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A Systematic Review On Kodo

Leena Chandrakar[1], Sanyogita Shahi[2*]

[1,2*]*Kalinga University, Raipur, Chhattisgarh, 492101, India*

***Corresponding Author:** Sanyogita Shahi*

** Kalinga University, Raipur, Chhattisgarh, 492101, India. Email: drsanyogitashahi@gmail.com*

Abstract

Millets are ancient grains known for their resilience in dry climates and poor soil conditions. They are nutrient-dense, low in gluten, and easy to digest. Kodo millet, a specific type of millet, is particularly high in calcium, iron, and phosphorus. Millets can contribute to food security and sovereignty, especially in vulnerable regions. Millets are mainly two types: naked grains (Major): Ragi, Jowar, and Bajra have husks that are easily removed and husked grains (Minor): Foxtail millet, small millets, and kodo millet require husk removal before consumption. Kodo millet is a drought-resistant crop well-suited for semi-arid regions. It is a good source of protein, fiber, minerals, and antioxidants. Kodo millet has potential health benefits in managing diabetes, cardiovascular disease, and obesity. It is affordable, readily available, and can be incorporated into various dishes. Kodo millet contains bioactive compounds like phenolics and phytochemicals with antioxidative and therapeutic properties. These compounds may contribute to disease prevention and overall health. Kodo millet is a valuable food grain with significant nutritional and health benefits. Its resilience and affordability make it a promising crop for food security and sustainable agriculture. The review also discusses other types of millets, their nutritional profiles, and uses. It highlights the importance of promoting millet consumption for both individual and societal well-being.

Keywords: Kodo Millets, phenolic compounds,

Introduction:

Millets, ancient grains known for their resilience and nutrition, offer a promising solution to global food security challenges. Their short growing season (as little as 65 days!) *(Prathyusha et al; 2021)* and ability to thrive in arid climates with poor soil make them ideal for vulnerable regions. Beyond being readily available and affordable, millets pack a powerful nutritional punch (Bhambulkar & Patil, 2020). They are naturally gluten-free, easy to digest, and rich in minerals like iron, magnesium, phosphorus, and potassium. Compared to rice and wheat, they boast superior calcium content (finger millet has nearly 10 times more!). Their low glycemic index also reduces the risk of diabetes. Millets empower farmers, *(Sadhukhan et al 2023.)* Thriving in diverse cropping systems with minimal water and nutrient requirements, they offer sustainable alternatives to resource-intensive crops like rice and wheat. Their short shelf life makes them "famine reserves" vital for unpredictable conditions like India's monsoons. Finger millet (rage), kodo millet, and other grain crops are included in the category of small millets. *(Joseph Michaelraj et al; 2013).* Millets grown for their little grains, which are carried on short, thin grassy plants, are often referred to as minor millets or small millets as opposed to major millets (Maize, Jowar, and Bajra). They refer to a group of little seeded cereal crops, in other words. The most important minor millets cultivated in India are: finger millet (ragi), proso millet, barnyard millet, Italian millet, kodo millet, little millet, Job's tears and, teff *(Sunil et al2022).* An old Kannada *saying*: **"A person who consumes rice is weightless like a bird, a person who consumes jowar is powerful like a wolf, and a person who consumes ragi is 'nirogi' (illness-free) for every day of his or her life."** Millet can be classified into two main groups according on whether or not the husk is present Naked grain (Major): Naked grains are millets like Ragi, Jowar, and Bajra that have been stripped of their hard, indigestible husk (Patil, R. N., & Bhambulkar, A. V.,2020). Husked grains (Minor): These must be removed from the seed coat before eating because it is inedible. This group includes foxtail millets, small millets, and kodo millets. *(Senthikumar et al; 2023)*. Five Major Millets are:

Sorghum (Jowar): Sorghum is the fifth most important cereal crop in the world. It is native to Africa and was first cultivated around 7000 B.P. Sorghum is a drought-resistant crop that can be grown in a variety of climates (Shahi, S., & Singh, S. K. ,2019).. It is a good source of fibre, iron, and protein. Sorghum is also used to make ethanol and bioplastics. When compared to other major grains like rice and wheat, jowar—also known as great millet—contains a higher proportion of calcium and is rich in fiber, iron, and protein. Numerous studies have shown that ordinary sorghum wax is very rich in policosanol, which decreases cholesterol levels (Sahoo, S., & Shahi, S. ,2021).

