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SHYAMAK (ECHINOCHLOA FRUMENTACEA LINN.): NUTRITIONAL BENEFITS AND AYURVEDIC PERSPECTIVE — A LITERATURE REVIEW

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ABSTRACT

Shyamak, known scientifically as Echinochloa frumentacea (Linn.) and colloquially as Barnyard Millet, is one of the oldest cultivated millets in the Indian subcontinent. It occupies an important place in Ayurvedic dietetics, described in classical texts such as the Charaka Samhita and Sushruta Samhita under the category of *Shuka Dhanya* (husked cereals). This literature review systematically examines the botanical identity, macro- and micro-nutritional profile, phytochemical constituents, and documented health benefits of *Shyamak*. Contemporary biomedical evidence corroborating traditional therapeutic claims — including antidiabetic, antioxidant, anti-inflammatory, and gut-health-promoting effects — is also reviewed. The convergence of Ayurvedic knowledge and modern nutritional science positions *Shyamak* as a valuable functional food with significant potential for addressing non-communicable diseases, food insecurity, and climate-resilient agriculture. Future research directions and gaps in clinical evidence are discussed.

KEYWORDS: *Shyamak; Barnyard Millet; Echinochloa frumentacea Linn.*

INTRODUCTION

Millets represent a diverse group of small-seeded grasses that have sustained human civilizations for millennia, particularly across South Asia and sub-Saharan Africa. Among these ancient grains, *Shyamak* — known in botanical nomenclature as Echinochloa frumentacea (Linn.) and commonly referred to as Barnyard Millet, Indian Barnyard Millet, or Sawa Millet — holds a distinctive position both in traditional Indian agriculture and in the classical literature of Ayurvedic medicine.[1]

Classified under the genus Echinochloa of the family Poaceae, *Shyamak* is a short-duration, drought-tolerant cereal crop that thrives in marginal soils with minimal inputs.[2] It is primarily cultivated in the states of Uttarakhand, Himachal Pradesh, Uttar Pradesh, Bihar, and parts of Maharashtra, and occupies a significant role in the agrarian economy and dietary culture of hilly regions. Globally, it is also cultivated in Japan, China, and Korea, where varieties of Echinochloa are consumed as part of traditional diets.[3]

From an Ayurvedic standpoint, *Shyamak* is categorized under *Shuka Dhanya* (husked cereals) and is extensively described in the classical *Brihat Trayi* —— specifically in the Charaka Samhita (*Sutrasthana* 27), Sushruta Samhita (*Sutrasthana* 46), and Ashtanga Hridayam (*Sutrasthana* 6). These texts attribute to *Shyamak* properties of being *Laghu* (light to digest), *Sheeta Veerya* (cooling in potency), and *Kaphapitta-shamaka*.[4]

In the contemporary era, rising incidence of lifestyle diseases such as type 2 diabetes mellitus, obesity, cardiovascular disease, and gastrointestinal disorders has renewed scientific interest in traditional grains as functional foods. *Shyamak's* high dietary fibre content, superior micronutrient density, and low glycemic response offer a compelling case for its reintegration into modern diets.[5] Additionally, in the context of climate

change and food sovereignty, the crop's resilience characteristics position it as a critical component of sustainable food systems.[6]

This literature review aims to systematically examine and consolidate available evidence on the botanical identity, nutritional composition, phytochemistry, pharmacological activities, and Ayurvedic therapeutic properties of *Shyamak.*

METHODOLOGY

This review follows the framework appropriate for literature reviews. Relevant literature was identified through systematic searches of PubMed/MEDLINE, Google Scholar, Web of Science, and Scopus databases using the following search terms (individually and in combination): *'Shyamak'*, 'Barnyard Millet', 'Echinochloa frumentacea', 'millet nutrition', *'Shuka Dhanya'*, 'millet Ayurveda', 'millet antidiabetic', and 'functional millet'.

Classical Ayurvedic texts — including the *Charaka Samhita, Sushruta Samhita, Ashtanga Hridayam, Bhavaprakasha Nighantu, Raja Nighantu, and Dhanvantari Nighantu* — were consulted in their original Sanskrit editions and authenticated translations. The Indian Council of Agricultural Research (ICAR) and the National Institute of Nutrition (NIN) databases were referenced for compositional data. Articles published in English between 1990 and 2025 were included.

RESULT

Botanical Identity and Taxonomy

Shyamak belongs to the kingdom Plantae, family Poaceae, tribe Paniceae, genus Echinochloa, and species frumentacea. The full taxonomic classification is presented below.

