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Review Article

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THYSANOLAENA MAXIMA (ROXB.) KUNTZE: A THERAPEUTICALLY LESS EXPLORED PLANT FROM NORTHEASTERN INDIA

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ABSTRACT
Thysanolaena maxima is a member of the Poaceae family of medicinal plants, and it is used to cure a variety of ailments, including boils, vomiting, stomach disorders, and infectious diseases like tuberculosis. *Thysanolaena maxima* has been found to possess a variety of chemicals, including terpenoids, polysaccharides, tannins, flavonoids, saponins, glycosides, phenols, and steroids. The current mini-review analyses its pharmacological profile, chemical components, and phytochemistry, with an emphasis on, cytotoxic, antioxidant and antimicrobial properties, in order to better assess the plant's medicinal potential. Traditional and modern medicine, as well as possible herbal therapy for a number of ailments, have a lot of potential for *Thysanolaena maxima.* Its active ingredients and pharmacological activities is yet to be thoroughly researched. This brief review has offered up-to-date work on *Thysanolaena maxima's* phtyochemical and other information, which will serve as a reference for future research

INTRODUCTION

One of the determinants for the effectiveness of healthcare system is the availability and utilization of appropriate medications. Conventional medications are still the most cost-effective and accessible treatment alternative within the essential healthcare framework [1]. People have relied on higher plants for their healthcare requirements since the dawn of civilization. Plants are becoming a great source for natural compounds that are being researched for medicinal impacts on human health. All around the globe, herbal medications are believed to be safer to use than synthetic remedies, so the utilization of therapeutically active plant products for pharmaceutical purposes is growing by the day. More than 80% of people are using a conventional medicine system that relies on alternative treatments such as extracts, as per World Health Organization. [2,3]. Herbs have occupied a unique place in life since the dawn of time, and substantial research has been carried out to give information about the use of plants and plant products. Researchers from all around the globe have been screening plants for biological

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activity with medicinal promise. Carbohydrates, proteins, and triglycerides, the primary products of photosynthesis, play a vital role in human nutrition [4]. Herbal medicines, ethnomedicine, essential oils, and cosmetics, as well as secondary plant metabolic products including flavonoids, alkaloids, and terpenoids, are used for medication production in various pharmaceutical industries. Many plant parts have been taken and employed for in vivo and in vitro investigations, including leaves, fruits, seeds, stems, and bark [5].

However, these therapeutic plants occupy a pathogenic habitat and occupy a pathogenic structure. Herbal medications can therefore be used to treat a wide range of human ailments. This explains why herbal treatments may be used for treating a wide spectrum of human illnesses [6]. As a result, medicinal plants have become a top focus in the area of phytotherapy because they have few undesirable effects. *Thysanolaena maxima*, commonly referred to as broomstick, is a well-known plant that has been used in traditional medicine and by traditional healers to cure a variety of diseases [7].

Botanical description and taxonomy

Thysanolaena maxima is a perennial forest grass distributed in Bangladesh, India, Thailand, Nepal, and Bhutan's mountainous regions. The plant's sprouts, called in Nepali Amriso, are used as brooms or cleaning tools. Tiger grass is a common name for this plant in the tropics, where it is used for decorative purposes [8]. It can be used to imitate the look of bamboo, which it resembles but has no relation to. In locations where its flowers are used as a cleaning tool, it is also known as broomstick. Tiger Grass is a perennial grass with huge tufts that may grow up to 2m tall. In some regions, the huge leaves, which can be up to 7cm broad, are used to wrap food for steaming. Flowers are found in little spikelets arranged in huge branching clusters. Brooms are made from flower stems that have been knotted together. Tiger Grass can be found at altitudes of up to 1800m all over India. The flowering season runs from March to June [9].

