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Review Article

Phytochemical Analysis and Anti-Microbial Activity of *Desmostachya Bipinnata*: A review

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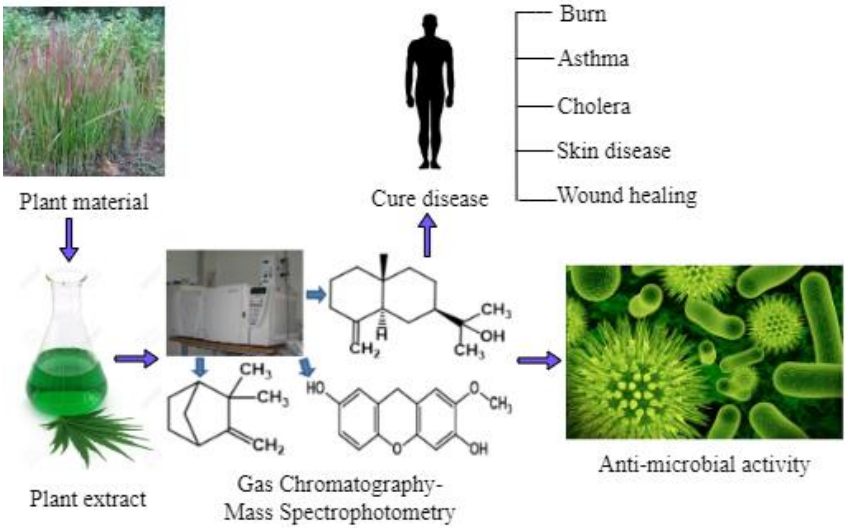
ABSTRACT

The medicinal plant has been in perpetual use as a traditional medicine in most Asian and African countries. One such plant is *Desmostachya bipinnata* Linn., a perennial plant of Poaceae family, which has been widely used to treat some infectious diseases. The screening of this plant revealed substantial phytochemicals such as flavonoids, alkaloids, glycosides and other constituents, which possess a wide range of biological activities such as anti-ulcerogenic, anti-helicobacter, anti-inflammatory and other antimicrobial activity. The major compounds found in *D. bipinnata* are L-limonene, camphene, β-eudesmol, trycin-7-glucoside and trycin. So far, research on this plant demonstrated that, the isolated compounds are safe for human use. However, further activities of the phytochemicals and their medicinal aspects needs to be studied so that more new compounds can be identified, which can be used for the treatment of different bacterial infections. This review is an attempt to comprise all the study of plant phytochemical and antimicrobial properties.

GRAPHICAL ABSTRACT



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Introduction

The majority of the population has used medicinal plants throughout the world for their primary health care needs. There has been exponential growth in the field of herbal medicine and traditional medicines due to the development of advanced technology in chemical analysis and biological activity assessment nowadays [1].

Desmostachya bipinnata Linnis a perennial grass that is distributed from North Africa to South Asia and belongs to family Poaceae or Graminae. It is regarded as a sacred grass and is used in religious rites [2, 3]. It is a rhizomatous perennial with 2-3 mm thick rhizomes and coarse, narrow, and tough leaves [4]. *D. bipinnata* has been found to be the source of vitamins, fiber, minerals, and nutrients for the therapy of different diseases [5]. This review paper has highlighted the phytochemical screening and antimicrobial activities of *D. bipinnata*.

Medicinal Uses

The pharmacological studies revealed that the plant possessed anti-inflammatory, anti-helicobacter, antiulcerogenic, antioxidant, anticancer antimicrobial, anti-diarrhoeal [6] and antiurolithic activity [7]. Roots are used as a cooling, diuretic, galactogogue, and astringent agent. It is also used for urinary calculi, other diseases of the bladder [8], piles, dysuria, carbuncle, cholera [9], and rheumatism [10]. The whole plant is utilized to treat the fistula-in-ano [11]. It is also used for the treatment of wounds, abdominal pain, skin diseases [12], calculus, and epistaxis [13]. This plant is also served as potential remedy to treat several ailments associated with free radicals [14] . Every part of this plant contributes to the medicinal use, as summarized in Table 1.

