in pearl, foxtail, and little millets, around (3-5%). Himanshu *et al.*, (2018) studied that fat is majorly distributed in bran layer and endosperm part of millet. Around 24% of total kernel fat only present in embryo. The fatty acid profile revealed that the content of saturated fatty acids is 17.9–21.6% while unsaturated fatty acids content is 78–82%.

## 2.3 Protein

Maximum protein content found in proso millet (12.5g) and foxtail millet (12.3g) (Pawar and Girish,2005) followed by pearl millet (10.9g) while barnyard millet has minimum protein content (6.2g) as shown in Table -1. Himanshu *et al.*, 2018 reported that albumins, globulins, cross-linked prolamin, glutelin-like, glutelin, etc., type of protein fractions found in millets. Millets are richer in prolamin and glutelin fractions followed by albumin + globulin fractions. Prolamin content of the total protein fraction highest in foxtail millets (47.6–63.4%), followed by finger millet (24.6–36.2%) and pearl millet (22.8 - 31.7%). Glutelin is higher in case of finger millet (12.4–28.2% of total protein) than foxtail (6.7% of total protein). In the millets, the combination of Albumin and Globulin fraction found in the ranges of 11.6 - 29.6% . Table- 2 shows the essential amino acid composition of minor millets.

**Table-2: Essential amino acid composition of millets**

Name of essential amino acids	Name of small millets			
	Foxtail millets	Proso millets	Kodo millets	Little millets
Approximate total N gm. /100 gm.	1.97	2.00	1.33	1.23
Arginine (mg. /gm.N)	220	290	270	250
Histidine (mg. /gm.N)	130	110	120	120
Lysine(mg. /gm.N)	140	190	150	110
Tryptophan(mg. /gm.N)	60	50	50	60
Phenylalanine(mg. /gm.N)	420	310	430	330
Methionine(mg. /gm.N)	180	160	180	180
Cystine(mg. /gm.N)	100	-	110	90
Threonine(mg. /gm.N)	190	150	200	190
Leucine(mg. /gm.N)	1040	760	650	760
Isoleucine(mg. /gm.N)	480	410	360	370
Valine(mg. /gm.N)	430	410	410	350

(Gopalan *et.al.*, 2018)

## 2.4 Fiber

People are experiencing numerous health issues as a result of fiber-free foods (Singh *et al.* 2022). Millets contain around 15-20% dietary fiber (Verma and Khurana 2019). Maximum dietary fiber content found in Pearl millet (11.5g) followed by finger millet (11.2g) and minimum in kodo millet (6.4g) Shown in Table 1. Himanshu *et al.*, (2018) reported that pearl millet contained water-insoluble (3.88%) and water-soluble (0.66%) non-starch polysaccharides while the pentosans content in finger millet and foxtail millet was 6.6 and 5.5%, respectively. They also studied that little, kodo, and barnyard millets have hemicelluloses A (composed of non-cellulosic beta-glucan) and hemicelluloses B (composed of hexose, pentose, and uronic acid).

## 2.5 Vitamins & Minerals

Table 1 shows that the maximum Thiamin (vitamin B1) present in foxtail millet (0.59mg), Riboflavin (vitamin B2), and Niacin (vitamin B3) maximum in proso millet 0.28mg and 4.5mg, respectively and Folic acid maximum in kodo millet (39.5µg). Himanshu *et al.*, 2018 studied that millets are rich in Vitamin E and B-complex vitamins (except Vitamin B 12). But tocopherol content in millets is lesser than in soybean. In millets, the tocopherols usually present as  $\gamma$ -isomer while  $\alpha$ -tocopherol content is very low. Vitamin E activity of  $\gamma$ -tocopherol is less than that of  $\alpha$ -tocopherol.

Minerals play a significant role in human health. Himanshu, *et al.* (2018) studied the mineral contents in major and minor millets and found that finger millet is rich in calcium and manganese contains 294-390mg/100g and 5.0-5.5 mg/100g, respectively. Maximum amount of phosphorous, contained in pearl millet i.e., 350-379 mg/100g. Potassium contained in pearl millet 440-442 mg/100g while in finger millet it is 408-570mg/100g. Zinc and iron found maximum in little millet i.e., 3.5-11mg/100g and 13-20mg/100g, respectively. Minor millets are rich source of magnesium and copper and found maximum in kodo millet i.e., 130-166 mg/100g and 1.6-5.8mg/100g.

As wheat, rice, maize, and sorghum do, pearl millet obtains soil nutrients thanks to its deep root structure. This crop is rich in iron, zinc, magnesium, copper, manganese, potassium, and phosphorus, among other minerals. It contains a lot of fiber and is a wonderful source of energy (Thakur *et al.* 2018). The high nutrient content of millet, a type of cereal, is known to include minerals including calcium, iron, zinc, potassium, and magnesium as well as protein, essential fatty acids, dietary fibre, and B vitamins (Rao Dayakar *et al.*, 2018).

## Conclusion-

Millets are healthy grain varieties. They are a great source of complex carbohydrates, protein, dietary fibers, vitamins, minerals, and phytochemicals, which are compounds that function as nutraceuticals or antioxidants. The aforementioned study indicates that finger millet had the lowest amounts of fat and a higher carbohydrate content than proso millet. Conversely, the fat contents of pearl, foxtail, and small millets are higher. Foxtail and proso millets have the highest protein content. Pearl millet has the greatest dietary fiber content of all the millets. While foxtail millet is high in vitamin B1, proso millet is high in vitamins B2 and B3. Finger millets contain the highest concentration of minerals. Even semi-arid and dry areas with poor fertility can support their growth.

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