Figure 1: *Thysanolaena maxima*

Table 1: Taxonomic classification of *Thysanolaena maxima*

The taxonomic classification of *Thysanolaena maxima* [10]	
Kingdom:	Plantae - Plants
Subkingdom:	Tracheobionta - Vascular plants
Super division:	Spermatophyta - Seed plants
Division:	Magnoliophyta - Flowering plants
Class:	Liliopsida – Monocotyledons
Subclass:	Commelinidae
Order:	Cyperales
Family:	Poaceae/Gramineae-Grass family
Genus:	Thysanolaena Nees- tiger grass
Species:	*Thysanolaena maxima (Roxb.) Kuntze*

Traditional uses

Thysanolaena maxima is a widely used medicinal herb that has been used in a variety of treatment regimens throughout history. Various tribes have used various portions of this plant in the past. As an anthelmintic, people of the Nepalese district of Palpa takes 2 teaspoons of root juice t.i.d for three days [11]. Traditional Khasi healers in Meghalaya, India, mixed *Thysanolaena maximum* flower paste with a spoonful of extinguished lime and applied it topically for the cure of boils. They also use the plant's young stem juice when their eyes grow red and dusty [12]. The Kanda tribal group of Sylhet, Bangladesh, takes pulverised flowers with water as antiemetics and to alleviate gastrointestinal troubles. The Dimasa tribes of Assam, India, consume the soft sections of new leaves and flower buds fresh to heal flatulence and enhance digestion [13]. The Chakma people of Chittagong, Bangladesh, take pills made from leaves twice a day to treat tuberculosis [14]

Chemical constituents isolated from *Thysanolaena maxima*

This plant is rich in medicinal benefits.. There are many different types of phytonutrients in plants, like terpenoids, carbohydrates, tannins, flavonoids, saponins, glycosides, phenols, and steroids [15]. More than 40 compounds have been isolated so far from various factions of *Thysanolaena maxima* extracts. The compounds were identified as Isorhamnetin-3-O-β-D-glucopyranoside (C_1), Luteolin-8-C-E-propenoic acid (C_2), Luteolin-8-C-β-D-glucopyranoside (C_3), Luteolin (C_4), 6"-O-acetylorientin-2"-O-α-L-rhamnopyranoside (amrisoside) (C_5), Tricin-7-O-β-D-glucopyranoside (C_6), Orientin-2"-O-α-L-rhamnopyranoside (C_7), Apigenin-6-C-β-D-glucopyranoside (C_8), Luteolin-6-C-β-D-glucopyranoside (C_9), Isoquercetin

(C_{10}), Isoswertisin (C_{11}), Luteolin-3',4'-dimethylether-7-O-β-D-glucopyranoside (C_{12}), uridine, 6-O-caffeoyl-D-glucopyranoside, 7S,7'S,8R,8'R -icariol A_2-9-O-(-D-glucopyranoside), syringic acid, jaboticabin acid (2-O-(3,4-dihydroxybenzoyl)-2,4,6-dihydroxyphenyl) acetic acid), isomeric mixture of erythro/threo guaiacylglycerol, 7α-hydroxysitosterol, ergosterol peroxide, (2E-3-(3,4-dihydroxyphenyl) prop-2-enoicanhydride), erigeside-C-(syringic acid-1-O-β-D-glucopyranoside), 1-O-feruloyl-2-O-p-coumaroylglycerol, β-sitosterol, (7S,8R)-erythro-syringylglycerol-b-O-4'-sinapyl ether-7-O-β-D-glucopyranoside, 7a-hydroxysitosterol, 7R,8R-4-Omethylsyringylglycerol, benzoic acid, adenosine, leonuriside-A, sucrose, glycerol, butyl protocatechuate, and tryptophan. [16]. Four compounds were discovered in a 1:1 ratio for dichloromethane and methanol extract employing vacuum liquid chromatography (VLC) on silica gel. Those four chemicals have been identified as 4-hydroxybenzaldehyde, β-stigmasterol, 4-hydroxycinnamic acid, and stigmast-4-en-3-one [17].

