RESEARCH PAPER

Phytochemical Profiling and Multifaceted Pharmacological Potential of Saccharum spontaneum Linn.: A Natural Treasure for Health and Industry

Asma Bee[1*]
[1]Department of Pharmacy, Lotus Institute of Pharmacy, Bareilly, Uttar Pradesh, India-243503
Email: asmabee70@gmail.com
***Corresponding Author: Asma Bee, Department of Pharmacy, Lotus Institute of Pharmacy, Bareilly, Uttar Pradesh, India-243503**
Email: asmabee70@gmail.com

ABSTRACT
Saccharum spontaneum Linn. generally known as wild sugarcane, is a plant rich in diverse chemical constituents. Gas chromatography mass spectrometry (GC-MS) analysis has identified compounds with potential antimicrobial, antioxidant, anti-inflammatory, and other therapeutic properties. These include aldehydes, fatty acids, diterpenes, and polyenoic fatty acids, each with distinct pharmacological activities. Preliminary Phytochemical analysis revealed the presence of alkaloids, phenolic compounds, saponins, carbohydrates, tannins, proteins, amino acids, coumarins, and flavonoids and all are characterised and identified by column chromatography, FT-IR, NMR, Mass spectrophotometry and other analytical methods. Studies have demonstrated the antioxidant potential of Saccharum spontaneum, emphasizing its ability to scavenge free radicals. Additionally, various studies have explored its antibacterial, antifungal, antidiabetic and anti-inflammatory activities. It has shown a significant role in combating urolithiasis and hyperlipidemia and as a CNS depressant. In this review article we had studied many other pharmacological studies.

Keywords: Saccharum spontaneum Linn, Anti diabetic Activity, Antioxidant activity, CNS depressant activity, anti-inflammatory.
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1. INTRODUCTION

Plants are essential for discovering medicinal products for medicine development, pharmaceuticals, food additives, and industrial qualities [1,2]. They offer diverse secondary metabolites, such as terpenoids, phenolics, polyphenols, and alkaloids, which can be used as antimicrobial agents for treating bacterial diseases [3]. However, plants and herbs contain amino acids and sugars, which pose risks of acryl amide pollution and potential carcinogenicity, neurological, genetic, reproductive, and developmental toxicity [4]. The ancient usage of medicinal herbs and their products—which exhibit pharmacological properties since antiquity—is the origin of folk medicine. Natural compounds have great therapeutic potential and are essential in the pharmaceutical industry's drug discovery process. Examples of these goods include bioflavonoid, glycosides, alkaloids, saponins, steroids, tannins, and terpenes.[5,6]. The belief that natural products are harmless has led to increased usage in affluent nations. However, public health concerns have arisen due to their global market and popularity [7]. Saccharum *spontaneum* Linn, a perennial shrub, is found in Asian regions and is fed to animals [8]. Sugarcane, a sustainable energy crop, is a significant source of biofuel and contributes 80% of global sugar production [9]. Saccharum *Spontaneum* Linn. is a long erect reed like perennial plant belonging to the family Poaceae. With extending rhizomatous roots, it can reach a height of three meters. Hard, erect leaves that are between 0.5 and 1 meter long and 6 and 5 mm wide. White, straight panicles with flimsy, whirling branches are covered in silky, white hair at the joints. Saccharum *spontaneum* Linn. has several synonyms, including Saccharum aegyptiacum wild, Saccharum biflorum Forssk, and Saccharum punctatum Schumach. It is also referred to by colloquial names such as thatch grass (English), wild cane, false sugar cane, Kans, kansi and Hindi), wild cane [10], loa, ahlek [11].

