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The Therapeutic Potential of *Kasha* (*Saccharum Spontaneum* Linn.) in Ayurveda: A Comprehensive Review

Dr. Sandhya Maravi[1], Dr. Deepika Singh[2], Dr. Shalini Varshney[3]

*[1,2] MD Scholar (Ayu.), *Dravyaguna Vigyan, Ayurvedic* and *Unani* Tibbia College, New Delhi, India

[3](Associate Professor (Ayu.), Department of *Dravyaguna Vigyan, Ayurvedic* and *Unani* Tibbia College, New Delhi, India.110005

ABSTRACT

Saccharum spontaneum Linn., known in Ayurveda as Kasha, is a perennial grass with a long-standing history of use in traditional Indian medicine. Revered as a key component of the classical formulation *Trina Panchamoola*, it has been traditionally indicated for a variety of ailments, particularly those related to the urinary system, inflammatory conditions, and bleeding disorders. This comprehensive review aims to synthesize the classical Ayurvedic knowledge of Kasha with contemporary scientific research to provide an evidence-based perspective on its therapeutic potential. The Ayurvedic pharmacodynamics (*Rasa Panchaka*) describe Kasha as having *Madhura* (sweet) and *Tikta* (bitter) tastes, *Sheeta Virya* (cold potency), and a *Vata-Pitta* pacifying nature, which aligns with its traditional use for inflammatory (*Pitta*-aggravated) conditions. Phytochemical analyses have revealed the presence of a rich array of secondary metabolites, including flavonoids, phenolic compounds, terpenoids, alkaloids, and saponins, which are concentrated in its roots, the primary medicinal part. Modern pharmacological studies have provided significant validation for its traditional claims. Preclinical research has robustly demonstrated its potent anti-urolithiatic activity, providing a scientific basis for its use in treating *Ashmari* (renal calculi). Furthermore, its significant diuretic, antioxidant, anti-inflammatory, antimicrobial, and central nervous system modulatory effects have been substantiated through various *in-vitro* and *in-vivo* models. This review bridges the gap between ancient wisdom and modern science, highlighting the strong correlation between Kasha's Ayurvedic properties and its scientifically validated bioactivities. The findings underscore its potential for development into standardized phytopharmaceuticals for managing urolithiasis and other inflammatory conditions, warranting further clinical investigation.

Keywords: *Saccharum spontaneum, Kasha*, Ayurveda, Diuretic, Lithotriptic, Mutrakṛcchra, Wild Sugarcane.

Introduction

Historical and Cultural Significance of Kasha

Saccharum spontaneum Linn., a plant deeply embedded in the ecological and cultural fabric of the Indian subcontinent, transcends its botanical identity to hold a place of reverence in ancient traditions. Long before its medicinal properties were catalogued in Ayurvedic texts, this resilient grass, known as Kasha, was integral to Vedic rituals and daily life.[1] Its presence in sacred ceremonies, often used as seating mats (*asanas*) for priests, underscores its perceived purity and spiritual significance.[1] Beyond its ritualistic use, an intriguing ethnobotanical application highlights its cultural importance the delicate, feathery flowers were ingeniously employed as natural pens to inscribe texts on traditional leaf manuscripts, a practice that speaks to a profound and intimate relationship between nature and scholarship in ancient India.[2] This historical context establishes Kasha not merely as a therapeutic agent but as a plant intertwined with the very heritage and knowledge systems it would later be documented in.

Saccharum spontaneum in the Ayurvedic Materia Medica

Within the structured framework of Ayurvedic medicine, Kasha is recognized as a formidable therapeutic herb. Its primary identity in the classical pharmacopoeia is as a principal component of *Trina Panchamoola*, a revered formulation comprising the roots of five specific medicinal grasses.[2] This inclusion immediately signals its importance for treating a distinct category of ailments, primarily disorders of the urinary system (*Mutravaha Srotas Vikara*). The classical texts of Ayurveda, including the *Charaka Samhita* and *Sushruta Samhita*, advocate for Kasha in the management of conditions characterized by inflammation, excess heat, and fluid imbalance. Its traditional indications include treating burning sensations (*Daha*), dysuria (*Mutrakrichra*), renal calculi (*Ashmari*), bleeding disorders (*Raktapitta*), and various gynaecological issues such as menorrhagia.[2] This established role in the Ayurvedic materia medica provides a rich foundation of empirical knowledge, refined over centuries of clinical observation.