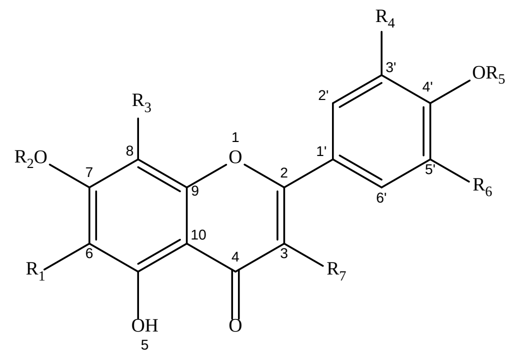
Chemical composition analysis

Tidarat et al. (2016) used enzymatic hydrolysis and two-stage microwave/chemical treatments to analyse the production of exceptionally efficient monomeric sugar from *Thysanolaena maximum.* The best pretreatment conditions were determined by varying reaction durations, temperatures, and chemical concentrations in order to improve the quantity of monomeric sugar produced. *Thysanolaena maxima* was microwave-assisted with a 1%(w/v) NaOH solution at 140 °C for 15 minutes, followed by a 0.5% (w/v) H_2SO_4 solution at 200 °C for 5 minutes. The liquid-solid ratio was maintained at 15:1. The maximum amount of monomeric sugar that could be released from NaOH-treated solids was 30.2g of sugar for every 100g. An impressive maximal sugar production rate of 110.4g/100g of NaOH-pretreatment *Thysanolaena maxima* was achieved by enzyme hydrolysis at pH 4.8, 45 °C for 12 hours with a concentration of 160µl/g of pretreated solids. This research also found that two-stage pretreatment is a good way to remove lignin and break down lignocellulosic structures, which makes enzyme hydrolysis more efficient [18].

Pharmacological activities

Antioxidant activity:

Nazia et al. conducted research to discover the scientific basis for DPPH radical scavenging activity; total phenolic content, total flavonoid content, and reducing power were used to assess the antioxidant properties of *Thysanolaena maximum* using three extracts (methanol, chloroform, and petroleum ether). According to the findings of this investigation, the extracts' scavenging activity increases with concentration. Methanol extract had the highest radical scavenging activity (IC50 = 36.940.62 g/ml), whereas petroleum ether extract had the lowest activity (IC50 = 94.869.20 g/ml).



C_1: R_1=R_2= R_3= H, R_4= OCH_3, R_5=R_6= H, R_7= O- β-D-glc
C_2: R_1=R_2= H, R_3= 8-C-propeonic acid, R_4=OH, R_5=R_6=R_7=H
C_3: R_1=R_2= H, R_3= -C-β-D-glc, R_4=OH, R_5=R_6=R_7=H
C_4: R_1=R_2= R_3= H, R_4=OH, R_5=R_6=R_7=H
C_5: R_1=R_2=H, R_3=6''-o-acetyl-β-D-glc-2''-O-a-L-rham, R_4= OH, R_5=R_6=R_7=H
C_6: R_1=H, R_2= β-D-glc, R_3= H, R_4= OCH_3, R_5=H, R_6= OCH_3, R_7=H
C_7: R_1=R_2= H, R_3= C-neoh, R_4=OH, R_5=R_6=R_7=H
C_8: R_1=-C-β-D-glc, R_2= R_3= R_4= R_5=R_6=R_7=H
C_9: R_1= C-β-D-glc, R_2= R_3= H, R_4=OH, R_5=R_6=R_7=H
C_{10}: R_1=R_2= R_3= H, R_4=OH, R_5=R_6= H, R_7= O-β-D-glc
C_{11}: R_1=H, R_2= OCH_3, R_3= C-β-D-glc, R_5=R_6=R_7=H
C_{12}: R_1=H, R_2=O-β-D-glc, R_3= H, R_4= OCH_3, R_5=CH_3, R_6=R_7=H

Figure-2: Structures of Chemical Constituents of *Thysanolaena maxima.*

The Folin-Ciocalteu solution and gallic acid had been used to determine the total antioxidant capacity of the extracts. The total phenolic content of the extracts was measured using a gallic acid standard curve and represented in gallic acid equivalents (mg/g, GAE).The highest phenolic compounds were found in the methanol extract (74.392.87 mg/g, GAE), followed by the chloroform extract (69.033.08 mg/g, GAE) and the petroleum ether extracts (56.8913.99 mg/g, GAE).

A colorimetric method was used to determine the flavonoid content, with aluminium chloride as the reference chemical. A quercetin standard curve was used to calculate the total flavonoid concentration, and the findings were represented in milligrammes per gramme of quercetin. The chloroform extract had the most flavonoid concentration (81.07.54 mg/g, QE), whereas the petroleum ether extract had the least (20.661.88 mg/g, QE).

The extracts' reducing power was tested using potassium ferricyanide, with plant extracts converting ferric ions to ferrous ions by producing a prussian blue coloured complex, with ascorbic acid as a control. Different extracts' reducing power was shown to increase with concentration. Chloroform extracts have a stronger reducing power than methanol and petroleum ether extracts [15]. Nazia et al. extracted seven fractions using dichloromethane: methanol (1:1) as the solvent, separated the fractions using preparative TLC, and tested them for DPPH free radical scavenging activity. The fractions' antiradical activity was determined using ascorbic acid as a standard. F-7 exhibited the highest antiradical scavenging activity (IC50 = 21.39±2.02 g/mL), whereas F-1 had the lowest (IC50 = 149.68±1.91 g/mL) [16].

