

Millet Cookies - Modern Food Products with Traditional Health Benefits

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Abstract

Food security majorly depends on grains. India is the largest producer of millet in the world with an annual production of around 10 million tonnes. Millets are small-grained, annual, warm-weather cereals, highly tolerant of drought and other extreme weather conditions with similar nutrient content to other major cereals, and belong to the Poaceae family, commonly known as the grass family, widely consumed in Asia. India produces a variety of millet like Sorghum, Pearl millet, Finger millet, Proso millet, Kodo millet, Foxtail millet, little millet, Barnyard millet, and Brown top millet. Millets are a rich source of proteins, fiber, minerals, and B-complex vitamins and also contain nutraceutical phytochemical compounds such as polyphenols, lignans, phytosterols, phytoestrogens, and phytocyanins. Consumption of millet helps in reducing the risk of heart disease, protects from diabetes, improves the digestive system, lowers the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels, and improves muscular and neural systems and are protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease. Fortification of millets helps to prevent micronutrient deficiency malnutrition. In today's scenario variety of healthy snacks prepared using millet can be an alternative to modern junk food for youngsters. The nutritious millet cookies are widely acceptable, easily available, and have a long shelf life. This review narrates the development, proximate analysis, and therapeutic benefits of varied types of millet cookies available in the local markets.

Key words: Nutraceuticals, Cookies, Therapeutic benefits, Millets

Food security majorly depends on grains. In 2020, global production of millet was 30.5 million tonnes, led by India with 41% of the world's total. India, the largest producer of millet produces around 10 million tons annually. India's Pearl Millet production accounts for 40.51 percent followed by Sorghum at 8.09 percent in the world production of millet in 2020. The major millets producing states in India are Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, and Uttarakhand. Millets are small-grained, annual, warm-weather cereals, highly tolerant of drought and other extreme weather conditions with similar nutrient content to other major cereals, and belong to the Poaceae family, commonly known as the grass family, widely consumed in Asia. In the majority of poor nations, millets are almost exclusively used for human food, whereas in wealthy nations, their usage has mostly been relegated to animal feed.

India produces a variety of millets like Sorghum millet – Jowar, Cholam, Pearl millet – Bajra, Kambu, Finger millet – Ragi, Kelvaragu, Proso millet – Barri, Panivaragu, Kodo millet - Kodra, Varagu, Foxtail millet/Italian Millet – Kangni, Thinai, Little millet – Kutki, Samai, Barnyard millet – Sanwa, Kuthiravaali. Millets are gluten-free and are useful dietary

cereals. Millets are a rich source of proteins, fiber, minerals, and B-complex vitamins and also contain nutraceutical phytochemical compounds such as polyphenols, lignans, phytosterols, phytoestrogens, and phytocyanins. These serve as immune system regulators, detoxifying agents, and antioxidants that guard against degenerative illnesses like cancer, diabetes, and cardiovascular conditions (Ambati, K, et al.). Consumption of millet reduces the risk of heart disease, protects from diabetes, improves the digestive system, lowers the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels, improves muscular and neural systems, and is protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease (Chandrasekara and Shahidi). Millets are rich in micronutrients like vitamins, beta-carotene, etc. Fortification of millets helps to prevent micronutrient deficiency malnutrition. Millets can be developed as food-based nutraceuticals in the form of cookies and can serve as therapeutic agents as they are rich in minerals, flavonoids, and amino acids (Singh *et al.*).

Millet grains, before consumption, are processed by common traditional processing techniques like decorticating/dehulling, malting, fermentation, roasting, flaking, and grinding to improve their edible, nutritional, and sensory properties

(Dayakar Rao, B). Millets are incredibly outstanding and offer a cure for malnutrition and obesity that has emerged as a double burden on India and affect the vast majority of Indians. In recent years, the production and consumption of snacks are incredibly increased due to urbanization, speedy work, fast food, and increased numbers of working women (Rao *et al.*).