Rationale for the Comprehensive Review

The enduring legacy of Kasha in traditional medicine is now being met with a burgeoning interest from the scientific community. While its efficacy has been trusted for millennia based on classical principles and empirical outcomes, a growing body of modern research is beginning to elucidate the phytochemical and pharmacological underpinnings of these traditional claims. A significant gap, however, persists between the wealth of traditional knowledge and the scattered, albeit promising, modern scientific data. This review is rationalized by the critical need to bridge this divide. By systematically collating, analyzing, and synthesizing the classical Ayurvedic understanding of Kasha with contemporary ethnopharmacological, phytochemical, and pharmacological evidence, this paper aims to construct a holistic and evidence-based profile of the plant. Such an integrated approach is essential to validate its traditional uses, understand its mechanisms of action, and identify clear pathways for future research, including its potential development into standardized, clinically proven phytopharmaceuticals.[6]

Botanical Profile and Distributio

Taxonomy and Nomenclature

Saccharum spontaneum is a member of the grass family, Poaceae (also known as Gramineae), a family of immense ecological and economic importance. Its formal taxonomic classification, established by Carl Linnaeus, places it within the genus *Saccharum*, which includes cultivated sugarcane (*Saccharum officinarum*).[8] The binomial name *Saccharum spontaneum* L. was first published in *Mantissa Plantarum* 2: 183 in 1771.[10]

Over the centuries, due to its vast geographical distribution and morphological variability, the plant has been described under numerous botanical synonyms. This has led to potential confusion in historical and scientific literature. Clarifying this nomenclature is crucial for accurate data consolidation. Notable synonyms include *Imperata spontanea* (L.) P.Beauv., *Saccharum aegyptiacum* Willd., *Saccharum canaliculatum* Roxb., and *Saccharum chinense* Nees ex Hook. & Arn..[9] Its common English names, such as Wild Sugarcane, Kans Grass, and Thatch Grass, reflect its appearance and traditional uses.[8] In Sanskrit, it is known by several names that describe its characteristics, including *Kasha*, *Kshugandha* (smelling like sugarcane), and *Sita Pushpa* (having white flowers).[2] The diverse vernacular names across different regions underscore its widespread presence and local importance (Table 1).

Table 1: Vernacular Names and Synonyms of *Saccharum spontaneum*

Category	**Name**	**Language/Region**
Scientific Name	*Saccharum spontaneum* L.	Binomial
Botanical Synonyms	*Imperata spontanea*, *Saccharum aegyptiacum*, *Saccharum canaliculatum*	N/A
Sanskrit Synonyms	Kasha, Kaasa, Kshugandha, Sita Pushpa, Nadeya, Lekhana	Sanskrit
Common English Names	Wild Sugarcane, Kans Grass, Thatch Grass, Tiger Grass	English
Vernacular Names	Kash, Kansh	Bengali
	Kas, Kasa, Kaans	Hindi
	Kadu kabbu	Kannada
	Nannana, Kusa	Malayalam
	Talahib, Tigbau	Tagalog, Bisaya (Philippines)
	Tian gen zi cao	Chinese
	Gelagah	Indonesian

Source: Compiled from [2]		

Morphological Characteristics

Saccharum spontaneum is a robust, erect, perennial grass that typically forms dense clumps or continuous canebrakes. It is characterized by a deep and extensive system of spreading rhizomatous roots, which contributes to its hardiness and vigorous growth.[8]

- **Culms (Stems):** The plant features slender, fibrous culms that are pithy and often hollow in the center. They can grow to a height of 1 to 4 meters. The culms are typically green to ivory-white when young, turning brown or black as they mature, and are noted for having little juice compared to cultivated sugarcane.[2]
- **Foliage:** The leaves are long, linear-lanceolate, and can reach up to 1 meter in length. A defining feature is the prominent, pale white midrib that runs down the center of the green leaf blade. The leaf margins are finely serrated and prickly to the touch, requiring care during handling.[2]
- **Inflorescence:** The most visually striking feature of *S. spontaneum* is its inflorescence. It produces large, terminal, branching panicles, typically 20-60 cm long, that tower above the foliage. These panicles are composed of numerous paired spikelets, each surrounded by copious, long, silky white hairs. This arrangement gives the inflorescence a dense, feathery, plume-like appearance, which is often tinged with reddish or purplish hues.[2]
- **Fruit:** The fruit is a caryopsis, a small, one-seeded grain measuring approximately 1.5 mm. It is tufted with hairs, facilitating dispersal over long distances by wind.[12]

Fig.1: *Saccharum spontaneum* Linn.

Geographical Distribution and Ecological Niche

Saccharum spontaneum possesses a vast native range, spanning the tropical and subtropical regions of the Old World. It is indigenous to large parts of Africa, Southern Europe (Italy), the Middle East, and across Asia from the Indian subcontinent to China, Japan, Southeast Asia, and extending to Papua New Guinea and Northern Australia.[8] The species is believed to have evolved in the sub-Himalayan valleys of India, from where it spread to diverse climatic zones.[17]

Its ecological adaptability is remarkable. It thrives in a wide array of habitats, demonstrating a preference for moist environments such as riverbanks, lakesides, freshwater and saline marshes, and silt plains. However, it is also highly tolerant of drier conditions and can be found in grasslands, deserts, sandy beaches, and disturbed open ground.[12] This hardiness allows it to colonize a variety of soil types, including infertile alluvial, sandy, and saline soils.[12]

This same resilience and rapid, vigorous growth that make it a valuable medicinal resource also contribute to its classification as an aggressive weed or invasive species in certain regions. In areas like the Panama Canal Watershed, it has spread extensively, outcompeting native vegetation and forming

dense, pure stands, particularly in areas cleared by floods or human activity.[16] This dual identity as both a therapeutic herb and an ecological challenge presents a unique opportunity. The very characteristics that define its invasiveness—fast growth, low nutrient requirements, and abundant biomass production—also make it a highly sustainable and readily available source of raw material. Rather than pursuing costly eradication measures, a bio-economic approach could be adopted, wherein this invasive biomass is systematically and sustainably harvested for the production of phytopharmaceuticals.[9] This would transform an ecological problem into a valuable resource for healthcare, aligning with modern principles of sustainable development and ethnopharmacology.

