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Phytochemicals and Pharmacological Properties of Saccharum *Benghalense*: A Review

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Abstract

Plants with antibacterial properties have been known since the time of the ancient Arabs, Egyptians, and Romans. The present review was based on the phytochemicals and pharmacological properties of Saccharum benghalense. The plant is known by its common names, Kana, Sarkanda, and Moonja, and it is found in Pakistan and Afghanistan as well as northern and western India. Saccharum benghalense is synonym for Tripidium benghalense that is also called as munj grass. It grows in desert regions and along river banks. The panicles on the tall grass have a smooth, greenish brown colour. The grass is up to seven feet high and is overgrown. The straight, pale straw-coloured leaf sheaths are villous at the apex and have long white hairs that are usually much longer than the average internode. It was discovered that the various plant components have been utilised to treat erysipelas, urinary problems, burning sensations, throat, herpes, dyspepsia, dyscaria, and eye ailments. The plant root is an active ingredient in several ayurvedic preparations and is used to treat vertigo, giddiness, and dysuria. It concluded that Saccharum Bengalense is a rich source of phytochemicals and related species have numerous reported therapeutic activities including Neuroprotective, Antioxidant, Antimicrobial, Anti-leishmanial, Cytotoxicity, Anti-urolithiasis, Anti-obesity, Anti-psychotic, Antifungal, Anti-inflammatory. Thus, it might be a promising herbal source for diverse medical conditions with minimum probability of side effects.

Keywords: Saccharum benghalense; Tripidium bengalense; phytochemicals; antioxidant; pharmacological properties

Introduction

Plants with antibacterial properties have been known since the time of the ancient Arabs, Egyptians, and Romans. Plants are used to treat a wide range of ailments by using their barks, leaves, roots, fluids, gums, fruits, and seeds, either as a powder or as a solution. Given that Saccharum munja is a therapeutic plant, inorganic nutrients from the plant's stem, flowers, and adjacent soils were discovered [1].

Description

Saccharum benghalense is synonym for Tripidium bengalense that is also called as munj grass. It grows in desert regions and along riverbanks. The panicles on the tall grass have a smooth, greenish brown colour. The grass is up to seven feet high and is overgrown. The straight, pale straw-coloured leaf sheaths are villous at the apex and have long white hairs that are usually much longer than the average internode. Occasionally, the tallest sheath may extend past the panicle's base [2]. Its white blossoms provide it aesthetic value (Figure 1).

Depiction of Saccharum benghalense.

Taxonomy

Kingdom	- Planata
Class	- Liliopsida
Order	- Poales
Family	- *Poaceae*
Genus	- *Saccharum/ Tripidium*
Species	- benghalense

Synonyms: Munj sweetcane, baruwa sugarcane or baruwa grass, bahupraja, bana, bhadramunja, Kana, Sarkanda and brahmanya.

Figure 1: Depiction of Saccharum benghalense.

Habitat

The plant is known by its common names, Kana, Sarkanda, and Moonja, and it is found in Pakistan and Afghanistan as well as northern and western India. Large tufted grass, the plant is of limited use as fodder because cattle and buffalo only consume the new leaves when there is a food shortage. The stem is used to make moorhas and chiks [3]. It is native to Myanmar, Bangladesh, Nepal, Afghanistan, Pakistan, northern India, and Iran. Northeastern India, particularly Assam in the Terai-Duar grasslands at the foot of the Himalayas, is a major region of native distribution [4].

Traditional uses

It was traditionally used in following ailments.

i. Fever
ii. Inflammation
iii. Bleeding wounds
iv. Burning sensations
v. Thrush
vi. Herpes
vii. Dyspepsia
viii. Dyscaria
ix. Erysipelas
x. Dyspepsia
xi. Vertigo Giddiness
xii. Dysuria

Nutritional contents

Antibiotic-containing plants have long been recognised since the ancient Arab, Egyptian, and Roman civilizations. A variety of ailments are treated with plant materials, including barks, leaves, roots, fluids, gums, fruits, and seeds, either in solution form or as a heterogeneous ground combination. Given Saccharum munja's significance in medicine, inorganic nutrients were extracted from the plant's stem, blooms, and surrounding soils [5-8]. In comparison to the flower (10–40 ppm), the stem (5–10 ppm) has a lower sodium content (10 ppm in their soils). Potassium levels in the stem (40.8-70.9 ppm) are higher than those in the plant's flowers (0.4-10.4 ppm) and soils (10-35 ppm). In the human body, sodium and potassium cations carry out a number of electrochemical tasks, including stabilising emulsions, neutralising charges, and supplying free energy for cell stimulation. The potential differential across the cell membrane momentarily alters because of Na+ entering and Ka+ exiting the cell during muscle contraction and nerve activation. The metabolic energy required to pump Ka+ back and Na+ out for a normal state is ATP (adenosine triphosphate). Since globulin is soluble in diluted salt solutions but insoluble in water, Na+ and Ka+ stabilise the oil in water emulsion and preserve the solubility of proteins.

