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A Comprehensive Review on *Hemidesmus indicus*

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ABSTRACT

This pioneering attempt aims to provide detailed information on *Hemidesmus indicus*, also called Anantmool belongs to the family Asclepediaceae is a well-known plant in herbal medicinal systems for its great potential against various diseases. This plant particularly its roots are known to have biological as well as pharmacological activities including apoptosis, free radical scavenging, antiresorptive, antivenom, antibacterial, antiulcer, anticancer, anti-angiogenic effects, antidiabetic properties. The present review article highlights the significance of species, botanical name, taxonomical classification, morphology, chemical constituents, chemical structures, phytochemistry, microscopic characteristics, adulterants, traditional uses, and pharmacological action. This extensive information will be of great value for future researchers.

INTRODUCTION

Hemidesmus indicus R. Br (Asclepiadaceae) commonly known as *Anantmul*. It is a common herb found throughout India. It is widely used in traditional Indian medicine and has been extensively studied for its pharmacological effects [1,2].

It is a perennial slender lactiferous, prostrate, or semierect climber widely distributed throughout India, from upper Gangetic plains east-wards to Assam, throughout Central, Western and Southern India. The traditional name is Sariva, Ananta, Anantamula but it is commonly known as ‘‘Indian Sarsaparilla’’. The drug consists of root with a characteristic pleasant smell of vanilla and acrid taste [3].

The first pharmacological study on the diuretic effects of *H. indicus* root was conducted in 1962. It has a widerange of ethnomedical uses, the most important of which is probably the treatment of dysentery and diarrhea. Traditionally, the water extract is used for treating diarrhea and dysentery, which has beneficial effects in addition to rehydration. It is also used to treat other infections, skin diseases, menorrhagia, postpartum convalescence, peptic ulcer and stomach pain, fever and headache pain and Inflammations, mouth sores, venereal diseases including gonorrhea and syphilis, impotence and as a blood purifier, refreshing tonic and appetite stimulant and to promote health and vitality, neutralizing snake bites and scorpion stings. In *Ayurveda* it is considered as one of the *rasayana* plants [1,4,5,6].

In Ayurvedic tradition, this plant is considered effectual as an antiarthritic and antirheumatic remedy. Ethanolic extract of root was found to be antihepatotoxic, in Ayurveda the root of *H. indicus* is considered to be demulcent, diaphoretic, diuretic and tonic [2,7,8,9].

It is useful in synphilis, leucoderma, hemicrania, rheumatism and also in liver and kidney disorders [4].

Table 1: Taxonomical Classification of *Hemidesmus indicus* [10]

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Gentianales
Family	Asclepiadaceae
Genus	*Hemidesmus*
Species	*Indicus*

Table 2: Vernacular names of *Hemidesmus indicus* [10]

English	Indian Sarsaparilla
Hindi	Magrabu
Kannada	Namada-beru
Sanskrit	Anantmul
Tamil	Arakkam

Geographical distribution

Hemidesmus indicus R. Br. (*H. indicus*) belonging to the Asclepiadaceae family is a famous medicinal ingredient with many medicinal applications in the Ayurvedic system of medicine. *H. indicus* is native to India,where it is still found mainly in the wild. *H. indicus* is a prostrate or semi-erect shrub found throughout India, from the upper Gangetic plains, east to Assam, throughout central India, west and south up to India. 600 m high.

It is also known to grow in Malaysia, Indonesia, Pakistan, Bangladesh, and Sri Lanka [3,4].

Description of the plant

It is a lactiferous, perennial, fast-growing thin creeper vine [4,11,18].

Fig. 1: *Hemidesmus indicus.*

Steam: Numerous slender stems having thickened nodes [4,11].

Fig. 2: Stem of *H. indicus.*

Leaves: Simple, opposite, very variable from elliptic-oblong to linear lanceolate and 5-10 cm long. It is dark green in color with reticulate vein [4]. Smooth, shiny and firm, varying in shape and size according to their age [18].

Fig. 3: Leaves of *H. indicus.*

Flower: Greenish purple crowded in subsessile cymes Small green outside, deep purple inside [4,18].