Kasha in Ayurvedic Principles (*Dravyaguna*)

The therapeutic action of any substance in Ayurveda is understood through *Dravyaguna*, the science of herbal pharmacodynamics. This is systematically described by the *Rasa Panchaka* framework, which provides a predictive model for a herb's effect on the body's physiological and pathological processes.

Ayurvedic Properties: The *Rasa Panchaka* Framework

The complete pharmacodynamic profile of Kasha is detailed in classical texts and provides the foundation for its clinical use. Each attribute of the *Rasa Panchaka* contributes to its overall therapeutic effect (Table 2).[20]

- ***Rasa* (Taste):** Kasha is described as having a combination of *Madhura* (Sweet) and *Tikta* (Bitter) tastes.[2] The *Madhura Rasa* is generally associated with nourishing, strengthening, and cooling properties, while the *Tikta Rasa* is known for its anti-inflammatory, detoxifying, and fever-reducing actions.
- ***Guna* (Qualities):** Its primary qualities are *Laghu* (Light) and *Snigdha* (Unctuous/Oily).[2] *Laghu Guna* suggests that it is easy to digest and does not cause heaviness, while *Snigdha Guna* indicates a moisturizing or soothing quality, which helps in pacifying the dryness associated with *Vata Dosha*.
- ***Virya* (Potency):** Kasha possesses *Sheeta Virya* (Cold Potency).[2] This is a crucial attribute, as substances with cold potency are the primary choice for treating conditions associated with heat, inflammation, and burning sensations, which are characteristic of aggravated *Pitta Dosha*.
- ***Vipaka* (Post-digestive Effect):** The post-digestive effect is *Madhura* (Sweet).[2] A sweet *Vipaka* implies a long-term nourishing, tonic, and tissue-building effect on the body.
- ***Karma* (Action on *Doshas*):** Based on the combination of these properties, the primary action of Kasha is to pacify or balance aggravated *Vata* and *Pitta Doshas* (*Vata-Pitta Shamaka*).[2] Its *Sheeta Virya* directly counters the heat of *Pitta*, while its *Madhura Rasa*, *Snigdha Guna*, and *Madhura Vipaka* help to alleviate the dryness and instability of *Vata*.

Table 2: The *Rasa Panchaka* (Ayurvedic Pharmacodynamics) of Kasha

Ayurvedic Attribute	Sanskrit Term	Property of Kasha	Implied Therapeutic Action
Taste	*Rasa*	*Madhura* (Sweet), *Tikta* (Bitter)	Nourishing, Anti-inflammatory, Detoxifying
Qualities	*Guna*	*Laghu* (Light), *Snigdha* (Unctuous)	Easy to digest, Soothing, Pacifies dryness
Potency	*Virya*	*Sheeta* (Cold)	Cooling, Anti-inflammatory, Reduces burning
Post-digestive Effect	*Vipaka*	*Madhura* (Sweet)	Tonic, Nourishing, Tissue-building
Action on *Doshas*	*Karma*	*Vata-Pitta Shamaka*	Balances Vata and Pitta doshas
Source: Compiled from [2]			

Classical Categorization in Ayurvedic Texts

The authority and specific applications of Kasha are further established by its categorization within the major classical treatises of Ayurveda. These classifications group herbs based on their primary actions, providing clear guidance for their clinical use.

- **In Charaka Samhita:** Kasha is included in two important *ganas* (groups):
    1. ***Mutravirechaniya:*** A group of herbs that promote urination and help normalize the composition and color of urine. This directly points to its primary use in urinary disorders.[2]
    2. ***Stanyajanana:*** A group of herbs that promote or enhance the production of breast milk (galactagogues).[2]
- **In Sushruta Samhita:** Kasha is a principal member of the ***Trina Panchamoola***, the "group of five medicinal grasses," which is renowned for its efficacy in treating urinary and *Pitta*-related disorders.[2]
- **In Nighantus (Lexicons):** Later texts that serve as detailed materia medicas also categorize Kasha in specific sections, such as the *Guduchyadi Varga* of *Bhavaprakash Nighantu* and the *Karaveeradi Varga* of *Dhanvantari Nighantu*, further cementing its identity and uses.[2]

Traditional Therapeutic Indications and Part-Specific Uses

Based on its Ayurvedic properties and classical categorizations, Kasha is traditionally indicated for a wide range of health conditions. Different parts of the plant are utilized for specific therapeutic effects.