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The soil in which Saccharum munja is grown contains lower levels of calcium (0.14-6 ppm) than the plant stem (24-80 ppm) and flowers (24-120 ppm). As factor IV in the blood clotting mechanism, calcium is vital. Prothrombin must be converted to thrombin, which activates fibrinogen to form the fibrin network, along with thromboplastin. Plant stems (43-430 ppm) and flowers (0.48–48 ppm) have greater levels of magnesium than soil (0.21–1.26 ppm). Magnesium is essential for the activation of enzymes that convert adenosine triphosphate to adenosine triphosphate by phosphate transfer. These enzymes are widely distributed and vital, affecting all essential biological processes, including glycolysis. Magnesium is also necessary for the physical stability of chromosomes, ribosomes, and DNA. Thus, for cell duplication, a specific amount of magnesium is needed. Mg+2 is not lacking in the body, but it can occur in cases of drunkenness and renal failure, which can lead to magnesium deficiency and subsequent symptoms like spasmophilia, sadness, and hallucinations. A high magnesium intake may impede neuromuscular transmission.

Soil has a higher concentration of iron (172–860 ppm) than plant stems (285-704) and flowers (218–553). One gramme of the four to six grammes of iron that make up the human body is found in the spleen and liver. The body uses iron to carry oxygen through haemoglobin and myoglobin, which in turn enables cell respiration. The intracellular cytochrome enzyme system, which produces energy, also contains iron. Because of iron deficiency, a substantial iron intake is necessary during pregnancy. The recommended daily intake of iron is between 10 and 20 mg. If this amount is not met, a deficiency may develop that can cause hemolytic anaemia, stomatitis, palpitations, listlessness, excretion, and sluggish physical activity. Over 50 mg of iron is consumed, which builds up in the liver as haemosidrin and causes haemachromatosis, which manifests as grey skin, skin coloration, hepatic enlargement, pancreatic infiltration with diabetes, and heart failure from myocardial illnesses.

The amount of chlorides in a flower (199–500 ppm) and a stem (157–203 ppm) is more than that in the soil (17.8–78 ppm). Chloride is taken up from the soil as chloride ions (Cl-1) and is necessary for acid-base equilibrium, water balance, and osmotic pressure management without forming a structural unit. It could be used to the cell division of leaves and roots. Bicarbonates differ in soil (106-600 ppm) from those in the stem (300-710 ppm) and flowers (288-820 ppm). Because of the high concentration of bicarbonate ions, pancreatic secretion is alkaline in nature. It is composed of an aqueous bicarbonate component from the duct cells and an enzymatic component from the acinar cells. This helps to counteract the stomach acid's acidity so that the enzymes can work effectively. Alkaline-range bicarbonate/chloride (HCOGraphic-1/Cl-1) exchangers control intracellular pH.

In comparison to dirt (0.1-0.25ppm), phosphate ions are more abundant in stems (0.7-1.04ppm) and flowers (0.35-0.8ppm). Within the cell, phosphor is involved in the transportation of fatty acids. Adenosine triphosphate (ATP) and adenosine diphosphate (ADP) are two examples of phosphate bonds via which it is utilised in the storage and transfer of metabolic energy. In comparison to the nearby soil (100-250 ppm), sulphate ions are lower in plant stems (86-154 ppm) and plant flowers (20-240 ppm). High energy bond formation in acetyl coenzyme-A and lipoic acid derivatives (thioctic acid) is also attributed to sulphur. The sulphahudryl group (-SH) is a chelating agent that binds to heavy metals and is part of the detoxification process. The detoxication agent "British anti lewisite" works by binding the arsenic atoms in the poison gas chlorovinylarsine. In lead poisoning, B-penicillamine functions as a detoxifying agent.