Kingdom: Plantae | Division: Magnoliophyta | Class: Liliopsida | Order: Cyperales | Family: Poaceae | Genus: Echinochloa | Species: E. frumentacea (Linn).

Vernacular names across India include Samak/Sama (Hindi), Oodalu (Kannada), Kuthiraivali (Tamil), Jhangora (Uttarakhand), and Vari (Marathi).[7] In Ayurvedic texts, it is described as *Shyamaka*, *Shyama* etc.

Morphologically, *Shyamak* is an annual grass reaching 50–120 cm in height with flattened leaf blades and a paniculate inflorescence bearing numerous racemes. The grains are small, ovate, approximately 1.5–2 mm in length, enclosed in a hull, and ivory to pale yellow in color when dehulled. The crop matures within 45–65 days, making it one of the fastest-maturing cereals known.[8]

Nutritional Composition

Macronutrients

Shyamak possesses a balanced macro nutritional profile with particular strengths in dietary fiber composition. Proximate analysis studies consistently report protein content in the range of 5.5–7.5 g per 100 g and carbohydrate content of 62–67 g.[9] Its dietary fiber content of approximately 9.8 g per 100 g is significantly superior to polished rice (0.2 g) and white wheat flour (2.7 g), which is of clinical importance in metabolic disease management.[10]

The starch in *Shyamak* is characterized by a higher proportion of resistant starch and a lower amylose-to-amylopectin ratio compared to rice, contributing to its relatively low glycemic index (GI) values reported in the range of 50–54, compared to 64–72 for white rice.[11] This property underpins the grain's utility in diabetic dietary management.

Micronutrients

Shyamak is a rich source of several micronutrients that are commonly deficient in cereal-based diets. Iron content (4.2–5.6 mg/100 g) is substantially higher than rice (0.7 mg/100 g) and comparable to green leafy vegetables, making it relevant to addressing iron-deficiency anaemia. Zinc content (2.8–3.2 mg/100 g), calcium (20–22 mg/100 g), phosphorus (270–290 mg/100 g), and magnesium (82 mg/100 g) further underscore its micronutritional density.[12]

B-vitamin content, particularly thiamine (0.33 mg/100 g), niacin (4.2 mg/100 g), and riboflavin (0.10 mg/100 g), is appreciable and exceeds that of polished rice, which loses much of its B-vitamin content during milling.[13] Table 1 below presents a comparative overview of the nutritional composition of *Shyamak* versus polished white rice.

Table 1: Comparative Nutritional Composition of Shyamak (Barnyard Millet) and Polished White Rice per 100 g dry weight. Source: NIN, ICMR (2017); Devi et al. (2014).

Nutrient	Shyamak (per 100 g)	Rice (per 100 g)
Energy (kcal)	307	346
Protein (g)	6.2	6.8
Fat (g)	3.6	0.5
Carbohydrates (g)	65.5	79.0
Dietary Fibre (g)	9.8	0.2
Calcium (mg)	20	10
Iron (mg)	5.0	0.7
Phosphorus (mg)	280	160
Zinc (mg)	3.0	1.1
Thiamine (mg)	0.33	0.06
Riboflavin (mg)	0.10	0.06
Niacin (mg)	4.2	1.9

Phytochemicals and Bioactive Compounds

Beyond macronutrients and vitamins, *Shyamak* contains a diverse array of bioactive phytochemicals. Polyphenols — including ferulic acid, p-coumaric acid, caffeic acid, and protocatechuic acid — are reported in significant concentrations in the bran fraction.[14] Total phenolic

content (TPC) ranges from 8.2 to 12.6 mg gallic acid equivalent (GAE) per gram of extract across multiple studies.[15]

Flavonoids, particularly vitexin, orientin, and tricin, have been identified in *Shyamak* extracts and are associated with antioxidant, anti-inflammatory, and cardioprotective activities.[16] The grain also contains phytosterols (primarily beta-sitosterol and campesterol) and tocols (tocopherols and tocotrienols), contributing to its lipid-modulating properties. Phytic acid content, while present, is lower than that of sorghum and pearl millet, reducing concerns about mineral bioavailability.[17]

Ayurvedic Perspective on Shyamak

Classical Textual References

Shyamak is described in multiple classical Ayurvedic texts. In the *Charaka Samhita*, it is enumerated among the *Shuka Dhanya* group and described as *Laghu* (light), *Sheeta* (cooling), *Vatala*(Vata increasing) and suitable for *Kaphapittaja* conditions. The text states that *Shyamak* is *grahi* (absorbent) and *Shoshana*(drying).[18] It is mentioned in diet for *prameha*[19], *raktapitta*[20], *udararoga*[21], *arshas*[22], *kasa*[23] and *urustambha.*[24]

The *Sushruta Samhita* echoes these properties and notes its utility in *prameha* and *atisthoulya*.[25] The *Ashtanga Hridaya* of Vagbhata has also described *shyamak* similar to as told by Acharya Charaka.[26] It is indicated in *prameha, atisthoulya* and *kasaroga*.

