International Journal of Botany Studies
ISSN: 2455-541X; Impact Factor: RJIF 5.12
Received: 21-07-2020; Accepted: 07-08-2020: Published: 21-08-2020
www.botanyjournals.com
Volume 5; Issue 4; 2020; Page No. 224-231

Pharmacognostic and phytochemical studies on *Hemidesmus indicus* and its substitute *Decalepis hamiltonii* – review

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Abstract
Hemidesmus indicus and its substitute *Decalepis hamiltonii* are an important and widely used medicinal plants belongs to family Apocynaceae and majorly contains phyto-constitutes such as hexatriacontane, lupeol, α-amyrin, β-amyrin, 2-Hydroxy-4-methoxybenzaldehyde (2H4MB) and sitosterol. The roots of the drug used as coolant and a blood-purifier in traditional system of medicines having properties like emetic, diuretic, anti-inflammatory, etc. Due to its over exploitation, limitations for natural regeneration the said drug is in the vulnerable in the forests. The roots of *H. indicus* (Sariva) in ayurvedic preparations like Amritamalaka taila, Drakshadi churna, Shatavari rasayana and Yeshtimadhu taila. Serious efforts for high quality studies is required to identify the novel clinical properties of the plant, the identification and isolation of the particular compound responsible for the specific activity.

Keywords: medicinal, phyto-constitutes, drug, *Hemidesmus indicus*

Introduction

Hemidesmus indicus (L.) R. Br. ex Schult.:

Medicinally important and reputed drug *H. indicus* (L.) R. Br. ex Schult. belonging to family Apocynaceae is once again receiving some consideration in the world of Ayurvedic medicine. A climbing plant that grows in central, western and southern parts of India, *H. indicus* was used by the native therapists in India for nephritic complaints, syphilis, and sore mouth (in children). The roots of Sariva in Ayurveda preparations like, Drakshadi churna, Amritamalaka taila, Yeshtimadfvhu taila and Shatavari rasayana (Gokul *et al*., 2020) [19]. *H. indicus* in the presence of alkaloids, flavonoid and Phenols compounds are benefit for human immunity (Malarvizhi and Manoharan, 2019) [35]. Nutan *et al*. (2020) [49] determine the bioactive compounds, physicochemical composition and anti-oxidant activity of *H. indicus*. In 1831, *H. indicus* was introduced into European medicine (Banerji *et al*., 2017) [6]. Nandy *et al*. (2020) [47] stated *H. indicus* is an important role in Ayurveda, traditional Indian medicine and also European medicine. The main pharmacognostic properties are anti-cancer, antioxidant, anti-diabetic, anti-ulcerogenic, hepatoprotective, neuroprotective, cardioprotective, nephroprotective, anti-inflammatory, anti-ophidian, antimicrobial etc. *H. indicus* is an official drug in Indian and British pharmacopoeia. The plant has wide ranging medicinal benefits. The main medicinal properties of the plant are attributed to its roots even though leaf and stem extracts also have medicinal values (Saha *et al*., 2003) [60]. 2-hydroxy-4-methoxy benzaledhyde is a high value flavour product and is expensive. It is often used as a substitute for vanilla in ice creams. It is used as an ingredient in herbal tea preparations (Khanna and Kannabiran, 2008) [26].

Today, *H. indicus* is receiving renewed attention as an Ayurvedic medicinal an herbal product that may have health benefits for blood purification, kidney and urinary disorders, and skin infections (Weissner, 2014 [78]; Mane *et al*., 2017) [37].

The non-availability of the roots of *H. indicus* in bulk quantities as required by drug manufacturers and physicians, the roots of *D. hamiltonii* are used in South India as a substitute for the roots of *H. indicus*. The plant is often adulterated with *Ichnocarpus frutescens* or *Decalepis hamiltonii* (Giridhar *et al*., 2004) [18].

Decalepis hamiltonii Wight &Arn.:

The drug *Decalepis hamiltonii* Wight &Arn. (Family-Apocynaceae) is an endemic and endangered plant of Andhra Pradesh. It is endemic to southern parts of India. Herbal health drinks from its roots are prepared by Yanadi tribe of the area. The plant is a liana, locally called *Maredu kommulu* or *Barre sugnadhi* or *Maredugaddalu* (Telugu). It grows in between the rocks and places where there is thick vegetation. Milky latex is present in the entire plant. Each root is 5-10 cm in diameter and 4-10 roots arise from the rootstock. A. 2-3-year-old plant produce 15-20 kg of roots and one-year old plant produces 1-2 kg of roots (Vedavathy, 2004) [78].