Organic contents

a. Stems: Reducing sugars i.e., glucose, xylose, galactose and rhamnose, Magnesium, Calcium, Bicarbonates, Phosphate & chloride ions [9,10].

b. Blossoms: Iron [11]

c. Flower: Magnesium, Calcium, Bicarbonates, Phosphate & chloride ions [12]

These are following mentioned medicinal uses of munj grass [13,14]

a. Used as a refrigerant.

b. Saccharum munja is good for thrush, herpes, duypepsia, erysipelas, burning, dyscaria, urinary problems, and eye disorders.

c. Roots are used to treat dysuria, vertigo, and giddiness.

d. It is used to stop wounds from leaking blood.

e. Additionally, roots are utilised to cure inflammation and fever.

f. Saccharum munja grass is used as a kind of gauze pad to stop blood flow.

g. The smoke from burning roots scalds the skin after giving delivery.

d. Phytochemicals

Upon preliminary screening of phytoconstituents, Saccharum benghalense showed an excellent presence of different moieties. Alkaloids, terpenoids, flavonoids, phenols, coumarins and betacyanin were observed in abundance. While cardiac glycosides, tannins, steroids, were obtained in moderate quantity. The glycosides, saponins, and anthocyanin were found absent. After preliminary screening, Saccharum benghalense demonstrated for following phytoconstituents [15] (Table 1).

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Table 1: Phytochemicals in Saccharum benghalense leaves extract.

Phytoconstituents	Leaves extract of Saccharum benghalense
Alkaloids	++
Glycosides	_
Cardiac glycosides	+
Tannins	+
Saponins	_
Terpenoids	++
Steroids	+
Flavonoids	++
Phenols	++
Coumarins	++
Anthocyanin	_
Betacyanin	++

Absent (-), Present (+), Abundance (++)

e. Pharmacological properties

Saccharum benghalense and other related species have shown the numerous pharmacological properties as follows.

f. Neuroprotective

The research was based on the screening of phytoconstituents and neuroprotective potentials of hydroalcoholic extracts of Saccharum benghalense. The leaves of Saccharum benghalense was obtained from the Rohilkhand region, Uttar Pradesh. The plant was identified and authenticated by the botanist. The leaves were washed making dust-free and dried at room temperature or shade. The dried leaves were rendered into coarse powders and then finally into fine ones. The powder is weighed and extracted through cold maceration process using hydro-alcoholic solution (water and ethanol; 1:1). The plant extract was performed its preliminary screening of phytoconstituents. The animal house, Department of Pharmacy, MJP Rohilkhand University, Bareilly provided Wistar albino rats of either sex weighing 120-140g. The animals were kept in good health, with room temperatures of 25°C and a 12-hour light/dark cycle. The rats were divided in 4 groups i.e., group 1: administered normal saline, group 2: administered Sodium arsenite (40mg/kg/day, p. o.), group 3: administered Sodium arsenite (40mg/kg/day, p. o.) + hydroalcoholic leaves extract of Saccharum benghalense (HLSB), (200mg/kg/day, p. o.) and group 4: administered Sodium arsenite (40mg/kg/day, p. o.) + hydroalcoholic leaves extract of Saccharum benghalense (HLSB), (400mg/kg/day, p. o.) for 21 days. Neuroprotective activity was observed through both behavioural (EPM, Light/dark arena, FST) and biochemicals (SOD, lipid peroxidation) parameters. In results, Saccharum benghalense significantly exhibited the antioxidant and neuroprotective effects in all the parameters when compared with sodium arsenite treated rats. It decreased lipid peroxidation that indicates its antioxidant action. SOD level was also found lowered in animals treated with the Saccharum benghalense herbal extract that indicates for their neuroprotective effect. In conclusion, hydro-alcoholic leaves extract of Saccharum benghalense is significant neuroprotective and antioxidant herbal drug. In future aspects, the responsible chemical constituents could be identified and isolated for an effective therapeutic moiety [15].

g. Antioxidant

Preliminary phytochemical tests were done and antioxidant activities were evaluated using ELISA and theirIC50 values and AAI (%) were recorded. ANOVA was used for statistical analyses. DNA damage protection assay wasdone using p1391Z plasmid DNA and DNA bands were analyzed. Antimicrobial activity was done via disc diffusionmethod and MIC and Activity Index were determined. Cytotoxic activity was carried out using the brine shrimps' assayand LC50 values were calculated using probit analysis program. Phytochemical studies confirmed the presence of secondary metabolites in most of the plant extracts. Maximumantioxidant potential was revealed in DiAEE, DiAAE (AAI- 54.54% and 43.24%) and DaAEE and DaAAE (AAI- 49.13% and 44.52%). However, PoAEE and PoAAE showed minimum antioxidant potential (AAI- 41.04% and 34.11%). SaSEE, DiAEE and ElIEE showed very little DNA damage protection activity. In antimicrobial assay, DaAEE significantly inhibited the growth of most of the microbial pathogens (nine microbes out of eleven tested microbes) among ethanol extracts while DaAAE and ImCAE showed maximum inhibition (eight microbes out of eleven tested microbes) among acetone plant extracts. However, PoAEE and PoAAE showed least antimicrobial activity. F. oxysporum and A. niger were revealed as the mostresistant micro-organisms. ImCEA and ImCAE showed maximum cytotoxic potential (LC50 11.004 ppm and 7.932 ppm) ascompared to the other plant extracts [16].