Fig. 4: Flower of *H. indicus.*

Fruits: Slender and cylindrical spreading follicles, approximately 10 cm long [4].

Seeds: Seeds are white and covered in tiny silvery white hairs, 6 to 8 cm long [4].

Roots: Roots occur in pieces, about 30 cm long and 3-8 mm in diameter [4].

Equipped with numerous thick roots and secondary roots, dark brown external appearance, sometimes coloredwith purplish-gray, yellow, woody center, surrounded by a layer of white,

mealy, brownish, corky bark, characterized by transverse cracks and longitudinal cracks and is easily rigid from the central hard core [18].

Roots are cylindrical in shape, irregularly bent [4].

Fig. 5: Roots of *H. indicus*.

Microscopic characteristics of *Hemidesmus indicus* [19]

Cork

Different layers of tissue as compressed, thick-walled, suberized, rectangular, tangentially elongated, 5 to 25cells rows of bands of narrow, scaly cells filled with reddish or purplish-brown contents.

Phellogen

Distinct colorless1 or 2 row cells.

Phelloderm

4 to 16 compressed rows of tannin (brownish content) and crystals of calcium oxalate

Cortex

Wide sector of skinny walled, polygonal, parenchymatous cells with abundant round to oval, helmet shaped, simple and multi-component starch grains with hillum; non-articulated laticiferous canals, cavities, brownish content, oil globules and prismatic crystals; hardly ever a few sclereids between phelloderm and cortexregions in roots above 1 cm thickness.

Phloem

4 to 14 layers of narrow sector of phloem cells along with sieve elements, skinny walled tangentially elongated, large towards outer edge and come to be smaller compressed square cells towards inner facet; ceratenchyma, laticiferous cells, a few starch grains and prismatic crystals are observed disbursed inside the vicinity; in root inventory pith location incorporate corporations of primary inner phloem inclusive of compressed collapsed cells, without any mobile content and fibers.

Xylem

Very wide quarter of xylem consist variously sized, round to oval, in the single or 2 or 3 grouped, diffused porous vessels displaying some tylosis and resin like brownish content material; thick-walled xylem fibres with huge lumen; thick walled xylem axial parenchyma parenchyma containing a few starch grains, oil globules and prismatic crystals of calcium oxalate.

Medullary ray

Phloem rays uni-seriate (5 to 8), cells being larger in size than that of other phloem cells; basically uniseriate xylem rays, not often bi or tri-seriate with a few starch grains, oil globules and prismatic crystalof calcium oxalate.

Pith

Pith is absent and centrally protoxylem is present. Thin-walled parenchymatous cells embedded with plentifulstarch grains, a few laticiferous cells, prismatic crystals in root stock.

