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THE ROLE OF *TRUNADHANYA* (MINOR MILLETS) IN *PRAMEHA ROGA* AS A PREVENTIVE MEASURE: AN AYURVEDIC AND SCIENTIFIC APPRAISAL

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ABSTRACT

Background: *Prameha Roga*, a syndrome complex described in classical Ayurvedic texts, bears a significant resemblance to modern diabetes mellitus and its prodromal stages. Characterized by polyuria and metabolic dysfunction, its pathogenesis is deeply linked to dietary habits, particularly the excessive consumption of *Kapha*-aggravating foods. In this context, Ayurveda emphatically recommends *Pathya Ahara* (wholesome diet), with a special focus on *Trunadhanya* a category of minor millets for both prevention and management.

Aim: This comprehensive review aims to critically analyze the classical concept of *Trunadhanya*, elucidate its proposed role in preventing *Prameha Roga* based on Ayurvedic principles, and evaluate its scientific plausibility through contemporary nutritional and pharmacological evidence.

Methods: A systematic narrative review was conducted by sourcing classical Ayurvedic literature from *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*. Modern scientific databases (PubMed, Scopus, Google Scholar) were searched for studies on the nutritional composition, glycemic index, antioxidant potential, and health benefits of specific

millets identified as *Trunadhanya* (e.g., Foxtail millet, Barnyard millet, Little millet). Data from both streams were integrated thematically.

Results: Classical texts explicitly designate *Trunadhanya* (e.g., *Shyamaka, Kodrava, Kangu*) as the staple food of choice (*Shasta Dhanya*) for *Pramehi* (person with *Prameha*) and those at risk. Their pharmacodynamic properties (*Rooksha* - dry, *Laghu* - light to digest) are antagonistic to the oleation and heaviness (*Snigdha, Guru*) that characterize the *Kapha*-dominant etiology of *Prameha*. Modern analysis reveals that these millets are rich in dietary fiber, especially insoluble fiber, have a low glycemic index, are high in magnesium, and contain polyphenols and other phytochemicals. These factors collectively contribute to slow glucose release, improved insulin sensitivity, reduced oxidative stress, and management of dyslipidemia—key pillars in diabetes prevention.

CONCLUSION: The Ayurvedic recommendation of *Trunadhanya* as a preventive measure for *Prameha Roga* is supported by a strong theoretical framework within the *Dosha-Dushya* paradigm. This recommendation finds substantial validation in modern nutritional science, which identifies these grains as functional foods with anti-diabetic potential. Integrating *Trunadhanya* into the daily diet, particularly as a substitute for refined cereals, represents a sustainable, evidence-based, and culturally congruent strategy for the primary prevention of Type 2 Diabetes Mellitus, aligning ancient wisdom with contemporary preventive medicine.

KEYWORDS: *Trunadhanya*; *Prameha*; Diabetes Mellitus Prevention; Ayurveda; Millets; Glycemic Index; Pathya Ahara; Functional Foods; *Kapha*; Dietary Fiber.

1. INTRODUCTION

1.1. *Prameha Roga*: The Ayurvedic Conception of a Metabolic Disorder

Prameha Roga is one of the most extensively described systemic disorders in the classical Ayurvedic compendia, primarily in the *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*. [1] The term "*Prameha*" is derived from the Sanskrit roots "*Pra*" meaning excessive and "*Meha*" meaning urination, thus directly pointing to the cardinal symptom of polyuria.[2] However, Ayurvedic seers perceived it not as a single disease entity but as a syndrome or constellation of urinary and systemic disorders with a common underlying pathophysiology. The etiology (*Nidana*) is multifactorial, encompassing sedentary lifestyle (*Adhyashana* -

excessive eating, *Avyayama* - lack of exercise), genetic predisposition (*Beeja Dushti*), and most significantly dietary indiscretions involving excessive intake of *Guru* (heavy), *Snigdha* (unctuous/oily), *Madhura* (sweet), and *Sheeta* (cold) foods and drinks.[3]