- **Primary Indications:**
    - **Urinary System Disorders:** Its foremost application is in *Mutravaha Srotas Vikara*. It is used to treat *Mutrakrichra* (dysuria, painful urination), *Ashmari* (urolithiasis or renal calculi), and the associated burning sensation during micturition.[2]
    - **Gynaecological and Reproductive Health:** It is used to manage *Raktapradara* or *Menorrhagia* (excessive menstrual bleeding) and as a *Stanyajanana* (galactagogue) to improve lactation in nursing mothers. It is also considered a tonic and aphrodisiac, used for sexual debility.[2]
    - **Digestive and Metabolic Disorders:** Kasha is indicated for bleeding piles (haemorrhoids) and dyspepsia, particularly when associated with *Pitta* imbalance.[4] It is also used in conditions of obesity.[21]
    - **Systemic and Inflammatory Conditions:** Due to its *Sheeta Virya*, it is widely used to alleviate *Daha* (generalized burning sensation in the body), manage *Raktapitta* (bleeding disorders from various orifices), and in respiratory troubles.[4] Folk traditions in Tamil Nadu and Andhra Pradesh also report the use of its stem juice for mental illness and disturbances.[15]
- **Part-Specific Actions:**
    - **Roots:** This is the most medicinally valued part. The roots are described as sweet, astringent, emollient, refrigerant, diuretic, lithotriptic, purgative, tonic, and aphrodisiac. They form the basis of most formulations for urinary and gynaecological conditions.[2]
    - **Stems (Culms):** The stems are used to treat conditions of vitiated *Pitta* and *Vata*, including burning sensations, renal calculi, dyspepsia, haemorrhoids, and menorrhagia.[2]
    - **Leaves and Aerial Parts:** These parts are traditionally described as having cathartic, diuretic, and laxative properties.[2]

Phytochemical Composition

The diverse therapeutic activities of *Saccharum spontaneum* are attributable to a complex mixture of secondary metabolites distributed throughout the plant. Modern phytochemical investigations have successfully identified several major classes of these bioactive compounds, providing a chemical basis for its medicinal properties.

Major Classes of Secondary Metabolites

Screening of various extracts (aqueous, ethanolic, methanolic, chloroform) from different parts of the plant, including the roots, stems, and leaves, has consistently revealed the presence of a broad spectrum of phytochemicals. These compounds are known to possess a wide range of biological activities. The principal classes of constituents identified in *S. spontaneum* are summarized in Table 3.[6]

Table 3: Major Phytochemical Constituents Identified in *Saccharum spontaneum*

Phytochemical Class	Presence Reported in Plant Part(s)	Potential Bioactivity
Phenolic Compounds	Roots, Leaves	Antioxidant, Anti-inflammatory, Antimicrobial
Flavonoids	Roots, Leaves	Antioxidant, Anti-inflammatory, Anticancer, Cardioprotective
Alkaloids	Roots, Leaves, Stem	CNS active, Analgesic, Antimicrobial
Terpenoids/Triterpenes	Roots, Leaves	Anti-inflammatory, Antimicrobial, Cytotoxic
Saponins	Roots, Leaves	Anti-inflammatory, Immunomodulatory, Hypocholesterolemic
Tannins	Roots, Leaves, Stem	Astringent, Antioxidant, Antimicrobial, Wound healing
Steroids	Roots, Leaves, Stem	Anti-inflammatory, Hormonal activity
Glycosides	Roots, Stem	Cardiotonic, Diuretic, CNS active
Coumarins	Roots, Leaves, Stem	Anti-inflammatory, Anticoagulant, Antimicrobial
Quinones	Leaves, Stem	Antimicrobial, Laxative
Essential Oils	Roots	Aromatic, Antimicrobial
Source: Compiled from [6]		

The presence of this rich phytochemical profile, particularly the high content of phenolic compounds and flavonoids, strongly correlates with the plant's potent antioxidant and anti-inflammatory properties observed in pharmacological studies.[23] Similarly, the identification of alkaloids, tannins, and terpenoids provides a plausible explanation for its antimicrobial and CNS-modulatory effects.[24]

Phytochemistry of the Roots: The Primary Medicinal Part

In Ayurvedic practice, the roots (*moola*) are considered the most therapeutically active part of Kasha, a fact that is now being substantiated by phytochemical analysis. Studies focusing specifically on root extracts have shown them to be particularly rich reservoirs of bioactive compounds.[23]

Phytochemical screening of ethanolic and methanolic root extracts using methods like thin-layer chromatography (TLC) has confirmed the presence of a comprehensive suite of secondary metabolites. One detailed analysis of the ethanolic root extract identified phenols, triterpenes, essential oils, steroids, anthraquinones, coumarins, anthrones, flavonoids, and alkaloids.[23] Other studies corroborate these findings, noting that ethanolic and methanolic extracts yield a greater diversity and concentration of phytochemicals compared to less polar solvents, with tannins, steroids, and glycosides being particularly prominent.[23] The concentration of these varied and potent compounds in the roots validates their preferential use in classical Ayurvedic formulations for treating systemic conditions like urinary and inflammatory disorders.

Pharmacological Activities: Scientific Validation of Traditional Claims

The extensive traditional use of *Saccharum spontaneum* has prompted numerous modern scientific investigations to validate its therapeutic claims through preclinical *in-vitro* and *in-vivo* models. This research has generated substantial evidence supporting a wide range of pharmacological activities, many of which directly align with its Ayurvedic indications. A summary of the key pharmacological studies is presented in Table 4.

