

# Alternative grains in nutrition

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**Abstract.** Many people suffer from gluten sensitivity or gluten intolerance. They have to avoid or limit their gluten intake. Sorghum and millet are gluten-free cereals, wherefore persons with gluten sensitivity or gluten intolerance could consume them. Moreover, they have a lot of positive effects due to their phenolic compounds as phenol acid or flavonoid. Antioxidant activity in sorghum is especially high in comparison with other cereals. Our aim was to compare literature data about the chemical compositions of sorghum and millet with other grains.

## 1 Introduction

Sorghum and millet have an important role in the semi-arid tropics of Asia and Africa. These crops are the main sources of energy, protein, vitamins, and minerals for millions of the poorest people in these regions (FAO, 1995). Due to their antioxidant activity, they have a great benefit for the human organism. They have a positive effect on gut microbiota and work as inhibitors of chronic diseases (obesity and cancer). Moreover, sorghum contains carotenoids and has a high content of vitamin E (*Cardoso et al.*, 2015).

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**Keywords and phrases:** gluten, sorghum, millet, chemical compositions

## 1.1 Alternative grains

Sorghum and millet are alternative grains, which are cultivated in small areas. Their uses are mostly traditional (Berényi, 2013). There are major emerging uses for gluten-free food and beverage products (Taylor & Duodu, 2010).

### Sorghum

*Sorghum bicolor* (L.) is the fifth most important cereal in the world after rice, wheat, maize, and barley (Food Security Department, 1999). It can grow under excessive heat or in infertile soils (Mokrane *et al.*, 2010). The sorghum's area is 42 million ha. The biggest part is situated in Africa (24,5 million ha) and in Asia (10,6 million ha). In India, this number is 9,1 million ha, in USA is 6,6 million ha, and in Australia is 0,7 million ha (Kiran, 2014). The crop is suited to hot and dry agroecologies. Sorghum production includes two groups:

- group I countries (mainly in Asia and Africa) use sorghum for food;
- group II countries (developed and some developing countries) produce sorghum for animal feed. The crop yields an average of 3–5 t/ha (FAO, 1996).

Sorghum has the following species:

- *Sorghum vulgare Pers var. technicum*
- *Sorghum vulgare Pers var. saccharatum*
- *Sorghum vulgare Pers var. frumentaceum*
- *Sorghum vulgare Pers var. sudanense* (Németh, 2009).

### Millet

Millet (*Panicum miliaceum* L.) is a small-grained cereal. The most important strains of millets are:

- pearl millet (*Pennisetum glaucum*);
- finger millet (*Eleusine coracona*);
- proso millet (*Panicum miliaceum*);
- foxtail millet (*Stalia italica*).

The genus *Pennisetum* includes about 140 species, which include domesticated and wild-growing species. Millet areas are distributed in most of the Asian and African countries and also parts of Europe (Kajunas, 2001). Developing countries account for 94% of global output and an estimated 28 million tons: pearl millet – 15 million tons, foxtail millet – 5 million tons, proso millet – 4 million tons, finger millet – 3 million tons (FAO, 1996).

## 1.2 Chemical compositions of sorghum and millet

Sorghum provides several benefits such as essential fatty acids, proteins, carbohydrates, energy, minerals, vitamins, phytic acid, carotenoids, alcohols, flavonoids, phenolic acids, and bioactives (*Abugri et al.*, 2013). Due to lysine, sulphur-containing amino acids, threonine and tryptophan, millet has a good amino acid balance (*Ajiboye et al.*, 2014).

Table 1: Chemical parameters of cereals (% dry matter)

Cereals	Starch	Protein	Ash	Raw fat
Hard wheat	77.4	13.5	0.56	0.98
Soft wheat	77.9	11.0	0.71	0.86
Barley	53.6	19.4	2.88	2.31
Rye	58.0	13.3	1.96	2.53
Sorghum	67.7	12.1	1.87	3.32
Millet	67.4	8.8	1.82	4.22

According to *Bagli* (2008)

The protein content in sorghum is 12.1%, the protein content in millet is 8.8% (*Table 1*). The protein content in sorghum is quite variable. In most literatures, this value ranges from 6 to 16% (*Mokrane et al.*, 2010). The starch content in these grains is approximately equal (67%). The raw fat content in millet is 4.22%; therefore, the energy content is very high in this grain (*Table 1*).

Both grains have a large content of leucine: in sorghum: 832 mg/kg, in millet: 598 mg/kg. However, the phenylalanine and isoleucine content are also high in these cereals. The amount of valine and threonine is high as well; consequently, the essential amino acid composition in sorghum and millet is great (*Table 2*).