Table 1: Medicinal uses of different parts of *Desmostachya bipinnata*

S.N	Parts used	Disease cured	Reference
1	Leaf	Wounds, boils, skin	[1]
2	Root	Toothache, stomach disorder, indigestion, dental carrier diuretic, asthma, jaundice cholera, piles, carbuncle	[15] [16] [17] [9]
3	Rhizome	Diuretic, dysentery	[16,18]
4	Whole plant	Airway and gut disorder fistula-in-ano	[19] [11]

Phytochemical Constituents

The phytochemical assessment has resulted in isolation and identification of various compounds from different morphological parts of *D. bipinnata*. The plant contains vitamins, minerals, carbohydrates, alkaloids, steroids, glycoside, saponins, tannins, phenols, flavonoids, coumarins, volatile oils, lignin, starch, oil globules, and mucilage [20].

Gas chromatography-mass spectrophotometry (GC-MS) analysis of a methanolic extract of leaves of *D. bipinnata* revealed the presence of 10 compounds. The major compound found were benzofuran 2,3- dihydro and octasiloxane 1,1,3,3,5,5,7,7,9,9,11,11,13,13,15,15,-hexacamethyl with the retention factor 8.9 and 19.7 and peak area 56 and 72, respectively as the major compound [5]. Methanolic extract of leaves of *D. bipinnata* revealed the presence of bioactive compound β-sitosterol-D-glucopyranoside [3]. Five flavonoid glycosides were reported in 2008 from ethanol extract of aerial parts of *D. bipinnata,* which were identified as kaempferol, quercetin, quercetin-3-glucoside, trycin (Figure 1) and trycin-7-glucoside. Out of these compounds, trycin and trycin-7-glucoside revealed antiulcerogenic activity [21].

In 2011, five sterols from the leafy culms of *D. bipinnata* were reported and identified as

stigmasterol, *β*-sitosterol, daucosterol, stigmast-5-en-3*β*,7*β*-diol and stigmast-5-en-3*β*,7*α*-diol [22]. A new xanthene was isolated from methanolic extract, which was identified as 2,6-dihydroxy-7-methoxy-3H-xanthen-3-one (Figure 1) [23]. In 2009, flavonoid compound 4'-methoxy quercetin-7-O-glucoside (Figure 1) was isolated from methanolic extract [24].