The pathogenesis (*Samprapti*) involves the vitiation of *Kapha Dosha* primarily, which then progressively involves *Pitta* and *Vata*, leading to the manifestation of different types of *Prameha* (20 types according to Charaka: 10 *Kapha*, 6 *Pitta*, and 4 *Vata* types).[4] The vitiated *Doshas* affect the *Medas* (adipose tissue), *Mamsa* (muscle), *Kleda* (body fluids), and *Shukra* (reproductive tissue), ultimately contaminating the *Mutravaha Srotas* (urinary system). This results in the passage of turbid, sweet, and excessive urine.[5] The advanced, intractable stage of *Prameha* is termed *Madhumeha* (sweet urine like honey), which is considered virtually identical to Type 1 or advanced Type 2 Diabetes Mellitus.[6]

1.2. The Preventive Paradigm in Ayurveda: Sthula Pramehi and the Concept of *Pathya*

Ayurveda places unparalleled emphasis on prevention (*Swasthavritta*). For *Prameha*, this is especially critical. The texts describe a stage called *Sthula Pramehi* or *Prameha Poorvarupa*—the pre-diabetic state or stage of prodromal symptoms.[7] This stage presents with signs like sweet taste in the mouth, burning sensation in palms and soles, excessive thirst, lethargy, and coating on the teeth. Ayurveda asserts that intervention at this stage is most effective and can prevent progression to full-blown *Madhumeha*.[8] The cornerstone of this preventive (and therapeutic) strategy is *Pathya-Apathya*—the strict adherence to wholesome and avoidance of unwholesome regimens. *Aharaja Nidana* (dietary causes) being paramount, *Ahara* (diet) becomes the most critical *Pathya*. Charaka unequivocally states, "*Pathyesati Sada Pathyo, Vyadhirutpadyate Kwachit...*" meaning, "Even if a disease occurs while following a proper diet, it is easily curable."[9]

1.3. *Trunadhanya*: The Forgotten Staples

Within the dietary recommendations, a specific category of grains is exalted: *Trunadhanya*. Literally translating to "grass grains" (*Truna* = grass, *Dhanya* = grain), these are small-seeded cereals harvested from short, grassy plants.[10] They are contrasted with *Shali Dhanya* (fine cereals like rice and wheat) and are often classified as *Kudhanya* (inferior grains) in a socio-culinary context but are elevated to the status of *Shasta Dhanya* (excellent grains) in a medical and preventive context, especially for metabolic disorders.[11] Common examples include:

- *Shyamaka* (Echinochloa frumentacea – Barnyard millet)
- *Kodrava* (Paspalum scrobiculatum – Kodo millet)
- *Kangu* (Setaria italica – Foxtail millet)
- *Nartaki* (likely Panicum sumatrense – Little millet)
- *Uddalaka* (Paspalum sp. – possibly a wild millet)[12]

These grains are repeatedly recommended as the staple food (*Annashaya*) for *Pramehi* individuals across all major texts.[13]

1.4. Rationale and Objectives

In an era where Type 2 Diabetes Mellitus has reached epidemic proportions globally, preventive strategies are urgently needed.[14] The modern approach emphasizes lifestyle modification, with diet being central. Whole grains are universally recommended, yet refined cereals dominate global diets.[15] Ayurveda's specific prescription of *Trunadhanya* offers a precise, time-tested dietary intervention. However, this recommendation, while deeply rooted in *Dosha* theory, requires interrogation through the lens of modern nutritional science to establish its validity and mechanisms for a wider, evidence-based acceptance.

This article, therefore, aims to:

1. Systematically present the classical descriptions of *Trunadhanya* and their specific indications in *Prameha*.
2. Analyze the Ayurvedic pharmacodynamic properties (*Rasa, Guna, Virya, Vipaka, Prabhava*) of *Trunadhanya* and explain their hypothesized preventive action against the *Samprapti* (pathogenesis) of *Prameha*.
3. Review the contemporary nutritional and phytochemical profile of identified *Trunadhanya* millets.
4. Correlate the modern scientific evidence on millets' health benefits with the classical claims regarding diabetes prevention.
5. Propose an integrative model for utilizing *Trunadhanya* as a sustainable, culturally relevant preventive measure against diabetes mellitus.