Fig.1.0 *Saccharum spontaneum* Linn. Source Google

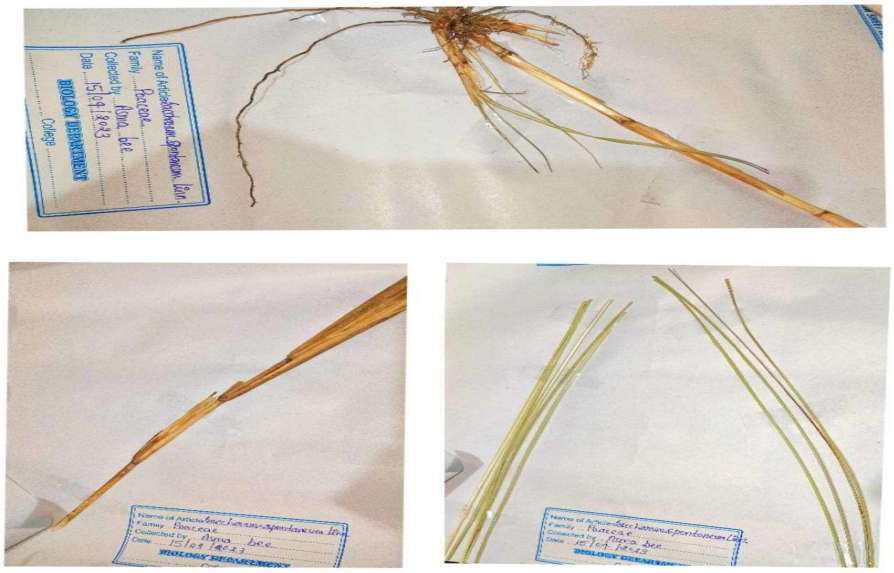


Fig.2.0 *Saccharum spontaneum* Linn shaded dried root, stem, leave

Saccharum spontaneum stems have a greenish-yellow color and polished appearance, with cylindrical, branched shapes and a fibrous inner core. Physicochemical analysis shows fibers and vessel elements, while preliminary phytochemical analysis indicates valuable phytoconstituents [12]. Saccharum munja, a nutritious and drought-tolerant grass, is traditionally used for ropes and baskets. Its stem contains valuable fiber and is used for various ailments, including burning sensations, thirst, and eye diseases. The plant's nutrients, including sodium, potassium, calcium, magnesium, iron, and chlorides, contribute to its medicinal importance [13,14]. Saccharum spontaneum contains carbohydrates, proteins, and amino acids, lignin, while its roots and root-stocks contain starch and polyphenols, providing antidiarrheal and CNS depressant effects in Ayurvedic medicine [15]. Saccharum spontaneum

contains drought-resistant genes [16,17,18,19,20,21,22,23,24,25]. It has low lignin content, can be pulped mildly, and has polysaccharides for high-quality paper. It is abundant along roadsides, in seasonal ponds, and in water sources. The transformation of sarkanda into pulp and paper offers industry supply and waste management benefits [26,27,28]. The plant effectively treats various ailments such as vomiting, mental illnesses, abdominal pain, vata and pitta ailments, obesity, anemia, problems, dyspnea, piles, burning, dyspepsia, respiratory, gynecological, and sexual weakness.