Among the *Nighantus*, the *Bhavaprakasha Nighantu* provides the most detailed description, classifying *Shyamak* under *Dhanya Varga* (cereal group) and attributing it properties of *Shoshana*(drying), *Ruksha*, *Kaphapittahrt*(reducing kapha and pitta) and *Vatala* (vata increasing).[27] The *Dhanvantari Nighantu* and *Raja Nighantu* also classify it under cereals with similar properties. In *Dhanvantari Nigantu* it is described as best among *trnadhanya* but has been mentioned as *snigdha* which is contradictory to other *Acharyas.* In addition to these properties it is also mentioned as having *sukrala* property and indicated in *masuri* and *grahani roga*.[28]

Dosha Analysis

Shyamak is classified as *Pitta Kapha-shamaka* and *Vatala.* Its *Sheeta Veerya* and *Kashaya rasa* pacifies *Pitta,* while its *Laghu* and *Ruksha Guna* address Kapha accumulation by reducing heaviness and moisture but can cause a slight increase in *Vata.*

Therapeutic Indications in Classical Texts

Classical Ayurvedic literature records *Shyamak* as beneficial in the following conditions: *Arsha* (haemorrhoids) — through its *Kashaya Rasa* and due to its high fiber content; *Prameha* (urinary disorders including diabetes) — through *Kapha*-reducing and *Grahi* actions; *Atisthoulya* (overweight and obesity)— through its *Kashaya rasa, Laghu, Ruksha, Shoshana, Lekhana Guna*. Significantly, the description of *Shyamak* in the management of *Prameha* — the category under which *Madhumeha* (diabetes mellitus equivalent) falls — in the Charaka Samhita represents one of the earliest dietary prescriptions for blood sugar regulation.

Health Benefits: Scientific Evidence

Antidiabetic Activity

Multiple in vitro, in vivo, and clinical studies have investigated *Shyamak's* antidiabetic potential. Studies by Ugare et al. (2014) demonstrated that *Shyamak*-supplemented diets in streptozotocin-induced diabetic rats significantly reduced fasting blood glucose, HbA1c, and improved insulin sensitivity compared to rice-fed controls.[29] The mechanism is attributed to high dietary fibre slowing glucose absorption, inhibition of alpha-amylase and alpha-glucosidase enzymes by polyphenols, and modulation of gut microbiota.[30]

Human intervention studies, though limited, suggest that substitution of 50% rice calories with *Shyamak* in meals significantly reduces postprandial glycemic response in both healthy and pre-diabetic subjects.[31] These findings align well with the classical Ayurvedic prescription of *Shyamak* in *Prameha* management.

Antioxidant Properties

Shyamak demonstrates significant antioxidant capacity across multiple assays. Total antioxidant capacity by DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay and FRAP (Ferric Reducing Antioxidant Power) assay shows that *Shyamak* bran extracts exhibit potency comparable to or exceeding that of other millets including finger millet and pearl millet.[32] The primary contributors identified are phenolic acids (particularly ferulic and caffeic acid), flavonoids, and tocols.

Kumari and Thayumanavan (1998) established that whole grain *Shyamak* has appreciably higher antioxidant activity than polished rice, attributing this to the intact bran layer.[33] Milling and processing significantly reduce this antioxidant potential, underscoring the importance of whole-grain consumption.

Anti-inflammatory Effects

Tricin, a flavone abundantly found in *Shyamak* and other millets, has been studied for its anti-inflammatory properties. Janicke et al. (2011) demonstrated tricin's inhibition of COX-2 (cyclooxygenase-2) enzyme activity, a key mediator of inflammatory pathways, at concentrations relevant to dietary intake.[34] In animal models, *Shyamak* bran extracts have been shown to significantly reduce serum levels of pro-inflammatory cytokines including TNF-alpha, IL-6, and CRP.[35]

These findings are consistent with the Ayurvedic property of *Sheeta Veerya* (cooling potency), which in classical terms indicates pacification of inflammatory *(Pitta*-aggravated) conditions.