D. hamiltonii tubers are using for edible purposes and food formulations. The *Decalepis hamiltonii* tuberous roots rich in 2-Hydroxy-4-methoxy benzaldehyde and other flavour metabolites in tuberous roots include aromatic alcohols, 4-Methoxy Cinnamic acid derivatives, vanillin, etc. which are known for its edible and medicinal use and have turn into endangered due to commercial over-exploitation (Matam *et al*., 2017) [38].

Hemidesmus indicus and *Decalepis hamiltonii* reveals that the biomass of said drug extensively used in *Ayurvedic* and other medicinal preparations.

Pharmocognostic study of *Hemidesmus indicus*

H. indicus has various medicinal activities and properties varying from chemo-preventive, anti-diarrheal, anti-cancerous, wound healing power, immuno-modulatory activities and antioxidant, anti-venoms, anti-leprotic, diuretic properties etc. (Kotteswari *et al*., 2018) [28]. Malarvizhi and Manoharan (2019) [35] studied *H. indicus*

indicate vital source of anti-oxidant, which is used to avert the oxidative stresses. *H. indicus* is pharmacological potential which can represent a stimulating botanical medicine in the oncological area. The standardized decoction of *H. indicus*, a plant suggesting a complex anticancer activity and explored its inhibition of proteasome activity in human leukaemia cells (Turrini *et al*., 2019) [75].

Nutan *et al*. (2019) [50] investigated the potential bioactive compounds of *H. indicus* has significantly inhibit the growth of colon cancer cells and plant extract can be used as adjuvant medicines in combination with regular chemotherapeutic agents.

Prasad and Wahi (1965) [53]; Deepak *et al*. (1997) [12] have investigated the pharmacognosy properties of root of *H. indicus* such as medidemine, hemisine and desmisine, pregnane oligoglycosides. Kirthikar and Basu (1980) [27] reported *H. indicus* is used as energetic herb for healing several ailments in Ayurvedic drug. This plant stem is used for diaphoretic, laxative, leucoderma, cough, asthma, diuretic as well as in treating brain, liver and kidney diseases, urinary discharges, uterine complaints, syphilis. Saryam *et al*. (2012) [62] stated that the *H. indicus* is used to cure leprosy, itching, skin disease, leucoderma, asthma, leucorrhoea, bronchitis, dysentery, syphilis, piles and paralysis.

Joshi *et al*. (2018) [24] proposed that *H. indicus* modulates the antioxidant in favour of oxidative stress reducing, hypoglycemia and improved the lipid profile in inhibition lipid peroxidation and modulation in superoxide dismutase, catalase, glutathione-S- transferase activity and glutathione content. Jayaram and Dharmesh (2011) [23] stated that the compound of 2- hydroxy-4- methoxy benzoic acid present in *H. indicus* root which is the active constituent used for the antioxidant property. Sayyed *et al*. (2014) [63] stated that *Swertia chirata* and *H. indicus* have been medicinally used in traditional as well as folklore for the treatment of some critical diseases and disorders. Balaji *et al*. (2017) [4] stated that plant of *H. indicus* root drugs used as tonic, diuretic, demulcent, diaphoretic. This drug used in the treatment of syphilis, chronic rheumatism and urinary disorders as well as antibacterial effects. Shalini and Rajan (2015) [64] reported significant of aqueous and ethanol extract of *H. indicus* roots decrease the diarrheal effect by reducing intestinal transit, faecal droppings and intestinal fluid secretion in rats and were observed ethanol extract at 200mg/kg b.w. 75.5% protective effect in faecal score, 51.2% in intestinal dropping and 56.6% for intestinal fluid secretion respectively. Riazunnisa *et al*. (2013) [58] reported that the in vitro antibacterial activity shown the *H. indicus* n-butanolic extracts excellent inhibitory activity against human pathogenic bacterial strains viz. *B. substilis, E. coli, Klebsiella pneumonia, Proteus vulgaris* and *Staphylococcus aureus*. Mookan *et al*. (2000) [42] showed *H. indicus* roots ethanol extract protecting effect against Rifampicin and Isoniazid (INH) stimulates liver toxicity. Extract of 100mg/kg b.w./day, for 15 days were stopped alteration in activities of isocitrate dehydrogenase, succinate dehydrogenase, cytochrome C oxidase, malate dehydrogenase, α ketoglutarate dehydrogenase and NADH dehydrogenase. These effects may be due to the presence of coumarino lignoids viz. hemidesmin-I and hemidesmin-II which has free radical scavenging activity.