2. PHYTOCHEMICAL PROFILE

Green, Ripe Grass contains crude protein, fiber, nitrogen, calcium, and phosphorus, with various chemical constituents. It contains various compounds, including calcium, sulphate, chloride, carbonate, starch, iron ferric, iron ferrous, phosphate, cyanide, and zinc. A study found that saccharum spontaneum linn. Significantly reduced total cholesterol serum levels in rats fed a high fat- diet, suggesting potential therapeutic applications in treating hyperlipidemia [29]. The analysis revealed the presence of 22 compounds, including notable ones like 2-Furancarboxaldehyde, 5-hydroxymethyl (22.63%), and d-Mannose (14.52%). The GC- MS spectrum profile confirmed these compounds, with retention times and relative percentages specified. The GC- MS analysis of the ethanolic extract from S. spontaneum identified diverse compounds with potential antimicrobial, antioxidant, anti-inflammatory, and other therapeutic properties. Notable compounds include aldehydes like 2-furancarboxaldehyde and 5-(hydroxymethyl)-, suggested for antimicrobial and preservative roles, and fatty acids like Tetra decanoic acid, with possible antioxidant and cancer-preventive effects. The study provides insights into the plant's chemical composition, supporting its traditional use for various ailments. The identified compounds from S. spontaneum's ethanolic extract have diverse potential activities. Aldehyde compounds exhibit antimicrobial effects. Phytol, a diterpene, displays antimicrobial, anti-inflammatory, anticancer, and diuretic traits. Octadecadienoic acid, methyl ester, has hepatoprotective, anti-inflammatory, and hypocholesterolemic qualities. Similarly, Octadecenamide (Z)-oleamide acts as an antimicrobial amide. Additionally, various compounds show anti-inflammatory, antihistaminic, anticancer, and other activities, including enhancing sex hormone activity [30,31]. Preliminary phytochemical analysis identified carbohydrates, alkaloids, phenolic compounds, saponins [32,33] tannins, proteins, amino acids, coumarins, and flavonoids. Column chromatography yielded three compounds: Compound 1 (3,3',4',5-Tetrahydroxy-6,8-dimethoxy flavone), Compound 2 (3,5-Dihydroxy-4'-methoxy-7-oxyglucopyronoside flavone), and Compound 3 (3,3',4',5,7-Pentahydroxy flavone), Characterization was done using FT-IR, NMR, and Mass spectrophotometric methods [34].

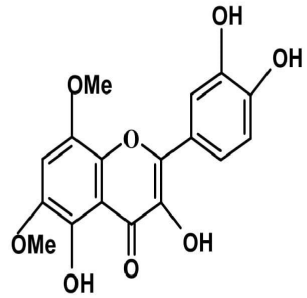
Jisen Zhang et al. studied the role of sucrose phosphate synthase (SPS) genes in sugar production in sugarcane, a crop derived from the hybridization of two species. They identified eight SPS gene sequences in S. officinarum and six in S. spontaneum. Phylogenetic analysis revealed a recently evolved subfamily, SPSD, in Poaceae species. Molecular evolution analysis showed polyploidy reduced selection pressure on SPS genes. SPS genes showed increased expression during leaf transition, suggesting photosynthesis. They also showed tissue-specific expression preferences between stem and leaf tissues, suggesting different aspects of carbohydrate metabolism [35].

Table. 1.0 Phytochemical data of *Saccharum spontaneum* Linn. has been described in the following table.[35]

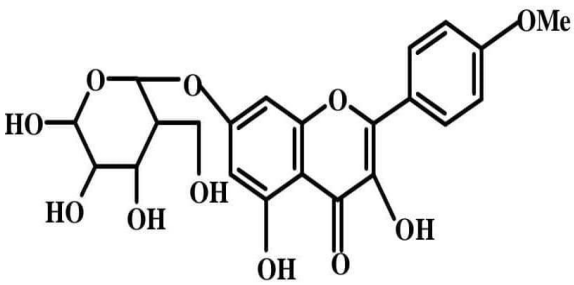
Name of compounds	Chemical structure	Nature of compound	Activity
2-Furancarboxaldehyde,5-(hydroxymethyl)-	$C_6H_6O_3$	Aldehyde	Antimicrobial, Preservative
9-Acetoxynonanal	$C_{11}H_{20}O_3$	Aldehyde	Antimicrobial
Vitamin D3	$C_{27}H_{44}O$	Seco-steroids	Hypovitaminosis D, vitamin D deficiency, osteoporosis
Tetradecanoic acid	$C_{14}H_{28}O_2$	Fatty acid	Antioxidant Cancer preventive Cosmetic Hypercholesterolemic Nematicide, Lubricant
	$C_{20}H_{40}O$	Diterpene	Antimicrobial, antiinflammatory, anticancer