Gastrointestinal Health

The high dietary fibre content of *Shyamak* — comprising both soluble (beta-glucans, arabinoxylans) and insoluble (cellulose, hemicellulose) fractions — exerts significant prebiotic and laxative effects. Studies in rat models demonstrate that *Shyamak* feeding promotes proliferation of beneficial Lactobacillus and Bifidobacterium species while reducing pathogenic Clostridium counts.[36]

Short-chain fatty acid (SCFA) production, particularly butyrate, is enhanced with *Shyamak* consumption — a property associated with intestinal epithelial integrity, anti-inflammatory signalling, and colon cancer risk reduction.[37] The classical *Grahi* property (astringent, absorbing) in Ayurveda may thus correspond to a complex of fibre-mediated gut normalisation effects.

Cardiovascular Health

Shyamak's lipid-modulating potential has been demonstrated in several animal studies. Diets supplemented with *Shyamak* were associated with significant reductions in total cholesterol, LDL-cholesterol, and triglycerides, along with modest increases in HDL-cholesterol in hyperlipidaemic rat models.[38] The phytosterols (beta-sitosterol) and tocols (tocotrienols) present in the grain are the primary agents attributed to this effect through competitive inhibition of cholesterol absorption at intestinal levels.

Additionally, *Shyamak's* magnesium content (82 mg/100 g) supports cardiac rhythmicity and vascular tone.[39]

Suitability During Fasting (Vrat) in Indian Culture

A notable ethnological use of *Shyamak* in India is its consumption during Hindu religious fasting periods (Vrat/Upvas). *Shyamak* rice (Sama ke chawal) is one of the few grains considered acceptable during Ekadashi, Navratri, and other observances. This practice aligns with its Ayurvedic properties of easy digestibility, cooling nature, and capacity to sustain the body under reduced caloric intake without disturbing metabolic equilibrium.[40] Its gluten-free nature and distinct taxonomic classification outside 'true cereals' may also contribute to its fasting suitability across different religious dietary traditions.

DISCUSSION

The evidence reviewed in this article reveals a remarkable convergence between classical Ayurvedic descriptions and modern scientific findings regarding *Shyamak*. The grain's *Kaphapitta shamana* property is reflected in its nutritional profile — it is neither excessively calorie-dense nor deficient, contains cooling bioactive compounds (polyphenols, flavonoids) that modulate inflammatory pathways, and provides substantial fibre that regulates metabolic and digestive functions.

The most clinically significant finding is the antidiabetic evidence supporting classical *Prameha* indications. The dual mechanism of fiber-mediated glycemic attenuation and polyphenol-mediated enzyme inhibition provides a plausible molecular basis for observations documented over 2,500 years ago. This represents a case study in the validation of traditional dietary knowledge through modern pharmacology.

However, several important gaps remain. Most pharmacological studies have used in vitro or animal models; rigorous randomized controlled trials in human subjects are scarce. The bioavailability of *Shyamak* polyphenols and minerals under different food processing conditions (fermentation, germination, milling) has not been systematically mapped. The optimal therapeutic dosage, food form, and duration of consumption for specific clinical conditions remain undefined within biomedical parameters.

From a food systems perspective, *Shyamak's* agronomic advantages — drought tolerance, low input requirements, rapid maturation — make it particularly suited to climate-vulnerable agricultural zones. The Indian government's designation of 2023 as the International Year of Millets (backed by UN resolution) has catalysed renewed research and policy attention to grains like *Shyamak*.[41] Integrating Ayurvedic nutritional wisdom with contemporary food technology, such as developing low-GI ready-to-cook products, functional beverages, and fortified weaning foods from *Shyamak*, represents a viable translational research direction.

CONCLUSION

Shyamak (Echinochloa frumentacea) is a nutritionally dense, pharmacologically active, and therapeutically versatile cereal grain that has been utilized in Ayurvedic dietetics for millennia. Its *Kapha pitta samana* property, high dietary fiber, superior micronutrient profile, and rich phytochemical content make it relevant to the prevention and dietary management of contemporary non-communicable diseases including diabetes mellitus, dyslipidemia, cardiovascular disease, and gastrointestinal disorders. The convergence of classical Ayurvedic prescriptions and modern biomedical evidence for *Shyamak's* therapeutic utility is substantial and warrants acceleration of clinical research. Promotion of *Shyamak* cultivation and consumption represents both a public health opportunity and a cultural reintegration of ancient Indian agronomic wisdom into the modern food system.

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