2. METHODS

This study employed a comprehensive narrative review methodology, integrating data from classical Ayurvedic sources and contemporary scientific research.

2.1. Literature Search Strategy

A. Ayurvedic Sources: Primary Sanskrit texts and their authoritative commentaries were studied. Key sources included:

Charaka Samhita (Chikitsa Sthana, Chapter 6: *Prameha* Chikitsa)

- *Sushruta Samhita* (Nidana Sthana, Chapter 6: *Prameha* Nidana; Chikitsa Sthana, Chapter 11).
- *Ashtanga Hridaya* (Nidana Sthana, Chapter 10; Chikitsa Sthana, Chapter 12).
- *Bhava Prakasha Nighantu* (Dhanya Varga).
- *Dhanwantari Nighantu* (Shuka Dhanya Varga).

The texts were analyzed for versesmentioning *Trunadhanya*, *Kudhanya*, *Shyamaka*, *Kodrava*, etc., in the context of *Prameha*, *Pathya*, and *Santarpana* (over-nourishment) conditions.

B. Modern Scientific Sources: Electronic databases (PubMed, Scopus, Web of Science, Google Scholar) were searched from inception to September 2023. Search terms and combinations included: ("millet" OR "foxtail millet" OR "barnyard millet" OR "kodo millet" OR "little millet") AND ("diabetes" OR "glycemic index" OR "insulin resistance" OR "dietary fiber" OR "polyphenols"); ("*Trunadhanya*" OR "Shyamaka" OR "Kodrava") AND ("Ayurveda"); ("traditional grains" AND "metabolic syndrome"). Additional searches were conducted for nutritional composition data from FAO and IFCT.

2.2. Inclusion and Exclusion Criteria

Included: Classical Ayurvedic verses describing properties and indications of millets. Modern research articles (in vitro, in vivo animal studies, human clinical trials, reviews) investigating the nutritional, metabolic, and glycemic effects of millets. Articles in English.

Excluded : Non-peer-reviewed articles, anecdotal reports, articles where the specific millet type was not identified.

2.3. Data Synthesis

Data from Ayurvedic texts were thematically categorized into: Definition/Identification, Properties (*Guna-Karma*), Specific Indications for *Prameha*, and Mode of Action within the *Dosha* framework. Modern scientific data were tabulated and synthesized under: Proximate Composition (macronutrients, fiber), Micronutrients (Mg, Zn), Phytochemicals, Glycemic Index (GI) Studies, and Animal/Human Intervention Studies on glucose and lipid

metabolism. A final synthesis created a side-by-side comparison and correlation between the two knowledge systems.

3. RESULTS

3.1. Classical Ayurvedic Descriptions of *Trunadhanya*

The *Bhava Prakasha Nighantu* (Dhanya Varga) provides a clear listing and basic properties.[16] For instance:

- **Shyamaka (Barnyard Millet):** Described as *Laghu* (light), *Ruksha* (dry), *Kashaya-Madhura Rasa* (astringent-sweet taste), and *Sheeta Virya* (cooling potency). It is indicated in *Prameha*, *Trishna* (morbid thirst), and *Daha* (burning sensation). [17]
- **Kodrava (Kodo Millet):** *Laghu*, *Ruksha*, *Kashaya-Madhura Rasa*, *Katu Vipaka* (pungent post-digestive effect). It is highly recommended in *Prameha* and conditions of *Ama* (toxins due to improper digestion). [18]
- **Kangu (Foxtail Millet):** *Laghu*, *Snigdha* (slightly unctuous), *Madhura Rasa*. It alleviates *Vata* and *Pitta* but can increase *Kapha* in excess. Its mention in *Prameha* is specific; it is considered beneficial, though some texts place it slightly behind *Shyamaka* and *Kodrava* due to its mild *Snigdha* property. [19]