The mineral content in millet is very high compared with other cereals; it is especially rich in P, K, Mg, Ca, and Fe. Sorghum has a lot of P, K, and Mg (*Table 3*).

Table 2: Essential amino acid composition (mg/kg) and chemical score of sorghum and millet proteins

	Sorghum	Pearl millet
Isoleucine	245	256
Leucine	832	598
Lysine	126	214
Methionine	87	154
Cystine	94	148
Phenylalanine	306	301
Tyrosine	167	203
Threonine	189	241
Tryptophan	63	122
Valine	313	345
<b>Chemical score</b>	37	63

According to *Bagli* (2008)

Table 3: Mineral content of cereals (mg/kg)

	Hard wheat	Soft wheat	Barley	Sorghum	Rye	Millet
P	3498	977.6	4570	349.9	3620	2879
K	826.2	1225	4572	239.9	3570	2798
Mg	301.2	306.5	1971	187.7	1328	1488
Ca	159.5	202.2	736.2	27.3	348.7	508.6
Na	46	38.4	238.4	4.6	67.2	60.89
Zn	30.8	7.6	74.2	3.1	30.6	65.9
Fe	13.2	13.9	128.4	10.6	44	199.8
Mn	5.2	8.1	9.2	1.2	24.4	8.1
Cu	1.4	1.6	5.7	0.2	2.9	3.4
Cr	0.1	0.001	0.9	0.8	0.7	7.7

According to *Bagli* (2008)

Sorghum has the highest phenol content among cereals and the most intensive antioxidant activity. The phenolic compounds are 4128  $\mu\text{g/g}$ , while in wheat this amount is only between 501 and 562  $\mu\text{g/g}$ . The antioxidant capacity in sorghum is 195.8  $\mu\text{mole/g}$ , while in wheat it is only 4.17–4.33  $\mu\text{mole/g}$  (*Table 4*).

Table 4: Antioxidant activity and phenol compounds of cereals

Cereals	Phenol compounds (gallic acid equivalents) ( $\mu\text{g/g}$ )	“DPPH” antioxidant capacity after 10 minutes ( $\mu\text{mole/g}$ ), “ABTS”	“ABTS” antioxidant capacity after 3 minutes ( $\mu\text{mole/g}$ )
Hard wheat	562	4.33	8.8
Soft wheat	501	4.17	8.3
Barley	879	21.00	14.9
Sorghum	4128	195.8	51.7
Rye	1026	12.17	13.0
Millet	1387	23.83	21.4

According to *Bagli* (2008)

Table 5: Dietary fibre in cereals (% dry matter)

Cereals	Soluble dietary fibre	Resistant starch	Insoluble dietary fibre	Total dietary fibre content
Hard wheat	1.61	0.20	2.98	4.59
Soft wheat	1.78	0.55	1.87	3.65
Barley	2.56	0.23	22.07	24.63
Sorghum	1.42	1.77	19.59	21.01
Rye	3.70	0.20	14.07	17.77
Millet	1.45	1.96	13.50	14.95

According to *Bagli* (2008)

Sorghum contains 21% of total dietary fibre content. The insoluble dietary fibre is also high, 19.59%. The total dietary fibre content in millet is lower, 14.95%; otherwise, the soluble dietary fibre in sorghum (1.42%) and in millet (1.45%) is approximately equal (*Table 5*). Waxy starch includes about 100% amylopectin, while non-waxy sorghum starch has 75% amylopectin and 25% amylose (*Wong et al.*, 2009).

Finger millet contain phytates (0.48%), polyphenols, tannins (0.61%), trypsin inhibitors, and fibres, which have antinutrient effects due to chelating and inhibitor activities (*Palanisamy et al.*, 2014). Finger millet, from cereals, is a rich source of Ca, containing 300 to 350 mg/100g of it (*Kiran*, 2014).

### 1.3 Utilization as food

During the past few years, sorghum and millet production has increased. Sorghum is used as steamed, leavened, and fat-fried product (FAO, 1995). Furthermore, sorghum use is similar to that of corn: starch, glucose, syrup, and oil can be produced. Moreover, it can be used in preparing whole-grain products, bread, pancake, dumpling, mush, cake, pasta, and beer. Broom and forage can also be prepared from them. Millet is used as traditional food and beverage products, with malting and lactic acid fermentation technologies (*Taylor & Kruger*, 2016).

## 2 Conclusions

Sorghum and millet have a great essential amino acid composition. The mineral content in millet is very high in comparison with other cereals; it is especially rich in P, K, Mg, Ca, and Fe. Sorghum has the highest phenolic compounds among cereals and the most intensive antioxidant activity.

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