h. Antimicrobial

The antibacterial ability of Saccharum spontaneum (Family: Poaceae) against human pathogenic bacterial strains was assessed in this study. To determine the percentage zone of inhibition, disc diffusion method in vitro antibacterial tests were run on nutrient agar. With relative percentages of inhibition of 76.90, 71.60, 57.40, 56.85, 70.40, 69.90, 61.05, and 54.30, respectively, the whole plant's extract demonstrated the significant zone of inhibition (mm) against Staphylococcus aureus (17.00), Streptococcus pneumoniae (16.50), Bacillus cereus (15.90), Bacillus pumilus (15.45), Escherichia coli (18.00), Klebsiella pneumoniae (17.10), Pseudomonas aeruginosa (15.20), and Citrobacter freundii (14.00). The minimal inhibitory concentration (MIC), which was determined using the modified agar well diffusion method, ranges from 75 to 300 ng/ml for G+ve strains and from 75 to 600 ng/ml for G-ve strains. Because of the tannins and flavonoids present, it prevents bacteria from growing on the majority of regulatory levels, including peptidoglycan, DNA, RNA, and protein synthesis [17].

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i. Anti-leishmanial

Saccharum spontaneum (L) and Mangifera indica (L), when compared to other plants examined, had the highest total antioxidant capacity as assessed by the phosphomolybdenum assay (~108 and ~100 µg AAE/g of DW, respectively). On 1,1-diphenyl-2-picrylhydrazyl, S. spontaneum exhibited exceptional scavenging action (EC50 44.9 µg/mL). The least poisonous strains were S. spontaneum and C. sativa (CC50, 113.0 and 109.4 µg/mL, respectively). Furthermore, the in vitro assessment of plant CMEs' antileishmanial capability revealed a dose-dependent growth suppression of axenic amastigotes and L. major promastigotes [18].

j. Cytotoxicity

The study aimed to examine the in vitro antibacterial, cytotoxic, and antioxidant properties of the flower extract, *Saccharum spontaneum Linn*. (Gramineae Family). To test for bacterial and fungal infections in vitro, the disc diffusion technique was employed. In disc diffusion for antibacterial study against 4 Gram-positive and 8 Gram-negative pathogenic bacteria, zones of inhibition were seen. The average zone of inhibition in the extract was found to be between 9 and 14 mm. Against Shigella dysenteriae, a sizable 14 mm zone of inhibition was seen. The chemical exhibited mild to moderate zones of inhibition against three tested fungus in antifungal screening. Using the Brine shrimp lethality Bioassay and the LC50 values of standard vincristin sulphate as a positive control, the cytotoxic activities of the crude extract were ascertained. The results showed that the crude extract had cytotoxic activities of 6.63µg/ml and 10.64µg/ml, respectively. Nevertheless, the IC50 values for the conventional ascorbic acid and crude chloroform extract demonstrated antioxidant activity, at 51.04µg/ml and 43.04µg/ml, respectively [19].

k. Anti-urolithiasis

It has been observed that Saccharum spontaneum ethanol root extract exhibits anti-urolithiasis efficacy in rats, protecting against urolithiasis produced by ethylene glycol and glycolic acid. Rats with urolithiasis have higher urine concentrations of urea, uric acid, calcium, oxalate, and creatinine when exposed to ethylene glycol, while rats with glycolic acid have higher levels of sodium, potassium, chloride, protein, and lipid peroxidation. Rats with urolithiasis showed restored levels when given 200 and 300 mg/kg p.o. of Saccharum spontaneum ethanol extract. Additionally, ethanol extract corrects modifications in lysosomal enzymes such as xanthine oxidase, β-D-glucuronidase in the kidney and liver, and n-acetyl-d-glucosaminidase in the urine, serum, and liver of rats with urolithiasis [20].

l. Anti-obesity

At 200 and 400 mg/kg (p.o.), an ethanol extract of Saccharum spontaneum was shown to have anti-obesity effects in obese rats caused by the High Fat Diet. Saccharum spontaneum ethanol extract undid all the negative consequences of eating a high-fat diet, including weight increase, blood sugar, cholesterol, and organ weights [21].