Table 4: Summary of Key Preclinical Pharmacological Studies on *Saccharum spontaneum* Extracts

Pharmacological Activity	Plant Part & Extract	Experimental Model	Key Findings	Reference(s)
Anti-urolithiatic	Root (Ethanolic)	Ethylene glycol & glycolic acid-induced urolithiasis in rats	Restored urinary levels of Ca, oxalate, urea, uric acid. Normalized lysosomal enzymes. Effect comparable to thiazide.	[21]
Diuretic	Root	Traditional texts, clinical observation	Classified as *Mutravirechaniya*. Used to promote urine output and cleanse the bladder.	[2]
Antioxidant	Whole Plant, Root (Ethanolic); Flower (Methanolic)	*In-vitro* DPPH, FRAP, Phosphomolybdenum assays	Moderate to significant free radical scavenging activity. High flavonoid and phenolic content.	[25]
Anti-inflammatory	Root (Ethanolic)	Carrageenan-induced paw edema in mice	2% formulated cream showed significant reduction in edema, exceeding diclofenac at 3 hours.	[31]
Antimicrobial	Whole Plant (Methanolic); Leaf (Ethanolic)	Disc diffusion & MIC assays against G+ve & G-ve bacteria	Broad-spectrum activity against *S. aureus*, *E. coli*, *K. pneumoniae*, etc. MIC: 75-600 µg/ml.	[26]
CNS Depressant	Stem (Aqueous, Ethanolic, Chloroform)	Actophotometer (locomotor activity) in rats	Significant, dose-dependent reduction in motor activity.	[21]
Anti-psychotic	Stem (Aqueous, Ethanolic)	Pole-climbing model in rats	Delayed latency to climb, indicating potential anti-psychotic effects.	[2]
Anticancer (Hepatocellular)	Flower (Methanolic)	*In-vitro* (HepG2 cells) & *in-vivo* (DEN-induced HCC model)	Cytotoxic to HepG2 cells (= 25.5 µM/mL). Mitigated liver injury in animal model.	[29]
Anti-obesity	Whole Plant (Ethanolic)	High-fat diet-induced obesity in rats	Reversed increases in body weight, glucose, and lipid levels.	[21]

Anti-urolithiatic and Diuretic Potential

The most significant and well-validated therapeutic action of *S. spontaneum* is its effect on the urinary system. This directly corroborates its classical Ayurvedic classification as a *Mutravirechaniya* (diuretic/urine-normalizing) herb and its primary indication for *Ashmari* (renal calculi).

Several rigorous *in-vivo* studies have demonstrated its potent anti-urolithiatic activity. In rat models where urolithiasis was induced using ethylene glycol or glycolic acid, oral administration of an ethanolic root extract of Kasha (at doses of 200 and 300 mg/kg) produced remarkable therapeutic effects.[2] The extract significantly reversed the pathological elevation of urinary stone-forming constituents such as calcium, oxalate, urea, and uric acid. Furthermore, it corrected the levels of key lysosomal enzymes like xanthine oxidase and

-D-glucuronidase in the kidney and liver, which are implicated in the pathogenesis of stone formation. The efficacy of the extract was found to be comparable to that of the standard diuretic and anti-urolithiatic drug, thiazide, demonstrating its powerful potential in managing and preventing kidney stones.[28]

These scientific findings provide a clear mechanistic explanation for the ancient Ayurvedic observations. The traditional term *Ashmarihara* (stone-remover) or *lithotriptic* [4] is not merely a description of increased urine flow (diuresis), but points to a more specific action on the pathophysiology of stone formation. The modern research confirms this by showing that the extract modulates the very biochemical markers—hyperoxaluria and hypercalciuria—that lead to crystal nucleation and growth. Therefore, the anti-urolithiatic activity identified in modern pharmacology is the precise biochemical correlate of Kasha's traditionally known efficacy in treating *Ashmari*.

Antioxidant and Anti-inflammatory Properties

The Ayurvedic system attributes the ability of Kasha to treat inflammatory conditions and burning sensations (*Daha*) to its *Sheeta Virya* (cold potency) and its capacity to pacify aggravated *Pitta Dosha*. Modern research validates this through the language of biochemistry, demonstrating significant antioxidant and anti-inflammatory activities.

- **Antioxidant Activity:** Multiple *in-vitro* studies have confirmed the free radical scavenging potential of *S. spontaneum* extracts. Using assays such as DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging, FRAP (Ferric Reducing Antioxidant Power), and the phosphomolybdenum method for total antioxidant activity, researchers have shown that ethanolic extracts of the root and whole plant exhibit moderate to significant antioxidant effects.[25] One study reported an value of 488 µg/ml for the ethanolic extract in a total antioxidant assay, which was comparable to the standard, ascorbic acid (of 410 µg/ml).[25] More recently, a methanolic extract of the flowers also showed potent antioxidant activity.[29] This activity is consistently attributed to the high concentration of total phenolic and flavonoid compounds in the extracts, which are well-known natural antioxidants.[25]
- **Anti-inflammatory Activity:** The anti-inflammatory potential has been confirmed *in-vivo*. A key study evaluated a cream formulated with 0.5% to 2% ethanolic root extract in a carrageenan-induced paw edema model in mice.[31] The results were compelling: the 2% extract cream demonstrated a significant reduction in inflammation, and after three hours of application, its effect surpassed that of the standard anti-inflammatory drug, Diclofenac 1% gel.[31] Another study also reported slight anti-inflammatory activity of a related species, *Saccharum munja*, against carrageenin-induced edema.[36]