Cookies are very popular among all age groups due to their variety in taste, texture, and aroma. They are foods with a longer shelf life that have minimal moisture content and are typically made from refined wheat flour, oil, and sugar. The major ingredient for the preparation of cookies is refined wheat flour due to its gluten content. As refined wheat flour contains

a higher proportion of starch and a low proportion of dietary fibre and minerals, the cookies are poor in proteins, fats, and minerals (Archana R *et al.*). To improve cookies' nutritive value, refined wheat flour can be replaced with millet flour which is of better nutritive quality. Millet cookies from millets are nutritious and healthy as they are rich in dietary fibers, proteins, fatty acids, minerals, and bioactive compounds (Brites *et al.*, 2018; Taylor *et al.*, 2006; Torbica *et al.*, 2012). The nutritious millet cookies are widely acceptable, easily available, and have a long shelf life. In today's scenario variety of healthy snacks prepared using millet can be used as an alternative to modern junk food for youngsters.

Table 1 Nutritive Composition of the Raw Millet Cereals per 100 g

Millet (g)	Proteins (g)	Fiber (g)	Minerals (g)	Iron (mg)	Calcium (mg)
Sorghum millet	10.4	1.6	1.6	4.1	25
Pearl millet	11.6	1.2	2.3	8.0	42
Finger millet	7.3	3.6	2.7	3.9	344
Foxtail millet	12.3	8.0	3.3	2.8	31
Proso millet	12.5	2.2	1.9	0.8	14
Kodo millet	8.3	9.0	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17
Barnyard millet	6.2	9.8	4.4	5.0	20

Source: Nutritive value of Indian Foods, C. Gopalan, B.V. Rama Sastri & S.C. Balasubramanian

Analysis of different types of millet cookies, nutritive composition, organoleptic evaluation, shelf life and therapeutic benefits

Formulation: The ratio of ingredients taken for making the cookies.

Preparation: The ingredients were cleaned, roasted, and powdered as flour. All the flour was mixed and baked at specified temperatures in the oven for a specific period.

Sensory Analysis: The ready-to-eat cookies were evaluated for sensory analysis with the help of a panel of 15 to 30 trained/semi-trained members. The participants of the panel were asked to use a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely) to rate their degree of liking. The parameters analyzed during the sensory evaluation were: colour, appearance, texture, flavor (taste and aroma), and overall acceptability as per the methodology reported earlier (Meilgaard *et al.*, Subbulakshmi, B *et al.*)

Shelf life: The cookies prepared were used for storage study. During the storage study their nutritional composition, organoleptic properties, and microbial quality were analyzed using standard procedures to check their quality.

Table 2 Proximate analysis of Sorghum millet cookies

Parameter (g/100 g)	Sorghum millet Cookies
Moisture (%)	7.10
Protein (%)	10.43
Fat (%)	27.37
Ash (%)	1.13
Carbohydrate (%)	53.97

Source: Aljobair (2022)

Sorghum (Jowar) Millet Cookies

Formulation and Preparation

The cookies were formulated using Sorghum flour (75%), wheat flour (10%), refined sugar (15%), guar gum, shortening, baking powder, cinnamon powder, salt, and eggs.

All ingredients were mixed and baked at 180°C for 15 to 20 mins. A sensory evaluation was done and it was highly acceptable by the panel. The shelf life was found to be 3 months.

Therapeutic Benefits of Sorghum millet cookies

The incorporation of sorghum flour in cookie formulation improved the physicochemical, nutritional, and bioactive properties of the cookies without any major effect on the sensory quality. Sorghum can enhance nutrition and health as it is rich in nutrients and bioactive compounds. It has a high proportion of calcium, iron, protein, and fiber. Enriched with fiber it helps in weight loss. These gluten-free cookies are considered a safe food grain alternative for celiac disease and gluten insensitivity. According to molecular pieces of evidence, sorghum is completely gluten-free, providing humongous health benefits. According to research, normal sorghum wax is a good source of policosanols, which lower cholesterol levels (Reddy 2017).

Pearl Millet (Bajra) Cookies

Formulation and Preparation

The cookies were formulated using Pearl millet flour (50%), fat (25%), Sugar (25%), and Vanilla essence. All the ingredients were mixed and baked at 200°C for 20 mins. Sensory evaluation values were 9.