Phytol			**diuretic**
9,12- Octadecadienoic acid, methyl ester, (E,E)-	**$C_{19}H_{34}O_2$**	**Polyenoic fatty acid**	**Hepatoprotective, antihistaminic, hypocholesterolemic, antieczemic**
1,2- Benzenedicarboxylic acid, diisooctyl ester	**$C_{24}H_{38}O_4$**	**Plasticizer compound**	**Antimicrobial Antifouling**
Cis- Z- á- Bisabolene epoxide	**$C_{15}H_{24}O$**	**Pheromone compound**	**To increase sex hormone Activity**

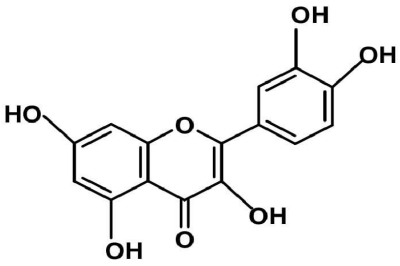
Chemical structure of different chemical compounds has been given below-



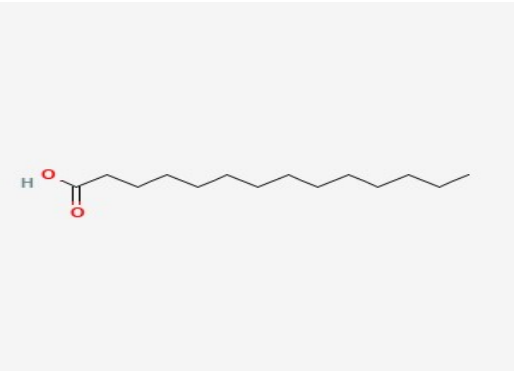
(3,3',4',5-Tetrahydroxy-6,8-dimethoxy flavone) [34]



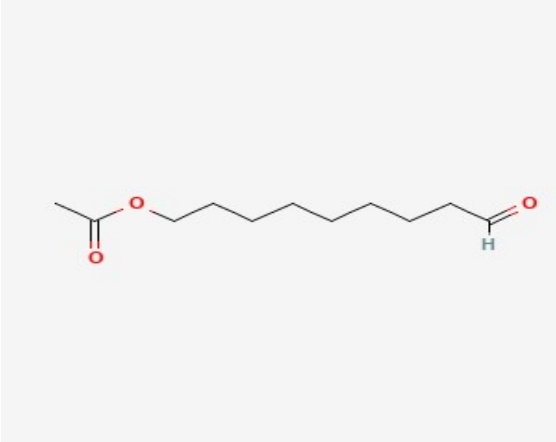
(3,5-Dihydroxy-4'-methoxy-7-oxyglucopyronoside)[34] flavone)



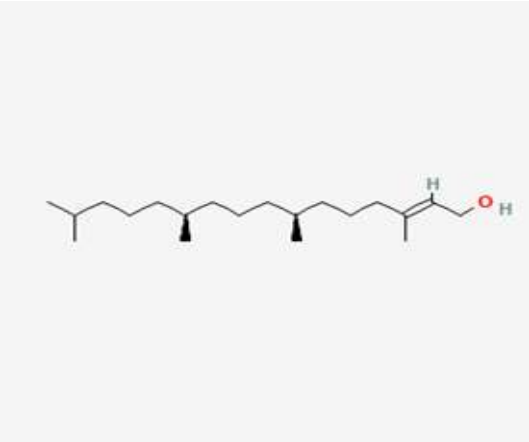
(3,3',4',5,7-Pentahydroxy flavone) [34]



(Tetradecanoic acid) [Pubchem]



9-Acetoxynonanal [Pubchem]



Phytol [Pubchem]