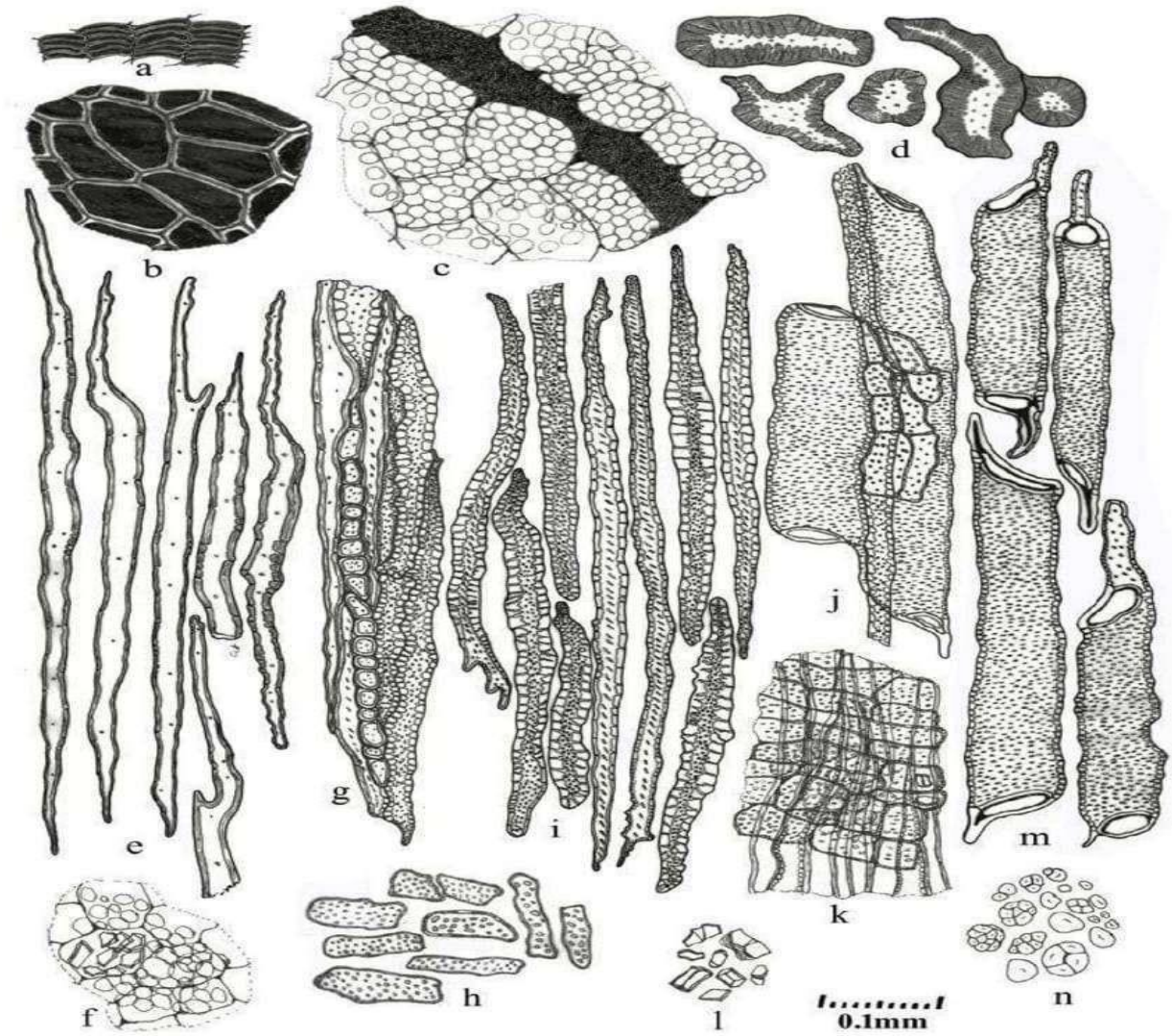


Fig. 6: Powder microscopy of *H. indicus* root and root stock. a) cork cells in sectional view; b) cork cells in surface view; c) fragment of parenchyma cells associated with laticiferous canal; d) stone cells and sclereids; e) thick-walled, wide lumen, sharp end fibres; f) parenchymatous cells embedded with starch grains and prismatic crystals of calcium oxalate; g) tangential longitudinally cut xylem ray associated with fibre and fibre tracheids;

h) lignified xylem parenchyma; i) thick walled fibre tracheids; j) longitudinally cut fragment of fiber tracheid associated with xylem parenchyma and pitted vessels; k) radial longitudinally cut xylem ray crossing with fibre, fibre tracheids and ray cells embedded with starch grains and prismatic crystals of calcium oxalate; l) prismatic crystals of calcium oxalate; m) tailed, simple perforated, pitted vessels; n. starchgrains[19].

Phytochemical studies

H.indicus exists in two form , first one is var. *indicus* and another one is var. *pubescens* although their constituent are same var. *pubescens* contains higher concentration of β-sitosterol and tannins whereasvar. *indicus* contains higher concentration of phenols and free amino acid [1,29].

.**Leaves:**

It possesses 2.5% of tannins, coumarin olignoids hemidesminine, hemidesmin 1, hemidesmin 2 [10]. Leaves of *H.indicus* contain cardiac glycosides, Tanins, Saponins[4].

Stem:

It contains glycosides like hemidine and indicine [10].

Flower:

Flowers of *H. indicus* contains glycosides, hyperoxide, isoquercetin, and rutin, flavonoid[4,10].

