

PHYTO CHEMISTRY OF MILLETS AND FEW STAPLE CEREALS

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Summary

Millet are one of the most important food crops plays a very important role in the agriculture and food of many developing countries. They are highly nutritious and most digestible grains available in the world. Millets are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture. Millets contain 60-70% carbohydrates, 7-11% proteins, 1.5-5% fat, and 2-7% crude fiber and are also rich in vitamins and minerals. They are excellent source of vitamin B, magnesium, and antioxidants. The vast array of biologically active compounds in these crops, including tannins, phenols, anthocyanin, flavonoids and phytates, may indicate their potential as therapeutic agents such as anti-microbial effect, antidiabetic, antioxidative etc. Millet is

an alkaline forming gluten-free grain rich in Vitamin B such as Niacin, folacin, riboflavin, thiamine and phosphorus that play a key role in energy synthesis in the body. The present chapter provides detailed information about the botanical description and distribution, origin, classification and phyto-constituents, nutraceutical values and health benefits of Millets. On the basis of knowledge provided by the present literature, it is suggested that Millets might provide alternative climate-smart crops, and as a nutritious food, fulfil the nutritional needs of global population and to find ways to consume the millets nutritionally, effectively and to reduce the problems of malnutrition and other health problems. The urgent and immediate need is to put millets into the public distribution system. Research institutions must give a new thrust on millet areas and issues. But such research initiatives must be led by farmers since they offer exciting perspectives for the research which has to be people-centered and people directed.

1. Introduction

The most striking feature of the planet earth is the existence of life and its diversity. Biodiversity is the variety and variability of life which includes all the plants and animals that live and grow on the Earth, all the habitats in which they survive, and all the natural processes of which they are a part. The earth supports an incredible array of living things. Plant biodiversity is the most effective resource that has been treasured from nature within the kind of food, fodder, fibers, shelter, biomass, etc. required for the survival and sustainability of humankind. Plant diversity helps to take care of biophysical systems and maintain balance of the earth and climate, thereby stabilizing the life system on the planet earth. Food is any substance which provides an organism with energy and nutrients necessary for its health and existence. To maintain good health humans must consume both energy producing food such as carbohydrates and fats and a proper balance of the other nutrients like proteins, vitamin, minerals and water regularly. It is estimated that on a worldwide scale plants directly provide 88 percent of the calories (i.e. carbohydrates and fats) and 80 percent of proteins that human beings consume; the rest come from animal products.

Plant-based foods are generally classified into fruits, vegetables, legumes, grains, nuts, and seeds; their derived processed counterparts such as breads, cooked and fermented vegetables and legumes; and fruit juices, jellies and jams; and their derived ingredients like seed-derived oils, sugars, and a few herbs and spices. Evidence from several studies has shown that diets rich in plant foods are protective against several degenerative diseases such as cancer, cardiovascular ailments, diabetes, metabolic syndrome and Parkinsons disease, and many others. In the last years, whole grain cereals have received more significant consideration because of its fiber content and presence of a mixture of bioactive compounds like antioxidants and phytochemicals. Presence of natural antioxidants in the plant foods specifically polyphenols, carotenoids, vitamin C, and tocopherol are known to prevent free radical damage. Studies conducted by several scientists revealed that the health benefits of whole grains are correlated with phytochemicals and nutraceutical properties. It was suggested that the health benefits of whole grains consumption are due of presence of unique bioactive compounds in whole grains. Grains such as wheat, rice, maize are the basis of daily diets for many populations worldwide. They are the seeds of plants, mainly belonging to the botanical groups of cereals, pseudo cereal, millets and legumes. The top crops such as wheat, rice,

corn, barley, sorghum, oat and millet that feed the planet are cereals and belong to the Poaceae family.

Millet is a general term for a wide range of small seeded grasses that are nutritionally rich and may be used for grain and/or forage in many regions of the world. In India, commonly grown millets include *sorghum*, bulrush millet, *ragi*, Italian millet, little millet, barnyard millet, proso millet and kodo millet. Millets are important but underutilized crops in tropical and semiarid regions of the planet which exhibit greater resistance to pests and diseases, good adaptation to a wide range of environmental conditions and give good yield of production, can withstand significant levels of salinity, immune to water logging, drought tolerant, require little inputs during growth and with increasing world population and decreasing water supplies they represent important crops for future human use. Millets are highly nutritious, high energy food, non-glutinous and non-acid forming foods. Millets are considered to be the least allergenic and most digestible grains available. In recent years, they are considered to be an important component of processed foods. Compared to rice, especially white rice, millets release lesser percentage of glucose and over an extended period of our time. This lowers the risk of diabetes.