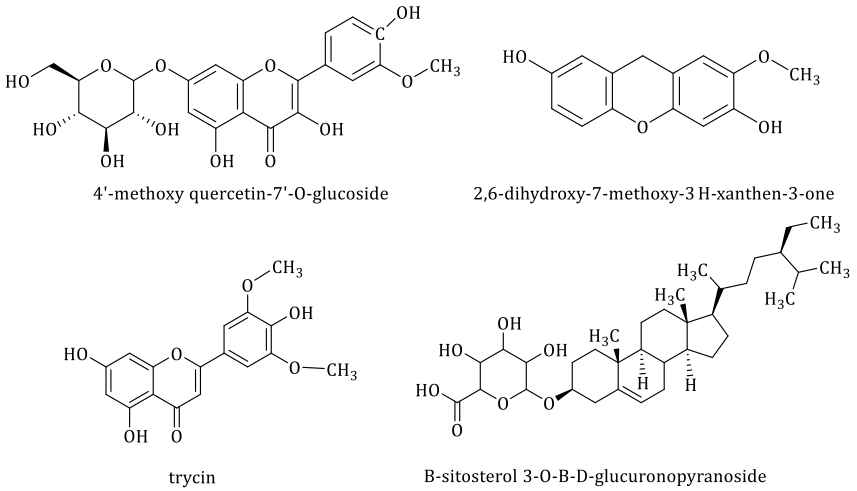

Figure 1: Structure of some compounds found in the extracts

GC-MS analysis of the plant essential oil contains β-eudesmol (11.2%), eseroline (25.1%), calarene (3.5%), camphene (16.8%), caryophyllene diepoxide (12.3%), isobornyl acetate (9.9%), tricyclene (4.3%), and trans-2,6-gamma-Irone (2.2%). The oil also contained smaller percentage of endoborneol, (-)caryophyllene oxide, diphenyliodinium bromide, L-limonene, 2-cyclohexene-1-one, caryophyllene oxide and 8-nitro-12-tridecanolide [25]. GC-MS chromatogram analysis of alcoholic extract of rootstock of *D. bipinnata* results in the isolation of lipid compounds such as *ρ*-hydroxycinnamic acid ethyl ester (16.2%), palmitic acid (15.1%), palmitic acid ethyl ester (9.2%), linoleic acid (6.6%), oleic acid (6.5%), linoleic acid ethyl ester (7.5%), oleic acid ethyl ester (4.5%), stearic acid ethyl ester (2.2%) and 2-methoxy-4-formylphenol [26]. 5-Hydroxymethyl 2-furfural, β-amyrin, β-sitosterol, β-sitosterol-glucoside, stigmasterol-glucoside, and sucrose were isolated from the ethanolic extract of the rootstock of *D. bipinnata* [27]. All these isolated compounds possess excellent phytochemical activity, as summarized in Table 2.

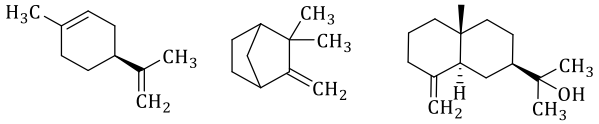

Figure 2: Some terpenes present in the essential oil of *D. bipinnata*.

Table 2: Pharmacological activity of compounds isolated from *D. bipinnata*

S.N	Compounds	Activity	Reference
1.	**4'-Methoxy quercetin-7-O-glucoside**	**Anti-helicobacter**	**[24]**
2.	**2,6-Dihydroxy-7-methoxy-3*H*-xanthen-3-en**	**Anti-cancer**	**[22]**
3.	**Trycin and trycin-7-glucoside**	**Anti-ulcerogenic**	**[21]**
4.	***β*-Sitosterol-D-glucopyranoside**	**Anti-bacterial**	**[3]**
5.	**Camphene**	**Anti-oxidant**	**[25]**
6.	**L-Limonene**	**Antitumor, Antimutagenic,Anti-inflammatory**	**[25]**
7.	***β*-Eudesmol**	**Antimutagenic, Antitumor, Antisalmonella**	**[25]**

Antimicrobial Activity

The methanolic extract and essential oils of the plant showed inhibitory action against different organisms. The essential oil extracted by water distillation of aerial part of the plant possessed a good growth inhibition against Staphylococcus epidermidis (Table 3) [25]. The methanolic extract of leaf exhibited antimicrobial activity by inhibiting Salmonella typhimurium ATCC 14028 and S. aureus ATCC 259233 [5].