Mehmood *et al*. (2016) [39] studied that the bioactive compound 2-Hydroxy-4-methoxybenzaldehyde were showing the antibacterial and antifungal activities. This bioactive compound was highest diameter zone of inhibition against *Staphylococcus aureus*. Lupeol acetate isolated from the root extract of *H. indicus* used by snake poison neutralization (Chatterjee *et al*., 2006) [8]. Sigler *et al*. (2000) [66] isolated heminine and denicunine which are novel pregnane C21 steroidal glycosides from *H. indicus* dried stem. Tabassum *et al*. (2015) [72], *H. indicus* is used for treatment of diabetes, viral, cancer, lithic, hypo-tensive, fungal and bacterial. This plant root which shows that different activity viz. antimicrobial activity, anti-acne activity, anti-enterobacterial activity, activity, natriuretic and saliuretic activity, hepato-protective activity, reno-protective activity, anti-inflammatory activity, anti-arthritic activity, wound healing activity, anti-venom activity, and anti-nociceptive activity. Turrini *et al*. (2018) [76] investigated the ability of *H. indicus* a promising anticancer treatment to hopeful the activation of tumour-reactive adaptive immune responses is emergent as a critical necessity underlying their clinical efficiency. Indicated that the *H. indicus* induces immunogenic cell death in human tumour cells and suggested its potential significance in innovation cancer immunotherapy protocols.

Kundu *et al*. (2012) [30], the root extracts of *H. indicus* roots and *Vanilla planifolia* pods were rich in 4-hydroxy-3-methoxybenzaldehyde (vanillin) have been mostly used as flavours for food preparation, addition with 4-hydroxy-3-methoxybenzaldehyde is known to inhibit the activity of the enzyme acetylcholinesterase, hence these plant-based food flavours can be used for curing neurodegenerative disorders specially the Alzheimer's disease. Anoop and Jegadeesan (2003) [1] stated 2-hydroxy-4-methoxy benzoic acid present in *H. indicus* probably responsible for its antihyperlipidemic action in another in-vivo study in rats. HMBA 200ug/kg/day for 30 days after oral administration of ethanol for 30 days to rats reduced plasma whole cholesterol, lipoproteins, phospholipids, free fatty acids and concentration of plasma lipoprotein lipase was increased.

Nadkarni (1989) and Austin (2008) [44, 3] stated that *H. indicus* used as anti-diarrheal, antipyretic, tonic and refrigerant. Shete and Bodhankar (2010) [65] studied n-butanol fraction from the ethanolic root extract of *H. indicus* significantly enriched memory and learning power in mice. Therefore, in treatment of dementia seen in the Alzheimer's disease and other neurodegenerative disorders used the root extract as a memory recuperative agent. Saponin fraction from the *H. indicus* roots extract showed antimicrobial activity against *Staphylococcus aureus, Klebsiella pneumoniae, Salmonella typhi, Aspergillus flavus, A. niger* and *A. fumigatus* (Khanna and Kannabiran, 2008) [26]. Ratha *et al*. (2012) [55] investigated that *H. indicus* and *Vetiveria zizanoides* plant extracts inhibited growth of the bacterial strains. *H. indicus* and *V. zizanoides* extracts were comparing with the standard *Streptomycin, Ampicillin, penicillin* and antibiotics 100mg/disc. The *H. indicus* and *V. zizanoides* could be used in treating diseases caused by the test organisms. Gayathri and Kannabiran (2009) [16] *H. indicus* root of aqueous extract and *Ficus bengalensis* and *Pterocarpus marspium* plant barks showed antimicrobial activity against *Pseudomonas aeruginosa, Staphylococcus aureus* and *Klebsiella pneumoniae.* Das and Devaraj (2006) [10], glycosides obtained from *H. indicus* inhibited adherence of *Salmonella typhimurium* to host cell and hence reduced

its pathological effect and further, the bacterial surface hydrophobicity also reduced.