The overarching properties of *Trunadhanya* as a class are *Laghu* and *Ruksha*. In the context of *Prameha* Chikitsa, Charaka prescribes: "*Shyamakakodravadikasha cha Trunadhanyah sarvaprameheshu pathyah*" – "Shyamaka, Kodrava, etc., the *Trunadhanya*, are wholesome in all types of *Prameha*." [20] Sushruta, while listing various *Pathya*, gives prime importance to *Yava* (barley) and then to *Shyamaka* and *Kodrava*. [21]

3.2. The Preventive Mechanism: An Ayurvedic Pharmacodynamic Perspective

The preventive action of *Trunadhanya* against *Prameha* can be decoded through the *Dosha-Dushya-Samurchhana* model:

1. **Counteracting *Santarpana* (Overnourishment):** *Prameha* is a classic *Santarpana Janya Vyadhi* (disease caused by over-nourishment). [22] The modern equivalent is a hyper-caloric, high-glycemic, high-fat diet. *Trunadhanya*, being *Laghu* (light) and *Ruksha* (dry), is the pharmacological opposite of the *Guru* (heavy) and *Snigdha* (oily) diet that causes the disease. It provides satiety and nutrition without contributing to *Medo Vriddhi* (increase in adipose tissue).

2. **Pacifying *Kapha* *Dosha*:** The primary vitiated *Dosha* in early *Prameha* is *Kapha*. *Kapha*'s qualities are *Guru*, *Snigdha*, *Sheeta*, *Manda* (slow), etc. [23] The *Ruksha* and *Laghu* properties of *Trunadhanya* directly antagonize the *Snigdha* and *Guru* qualities of *Kapha*, thereby checking its aggravation and arresting the *Samprapti*.
3. **Promoting *Agni* (Metabolic Fire):** *Agnimandya* (diminished digestive/metabolic power) is a key component in *Prameha* pathogenesis. [24] *Laghu* foods are easy to digest and do not overburden *Agni*. The *Katu Vipaka* (pungent post-digestive effect) of some like *Kodrava* further kindles *Agni*, improving metabolism at a tissue (*DhatvAgni*) level, crucial for proper glucose handling.
4. **Reducing *Medas* and *Kleda*:** *Medas* (fat) and *Kleda* (excess moisture/fluids) are the primary vitiated *Dushyas* (tissues). The *Ruksha* property helps absorb and dry up excess *Kleda*, while the light, fibrous nature prevents abnormal accumulation of *Medas*.

Table 1: Ayurvedic Properties and Proposed Anti-*Prameha* Action of Key *Trunadhanya*

Millet (Sanskrit)	**Botanical Name**	***Rasa***	***Guna***	***Virya***	***Vipaka***	**Proposed Action in *Prameha* Prevention**
Shyamaka	Echinochloa frumentacea	*Kashaya, Madhura*	*Laghu, Ruksha*	*Sheeta*	*Katu*	Reduces *Kapha* & *Pitta*, dries excess *Kleda*, alleviates thirst & burning.
Kodrava	Paspalum scrobiculatum	*Kashaya, Madhura*	*Laghu, Ruksha*	*Ushna*	*Katu*	Strong *Kapha-Pitta* pacifier, promotes *Agni* due to *Katu Vipaka*, detoxifies.
Kangu	Setaria italica	*Madhura*	*Laghu, Snigdha*	*Sheeta*	*Madhura*	Balances Vata-*Pitta*, provides light nourishment; use in moderation.

3.3. Modern Scientific Profile of *Trunadhanya* Millets

3.3.1. Nutritional Composition: Millets are nutritionally dense. [25] They are:

- **Rich in Complex Carbohydrates and Dietary Fiber:** They have a higher proportion of non-starch polysaccharides (NSP) and resistant starch compared to refined rice and wheat. Barnyard millet contains up to 12.6% dietary fiber. [26] This fiber is

predominantly insoluble, which adds bulk, slows gastric emptying, and reduces the rate of glucose absorption.