Root:

Roots of *H. indicus* are predominant source of several phytoconstituents and their therapeutic values [10].It has been used as a tonic as well as diuretics [5].
It contains hemidesmol, resin and glucoside, tannin and resin, lupeol, β-sitosterol, α- and β-amyrins, lupeol, α-amyrin, lupeol acetate, β-amyrin acetate, hexa-Tricon ate acid, lupeol 1-octacosonal, steroid, terpenoid, flavonoid, and saponin. *H. indicus* contains 80% of crystalline material glucose hemidesmol, 2-hydroxy-4- methoxybenzaldehyde, glucoside, resin acid, sterol, and tannins [10].

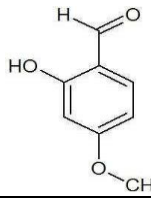
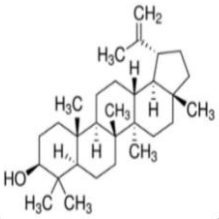
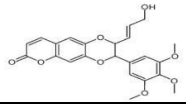
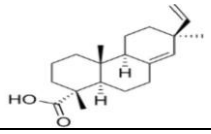
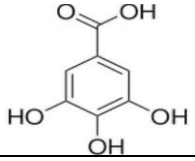
Quantitative evaluation of crude chemical components in *H. indicus* root extract gave the followingresults: Tannin 3.06%, saponin 12.55%, flavonoid 1.12%, alkaloid 1.23%, terpenoid 0.79%, coumarin 0.91% phenol 1.1%, the average amount of lupeol octacosanoate in root powder is 36.5 mg/g. *H.indicus* contains many biologically active compounds, including a new series of coumarino-lignans called hemidesmins, and steroidal glycosides called hemidesmosides A-C[1].

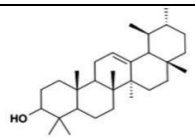
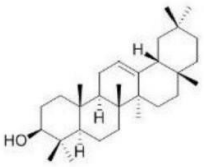
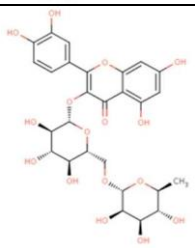
There are no clinical data demonstrating the effectiveness of *H. indicus* root extract in

humans or any specificindication. Extracts and components of *H. indicus* roots have potential antioxidant and antibacterial activities,as shown in Table 3, with many effects observed, e.g., hepatoprotective, cardioprotective, neuroprotective, hypoglycaemic, and anti-inflammatory and anti-diabetic properties, can be explained to a certain extent by theantioxidant properties of the extract. Terpenoids, flavonoids, coumarin lignans, aromatic aldehydes, saponins and other compound have antioxidant effects.

These are shown in **Table 3** together with the other important constituents of the Indicus and their biological activities as below.

Table 3: Chemical constituent and their uses

Class of compound	Name of the compounds	Structure	Biological activity	Ref.
Aromaticaldehydes	2-hydroxy, 4- methoxy benzaldehyde(2H4MB)		Anti- oxidant Anti-fungalAntidiabetic	[14]
Terpenoid	Lupeol		Anti-oxidant Anti-snake venom	[10] [16]
Lignans	Hemidesminine		Anticancerous Cytotoxic Cardioprotective	[1]
	Resin acid		Anti-bacterialAnti-oxidant	[10]
Tannins	tannins		Anti-oxidant Antidiarrheal	[10]
Phytosterols	α-amyrin		Anti-inflammatory Antimicrobial	[10]

				
Phytosterols	β-amyrin		Anti-inflammatory Antimicrobial	[10]
Flavonoid	Rutin		Antioxidant Anti-inflammatory Vasodilatory Antiedema Antiplatelet aggregation activity	[1]

Uses of *Hemidesmus indicus*

- It is used for skin disease, menorrhagia, post-partum recovery, stomach ulcer and gastric ailments, fever,headache, sore mouth.

- Venereal disease including gonorrhea and syphilis, impotence, and as a blood purifier, cooling tonicand appetite stimulant, and to promote health and vitality, neutralize snake bite and scorpion stings [1].