Finger Millet (Ragi): Finger millet is a gluten-free grain that is native to Africa. It is a good source of calcium, iron, and protein (Sanyogita Shahi, et al.,2022. Finger millet is also a good source of antioxidants. Finger millet is a popular food in India and Africa. Because it is so nutrient-dense, finger millet is a great diet for pregnant women, young children, and the elderly. Its high calcium content aids healthcare moms in making enough milk for their babies. *(Dida et al 2006).*

Pearl Millet (Bajra): Pearl millet is a drought-resistant crop that is native to Africa. It is a good source of protein, fiber, and iron. Pearl millet is also a good source of antioxidants. Pearl millet is a popular food in India and Africa. Pearl millet grains have a nutritional content of 60–70% carbohydrates, 10–12% protein, 3.5–5% fat, 1.5–3% fiber, and 1.5–2% ash. It has better nutritional value than other cereal crops. About 90 million people who live in semi-arid tropical regions of Africa and the Indian subcontinent rely on it as a main food. For flour porridge in Africa and unleavened flat bread in India, grain is usually crushed *(Bidinger et al 2004).*

Foxtail Millet (Korra): Italian, German-Hungarian, and Siberian millet are other names for foxtail millet (Setaria italica). Foxtail millet is a gluten-free grain that is native to China. It is a good source of protein, fiber, and iron (Shah, S.,2022)

. Foxtail millet is also a good source of antioxidants. Foxtail millet is a popular food in Asia. Consuming foxtail millet reduces the risk of developing diabetes. It facilitates the controlled release of glucose without affecting human body metabolism, and because it contains a good amount of magnesium, it is considered as a healthy for the heart food (Sharma et al 2018).

Little Millet (Sama): Little millet (Panicum sumatrense), which has its origins in Southeast Asia, is now grown all over India, but is especially popular in Madhya Pradesh, Orissa, Jharkhand, and Uttar Pradesh. Little millet is a gluten-free grain that is native to Southeast Asia (Shahi, S. 2019). It is a good source of protein, fiber, and iron. Little millet is also a good source of antioxidants. Little millet is a popular food in India. In a 2:1 ratio, little millet is usually mixed with black gram, sesame, soy, and pigeon pea (Pradeep et al 2011).

Kodo Millet:

Millets have earned the title of "poor man's food grain" over the years due to their great affordability. Major millets and minor millets are two categories for millets based on the size of their grains. The major millets are the kodo millet (Paspalum scrobiculatum), little millet (Panicum sumatrense), barnyard millet (Echinochloa frumentacea), fonio (Digitaria exilis), and teff (Eragrostis tef) millets, which are all members of the family

Poaceae and kingdom Plantae. The coarsest and gastro intestinally pleasing millets are kodo varieties (Shahi, S., et al.,2020). It is a very old millet grain that came from tropical Africa and originated in India about three thousand years ago. Kodo millet is also known as Indian Crown Grass, Native Paspalum, Ditch Millet, or Rice Grass. *(Swarnima Day et al; 2023, Jawahar,S,S et al.2019).* Kodo millet blooms are little, unassuming, and self-pollinating by nature, they did not open. *(Meghana GK et al; 2020).* Rain must not impede pollination in order to maintain the quality and effectiveness of seed growth. Polyphenols, flavonoids, and antioxidant chemicals are abundant in kodo millet. Kodo provides a lot of health advantages because it is nutritionally rich. Due to its abundance in phytochemicals and phytate, it has anti-cancer properties and also aids in lowering body weight and treating knee and joint pains/arthritis. It is a standard dish that simulates rice. It is easily digested, abundant in photochemical, and promotes weight loss. The antioxidant content of kodo millet is crucial for preventing a variety of lifestyle-related disorders. In addition to helping women's menstruation become more regular, kodo millet has a significant role in reducing pain in the joints. India, Pakistan, the Philippines, Indonesia, Vietnam, Thailand, and West Africa are the main areas of cultivation for Kodo millet *(Meghana GK et al; 2020).*