H. indicus aqueous root extract used as traditional medicine Jwarhar Mahakashayan an Ayurvedic preparation showed antipyretic-analgesic property with very low toxicity and ulcerogenicity in animal model (Gupta *et al*., 2010) [21]. Sultana *et al.* (2003) [71], ethanol extract of *H. indicus* were reported that application of cumene hydroperoxide showed increase level of antioxidant enzymes and also significant inhibition of cutaneous oxidative stress

Farook *et al*. (2011) [15] studied the treatment with *H. indicus* hydroalcoholic root extract at different doses like 100, 200 and 300 mg/kg b.w., p.o. were significantly formation of granulation tissue and prevented increase in volume of paw edema. At 300 mg/kg b.w greatest effect was observed which comparable to phenylbutazone 100 mg/kg b.w., i.p. and Lakshman *et al*. (2006) [31] also studied in carrageenan induced paw oedema. Methanol roots extract of *H. indicus* showed significant decrease in volume between 2-4 hr after treatment. Sony *et al*. (2013) [67] studied the *H. indicus* and *F. religiosa* combined ethanol extracts of different doses of 100, 200, 400, 800 mg/kg/ body weight orally administrated in albino rats. Resulted good antiulcer activity in the pylorus ligation model and very low significant activity in aspirin induced ulcer model. Madhu *et al*. (2017) [34] studied *H. indicus* roots aqueous extract make again in 2% aqueous tragacanth was dispense orally at a dose 0f 100 mg/kg, 300 mg/kg and 500 mg/kg in rats up to 30 days. The antipsychotic activity was screened by using apomorphine induced stereotyped behaviour and haloperidol induced catalepsy models. Concluded that the extract significantly prevented the stereotyped behaviour induced by apomorphine in rats and also increase the effect of catalepsy induced by haloperidol, thus the extract revealed anti-psychotic activity in experimental rats. Malathi and Maharani (2011) [36] studied that *H. indicus* roots ethanol extract of 100mg/kg and 200mg/kg showed significantly decreased the period of tonic extensor phase and the duration of clonus in pentylenetetrazol and also postictal depression in Maximal Electro Shock method in adult albino rats by used phenobarbitone as standard drug. Henceforth, the ethanol extract possess antiepileptic activity. Arunachalam *et al*. (2019) [2], *H. indicus* root extract can be used as a suitable alternate to treat biofilm arbitrated infection and would be considered in drug preparations to control the bacterial infections.

Nagarajan *et al*. (2001) [46] stated that the *H. indicus* (Indian sarsaparilla) of fragrant roots are used as herbal tea preparations and medicine. Das *et al*. (2003) [11] studied methanolic and aqueous extract of *H. indicus* root significant in albino rats. It was found that aqueous extract increased water absorption, Na+ and K+ from jejunum. Evans *et al*. (2004) [14] also stated that the *H. indicus* root powder or its aqueous extract can be integrated in oral rehydrating salt solution (ORS) towards increasing its anti-diarrheal efficiency by increased the absorption of water, Na+ and K+ from the sac and intestinal motility was unaffected.

Pharmocognostic study of *Decalepis hamiltonii*

Decalepis hamiltonii plant tuberous roots are usually used as a health drink and well known for its pharmaceutical properties (Reddy and Murthy, 2013; Kumar *et al*., 2015) [57, 29]. Murti and Sheshadiri (1941) [43] earlier studies have shown that the roots contain aldehyde, saponins, inositols, amyrins and lupeol as well as volatile compounds such as HMB, 2-phenyl ethyl alcohol, vanillin, benzaldehyde, and others. Imanishi *et al*., (1990) [22] studied that the extract of *D. hamiltonii* plant root has antioxidant, antifungal, antibacterial, insecticidal, cryoprotective, antipyretic, antiulcer, anxiolytic, antidiabetic, chemoprotective, hepatoprotective, and neuroprotective properties.

Chloroform and ethanol extracts of *Decalepis hamiltonii* were reported to possess antifungal activity against *Aspergillus niger* and weak antibacterial activity against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* (Nayar *et al*., 1978) [48]. The essential oil of *D. hamiltonii* was investigated for its antimicrobial activity. The essential oil inhibited the growth of *Escherichia coli*, *Salmonella typhi* and *Saccharomyces warum* (Reddy and Murthy, 2013) [57]. Giridhar *et al*., (2005) [17] reported that the *Decalepis hamiltonii* tubers produce 2- hydroxy 4-methoxy benzaldehyde and triacontanol treatment 2-hydroxy 4-methoxy benzaldehyde production is increased.