- Traditionally the root of *H. indicus* is considered to be demulscent, diaphoretic, diuretic and tonic. Itis also used in loss of appetite, fever, skin diseases, leucorrhoea, syphilis and rheumatism [2].

- Root has anti-microbial properties and potent anti-inflammatory activity [2].

- The decoction of the roots of *Hemidesmus indicus* is widely used in the traditional medicine for thetreatment of blood diseases, dyspepsia, loss of taste, dyspnea, cough [3].

- *H. indicus* are often used by traditional medical practitioners for the treatment of cancer [5].

- Roots of *H. indicus* has been used as tonic, diuretic and alterative [5].

- In Ayurvedic tradition *H. indicus* is considered effective as an antiarthritic and antirheumatic remedy [7].

Adulterants

Species of *periplocaceae were* used instead of *H. indicus*.
Trivrith shoot and hamiltonii root is used instead of roots [21].

Pharmacological activities of *Hemidesmus indicus*

Hemidesmus indicus, commonly known as **Indian Sarsaparilla** or **Anantmool**, has a long history of traditional use in various systems of medicine, particularly in Ayurveda and traditional Indian medicine. It is believed to possess several medicinal properties, and these properties have been mentioned in numerous articles and texts throughout history, both ancient and modern.

Some of the reported medicinal properties and uses of *Hemidesmus indicus* include:

Antivenom activity

Hemidesmus indicus root extracts effectively neutralized Viper venom induced lethal, haemorrhagic, coagulant, anticoagulant and inflammatory activity [8,9].

Protein binding and enzyme inhibitory properties have been demonstrated in natural chemicals such as sitosterol, pentacycloterpines, nitro compounds (aristolochic acid), cinnamic acid derivatives, curcuminoids, polyphenolic compounds and flavonoids. showed that various secondary metabolites such as phenols, flavonoids, terpenoids, xanthenes and quinonoids masked the different enzymatic activities of cobra venom. These secondary metabolites prevent the different enzymes in snake venom from binding to their potential targets, resulting in an antivenom effect. These active ingredients, such as B. A. Paniculata, give snake venom antivenom properties by altering the function of proteins and enzymes [15,16,24].

Antioxidant activity

The superoxide radical, as a precursor to the more reactive oxygen species is known to be very harmful to cellular components. Hydroxyl radicals are the most reactive species and initiate the peroxidation of cell membranes. The lipid radicals thus generated begin a chain reaction in the presence of oxygen, producing lipid peroxide, which decomposes into aldehydes such as malondialdehyde, which is considered mutagenic and carcinogenic. Plant extract shows inhibition of Fe3+ ADP induced lipid peroxidation and ascorbate systemin liver

imoginate.

It appears that phenylhydrazine can generate various reactive species, including superoxide radical, hydrogen peroxide, hydroxyl radical, and phenyl radical, under aerobic conditions. These reactive species can initiate the peroxidation of unsaturated fatty acids in endogenous membrane phospholipids, potentially affecting red cell membrane structure and function. The mentioned methanolic extract was able to inhibit phenylhydrazine- induced hemolysis of erythrocytes, suggesting its ability to scavenge these free radicals and protect against their damaging effects. This is significant because erythrocyte hemolysis in this modelis caused by the generation of different free radicals [2].

One of the most accepted methods of antioxidant activity is DPPH radical scavenging activity assay.

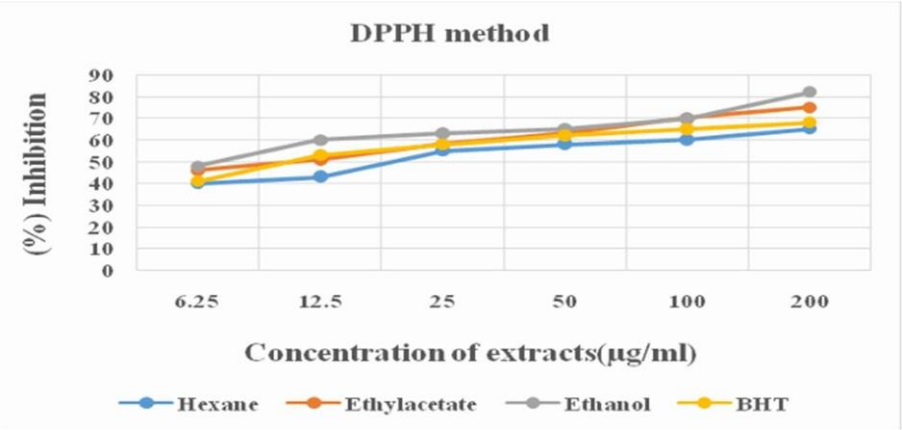


Fig. 7: DPPH method of Antioxidant property of *Hemidesmus indicus* root extracts [11].