3. PHARMACOLOGICAL ACTIVITIES

3.1. Antioxidant activity

M. Satya et al. evaluated the antioxidant potential of Saccharum *spontaneum* Linn. root extract using in vitro assays. The **DPPH radical scavenging activity** was assessed, with DPPH being reduced by antioxidants, resulting in a color change. The assay highlighted the extract's hydrogen donation ability and antioxidant efficacy. Similarly, the ABT's radical scavenging activity, focusing on proton radical scavenging, indicated the extract's potential to prevent lipid oxidation. The Ferric Reducing Antioxidant Power assay measured the reduction of ferric ions by the extract, demonstrating its capacity to stop lipid oxidation and capture free radicals. The root extract's activity increased with concentration, indicating its potential as an antioxidant. Comparisons with standards such as ascorbic acid and BHT were made, confirming the extract's antioxidant potential. In conclusion, the study emphasized the potent antioxidant and free radical scavenging abilities of Saccharum *spontaneum* Linn. root extract. These effects were attributed to its rich phytoconstituents like alkaloids, flavonoids, tannins, and others. The findings suggest that the extract could serve as a natural antioxidant with possible therapeutic applications for disease prevention and health enhancement [36]. The research conducted by Devi et al. focused on evaluating the antioxidant activity of various extracts from the aerial parts of Saccharum *spontaneum* Linn. They employed different methods to assess the antioxidant potential of these extracts. The study evaluated the antioxidant activity of Saccharum spontaneum extracts using **phosphomolybdic acid methods**. The methanolic extract showed the highest antioxidant activity, with an IC_{50} value of 300 µg/mL. The **FRAP assay** showed the highest reducing ability among the tested extracts, with an IC_{50} value of 228 µg/mL. The total flavonoids content of the methanolic extract was the highest, suggesting potential health benefits as a natural source of natural antioxidants. These findings contribute to understanding the plant's therapeutic potential and traditional medicine use [37]. Another study by Amutha Iswarya Devi et al. evaluated the antioxidant activity of different extracts of Saccharum *spontaneum* Linn. The methanolic extract exhibited the highest total antioxidant activity, surpassing petroleum ether and ethyl acetate extracts. Comparatively, standard ascorbate showed slightly stronger antioxidant effects. The reducing abilities of the extracts and ascorbate were also assessed, with the methanolic extract demonstrating the highest efficacy. Flavonoid content was measured in various extracts, and the methanolic extract contained the highest amount. Overall, the methanolic extract of Saccharum spontaneum displayed the strongest antioxidant potential among the tested extracts and compared well with standard ascorbate in terms of antioxidant activity [38]. Geetha Kodali et al. conducted a study investigating the antioxidant properties of ethanolic extracts from Saccharum spontaneum. They found that this extract exhibited substantial antioxidant effects by scavenging free radicals, including DPPH, nitric oxide, and lipid peroxidation, in a concentration-dependent manner. The presence of quantified phenolic compounds in the extracts likely contributed to their antioxidant activities. The study concluded that Saccharum *spontaneum* Linn. possesses notable antioxidant potential [39].

3.2. Antibacterial, antifungal & anti-inflammatory activity

Lapuz et al. investigated the root extract of S. *spontaneum* Linn. due to reported claims of its medicinal potential, including diuretic, galactagogue,