Sudha and Seeni (2001) [70] stated that chemical constituents of tuberous roots of *Hemidesmus indicus* and *Decalepis hamiltonii* are broadly used in the traditional system of medicine as a blood purifier. Food industry used as a flavouring agent for the preparation of soft drinks and bakery products. Rajani *et al*., (2016)[54] studied that methonolic extract of plant *Decalepis hamiltonii* different parts were obtained and evaluated for antibacterial activity against test organisms (Bacteria) *viz*; *Escherchia coli*, *Klebsiella pneumonia*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. However resulted *Decalepis hamiltonii* plant extracts were antimicrobial properties that can be used in new drugs for the cure of infectious diseases caused by pathogens. Devi and Latha (2012) [13] reported that the in vitro antibacterial activity of the various extracts of *D. hamiltonii* was studied against *Escherichia coli*, *Klebsiella pneumonia*, *Salmonella typhi*, *Proteus mirabilis*, *Vibrio cholera*, *Shigella sonnie*, *Serritias* sp, *Staphylococcus aureus* and *Bacillus subtilis* used by disc diffusion method. There were *Streptomycin* and *Gentamycin* used by standard reference drugs and solubilizing agent as well as a negative control used as DMSO (Dimethyl sulfoxide). Whereas all total extracts different degrees of antibacterial activity were found but except for aqueous extract.

Kumar *et al*., (2015) [29] studied that anti-diabetic, antimicrobial, antioxidant, chemo protective, anti-inflammatory, cytoprotective, neuroprotective, insecticidal and hepatoprotective properties in *Decalepis hemiltonii* endemic and threatened medicinal plant. Reddy and Murthy (2013) [57] stated that *Decalepis hamiltonii* used in the preparation of herbal drugs *viz*; Drakshadi churna, Amrutamataka taila, Yeshtimadhu taila and Shatavari rasayana. This plant tubers have antipyretic, antimicrobial, antiulcer, antioxidant, antidiabetic, anti-inflammatory, chemoprotective, insecticidal, cytoprotective, hepatoprotective and neuroprotective activities. Roots of *D. hamiltonii* in the pharmacological were used as anti-inflammatory, degenerative diseases including ischemic heart disease, atherosclerosis, ageing, cancer, diabetes mellitus, neurodegenerative and others diseases (Mohan *et al*., 2016) [41].

Nagarajan *et al*., (2001) [46] studied that volatile active compound such as HMB, vanillin, benzaldehyde, 2-phenyl ethyl alcohol, and others compound from *Decalepis*

hamiltonii plant roots. It possesses effective antioxidant properties, antiulcer, anti-inflammatory, antipyretic and gastroprotective activities (Lin *et al*., 1999; Parekh and Chanda, 2006 and Srivastava *et al*., 2013) [33, 51, 68]. Rathi *et al*., (2017) [56] *Decalepis hamiltonii* is a definitively accredited medicinal plant, majority of available reports in this plant pertains to nutraceutical or pharmaceutical significance of this plant, *in vitro* micro-propagation and assessing the insecticidal and antibacterial properties. Thangadurai *et al*., (2004) [74] studied the antimicrobial activity of petroleum ether, benzene, ethyl acetate, methanol extracts and chloroform of *Decalepis hamiltonii* against 15 different food- related microorganisms was evaluated. The suggested that petroleum ether and methanolic extracts used for the bioactivity- guided isolation of novel antimicrobials activity which prevents food spoilage. Kamireddy *et al*. (2018) [25] investigated the neuroprotective efficacy of *Decalepis hamiltonii* tuber extract against 6-Hydroxy dopamine (6-OHDA) induced neurotoxicity and associated effects in *Caenorhabditis elegans*. Further studies used for different two extract such as *D. hamiltonii* fresh tuber extract and *D. hamiltonii* purified 2H4MB fraction and observed that both extract showed significant levels of neuroprotective property against 6-OHDA induced neurotoxicity, which was evident in mitochondrial/dopaminergic function and antioxidant defence mechanism.

Thangadurai *et al*., (2002) [73] studied that the *D. hamiltonii* root inexpensive source of an essential oil rich in antimicrobial compounds against foodborne pathogens. Samydurai and Thangapandian (2012) [61] studied that different parts of *Decalepis hamiltonii* crude extracts of petroleum ether, methanol and aqueous extracts were tested against gastrointestinal pathogenic two gram positive such as *Staphylococcus aureus*, *Bacillus subtilis* and two-gram negative *E. coli*, *Klebsiella pneumoniae* bacteria and *Candida albicans* fungus causes skin disease.