The connection between these findings and Ayurvedic principles is profound. In Ayurveda, aggravated *Pitta Dosha* is the root cause of conditions involving heat, inflammation, and metabolic dysfunction.[39] Oxidative stress is the modern biochemical equivalent of this pathological heat. A herb with

Sheeta Virya (cold potency) is the logical therapeutic choice to counteract this, just as an anti-inflammatory or antioxidant agent is used in modern medicine. The scientifically proven antioxidant and anti-inflammatory mechanisms of Kasha are, therefore, the modern expression of its classical role as a *Pitta*-pacifying, cooling herb.

Antimicrobial Activity

Traditional medicine systems often use herbs to treat infections, and research shows that *S. spontaneum* possesses broad-spectrum antimicrobial properties. An *in-vitro* study evaluating a methanolic extract of the whole plant demonstrated significant antibacterial activity against a panel of human pathogenic bacteria.[26] The extract produced notable zones of inhibition against both Gram-positive strains, such as *Staphylococcus aureus* (17.00 mm) and *Streptococcus pneumoniae* (16.50 mm), and Gram-negative strains, including *Escherichia coli* (18.00 mm) and *Klebsiella pneumoniae* (17.10 mm). The minimum inhibitory concentration (MIC) values were determined to be in the range of 75-300 µg/ml for Gram-positive bacteria and 75-600 µg/ml for Gram-negative bacteria.[26] This activity is thought to be due to the presence of phytochemicals like tannins and flavonoids, which can disrupt critical bacterial processes such as cell wall synthesis and protein synthesis.[26] Further studies on an ethanol-based leaf extract also confirmed antimicrobial activity against *Bacillus subtilis*.[33]

Central Nervous System (CNS) Modulatory Effects

A fascinating area of Kasha's therapeutic potential lies in its effects on the central nervous system, which directly validates its folk use in some regions of India for treating mental illness and disturbances.[4] Preclinical studies using extracts from the stem have provided evidence for both CNS depressant and anti-psychotic activities.[21]

- **CNS Depressant Activity:** In studies using an actophotometer to measure locomotor activity in rats, aqueous, ethanolic, and chloroform extracts of the stem (at 1000 mg/kg) all caused a significant reduction in motor activity, indicating a CNS depressant effect.[21] The ethanolic extract was found to be particularly potent.[24]
- **Anti-psychotic Activity:** Using the pole-climbing conditioned avoidance response model in rats, a standard test for anti-psychotic potential, the aqueous and ethanolic extracts were shown to significantly delay the latency to climb the pole compared to the control group. This suggests an ability to modulate dopaminergic pathways, characteristic of anti-psychotic agents.[2]

Emerging Research: Hepatoprotective and Anticancer Activity

While much of the research on the *Saccharum* genus has focused on the hepatoprotective effects of its cultivated relative, *S. officinarum* [42], recent investigations into *S. spontaneum* are revealing promising new activities. A groundbreaking study investigated the methanolic extract of *S. spontaneum* flowers for its potential against hepatocellular carcinoma (HCC).[29] The study yielded significant results both *in-vitro* and *in-vivo*. The flower extract exhibited potent antioxidant activity and demonstrated significant dose- and time-dependent cytotoxicity against HepG2 human liver cancer cell lines, with a calculated value of 25.5 µM/mL. In a diethylnitrosamine-induced HCC animal model, the extract mitigated liver injury, as evidenced by a significant decrease in elevated liver enzyme levels. These findings suggest that *S. spontaneum* possesses notable antitumor efficacy and warrants further investigation as a potential therapeutic agent for hepatic cancer.[29]

Other Pharmacological Effects

In addition to the major activities detailed above, preliminary research has indicated other potential therapeutic benefits. An ethanolic extract of the whole plant was reported to possess an anti-obesity effect. In a study on high-fat diet-induced obese rats, the extract, administered at 200 and 400 mg/kg, effectively reversed the diet-induced increases in body weight gain, food intake, and adverse changes in glucose and lipid levels.[21] This opens another avenue for future research into its metabolic effects.

Role in Classical Ayurvedic Formulations

In Ayurveda, the therapeutic power of a herb is often realized through its inclusion in polyherbal formulations (*yogas*), where synergistic interactions enhance efficacy and balance potential side effects. Kasha is a cornerstone ingredient in several important classical formulations, particularly those aimed at treating disorders of the urinary system (*Mutravaha Srotas*).