Table 3 Proximate analysis of Pearl Millet Cookies

Parameter (g/100 g)	Pearl Millet Cookies
Moisture (g)	9.5
Proteins (g)	10.1
Fat (g)	5.0
Ash (g)	1.3
Carbohydrate	75
Energy (KCal)	382
Iron (mg)	5.83
Calcium (mg)	48.6
Phosphorus (mg)	270.0

Source: Florence *et al.* (2014)

Therapeutic Benefits of Pearl millet cookies

The incorporation of Pearl millet flour in the formulation of cookies enhanced the nutritional and sensory attributes of the cookies. In terms of protein, ash, and minerals including iron, calcium, and phosphorus, the cookies' nutritional value increased. Magnesium-rich pearl millet aids in the reduction of migraine attacks and respiratory issues in asthma sufferers. Gallstone occurrences can be reduced with the help of fibre content present in pearl millet. There is a reduction of excessive bile production due to the insoluble fibre present in pearl millet, which prevents the formation of gall stones in our body (Shweta *et al.*).

Foxtail millet (Kangni, Thinai) and wheat flour Cookies Formulation and Preparation

The cookies were formulated using foxtail millet flour (45%), wheat flour (55%), sugar, baking powder, Margarine, powdered sugar, and Vanilla essence. All the ingredients were mixed and baked at 165°C for 15 min. The sensory evaluation score was 7.38.

Table 4 Proximate Analysis of Foxtail Millet and Wheat Flour Cookies

Parameter (g/100 g)	Foxtail millet and wheat flour Cookies
Crude protein(%)	13.10
Crude fat (%)	5.70
Moisture content (%)	4.60
Crude Fiber (%)	0.07
Ash (%)	1.00

Source: Marak *et al.* (2019)

Therapeutic Benefits of Foxtail Millet and Wheat Flour Cookies

The foxtail millet and wheat cookies had enhanced nutritive and functional properties with increased antioxidant capacities. Without affecting the body's metabolism, foxtail millet helps in the steady release of glucose. Foxtail millet is known as a healthy heart food as it's an excellent source of magnesium and decreases the incidence of diabetes (Reddy 2017)

Barnyard Millet (Jhangora, Kudiraivali) Cookies Formulation and Preparation

The quality cookies were prepared from 20% wheat flour and 80% barnyard millet flour, Sugar, and fat. All the ingredients were mixed and baked at 180°C for 12 min. The sensory evaluation score was 9.00. Shelf life was found to be 3 months.

Table 5 Proximate analysis of Barnyard Millet Cookies

Parameter (g/100 g)	Barnyard Millet Cookies
Moisture (%)	3.00
Protein (%)	7.38
Fat (%)	27.10
Crude fiber (%)	8.22
Carbohydrate (%)	66.28
Calcium (mg/100g)	30.60
Phosphorous (mg/100g)	295.00
Iron (mg/100g)	4.98

Source: Salunke *et al.* (2019)

Therapeutic Benefits of Barnyard Millet Cookies

Barnyard millet has a nutritious digestible source of protein. It has a good amount of soluble and insoluble proportions of dietary fiber. Barnyard millet gets slowly

digested which makes it an ideal millet for sedentary workers. It has major fatty acids like linoleic acid, palmitic and oleic acid which lowers low-density lipoproteins and increases high-density lipoproteins. Patients with diabetes mellitus and cardiovascular disease may benefit from using barnyard millet. Barnyard millet is found to be the best in controlling blood glucose and lipid levels (Dayakar Rao *et al.*).

Kodo Millet (Kodra, Varagu) cookies

Formulation and Preparation

The cookies were prepared from Kodo millet flour 50%, Maida 50%, fat, and sugar. All the ingredients were mixed well and baked at 180°C for 12 mins. The sensory evaluation score was 7.40. shelf life was found to be 3 months.

Table 6 Proximate analysis of Kodo Millet Cookies

Parameter (g/100 g)	Kodo Millet Cookies
Moisture (%)	4.11
Protein (%)	10.08
Fat (%)	26.05
Crude fiber (%)	4.30
Carbohydrate (%)	69.79
Calcium (mg/100g)	24.93
Iron (mg/100g)	2.12

Source: Mitkal *et al.* (2019)

Therapeutic Benefits of Kodo Millet Cookies

Kodo millet has a close resemblance to rice and is used as traditional food. It has good fibre content and helps in weight loss. It is easily digestible and rich in photochemical and antioxidants which helps in preventing different lifestyle-related diseases. According to Ambati *et al.*, kodo millet is quite effective at decreasing joint and knee discomfort and helps women's periods become more regular (Ambati *et al.*).

Finger Millet (Ragi, Nachni) Cookies

Formulation and Preparation

The cookies were formulated using Finger millet flour 50%, Maida 50%, Sugar 25%, and Fat 25%. All the ingredients were mixed well and baked at 140°C for 15 mins. The sensory evaluation score was 8.40. The shelf was found to be 3 months.