and gastrointestinal/gynecological uses. Rising antibiotic costs further motivated research into S. spontaneum's alternative medical potential. The research aimed to evaluate antibacterial and anti-inflammatory properties of the extract and its cream formulation. S. *spontaneum* Linn. samples were collected authenticated, and extracted with 95% ethanol. Extracts were subjected to bio chemical screening, revealing the presence of sugar, glycosides, condensed tannins, and flavonoids. Antimicrobial evaluation used **Kirby-Bauer method** against different bacteria . Extract showed concentration-dependent inhibition against S. epidermidis and S. aureus, with no effect on P. aeruginosa. Creams containing extract were tested for properties, exhibiting spreadability but being less washable. Results indicated potential anti-inflammatory properties for the cream, especially at 2% concentration, comparable to standard Diclofenac sodium 1% gel. The study demonstrated S. spontaneum Linn.'s potential in anti-inflammatory applications [40]. In another study by Musaddique Hussain at el, the antibacterial action of Saccharum *spontaneum* against human pathogenic bacteria was evaluated. In vitro tests using the **disc diffusion method** on culture media revealed significant inhibition zones against various bacterial strains. The extract displayed strong inhibitory effects on Staphylococcus aureus, Streptococcus pneumoniae, B. cereus, B.pumilus, Escherichia coli, Klebsiella, P. aeruginosa, and Citrobacter freundii. The minimum inhibitory concentration (MIC) values, determined using a modified agar well diffusion method, ranged from 75 to 300 µg/ml for Gram-positive bacteria and 75 to 600 µg/ml for Gram-negative bacteria. The antibacterial action was attributed to the presence of tannins and flavonoids, which hindered bacterial growth by affecting multiple regulatory processes such as DNA, RNA, and protein synthesis [41]. The study conducted by Cagampan et al, aimed to evaluate the antimicrobial potential of *Saccharum spontaneum* leaf extract against Bacillus subtilis. They employed the **Kirby-Bauer Test and Minimum Inhibitory Concentration (MIC) determination** using various concentrations of the ethanol-based leaf extract. The results indicated a positive antimicrobial effect, with a zone of inhibition of 18 mm and an antimicrobial index (AI) of 0.8 in all replicates. However, the MIC results revealed the resistance of the microorganisms to all extract concentrations, suggesting that higher concentrations of B. subtilis couldn't be inhibited by the extract. Despite this, the study concluded that Saccharum *spontaneum* leaf extract does possess antimicrobial activity against Bacillus subtilis, albeit with observed resistance at certain concentrations [42]. Farhana Alam Ripa et al. conducted an antibacterial assay using the **disc diffusion technique** to evaluate the antimicrobial activity of Saccharum *spontaneum* extract. The study involved testing the extract against both G-positive and G-negative bacteria, including Bacillus megaterium, Bacillus subtilis, Staphylococcus aureus, Sarcina lutea, Salmonella paratyphi, Salmonella typhi, Vibrio parahemolyticus, Vibrio mimicus, Escherichia coli, Shigella dysenteriae, Pseudomonas aeruginosa, and Shigella boydii. The test discs, containing the extract, were placed alongside standard antibiotic discs in Petri dishes seeded with specific bacteria. After incubation, the antibacterial activity was determined by measuring the zone of inhibition in millimeters. The extract exhibited varying degrees of inhibitory effects against the tested bacterial strains [43]. The research conducted by J. Amutha Iswarya Devi et al. focused on investigating the antimicrobial properties of the ethanolic extract of the whole plant of Saccharum *spontaneum* Linn. The study used disc diffusion techniques to assess the extract's antibacterial activity against different types of bacteria. The results indicated significant inhibition zones for these bacteria, attributed to tannins, polyphenolic compounds, and flavonoids. This research offers valuable insights into the potential of Saccharum spontaneum Linn. as a natural antimicrobial agent for combating microbial resistance and developing alternative treatments for infectious diseases[44].

3.3. Antidiabetic activity

Febrina Mira examined how reed infusion (*Saccharum spontaneum* L.) affected blood glucose levels in male white mice (*Mus musculus*) given a 2g/kg body weight glucose load using the **Oral Glucose Tolerance Test (OGTT) method**. Six groups were involved: negative control- aquadest only, comparison group- 2g/kg glucose solution, positive group- 65mg/kg metformin, treatment groups- 10,20 and 30 percent reed infusion. All groups received a 30-minute pre-treatment before taking 2g/kg glucose orally. Blood glucose was measured for 30 to 180 minutes. Reed infusions at 10%, 20%, and 30% concentrations lowered blood glucose levels. Further analysis (two-way ANOVA, post-hoc Tukey test) showed that administration duration significantly impacted glucose reduction in mice[45]. The study conducted by Hage Assung et al. investigated the potential antidiabetic activity of the ethanolic extract of Saccharum spontaneum's young shoots using a streptozotocin-induced diabetic mouse model. Results showed mild reductions in peak blood glucose levels and area under the curve in both non-diabetic and diabetic mice. When diabetic mice were