Nutrient composition of Kodo millet

Nutrient	Quantity
Moisture	11.2%
Protein	8.1g
Fat	1.3g
Carbohydrate	64.3g
Fiber	8.3mg
Iron	0.5mg
Calcium	32mg
Phosphorus	169mg

Note: All value is for 100g of sample

Kodo millet although considered as one of the minor millets, forms a staple food. Kodo millet owing to its superior nutrient composition and nutritional quality in terms of digestibility of both proteins and carbohydrates. The present investigation was under taken to assess the physico chemical characteristics, value addition and storage quality. The results of the present study are discussed in this chapter. Kodo millet is a small seeded grain that varies very slightly in density, volume, and gram color. Before being dehulled, Kodo millet has small, light-yellow seeds. Dehulling further reduces the size of the seed, which then has a thousand grain weight, volume, and density of 2.8g, 1.2ml, and 1.84 correspondingly. Consumers often tolerate the dehulled grain's pale yellow to very cream-colored appearance.

Kodo millet significantly improved the organoleptic and storage quality of every product, which also helped to explain their widespread popularity. They may be helpful in treating diabetes, cardiovascular disease, constipation, and obesity because they are reasonable, easily accessible, and nutritious.

While whole grains, fruits, and vegetables provide essential nutrients, they also pack a hidden punch - bioactive compounds. These tiny powerhouses offer health benefits beyond basic nutrition, potentially reducing the risk of chronic diseases like cancer, Alzheimer's, and heart disease. Their secret weapon? Antioxidants and special molecules that influence how our bodies work.

Think of them as tiny soldiers: flavonoids and carotenoids are like shields against free radicals, while others regulate metabolism and gene expression. But there's a catch: some foods also contain "frenemies" called antinutrients that can block these soldiers' access.

Where do these powerhouses come from? Three main groups - terpenes, alkaloids, and phenolics - are built using four different pathways in plants *(Shahi et al; 2022).* Grains, in particular, are champion sources of phenolics, teaming up with vitamins and minerals to boost antioxidant activity. Wheat, rice, and millets are all-stars, offering protection against diabetes, cancer, and even nervous system disorders.

Bioactive Components of Kodo:

Kodo millets are tiny titans within our food. Beyond their nutritional content, certain foods hold tiny powerhouses called bioactive compounds. These hidden gems, found abundantly in whole grains, fruits, and vegetables, offer more than just energy fuel. Studies suggest they possess therapeutic potential, potentially lowering the risk of chronic diseases like diabetes, heart disease, and even cancer. The secret lies in their diverse chemical families – terpenes, alkaloids, and phenolic compounds, each with unique structures and abilities. These tiny warriors work on multiple fronts: inhibiting harmful reactions, scavenging free radicals, and influencing gene expression. However, some "antinutritional factors" can hinder their absorption (*(Dey S., Saxena 2022).*

One champion group, phenolic compounds, found abundantly in grains, act as powerful antioxidants *(Chandrakar et al; 2023).* These "symbiotic soldiers" not only boost immunity but also shine in minerals, vitamins, and amino acids, making grains both nutritional powerhouses and medicinal marvels. Research has found their potential in treating various diseases, highlighting grains like wheat, rice, and millets as treasure troves of health-promoting compounds. Other bioactive compounds present in kodo millets are-

1. Plant Power: Unveiling the Magic of Phytochemicals

Think of phytochemicals as tiny superheroes hidden within fruits, vegetables, and whole grains. These naturally occurring, bioactive compounds go beyond simply providing vitamins and minerals. They act like shields, protecting plants from environmental threats like UV rays, insects, and even disease. But their benefits extend beyond the plant kingdom. When we consume a variety of plant-based foods rich in phytochemicals, like broccoli, berries, or nuts, we unlock their potential to keep us healthy too, *(Pujari et al. 2022).* Recent research suggests these potent plant protectors can positively impact our health in numerous ways, potentially reducing the risk of chronic diseases.