Apoptosis activity

H. indicus was found to contain 2-hydroxy-4-methoxybenzaldehyde, 3-hydroxy-4-methoxybenzaldehydeand2-hydroxy-4-methoxy benzoic acid which induces apoptosis [3,25].

Antiresorptive activity

Hemidesmus indicus appears to be a promising candidate due to its antiosteoclastic activity, which is like that of bisphosphonates but without toxic effects. Its high effectiveness at low concentrations suggests its potential as a therapeutic agent. This makes it worth exploring *Hemidesmus indicus* for its therapeutic potential, either as a standalone treatment or in

combination with conventional drugs. Such an approach could potentially improve therapy adherence and have a positive impact on clinical outcomes [19].

Anticancer activity

The aqueous concentrated *Hemidesmus indicus* extract showed anti-genotoxic properties, indicating its potential safety in that regard. Additionally, when root powder suspension was administered to Swiss albino mice for acute toxicity testing, no lethality or noticeable changes in behavior were observed. Moreover, the LD50 (the lethal dose for 50% of the population) for the liver and kidney was significantly higher than the concentrations used in the study, emphasizing its safety.

These findings suggest that *H.I.* could serve as a potential adjuvant to traditional antitumor agents. Previous research has shown that *H.I.* enhances the antileukemia potential of drugs like 6-thioguanine, cytarabine, and methotrexate. It may be worthwhile to explore whether the decoction of *H.I.* can trigger an immunological response when combined with these or other tolerogenic traditional anticancer agents, potentially improving their effectiveness in combination therapy [6,26,27].

Anti-angiogenic effects

It appears that HI shows inhibitory effects. This inhibition was confirmed by examining its impact on post-transcriptional and post-translational modifications of proteins involved in vessel formation. The expression levels of VEGF, VEGFR-2, and HIF-1α were measured using mean fluorescence intensity.

In normoxia (normal oxygen conditions), HI primarily down-regulated VEGF expression in a dose- dependent manner, with the most significant effect at the highest tested concentration. However, in normoxia, *HI* did not have any noticeable impact on the expression of VEGFR-2 and HIF-1α.

In contrast, in hypoxia (low oxygen conditions), HI led to a down-regulation of all three proteins at all tested doses. Notably, the most pronounced effects on VEGFR-2 and HIF-1α were observed when treated with *HI* at a concentration of 0.93 mg/mL, resulting in a 40% reduction in VEGFR-2 and a 17% reduction in HIF-1α expression.

These findings suggest that *HI* has a dose-dependent inhibitory effect on angiogenesis,

particularly under hypoxic conditions [9].

A) Antidiabetic activity

Treatment with 2-hydroxy-4-methoxy benzoic acid resulted in the following effects in rats:

- Increased activity of total ATPases, Na/K ATPase, Mg2+-ATPase, and Ca2+-ATPase.
- Decreased levels of catalase, superoxide dismutase, glutathione peroxidase, and glutathione-S-transferase in erythrocytes.
- Enhanced levels of vitamin E.
- Lower levels of vitamin C and glutathione in both plasma and erythrocytes [14].

Additionally, an active principle called β-amyrin palmitate was identified in root extract and was reported to have the potential for treating diabetes mellitus at low concentrations in diabetic rats induced by alloxan and streptozotocin.

These findings suggest that 2-hydroxy-4-methoxy benzoic acid and β-amyrin palmitate may have potential therapeutic applications in the context of diabetes and oxidative stress [16].