Millets are high in minerals like iron, magnesium, phosphorous and potassium. Several scientists have reported that millets contain high quantity of α -tocopherol, dietary fiber, total carotenoids, and tryptophan content. Rao *et al.* (2011) evaluated the nutraceutical properties of small millets and stated that these millet varieties comprise of vast amounts of phenolics and other compounds such as tannins, alkaloids, flavonoids and saponin.

2. Origin and History of Millets

Millets are one of the oldest of cultivated crops. Records of culture for foxtail and proso millet extend back to 2000 to 1000 BC in China followed by evidence of the cultivation of millet in the Korean Peninsula dating to the center Jeulmun Pottery Period (around 3,500–2,000BC). In India, cultivation of millets has been mentioned in some of the oldest *Yajurveda* texts, identifying foxtail millet (*priyangava*), Barnyard millet (*aanava*) and black finger millet (*shyaamaka*), thus indicating that millet consumption was quite common, prior to the Indian Bronze Age (4,500BC).

2.1. Sorghum (*Sorghum Bicolor* (L.) Moench)

Cultivated Sorghum probably originated in East Central Africa, in or near Ethiopia or Sudan because of the great diversity of types growing in that region. The diversity of cultivated types decreases towards Southern Africa and Asia.

2.2. Pearl or Cattail Millet (*Pennisetum Glaucum* (L.) R. Br.)

Pearl millet is native to the Sahel. It has spread across Africa from West to East and from there to Southern Africa. It was introduced to India in 3000 BC and later to America, Brazil and Australia. It was originated in the African savannah and grown since prehistoric times. It is grown extensively in Africa, Asia, India and Middle East as

a grain. It was introduced into the United States at an early date but was seldom grown until 1875. It is primarily grown in southern United States as a short lived pasture. It is preferred over Sudan grass as a forage crop in the south. Varieties planted at Rosemount, Minnesota produced little or no seed, and their forage yield was low compared to foxtail varieties.

2.3. Finger Millets (Madua) [*Eleusine Coracana* (Gaertn)]

According to DeCandolle (1886), finger millet probably originated in India. It might have originated from yard grass, a grass that grows in many parts of northern India. It is supposed to have spread from India to Abyssinia and rest of Africa. Vavilov (1951) and Mehra (1962) consider *Eleusine coracana* to be of African origin.

2.4. Little Millet (*Panicum Sumatrense*)

It is native to India and is called Indian millet. The species name is based on a specimen collected from Sumatra (Indonesia).

2.5. Kodo (*Paspalum Scrobiculatum* L.)

Kodo millet is a very old crop and it was mentioned in ancient literature of India. According to some investigators, kodo millets might have originated in South-East Asia. They have been grown as fodder species in America, Australia and South Africa.

2.6. Foxtail Millet [*Setaria Italica* (L.) P. Beauvois]

Foxtail millet has probably originated in southern Asia and is the oldest of the cultivated millets. Its culture slowly spread westward towards Europe. Foxtail millet was rarely grown in the U.S. during colonial times, but its acreage increased dramatically within the Great Plains after 1850. However, with the introduction of Sudan grass, acreage planted to foxtail millet decreased. Today, Italian millet is grown primarily in eastern Asia.

2.7. Barnyard or Japanese Millet (Sawan) [*Echinochloa Crusgalli* (L.) P. Beauvois]

It is a domesticated relative of the seed, barn grass. It is grown for grain in Australia, Japan and other Asian countries. In the United States, it is grown primarily as forage.

2.8. Proso Millet (Cheena) (*Panicum Miliaceum* L.)

It was first grown along the eastern seaboard and was later introduced into the Dakotas where it later was grown on considerable acreage. In North Dakota acreage has ranged from 50,000 to 100,000 acres while in Minnesota only a couple of thousand acres are grown. Proso millet is grown within the Soviet Union, China, India and Western Europe. It was introduced into the U.S. from Europe during the 18th century.