Table 7 Proximate analysis of Finger Millet Cookies

Parameter (g/100 g)	Finger Millet Cookies
Moisture (%)	1.57
Protein (%)	4.69
Fat (%)	30.97
Crude fiber (%)	1.09
Ash (%)	1.09
Calcium (mg/100g)	94
Iron (mg/100g)	3.80
Zinc (mg/100g)	0.80

Source: Sinha and Sharma (2017)

Therapeutic Benefits of Finger Millet Cookies

Finger millet cookies are rich in minerals, fiber, calcium, iron, phosphorous, copper, and zinc. Diabetologists claim that the consumption of finger millet reduces blood glucose levels in the serum. Ragi is rich in dietary fiber which helps in preventing constipation. It has gluten-free properties and can be given for gluten intolerance. It is rich in calcium and vitamin D which helps in strengthening bones reducing the risk of bone fractures and osteoporosis. It is also rich in antioxidants having antimicrobial properties, which lowers the risk of atherosclerosis. Finger Millet is one of the most nutritious cereals and is a good source of natural calcium and iron helping

to overcome anemia. Ragi helps in different disease conditions like blood pressure, heart problems, and asthma and its low glycemic properties help diabetes to slow down digestion and control the release of glucose in blood. Finger millet helps to increase the hemoglobin level and helps to fight malnutrition and degenerative diseases (Reddy *et al.*).

Little Millet (Samai, Kutki) and Wheat flour cookies

The quality cookies were prepared from 80% little millet flour, 20% wheat flour sugar, and fat. All the ingredients were mixed well and baked at 140°C for 15 mins. The sensory evaluation score was 9.0. The shelf was found to be 3 months.

Table 8 Proximate analysis of Little Millet Cookies

Parameter (g/100 g)	Little Millet Cookies
Moisture (%)	4.26
Protein (%)	8.40
Fat (%)	29.10
Crude fiber (%)	6.46
Carbohydrates (%)	67.48
Iron (mg/100g)	8.42

Source: Biradar *et al.* (2021)

Therapeutic Benefits of Little Millet Cookies

Little millet is highly nutritious and may be called little but is not less in its nutritional content. It has a good source of B- Vitamin, Minerals like calcium, iron, zinc, and potassium among others. Additionally, it gives the body necessary lipids that aid in weight loss. Another benefit is that it has a high fibre content, which makes it the perfect substitute for rice in pongal or even kheer (Reddy 2017).

Proso Millet (Barri, Chena) Cookies

Formulation and Preparation

The proso millet cookies were made with proso millet flour (80%), maida (20%), sugar, and fat. All the ingredients were mixed well and baked at 140°C for 12 mins. The sensory evaluation score was 8.0. The shelf was found to be 3 months.

Table 9 Proximate analysis of Proso Millet Cookies

Parameter (g/100 g)	Proso Millet Cookies
Moisture (%)	9.5
Protein (%)	14.6
Fat (%)	1.3
Ash (%)	0.6
Dietary fibre (%)	4.4
Carbohydrates (%)	69.5

Source: Devisetti *et al.* (2021)

Therapeutic Benefits of Proso Millet Cookies

Proso millet has a high content of Niacin. It is beneficial in preventing and treating Pellagra, caused due to the deficiency of niacin (Vitamin B3). Pellagra causes skin disease with symptoms like dry, scaly, and rough skin. Proso millet consists of protein and niacin and is used as recuperative food, especially post-pregnancy or illness (Jana Kalinova 2007)

Multi Millet Cookies

Formulation and Preparation

The multi millets flour blend was prepared using whole wheat flour (20%), Kodo millet flour (20%), little millet flour (20%), foxtail millet flour (20%), and finger millet flour (20%). All the ingredients were mixed and baked at 180°C for 15 minutes. The sensory evaluation score was 8.0. shelf life was found to be 3 months.