Kasha as a Constituent of *Trina Panchamoola*

The most prominent role of Kasha is as one of the five herbs constituting the *Trina Panchamoola* (literally, "five grass roots"). This classical group consists of the roots of *Kusha* (*Desmostachya bipinnata*), *Kasha* (*Saccharum spontaneum*), *Nala* (*Arundo donax*), *Darbha* (*Imperata cylindrica*), and *Ikshu* (*Saccharum officinarum*).[3] This combination is highly esteemed in Ayurveda for its collective therapeutic properties. The group is characterized by a predominantly *Madhura Rasa* (sweet taste) and *Sheeta Virya* (cold potency), making it an ideal formulation for pacifying aggravated *Pitta* and *Vata* doshas.[48] Its primary sphere of action is the urinary system, where it functions as a potent diuretic, demulcent, and anti-inflammatory agent, making it the formulation of choice for a wide range of urinary disorders (*Mutravaha Srotogata Vikara*).[48]

Application in Formulations for Mutravaha Srotas Disorders (Urinary System)

Leveraging the synergistic power of the *Trina Panchamoola* group, Kasha is a key ingredient in several specific formulations designed to treat urinary ailments. These are available in various forms, such as decoctions (*Kashaya* or *Kwath*) and medicated ghee (*Ghrita*). The most notable of these are detailed in Table 5.

- ***Trinpanchmool Kwath/Kashaya:*** This is a simple water decoction of the five grass roots. It is widely prescribed for its diuretic and bladder-cleansing properties. It is indicated for conditions like *Mutrakrichra* (dysuria), urinary tract infections, and general kidney support, as it helps to soothe inflammation and promote healthy urine flow.[49]
- ***Ashmarihara Kashaya:*** As its name suggests (*Ashmari* = stone, *hara* = remover), this formulation is specifically designed for the treatment and prevention of renal calculi. Kasha root is a critical ingredient, often combined with other potent lithotriptic and diuretic herbs like *Pashanbheda* (*Bergenia ligulata*), *Gokshura* (*Tribulus terrestris*), and *Varuna* (*Crataeva nurvala*).[52] Its action is to help break down existing stones and flush them from the urinary tract.
- ***Mutravirechaniya Kashaya* and *Stanyajanana Kashaya:*** These are not specific product names but rather functional categories of formulations mentioned by Acharya Charaka, for which Kasha is a primary ingredient. This highlights its classical use in decoctions intended to promote urination and enhance lactation, respectively.[3]
- ***Trinapanchamoola Ghrita:*** This is a medicated ghee preparation where the active water-soluble principles of the five grass roots are infused into a lipid base (ghee). This form is particularly useful for chronic conditions and for pacifying *Vata* and *Pitta* doshas, as the ghee itself has soothing and nourishing properties. It is used for chronic urinary disorders and other *Pitta*-related inflammatory conditions.[48]

Table 5: Key Ayurvedic Formulations Containing Kasha for Urinary Disorders

Formulation Name	**Type**	**Key Ingredients (including Kasha)**	**Classical Indication**	**Probable Modern Correlation**
Trinpanchmool Kwath	Decoction (*Kwath*)	*Kusha, Kasha, Nala, Darbha, Ikshu*	*Mutrakrichra* (Dysuria), *Mutradaha* (Burning Micturition)	Urinary Tract Infection (UTI), Cystitis
Ashmarihara Kashaya	Decoction (*Kwath*)	*Kasha, Pashanbheda, Gokshura, Varuna, Kusha*	*Ashmari* (Calculi), *Sharkara* (Gravel)	Urolithiasis, Nephrolithiasis (Kidney Stones)
Mutravirechaniya Kashaya	Decoction (*Kwath*)	*Kasha* and other diuretic herbs	*Mutraghata* (Urine Obstruction), Scanty Urination	Diuresis, Oedema
Trinapanchamoola Ghrita	Medicated Ghee (*Ghrita*)	*Trina Panchamoola* roots, Ghee, Milk	Chronic *Mutravikara*, *Pittaja Roga*	Chronic UTI, Interstitial Cystitis, Inflammatory Disorders
Source: Compiled from [3]				

Safety and Toxicology

The long history of *Saccharum spontaneum* use in traditional food and medicine suggests a favorable safety profile. This empirical evidence is now being supported by modern toxicological studies, which are crucial for establishing the safety of any potential phytopharmaceutical agent.

Preclinical Safety Evaluation

Preclinical safety assessments are fundamental to determining the therapeutic index of a new drug or herbal extract. Studies conducted on the ethanolic root extract of *S. spontaneum* have indicated a very high margin of safety.[57]

- **Acute Toxicity:** An acute oral toxicity study was performed in Wistar albino rats according to standard guidelines. The extract was administered at escalating doses, including very high levels up to 2000 mg/kg body weight. Throughout the 14-day observation period, there was no mortality recorded, nor were there any clinical signs of toxicity or adverse changes in the autonomic or behavioral responses of the animals. This result establishes the median lethal dose () of the ethanolic root extract as being greater than 2000 mg/kg, classifying it as practically non-toxic.[57]
- **Sub-acute Toxicity:** To assess the safety of repeated administration, a 28-day sub-acute toxicity study was also conducted. Rats were given daily oral doses of the extract ranging from 100 to 500 mg/kg. The study found no adverse effects on the body weight of the animals compared to the control group. Furthermore, analysis of key biochemical parameters in the serum—including markers for kidney function (urea, uric acid, creatinine) and electrolytes (sodium, potassium, chloride)—showed no significant deviations from the normal range. This suggests that repeated, long-term administration of the extract at therapeutic dose levels is unlikely to cause systemic toxicity or organ damage.[57]

This strong preclinical safety data is a critical finding. It provides the necessary scientific confidence to proceed with further research, including human clinical trials. The low toxicity observed in these controlled studies aligns perfectly with the plant's centuries-long history of use in traditional medicine, where herbs with significant toxicity would have been empirically identified and avoided.