- **Low Glycemic Index (GI):** Numerous studies have confirmed the low GI of millets. Foxtail millet has a GI of around 59-65, barnyard millet 41-50, and kodo millet 52-57, classifying them as low to medium GI foods, in contrast to white rice (GI ~73) and white bread (GI ~75). [27, 28]
- **High in Magnesium:** Magnesium is a critical cofactor for over 300 enzymes, including those involved in glucose metabolism and insulin action. [29] Millets are an excellent source, with finger millet containing up to 137 mg/100g. Magnesium deficiency is linked to insulin resistance.
- **Good Source of Phytochemicals:** They contain phenolic acids (ferulic acid, p-coumaric acid), flavonoids, and tannins. [30] These compounds exhibit strong antioxidant activity, scavenging free radicals that contribute to oxidative stress—a key driver of diabetic complications and beta-cell dysfunction.

Table 2: Comparative Nutritional Profile per 100g edible portion (approx.) [31, 32]

Nutrient	Foxtail Millet	Barnyard Millet	Kodo Millet	Brown Rice	Whole Wheat
Energy (Kcal)	331	307	353	362	340
Protein (g)	12.3	11.0	9.8	7.9	13.7
Fat (g)	4.3	3.9	3.6	2.7	2.0
Dietary Fiber (g)	8.0	12.6	10.2	3.4	12.2
Magnesium (mg)	81	82	147	143	138
Glycemic Index	~62	~45	~55	~68	~54

3.3.2. Evidence from Preclinical and Clinical Studies:

- **Animal Studies:** Multiple studies in diabetic rodent models have shown that millet-based diets (foxtail, barnyard, finger) significantly reduce fasting blood glucose, improve glucose tolerance, increase serum insulin, and ameliorate dyslipidemia (high triglycerides, cholesterol). [33, 34] These effects are attributed to increased hepatic glycogen storage, improved antioxidant status (increased SOD, GSH, decreased MDA), and enhanced insulin signaling.

- **Human Intervention Studies:** A randomized controlled trial involving diabetic subjects consuming a foxtail millet-based diet for 12 weeks showed a significant reduction in

HbA1c, fasting and postprandial glucose, and insulin resistance (HOMA-IR) compared to the group on a routine diabetic diet. [35] Another study on barnyard millet supplementation reported improved glycemic control and reduced total and LDL cholesterol. [36]

- **Mechanistic Insights:**

❖ **Slow Digestion & Low GI:** High fiber and resistant starch content delay carbohydrate digestion and absorption, flattening postprandial glucose spikes. [37]

❖ **Improved Insulin Sensitivity:** Magnesium and polyphenols are known to enhance insulin receptor activity and GLUT-4 translocation. [38, 39]

❖ **Antioxidant & Anti-inflammatory Action:** Phenolic compounds reduce oxidative stress and inflammatory cytokines (like TNF-α, IL-6), which are implicated in insulin resistance. [40]

❖ **Prebiotic Effect:** The fiber in millets acts as a prebiotic, promoting beneficial gut microbiota. A healthy gut microbiome is increasingly linked to improved metabolic health and reduced diabetes risk. [41]

4. DISCUSSION

The convergence of Ayurvedic wisdom and modern nutritional science on the role of *Trunadhanya* in preventing *Prameha*/Diabetes is striking and holds profound implications for public health.

4.1. Theoretical Synergy: From *Dosha* to Molecules

The classical designation of *Trunadhanya* as *Laghu* and *Ruksha* finds its modern correlate in their high dietary fiber and low fat content, which impart a feeling of lightness, slow digestibility, and reduced caloric density. The *Kapha*-pacifying action translates to countering the modern pathophysiology of metabolic syndrome: insulin resistance, obesity, and dyslipidemia. The concept of *Kleda* (excess fluid/moisture) may be analogous to fluid retention and intracellular edema seen in hyperglycemic states, which the *Ruksha* property helps mitigate, possibly through improved glycemic control and osmotic balance.