treated with the extract over an extended period of time, their blood glucose levels significantly decreased and their body weight slightly improved. The extract also reduced triglycerides and creatinine levels, suggesting potential benefits for lipid metabolism and kidney function[46].

3.4. Antiurolithiatic activity

The Sathya et al. study looked into the potential protection against calcium oxalate calculi in rats provided by the ethanolic extract of Saccharum *spontaneum* roots. The researchers divided 30 Wistar rats into five groups, induced to develop urolithiasis, and treated with different doses of the extract. The results showed that the ethanolic extract significantly improved the condition of rats with urolithiasis, normalizing urinary levels of urea, uric acid, and creatinine. The extract also increased urine volume, reducing the tendency for crystal formation in the urinary system[47,48]. In another study, Kokilavani et al. found that the ethanolic root extract of Saccharum *spontaneum* was used to treat urolithiasis caused by glycolic acid. It significantly increased reduced-D-glucuronidase levels in liver and kidney, reduced xanthineoxidase levels in liver and kidney, and n-acetyl-d-glucosaminidase levels in serum and urine[49,50] .

3.5. Antihyperlipidemic activity

Geetha Kodali et al. conducted a study in which they induced hyperlipidemia in rats using an atherogenic diet. They investigated the effects of the ethanolic extract of Saccharum *spontaneum* whole plant and a standard medication (atorvastatin) on lipid levels. The ethanolic extract given orally at 100 and 200 mg/kg for 21 days, significantly lowered total cholesterol, triglycerides, and LDL cholesterol levels while increasing HDL cholesterol in a dose-dependent manner. This suggests that ESSW has notable Antihyperlipidemic properties and is potentially useful for treating vascular disorders like atherosclerosis due to its antioxidant compounds, like phenolic compounds found in the plant[51].

3.6. Antidiarrheoal and CNS depressant activity

The putative anti-diarrheal and central nervous system (CNS) depressive properties of Saccharum spontaneum Linn's methanolic extract were studied by Md. Mynol Islam Vhuiyan et al. According to the study, the extract has CNS-depressive, anti-diarrheal, and phytochemical properties. The extract inhibited the production of moist feces in castor oil-induced diarrhea, with percentages of 79.41% and 85.29% at 200 and 400 mg/kg, respectively. Additionally, the CNS depressant activity was assessed, and results revealed a dose-dependent decrease in hypnosis caused by pentobarbitone as well as a decrease in locomotor and exploratory behavior [52].

Table 2.0: Pharmacological activities of different parts of Saccharum *spontaneum* Linn.

Part of Plant	Activity	Extract/Solvent	Animal Model/Study	Ref
Saccharum spontaneum Linn. whole plant	Antioxidant activity	Ethanolic extract	DPPH radical scavenging activity	[36]
Saccharum spontaneum Linn. whole plant	Antioxidant activity	Ethanolic extract	phosphomolybdic acid methods	[37]
Saccharum spontaneum Linn. leaf	Anti-microbial	Ethanolic extract	disc diffusion method Staphylococcus aureus, Streptococcus pneumoniae, Escherichia coli, Klebsiella pneumoniae	[41-44]
Saccharum spontaneum Linn.young shoot	Antidiabetic activity	Ethanolic extract	Oral Glucose Tolerance Test (OGTT) method a streptozotocin-induced diabetic mouse model	[45,46]
Saccharum spontaneum Linn.root	Antiurolithiatic activity	ethanolic extract	calcium oxalate calculi in rats	[47,48]
Saccharum spontaneum whole plant	Antihyperlipidemic activity	ethanolic extract	induced hyperlipidemia in rats using an atherogenic diet	[49,50]
Saccharum	Antidiarrheoal	methanolic extract	castor oil-induced	[51]

spontaneum Linn. whole plant	activity			
Saccharum spontaneum Linn.whole plant	CNS depressant activity	methanolic extract	pentobarbitone-induced hypnosis	[52]