2.9. Brown Top Millet (*Panicum Ramosum*)

It is a native of India and was introduced into the United States in 1915. It is grown in south eastern United States for hay or pasture; bird and quail feed plantings on game preserves. It is sometimes sold to Minnesota sportsmen for this purpose. Seed and forage yields of brown top millet are low in Minnesota tests and it didn't compete well with weeds.

3. Distribution

Millets are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture. They account for India as the top most producers of millets followed by Nigeria for the year 2000 and 2009. In India, eight millets species (Sorghum, Pearl millet, Finger millet, Foxtail millet, Kodo millet, Proso millet, Barnyard millet and little millet) are commonly cultivated under rain fed conditions. Further, in each of the millet growing areas at least 4 to 5 species are cultivated either as primary or allied crop in combination with the pulses, oilseeds, spices and condiments. For instance, while pearl millet and sorghum are primary crop and allied crops respectively in the desert regions of Rajasthan, in the eastern parts of Rajasthan and Gujarat it is the opposite. Similarly, sorghum is sown as major crop in the Telangana, Andhra Pradesh, Maharashtra and parts of Central India, while it is considered as fodder crop in some of the Southern regions.

3.1. Sorghum [*Sorghum bicolor* (L.) Moench]

It is the fourth in importance among the world's leading cereals being cultivated over an area of about 43.7 million hectares with a production of about 62.8 million tones. Among the Sorghum growing countries, India ranks first in acreage but second in production, USA being the largest producer in the world. Other important growing countries are China, Nigeria, Sudan and Argentina. In regards to average yield, Argentina ranks first (4375 kg per hectare) followed by USA (4370 kg per hectare). Whereas the average yield of sorghum in India is only 852 kg per hectare. Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh, Gujarat, Tamil Nadu, Rajasthan and Uttar Pradesh are the important Sorghum growing states.

3.2. Pearl or Cattail millet [*Pennisetum glaucum* (L.) R. Br.]

It is a crop grown mostly in tropical climate. It is widely grown in Africa and Asia. The important pearl millet growing countries are India, China, Nigeria, Pakistan, Sudan, Egypt, Arabia and Russia. In India, it is grown over an area of 8.9 million hectares with total production of 5.7 million tones. Pearl millet is grown over everywhere except in high rainfall areas like Assam, West Bengal and Orissa. States of Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana account for 87% of total area.

3.3. Finger Millet (*Eleusine coracana* (L.) Gaertn)

Finger millet is widely cultivated in India, Africa, Ceylon, Malaysia, China and Japan. It is the most important small millet in the tropics (12% of global millet area) and is

cultivated in more than 25 countries in Africa (eastern and southern) and Asia (from Middle East to Far East) predominantly. In India, it is an important crop of Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Orissa, Bihar, Uttar Pradesh and Himachal Pradesh.

3.4. Little Millet (*Panicum sumatrense* Roth ex Roem. & Schult)

Little millet is an important crop grown for food and feed in the tribal belt of Madhya Pradesh, Chhattisgarh and Andhra Pradesh in India. It is described as a fast growing, short duration cereal, which may withstand both drought and water logging.

3.5. Kodo Millet (*Paspalum scrobiculatum* L.)

Kodo millet is grown as a cereal in India only. In India, it is grown in Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu and Uttar Pradesh. In Uttar Pradesh, it is grown mostly in Gorakhpur, Basti, Gonad, Deoria, Mirzapur and Sitapur districts. Kodo millet may be a long duration crop and grows well in shallow also as deep soils.

3.6. Foxtail Millet (*Setaria italica* (L.) Beauv.)

Foxtail millet ranks second in among the millet produced globally world's total production of millets. The annual production of foxtail millet was estimated to be five million tons with China being the main producer (3.7 million tons). It is mainly grown on poor or marginal soils in southern Europe and in temperate, subtropical, and tropical Asia. It can grow over a good range of altitudes starting from water level to 2000 m above mean water level. Foxtail millet is fairly tolerant to drought; it can escape some droughts due to early maturity. Due to its short life cycle, it is often grown as a short-term crop. It is also cultivated as a land crop under marginal and sub-marginal lands. It requires water within the later stages of the crop growth but cannot tolerate water logging.

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Bibliographic sketch

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