2. Unveiling the Diversity of Phenolics: From Flavonoids to Tannins

Phenolics are a diverse group of plant compounds, each acting like a tiny doctor with unique specialties. Imagine them as a team of superheroes, each with their own powers. Flavonoids, for example, come in many forms, like the vibrant anthocyanins that paint berries red and blue, or the protective antioxidants found in onions and tea. Then there are phenolic acids, like the gut-friendly fibre found in whole grains, and lignans, which have been linked to reduced cancer risk. But not all phenolics are equal. Tannins, found in tea and some fruits, can act as "antinutrients," making it harder for us to absorb certain nutrients. However, even these have potential benefits, like aiding digestion or even fighting harmful bacteria. So, while the world of phenolics is complex, their overall impact is clear: they're essential allies in our quest for health and well-being *(Tsuzuki et al. 2018).*

3. Catechin: The Cancer-Fighting Flavonoid

Catechin, a superhero among flavonoids, packs a powerful punch against cancer. Studies have shown its ability to *(Ofosu et al. 2020)*:

a. **Halt cell growth:** It puts cancer cells on hold, preventing them from multiplying.
b. **Trigger apoptosis:** It sends a self-destruct signal to cancer cells, eliminating them naturally.
c. **Tame inflammation:** It soothes the battlefield within, reducing inflammation that can fuel cancer growth.
d. **Block angiogenesis:** It cuts off the blood supply to tumours, starving them of resources.
e. **Hinder metastasis:** It throws a wrench in cancer's travel plans, preventing it from spreading.

Kodo millets are brimming with this potent protector. They contain 1.10 ppm of catechin, offering a delicious and natural way to boost your defences.

4. Naringin: The Osteoporosis-Fighter from Citrus

Naringin, a flavanone glycoside found in citrus fruits and surprisingly kodo millets (11.97 ppm!), is a champion for bone health, *(Nagre et al. 2023).* It flexes its muscles by:

a. **Boosting osteocalcin:** This protein helps build strong bones, and naringin gives it a power-up.
b. **Revving up alkaline phosphatase:** This enzyme plays a vital role in bone mineralization, and naringin gets it working overtime.
c. **Raising osteocalcin levels:** More of this bone-building protein means stronger, denser bones.
   These properties make kodo millets as a natural osteoporosis fighter.

5. p-Coumaric Acid: The Antioxidant Avenger

Imagine a tiny shield protecting your cells from harmful free radicals – that's p-coumaric acid in action, *(Yuan et al. 2020).* This phenolic acid, found in kodo millets at 1.38 ppm, is a triple threat *(Bijalwan et al. 2016):*

a. **Cuts down lipid peroxidation:** It stops the damaging oxidation of fats in your body, keeping your cells healthy.

b. Tames cholesterol: It keeps cholesterol levels in check, reducing the risk of heart disease.

c. **Lowers LDL (bad) cholesterol:** It targets the bad cholesterol, leaving the good kind to do its job *(Chandrasekara, A. et al.2010).*

Kodo millets, with their p-coumaric acid shield, are like a delicious daily dose of protection for your heart and overall health.

6. Taxifolin: The Inflammation Tamer

Taxifolin, a flavonoid found in onions and citrus fruits. It is present in Kodo millets, is a master of quelling inflammation i.e a bowl of kodo millets – nature's anti-inflammatory powerhouse, *(Wang et al 2022).* It works its magic by:

a. **Reducing lipid peroxidation:** Just like p-coumaric acid, it protects your cells from free radical damage *(Sabuz et al. 2023).*

b. Acting as a powerful antioxidant: It scavenges free radicals, preventing them from causing harm *(Khare et al. 2020).*

c. Calming inflammation during injury: Whether it's a workout or a cut, taxifolin helps your body heal gently *(Dey et al. 2022).*

7. Pterin 6-Carboxylic Acid: The Folate Friend

This mouthful of a compound sounds complex, but its role in kodo millets is simple: it helps our body to absorb folic acid *(Dey et al. 2022)*, a crucial nutrient for healthy cell growth and development. Kodo millets, especially germinated ones (boasting 15.84% more phenols!), are a natural source of this beneficial compound *(Juzeniene et al. 2016).*

8. Campesterol: The Cholesterol Challenger

This plant sterol found in kodo millets (0.31% in raw, 2.60% in germinated) is like a friendly imposter *(Priya Verma et al. 2023).* It has a structure similar to cholesterol, but instead of clogging of arteries, it helps lower the bad cholesterol levels. And that's not all – studies suggest it may even have anti-cancer properties.