The emphasis on these grains for *Sthula Pramehi* (pre-diabetic) is particularly astute. At this stage, insulin resistance is developing, but beta-cell function is largely intact. Interventions that lower glycemic load, improve insulin sensitivity, and reduce oxidative stress—exactly what *Trunadhanya* does—can prevent or delay the onset of frank diabetes. This aligns

perfectly with modern diabetes prevention programs like the Diabetes Prevention Program (DPP), where lifestyle modification focusing on diet was more effective than metformin. [42]

4.2. *Trunadhanya* as a Sustainable Functional Food

Beyond individual health, *Trunadhanya* offers ecological and economic advantages. Millets are hardy, drought-resistant crops requiring minimal water and input, making them climate-smart grains. [43] Their revival can enhance agricultural biodiversity, food security, and farmer resilience. Promoting them as "diabetes-preventive grains" can create a value-based market, encouraging their cultivation and consumption. Integrating them into public health nutrition guidelines, school meal programs, and urban diets can be a cost-effective preventive strategy.

4.3. Addressing Potential Limitations and Research Gaps

While the evidence is promising, certain gaps need addressing:

1. **Standardization and Identification:** Correlating specific Sanskrit names (*Shyamaka*, *Kodrava*) with precise botanical species can sometimes be ambiguous. Further phytochemical and pharmacognostic studies are needed for definitive identification.
2. **Long-term Human Trials:** Most human studies are of short duration. Large-scale, long-term randomized controlled trials specifically investigating the role of a *Trunadhanya*-based diet in preventing the progression from pre-diabetes to diabetes are required.
3. **Bioavailability and Antinutrients:** Millets contain antinutrients like phytates and tannins, which can bind minerals. Traditional processing methods like soaking, germination, and fermentation—also recommended in Ayurveda (*Shoka Dhanya*)—can reduce these and enhance nutrient bioavailability. [44] Research should integrate these traditional processing techniques.
4. **Individualized Approach (Prakriti):** Ayurveda tailors diet to individual constitution (*Prakriti*). While *Trunadhanya* is generally *Kapha*-pacifying, its effects on different *Prakriti* types (e.g., *Vata* individuals may need careful incorporation due to *Ruksha* property) need systematic study.

4.4. An Integrative Preventive Model

A proposed model for integrating *Trunadhanya* into diabetes prevention:

- **Primary Prevention (General Population):** Advocate replacing at least 30-50% of refined cereal (white rice, white bread) intake with whole millets (*Trunadhanya*). Public awareness campaigns highlighting their low GI and high fiber content.
- **Secondary Prevention (High-Risk/Pre-diabetic):** Structured dietary counseling emphasizing *Trunadhanya* as the primary staple, combined with other *Pathya* measures (regular exercise, weight management). Regular monitoring of glycemic parameters.
- **Tertiary Prevention (Diabetic Patients):** Use as part of medical nutrition therapy to improve glycemic control and reduce cardiovascular risk factors.
- **Culinary Innovation:** Develop palatable, convenient food products (millet flakes, upma mixes, baked goods) to enhance acceptability in urban settings.

5. CONCLUSION

The ancient Ayurvedic seers, through keen observation and a holistic understanding of physiology and diet, identified *Trunadhanya,* the group of minor millets, as a potent preventive tool against *Prameha Roga*. This review demonstrates that this prescription is not merely metaphorical or tradition-bound but is robustly supported by contemporary scientific evidence. The *Laghu* and *Ruksha* properties correspond to a high-fiber, low-glycemic-index, and nutrient-dense profile that actively counters the fundamental processes of insulin resistance, hyperglycemia, and oxidative stress underlying Type 2 Diabetes Mellitus.

The role of *Trunadhanya* in *Prameha* prevention, therefore, transcends historical interest. It presents a validated, sustainable, and practical dietary strategy for the modern global diabetes epidemic. By bridging the conceptual framework of *Dosha* theory with the mechanistic insights of nutritional biochemistry, we can reclaim these forgotten grains. Future research should focus on robust clinical trials and the development of culturally sensitive, millet-based dietary guidelines. Ultimately, the reintegration of *Trunadhanya* into daily diets stands as a powerful testament to the relevance of Ayurveda's preventive wisdom and offers a tangible path towards a healthier, more resilient population.

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