m. Anti-psychotic

Using the Pole Climbing Model, the anti-psychotic efficacy of aqueous and ethanol extract was investigated in male Wistar rats at 1000 mg/kg p.o. Compared to the control group, the Saccharum spontaneum aqueous and ethanol extract delays the latency to ascend the pole. This study demonstrated Saccharum spontaneum's antipsychotic effects on rats [22].

n. Antifungal

Saccharum spontaneum flower extract (500µg/disc) showed antifungal efficacy against Saccharomyces cerevisiae, Aspergillus niger, and Candida albicans. Of the fungi examined, Aspergillus niger exhibited the largest zone of inhibition [23].

o. Anti-inflammatory

When used in conjunction with carrageenan to induce paw edoema in mice, cream of root extracts shown anti-inflammatory action. Carrageenan (1%), 0.1 ml injection, was used to cause inflammation. A digital Vernier calliper was used to quantify the degree of inflammation at 0, 1, 2, and 3 hours following the shock. The plant's pre-made 2% root extract lotion has anti-inflammatory properties, according to the study's findings [24].

p. Acute Oral Toxicity

The evaluation of the phytoconstituents, antioxidant, and acute oral toxicity profiles of three native Indian medicinal plants-R. tuberosa, *D. annulatum*, and *S. bengalense*—found in the methanolic extracts served as the foundation for the current investigation. Complete plants of Ruellia tuberosa, Saccharum bengalense, and Dichanthium annulatum were gathered from Hooghly, West Bengal, India. Specimens of whole plants of *D. annulatum* (Ref No. CNH/50/2014/Tech.II/103) and R. tuberosa (Ref No. CNH/2017/Tech. II/19) have been identified by the Central National Herbarium, Botanical Survey of India, Ministry of Environment and Forest, Government of India. The extraction procedure was carried out using a Soxhlet equipment. The methanolic extracts of *D. annulatum*, *S. bengalense*, and R. tuberosa underwent qualitative phytochemical analysis using the previously outlined procedures. Studies on acute oral toxicity, total phenolic content, total flavonoid content, and free radical scavenging were conducted. The results showed that in the methanolic extracts of Dichanthium annulatum Whole Plant (DAW), Saccharum bengalense Whole Plant (SBW), and Ruellia Tuberose Flowers (RTF), phenolics, flavonoids, and alkaloids were present as major groups of important secondary metabolites and carbohydrates as important biomolecules. During the first 72 hours of regular observation, no animal deaths were reported for any of the three extracts (DAW, SBW, or RTF) in this dosage regimen. Thus, 200 to 100 mg/kg for DAW, 400 to 200 mg/kg for SBW, and 100 to 50 mg/

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kg for RTF-1/10th to 1/20th of these doses- were deemed safe. It was determined that all three plants-Chicanthium Annulatum Whole Plant (DAW), Saccharum Bengalense Whole Plant (SBW), and Ruellia Tuberose Flowers (RTF)—are safe according to an acute oral toxicity profile and are rich sources of flavonoids and phenolic compounds, among other things [25].

Commercial Uses

i. Roof thatching is made from the raw material of this species.

ii. We use it to make baskets.

iii. Ropes are made from its fibre.

iv. It is one of the native mines that has been successfully colonised ecologically.

v. It grows in pure spots on skeletal soils in rocky environments.

vi. It creates a vast root system that holds the soil and pebbles together and grows into tall, dense clusters with tufts of high biomass.

vii. Low-income residents use it to make mats, huts, hand fans, ropes, baskets, brooms, and shields to defend crops.

viii. It is a species of choice for restoring rocky, erosion-prone slopes and turning them into very valuable biological and socioeconomic areas.

Conclusion

The nutritional components found in Saccharum munja's many parts- sodium, potassium, calcium, magnesium, chloride, bicarbonates, iron, phosphate, and sulphate- are what give it its therapeutic value. The plant has historically been used to treat fever, inflammation, and bleeding wounds. It was discovered that the various plant components have been utilised to treat erysipelas, urinary problems, burning sensations, throat, herpes, dyspepsia, dyscaria, and eye ailments. The plant root is an active ingredient in several ayurvedic preparations and is used to treat vertigo, giddiness, and dysuria. It concluded that Saccharum Bengalense is a rich source of phytochemicals and related species have numerous reported therapeutic activities including Neuroprotective, Antioxidant, Antimicrobial, Anti-leishmanial, Cytotoxicity, Anti-urolithiasis, Anti-obesity, Anti-psychotic, Antifungal, Anti-inflammatory. Thus, it might be a promising herbal source for diverse medical conditions with minimum probability of side effects.

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Nil.

Conflict Of Interest

Authors have declared for none conflict of interest.

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