Table 3: Antimicrobial activities of *D. bipinnata*

S.N.	Extracts	Part of plant	Inhibited micro-organisms	References
1	Essential oil	Aerial part	*S. aureus*, *S. epidermidis*, *E. coli*, *p. auerigonsa*	[25]
2	Ethanol	Whole plant	*M. luteus*, *B. subtilis*, *P. mirabilis*, *S. typhi*, *S. ventricull, S. aureus, C. tropicalis*, *C. albicans*, *A. flavus*, *A. fumigates*, *P. chrysogenum, P. aeruginosa*	[29],[32]
		Root stock	*K. pneumonia* (NCIM 2957), *E. coli* (NCIM 2931), *P. vulgaris* (NCIM 2857), *S. typhimurium* (NCIM 2501), *B. cereus* (NCIM 2458 and *E. aerogens* (NCIM 5139)	[31]
		Root	*E. coli*, *K. pneumonia*, *S. aureus*	[30]
3	Methanol extract	Leaves	*S. typhi*, *S. aureus*	[5]
		Aerial	*H. pylori*	[28]
		Whole plant	*H. pylori*	[24]
4	Hydroalcoholic extract	Leaves	*E. faecalis,S. dysenteriae* (ATCC 23513), *P. aeruginosa* (MTCC 741,1688), *S. aureus* (MTCC 3160), *S. aureus* strain (MTCC 96), *P. mirabilis* (MTCC 425) and *K. pneumonia* (MTCC 432)	[3]
5	Petroleum ether	Whole plant	*P. aeruginosa*	[32]
6	Acetone	Whole plant	*P. aeruginosa*	[32]
7	Chloroform	Whole plant	*P. aeruginosa*	[32]

The clinical sample of Helicobacter pylori has been susceptible to methanolic extract of the whole plant with a minimum inhibitory concentration (MIC) of 40 µg/mL. Further fractionation revealed high anti-helicobacter activity of ethyl acetate and butanol fractions with MIC values 0.8 and 1.3 mg/mL, respectively. Furthermore, a flavonoid compound 4'-methoxy quercetin-7-O-glucoside inhibited the H. pylori with MIC 62 µg/mL [24]. Similar study was reported in 2018 where aerial part methanol extract, n- butanol and ether extract exhibited anti-helicobacter activities with MIC values 6.3, 6.3 and 12.5 mg/mL [28].

Ethanolic extract of the plant demonstrated high antibacterial activity against Micrococcus luteus and Bacillus subtilis, a moderate inhibition activity against Proteus mirabilis, Pseudomonas aeruginosa, S. typhi, Sarcina ventricull and S. aureus. In addition, this extract showed antifungal activity against Candida tropicalis, C. albicans, Aspergillus flavus, A. fumigates and Penicillium chrysogenum [29].

Ethanolic root extract possessed antibacterial activity against Escherichia coli, Klebsiella pneumoniae and S. aureus [30]. Ethanolic root stock inhibited K. pneumonia (NCIM 2957), E. coli (NCIM 2931), P. vulgaris (NCIM 2857), S. typhimurium (NCIM 2501), B. cereus (NCIM 2458) and E. aerogens (NCIM 5139) with MIC value of 0.9, 31.2, 62.5, 62.5, 31.2, 500 mg/mL, respectively [31]. A study conducted in 2016 revealed P. aeruginosa was susceptible to ethanol, acetone, chloroform, petroleum ether extract of the whole plant [32]. A bioactive compound *β*-sitosterol-*D*-glucopyranpnoside

isolated from the extract exhibited antimicrobial activity against Enterococcus faecalis (MTCC 439), Shigella dysenteriae (ATCC 23513), Pseudomonas aeruginosa (MTCC 741,1688), S. aureus (MTCC 3160), S. aureus strain (MTCC 96), P. mirabilis (MTCC 425) and K. pneumonia (MTCC 432) with an MIC value of 15, 12, 10, 50, 24, 25, and 25 µg/mL, respectively [3]. Silver nanoparticles synthesized from the leaves exhibited inhibitory actions against the E. coli, S. aureus and S. mutans with inhibition zone of 13.5±1, 21±1, and 18.5±1.3 mm, respectively at 20 mg/mL concentration [33].

Conclusion

D. bipinnata has been widely used in the traditional medicine of some countries including, Nepal, India, and Sri Lanka. The crude extracts and essential oils of *D. bipinnata* has shown effective antimicrobial activity against various microorganisms. In addition, the crude extract and some pure compounds demonstrated to have anti-cancerous, anti-mutagenic and anti-tumorous properties. Thus, further research in isolating more pure compounds and formulating extracts, and bioassay with a new therapeutic target may be useful in providing important information about potent therapeutic use.

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Conflict of Interest

We have no conflicts of interest to disclose.

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