Antimicrobial activity

The disc diffusion technique was used to test Thysanolaena maximum antibacterial activity against *Shigella boydii, Bacillus subtilis, Salmonella typhi, Vibrio mimicus, Bacillus megaterium, Staphylococcus aureus, Pseudomonas aeruginosa, Sarcina lutea, Escherichia coli, Shigella dysenteriae, Bacillus cereus*, and Kanamycin as control taking methanolic extracts of chloroform, and petroleum ether for *Thysanolaena maxima* using disc diffusion method. The chloroform extract's antibacterial activity ranges from 8 to 16 mm, with the maximal antimicrobial effect against Bacillus subtilis (15.330.29 mm at 600 g/disc). This extract showed moderate effectiveness against other strains when compared to the normal disc Kanamycin (30 g/disc). The antibacterial activity of the methanol extract extended from 8 to 11 mm, with the greatest antibacterial activity towards Escherichia coli (10.33±1.52 mm at 600 g/disc). Tests on the petroleum ether extract found that it was completely ineffective against all of the bacterial strains that were used [14].

Cytotoxic Activity

Nazia et al. (2020) isolated 4-hydroxybenzaldehyde, 4-hydroxycinnamic acid, 4-hydroxybenzoic acid, stigmast-4-en-3-one, and -stigmasterol from the aerial portion of Thysanolaena maximum and investigated their cytotoxic effects on the Vero cell line. A modified Trypan Blue Exclusion Method was employed to evaluate cytotoxic activity. Cells were cultured in 75cm^2 flasks in 5% (v/v) CO2 at 37 °C using the media described by Khan et al., 2018 [19]. The 1/2 inhibitory value of each compound was evaluated employing dose response curves.

The molecule Stigmast-4-en-3-one was discovered to be most cytotoxic among tested compounds, possessing an IC50 value of 5.82g/mL. With an IC50 value of 7.6 g/mL, 4-hydroxybenzaldehyde showed remarkable inhibition, 4-hydroxybenzoic acid and β-stigmasterol were both found to be ineffective in the Vero cell line, with no significant change in cell viability at the quantities examined. At a concentration of 5.0 g/mL, 4-hydroxycinnamic acid decreased cell viability by 22.7 percent in the Vero cell line, but compound 4-hydroxy benzoic acid exhibited the maximum cell growth by 88.8% [16]. Nazia et al. (2016) used a lethality bioassay employing varied doses of methanolic, extracts of chloroform and pet. ether to evaluate cytotoxic activity. The stock solution was prepared using pure dimethyl sulfoxide (DMSO) and the required amounts of various extracts. The results for the same are depicted as the chloroform extract had the lowest LC_{50} value (386.92±80.47 µg/ml) while in brine shrimp lethality test, the petroleum ether extract achieved the highest LC50 value (579.0578.08 g/ml).When compared to normal Vincristine sulphate (LC_{50} = 1.11±0.455 µg/ml), the extracts had limited cytotoxic activity [15].

CONCLUSIONS AND PERSPECTIVES

Plant-based formulations have received a lot of attention due to the presence of significant bioactive molecules/compounds for the treatment of a wide variety of infections and other ailments. *Thysanolaena maxima* have a lot of potential in both traditional and modern medicine, as well as possible herbal therapy for a wide range of ailments.

This review summarizes the ethnobotanical application, phytochemistry, and pharmacological actions of *Thysanolaena maxima*. According to this little review, the presence of phytochemicals in *T. maxima* resulted in a wide variety of pharmacological actions, including antioxidant, antibacterial, and cytotoxic capabilities. New discoveries, on the other hand, may strengthen *Thysanolaena maxima*'s current medicinal value and encourage its future use in modern medicine.

FINANCIAL ASSISTANCE

Nil

CONFLICT OF INTEREST

The authors declare no conflict of interest

AUTHOR CONTRIBUTION

Safal Sharma did a proper literature survey, collected data, design the work, and wrote a portion of paper. Sushilta Pradhan collected data and wrote a portion of paper. Bibhas Pandit conceived and designs the paper, and reviewed the whole paper. Jyochhana Priya Mohanty Conceived and design the analysis. All the authors design the final manuscript.

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