9. Sinapic Acid: The Anti-Obesity Tiny Trio:

Kodo millets hold a secret weapon against obesity. Sinapic acid, along with its antioxidant and anti-inflammatory powers, packs an extra punch: it helps fight obesity, *(Chauhan et al. 2018).* This powerful compound, found in trace amounts (7.9 ppm), packs a triple punch of health, *(Priya Verma et al; 2023):*

1. Antioxidant Ace: Sinapic acid shields your cells from harmful free radicals like a tiny knight wielding a shining shield. This prevents damage that can lead to chronic diseases like cancer and heart disease *(Dey et al; 2022).*

2. Inflammation Tamer: When your body gets stressed or injured, inflammation kicks in. But sinapic acid acts like a soothing balm, calming the flames of inflammation and promoting healing.

3. Anti-Obesity Ally: Sinapic acid, along with its antioxidant and anti-inflammatory companions, helps break down fat and prevent new fat from forming. This translates to a slimmer waistline and a healthier you, in short: kodo millets are a tiny army of health defenders, *(Anitha et al; 2021).*

In essence, these invisible champions within our food offer a promising path towards health and well-being, waiting to be unlocked through a diverse, colourful diet.

Result and Discussion:

Kodo millet, despite its small size, punches a big nutritional weight. It's a complete meal in itself, offering a good balance of protein, fat, fiber, hydration, and sugars. It's also a champion of minerals like calcium, iron, and phosphorus, making it a dietary powerhouse. What's even more impressive is its digestibility – both proteins and carbs are easily absorbed by the body. Research on kodo millet highlights its remarkable qualities with a powerful punch of health benefits due to its unique composition of bioactive compounds.

a. Phytochemicals: These plant superheroes, like flavonoids and antioxidants, shield your cells from harm, protect against chronic diseases, and even boost immunity. Kodo millet is a treasure trove of these tiny guardians.

b. Phenolic Powerhouse: Catechin, naringin, and p-coumaric acid are just a few of the phenolic superstars found in kodo millet. These potent compounds fight inflammation, build strong bones, and lower bad cholesterol, making you a fortress against illness.

c. Taxifolin the Tamer: Feeling achy? Taxifolin, another kodo millet resident, quells inflammation and promotes gentle healing, keeping you comfortable and active.

d. Folate Friend: Pterin 6-carboxylic acid, though complex in name, plays a simple yet crucial role: it helps absorb folic acid, vital for healthy cell growth. Kodo millet, especially germinated, is a natural source of this essential nutrient.

e. Cholesterol Challenger: Campesterol, a plant sterol in kodo millet, acts like a friendly imposter. It resembles cholesterol but lowers bad cholesterol levels, keeping your heart happy and healthy.

f. Anti-Obesity Trio: Sinapic acid, along with its antioxidant and anti-inflammatory powers, packs an extra punch: it fights obesity! This tiny warrior breaks down fat and prevents its formation, helping you maintain a healthy weight.

g. Probiotic potential: Kodo millet's high fiber content makes it ideal for creating gut-friendly probiotic drinks, aiding digestion.

h. Functional food development: This underutilized grain holds untapped potential for creating functional foods enriched with its natural health benefits. Optimizing extraction and purification methods for bioactive compounds from kodo millet is a key research area.

i. Safety and allergenicity: Before becoming a staple in functional foods, kodo millet needs thorough evaluation for microbiological safety, allergenicity, and potential toxicity.

These invisible champions within kodo millet paint a promising picture of health and well-being. By incorporating this tiny powerhouse into your diet, you unlock a natural defense against chronic diseases, inflammation, and even obesity. Remember, it's not just a grain; it's an army of microscopic knights working tirelessly to keep you healthy and thriving.

Conclusion:

In conclusion, millets are more than just food with impressive nutritional profile, diverse genetic potential, and promising health benefits make it a future star in the food world. They are a path to food sovereignty, offering nutritional security, environmental sustainability, and economic empowerment for farmers and communities alike. Their reintroduction into food programs and a shift towards millet-based agriculture hold immense potential for a healthier and more secure future. Continued research and development efforts can unlock its full potential, leading to new and exciting food innovations that promote health and well-being.

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