Table 10 Proximate analysis of Multi Millet Cookies

Parameter (g/100 g)	Multi Millet Cookies
Moisture (%)	2.73
Carbohydrate (g)	65.59
Protein (g)	13.15
Fat (g)	20.57
Crude Fibre (g)	1.92
Ash (g)	0.84
Calcium (mg)	31.42
Iron (mg)	1.74

Source: Subbulakshmi and Malathi (2017)

Table 11 Therapeutic Benefits of Multi Millets

Name of the Millets	Major health benefits
Pearl millet	Prevents cardiac diseases, lowers lipid levels, is a natural antioxidant, and reduces inflammatory bowel diseases
Finger Millet	Helps in reducing gastrointestinal tract disorders and acts as an anti-diabetic and antioxidant.
Barnyardmillet	Acts as an inhibitor of the cancer-developing cells reduces bloodglucose and lipid levels.
Proso millet	Improves glycemic response, protects againstliver injury
Little millet	Controls blood glucose and cholesterol levels
Foxtail millet	Controls blood glucose and cholesterol levels, reduces inflammation and has a hypertrophic response.

Source: Sireesh *et al.* (2011), Surekha (2004), Park *et al.* (2008), Sharma *et al.* (2016), Muthamilarasan *et al.* (2016), Islam *et al.* (2015)

Millets are a rich source of proteins, fibre, minerals, and B-complex vitamins and also contain neutraceutical phytochemical compounds such as polyphenols, lignans, phytosterols, phytoestrogens, phytocyanins (Bhat *et al.*). The cookies made with different types of millet were found to have good amount of protein, fibre and fat. Incorporation or replacement of millet in the formulation of cookies improves the physicochemical, nutritional, and bioactive properties of the cookies without a major effect on the sensory quality. Overall acceptability done through sensory evaluation was also commendable with an average score of 7. Fortification of millets helps to prevent micronutrient deficiencies, gluten intolerance and malnutrition among children. Millet flour as a replacement for refined flour in the preparation of cookies was

effective in enhancing its nutritional and sensory attributes. Thus, the Nutritive value of the cookies improved in terms of protein, ash, and mineral content like iron, calcium, zinc, sodium and phosphorus. The nutritious millet cookies are widely acceptable, easily available and have a shelf life of 90 days approximately. Easy accessibility and availability of these cookies will help in meeting daily needs of millet intake by an individual. Millets have been traditionally used to treat various health disorders. Modern millet cookies may also help in combating health issues when taken in adequate amount.

Millets help in increasing insulin sensitivity action. Increased sensitivity of insulin's action is correlated with a less dramatic rise in blood glucose levels. Avoiding high peaks and low valleys in blood sugar reduces the strain on the pancreas,

which is crucial for both people with diabetes and those who are at risk of type 2 diabetes. (Subbulakshmi, B., & Malathi, D et al). Consumption of millet reduces the risk of heart disease, protects from diabetes, improves the digestive system, lowers the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels, improves muscular and neural systems, and is protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease (Dayakar Rao *et al.*, Marak *et al.*). Millets are gluten-free pseudo-cereals that help in gluten-related disorders such as wheat allergies, gluten ataxia, non-celiac gluten sensitivity, and the most well-known, celiac disease.

Fortification of millets helps to prevent micronutrient deficiency malnutrition. Micronutrient deficiencies, like iron, iodine, and zinc, are major public health problem in the developing world which affects more than fifty percent of infants, children, and women of reproductive-bearing age (Bhumika *et al.*, Tripathi *et al.*). Millets are helpful in micronutrient deficiencies that lead to infectious diseases; poor growth of physical and cognitive development, lethargic activities, and ante-natal complications, which left unattended, may lead to morbidity and mortality (Muthayya *et al.*). Foods made from millet are thought to be possible prebiotics and probiotics with potential health advantages. Millets are

consumed widely as traditional medicines and are important food that preserves health (Nithiyanantham *et al.*). Foxtail millet, proso millet, and barnyard millet are three types of waxy starch that can be utilized in newborn feeds. Researchers have discovered the molecular foundation for this waxy starch.

CONCLUSION

Millets have enhanced nutritive and functional properties with increased antioxidant capacities for health benefits. Consumption of millet help in reducing the risk of heart disease, diabetes, digestive disorders, cancer, respiratory issues, and neural disorders and are protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease. Millets have been rarely introduced in recent times as a part of daily diet. As a result, many of us and our children do not know the different types of millet available and their health benefits. This modern snack can be replaced with unhealthy snacks to provide a healthy alternative for today's generation, among both high and low-income people. The modification of traditional food into modern food item has contributed in raising the economy of the country by helping in combating poverty and malnutrition.

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