Antiviral activity

Ethanolic extract of *H. indicus* roots showed higher activity against Bacillus megaterium, staphylococcus aureus, pseudomonas aeruginosa and Klebsiella pneumonia (with inhibition zones of 24,22,23 and 26 mm diameter) compared to with other extracts containing hexane and ethyl acetate.

Hexane extract showed minimal activity against Staphylococcus with an inhibition zone of 9. mm.

Ethyl acetate extract has maximum activity against B. magisterium with an inhibition zone of 22 mm and minimal activity against S. staphylococcus aureus with an inhibition zone of 12 mm and moderate activity against P. aeruginosa and K. pneumonia with an inhibition zone of respectively 21 and 16 mm.

Ethanol extract showed maximum activity against Klebsiella pneumonia with a zone of inhibition of 26 mm comparable to the control (ampicillin) with a zone of inhibition of 27 mm diameter. The control (ampicillin) with a concentration of 10 µg/ml had inhibition zones

of 26, 24, 28 and 27 mm for Bacillus megaterium, staphylococcus aureus, pseudomonas aeruginosa and Klebsiella pneumonia, respectively.

Overall, the ethanolic extract of *H. indicus*, containing all studied phytochemicals such as alkaloids, flavonoids, tannins, steroids, and phenols, exhibited higher antibacterial activity than other extracts with hexane and ethyl acetate [11,28].

The anti-biofilm activity of *HI* was evaluated relative to the SEs formed in MTP. SE grown in the presence of *HI* (100–600 mg ml 1) showed a concentration-dependent reduction in biofilm formation.

Spectrophotometric quantification of biofilm formation by SE showed an 80% reduction at 500 mg ml *H. Indicus* [12].

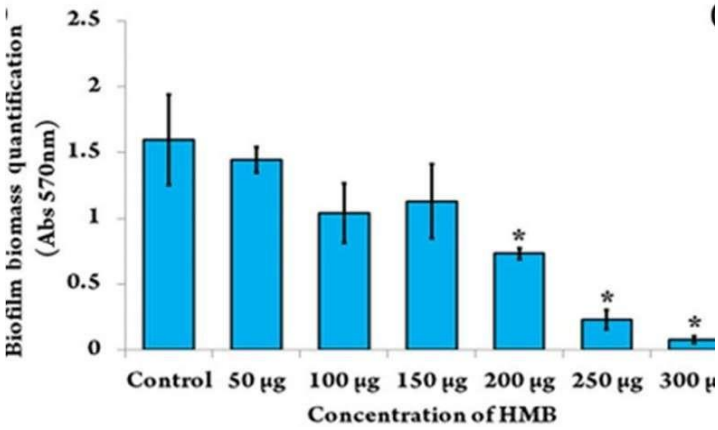


Fig. 8: Inhibition of SE biofilm formation by HMB at increasing concentrations ranging from 50- 300l gml 1. HMB concentrations 250 and 300mgml 1 inhibited almost completely SE biofilm formation [12].

Antiulcer activity

A study on the antiulcer properties of root extracts showed that flowering time extracts had antiulcer properties, resulting in a significant reduction in the formation of gastric and duodenal lesions in rats inducedby pyloric ligation, gastric ulcer caused by aspirin, and gastric ulcer caused by aspirin and cysteamine inducedulcer. Duodenal ulcer. They found a decrease in aggressive factors such as pepsin and proteins and an increasein resistance factors such as pH, hexose, hexosamine, fucose and sialic acid.

Increased hexosamine and carbohydrate/protein ratio and reduced pepsin content, promoting greater mucus secretion and protection against ulcers, comparable to the standard drugs ranitidine and omeprazole. These results suggest that extract can selectively inhibit [18].

CONCLUSION

The review article summarizes the botanical names, taxonomical classification, morphology, traditional uses and pharmacological action of genus *Hemidesmus indicus.* In this study, we have review literature that include traditional uses and pharmacological action like antidiabetic, antivenom, antiresorptive, apoptosis, antibacterial and antioxidant. More clinical trials, however are needed to support its therapeutic uses. Therefore, there remains ample scope for further scientific exploration of to determine their therapeutic efficacy as well as commercial potential.

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