Discussion and Future Perspectives

Correlating Ayurvedic Principles with Modern Pharmacology

The comprehensive body of evidence on *Saccharum spontaneum* presents a compelling case study in the validation of traditional medicine through modern science. There is a remarkable congruence between the herb's classical Ayurvedic profile and its pharmacologically demonstrated activities.

- The herb's classification as having ***Sheeta Virya*** (cold potency) and being a ***Pitta-Shamaka*** (Pitta-pacifier) is the Ayurvedic explanation for its use in inflammatory conditions and states of excess heat, such as *Daha* (burning sensation). This principle finds its direct molecular correlate in the scientifically proven **anti-inflammatory** and **antioxidant** activities of its extracts. The ability to inhibit inflammatory mediators (as seen in the carrageenan edema model) and scavenge free radicals (as seen in DPPH and FRAP assays) is the biochemical mechanism by which the herb exerts its "cooling" effect.
- Its primary Ayurvedic classification as ***Mutravirechaniya*** (urine-promoting) and its indication for ***Ashmari*** (calculi) are robustly supported by modern research. The demonstrated **diuretic** and, more specifically, **anti-urolithiatic** effects provide a precise mechanism. The herb does not simply increase urine volume; it actively interferes with the crystallization process of stone-forming minerals like calcium oxalate, thus validating its traditional role as a "stone-remover."
- The qualities of ***Madhura Rasa*** (sweet taste) and ***Madhura Vipaka*** (sweet post-digestive effect), combined with its ***Snigdha Guna*** (unctuous quality), suggest a nourishing, strengthening, and tonic effect in Ayurveda. These properties align well with its traditional use as a **galactagogue** (*Stanyajanana*), **aphrodisiac**, and general tonic for debility. While the direct mechanisms for these effects are less studied, they point towards a restorative action that warrants further investigation.

Gaps in Research and Directions for Future Studies

Despite the strong preclinical evidence, the journey of Kasha from a traditional herb to a globally accepted modern medicine is incomplete. Several critical research gaps need to be addressed to unlock its full potential.

- **Human Clinical Trials:** The most significant gap is the complete absence of human clinical trials. Given the robust preclinical data, particularly for urolithiasis, well-designed, randomized controlled trials are the logical and most crucial next step. Such trials are needed to confirm efficacy, establish optimal human dosage, and evaluate safety in patient populations.
- **Elucidation of Molecular Mechanisms:** While activities like anti-inflammation and CNS depression have been demonstrated, the precise molecular targets and signaling pathways involved remain largely unknown. Mechanistic studies are required to understand how the extracts modulate cyclooxygenase pathways, dopaminergic systems, or renal ion channels.
- **Bioactive Compound Isolation and Characterization:** The therapeutic effects of *Kasha* are due to a complex mixture of phytochemicals. Bioactivity-guided fractionation is needed to isolate the specific compounds responsible for each key pharmacological effect (e.g., which specific flavonoid or terpenoid is most potent against urolithiasis). This would enable the development of highly potent and targeted medicines.
- **Standardization of Extracts:** For *Kasha* to be used reliably in a clinical setting, standardized extracts are essential. Research should focus on developing analytical methods (like HPLC or HPTLC) to quantify key bioactive marker compounds, ensuring that different batches of the extract have consistent chemical profiles and predictable therapeutic efficacy.
- **Investigation of Synergistic Effects:** *Kasha* is most often used in polyherbal formulations like *Trina Panchamoola*. Modern pharmacological studies should investigate these combinations to determine if the herbs act synergistically, where the combined effect is greater than the sum of their individual effects. This would provide a scientific basis for the wisdom of traditional Ayurvedic formulation principles.

Conclusion

Saccharum spontaneum Linn., or *Kasha*, stands as a powerful testament to the wisdom of Ayurvedic medicine, with its traditional therapeutic applications now being progressively validated by modern scientific inquiry. This review establishes that *Kasha* is not merely a folk remedy but a potent medicinal plant with a rich phytochemical arsenal and a diverse range of pharmacological activities. The remarkable consistency between its classical Ayurvedic properties particularly its *Sheeta Virya* and *Mutravirechaniya* actions and its scientifically demonstrated anti-inflammatory, antioxidant, diuretic, and anti-urolithiatic effects is undeniable. The strong preclinical evidence for its efficacy in preventing and treating renal calculi, combined with its excellent safety profile, positions *Kasha* as a prime candidate for development into a standardized, evidence-based phytopharmaceutical. This convergence of ancient knowledge and contemporary research highlights the immense value of ethnopharmacology as a discipline for discovering and developing new therapeutic agents to address global health challenges. Further investment in clinical trials and mechanistic studies is imperative to translate the profound therapeutic potential of this ancient grass into modern medical practice.

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