4. TOXICOLOGICAL STUDIES

The study analyzed the acute toxicity potential of ethanolic extract of Saccharum *spontaneum* Linn. finding a low LD_{50} of over 2000 mg/kg body weight. Behavioral observations included increased respiration rate, somato-motor activity, convulsions, tremors, and itching, but no mortality. Biochemical analysis revealed elevated levels of AST, ALT total proteins, globulins, cholesterol, triglycerides, LDL, platelet count, MCV, MCH, WBC count, and lymphocytes. The study concluded that further research is needed to assess the safety and potential long-term effects of S. spontaneum extract [53][54].

5. CONCLUSION

In conclusion, Saccharum *spontaneum* Linn, generally known as wild sugarcane, is a plant rich in diverse chemical constituents that hold significant pharmacological potential. Gas chromatography-mass spectrometry (GC-MS) analysis has identified various compounds with antimicrobial, antioxidant, anti-inflammatory, and other therapeutic properties. These compounds include aldehydes, fatty acids, diterpenes, and polyenoic fatty acids, each with distinct pharmacological activities. Preliminary phytochemical analysis also revealed the presence of aldehydes(2-Furancarboxaldehyde,5-(hydroxymethyl, 9-Acetoxynonanal),fatty acids (Tetradecanoic acid), polyenoic fatty acid(9,12- Octadecadienoic acid, methyl ester, (E,E) & 9,12,15- Octadecatrienoic acid, methyl ester, (Z,Z,Z)), pheromone compound (Cis-Z- á- Bisabolene epoxide), diterpene (Phytol), carbohydrates, phenolic compounds, saponins, tannins, proteins, amino acids, coumarins, alkaloids and flavonoids in Saccharum *spontaneum*. Some pharmacological studies have demonstrated the antioxidant potential of Saccharum spontaneum, highlighting its ability to scavenge free radicals. Various other studies have explored its antibacterial, antifungal, anti-inflammatory, and antidiabetic activities. Some pharmacological evaluation studies also explain their efficiency in combating urolithiasis, hyperlipidemia, and as a CNS depressant. Some toxicity studies have included adverse effect of saccharum *spontaneum* linn. so, all there is need for further studies to assess possible adverse and toxic effect of Saccharum *spontaneum* linn. Extract. It is essential to consider safety and toxicity aspects when utilizing Saccharum spontaneum extracts or derivatives, as acute toxicity studies have indicated some potential adverse effects. Further research and extensive toxicological assessments are necessary to determine the long-term safety and optimal dosages for therapeutic applications. Many other Ayurvedic plants [55]such as Syzygium genus exhibit vital therapeutic properties, addressing a range of health issues, including anti-diabetic, antioxidant, anti-bacterial, anti-inflammatory, platelet inhibition, and hepatoprotective effects[56] . Their efficacy extends beyond general health, proving beneficial in specific conditions like bronchial asthma[57]. The study of these natural remedies provides valuable insights into maintaining robust and secure health. Ongoing research holds the potential to unveil additional methods for enhanced health management. In summary, Ayurvedic plants stand as versatile contributors to holistic well-being, offering diverse health benefits. In summary, Saccharum *spontaneum* Linn. offers a rich source of bioactive compounds with diverse pharmacological activities, making it a promising candidate for further research in the development of natural remedies and pharmaceutical applications. However, caution must be exercised in its use, ensuring a thorough understanding of its safety profile and proper dosage guidelines.

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