Phytochemical study of *Hemidesmus indicus*

Phytoconstituents of *H. indicus* roots revealed the presence of terpenoids, flavonoids, phenols and about 40 different phytochemical compositions by using LC-MS analysis (Joshi *et al*., 2018) [24]. Nandy *et al*. (2020) [47] revealed the phytochemical compound of the *H. indicus* root such as phenolics, aromatic aldehydes and their derivatives, triterpenoids and many other compounds. The phytochemical screening of the *H. indicus* leaf extracts is the presence of carbohydrates, tannins, alkaloids, flavonoids, steroids, glycosides (Riazunnisa *et al*., 2013) [58]. Balaji *et al*. (2017) [4] stated that the root of *H. indicus* significant phytochemicals such as flavonoids, steroids, phenols, alkaloids and tannins that are therapeutically important. Sayyed *et al*. (2014) [63] investigated that the carbohydrates, glycosides, alkaloids, phenols, flavonoids and tannins presence in *Swertia chirata* and *H. indicus*. Khanna and Kanabiran, (2008) [26] stated that the phytochemical analysis of *H. indicus* plant presence of different chemical compound viz. saponins, flavanoids, terpenoids, tannins, cardiac glycosides, sapogenins, phytosterols, cardenolides, carbohydrates, proteins, phenolic compounds and volatile oils. Malarvizhi and Manoharan (2019) [35] studied qualitative phytochemical analysis of *H. indicus* were presence of phenols, glycosides, flavonoids, steroids, oils and saponnis absent. In tissue culture plant and wild plant of *H. indicus* and *D. hamiltonii* are produced equal amounts of 2-hydroxy-4-methoxy benzaldehyde (Giridhar *et al*., 2004) [18]. *H. indicus* is a rich source of secondary metabolites viz. flavonoids, pregnane glycosides and 2-hydroxy-4-methoxybenzaldehyde (Subramanian and Nair 1968; Nagarajan and Rao, 2003) [69, 45]. Ratha *et al*. (2012) [55] reported that preliminary phytochemical analysis such as alkaloids, flavonoids, amino acid, tannins and saponins from *H. indicus* and *Vetiveria zizanoides* plants. Sigler *et al*. (2000) [66] investigated two novel pregnane glycosides such as denicunine and heminine from *H. indicus* plant dried stem. Nagarajan *et al*. (2001) [46] obtained volatiles compound from fragrant roots of *H. indicus* by steam distillation including 2-hydroxy-4-methoxybenzaldehyde and ledol. Cherku *et al*. (2016) [9] reported that qualitative and quantitative analysis of the *H. indicus* roots of an elite ecotype were carried out for estimation of secondary metabolites. By using HPLC method the quantity of 2-hydroxy-4-methoxybenzaldehyde and lupeol in the plant material were detected as 0.2638 mg/g and 0.1994 mg/g respectively.

Mishra *et al*. (2018) [40] concluded that *H. indicus* possesses phytochemical compounds responsible for its anti-oxidant and choleretic activity. The highest amount of phytochemicals showed in the root extract as compared leaf and stem. Presence of many different phyto-constitutes of plant viz., alkaloids, tannins, flavonoids, saponins, terpenoids, carbohydrate, glycosides, proteins, flavonone, flavone, and flavonol, polyphenolic contents, as well as hydrogen peroxide scavenging activity. Saryam *et al*. (2012) [62] investigated the Physico-chemical and preliminary phytochemical screening of *H. indicus* root and present of alkaloids, carbohydrates, glycosides, steroids, saponins, terpenoids and polyphenol. *H. indicus* root ethanol and aqueous extracts used for the thin layer chromatography (TLC) were found the three Rf value (0.78, 0.71 & 0.38) and two Rf value (0.75 & 0.51) respectively.

Gupta *et al*. (1992) [20] studied the ethanol extract of the stem of *H. indicus* give a new triterpene lactone, characterized as 3-keto-lup-12-ene-21-+28-olide. Additional, first time chemical compound isolated from this plant viz., A'z-dehydrolupanyl-3fiacetate, A"-dehydrolupeol acetate, lupanone, hexadecanoic acid, 3-hydroxy-4- methoxybenzaldehyde and 4-hydroxy-3-methoxybenzaldehyde. Roy *et al*. (2002) [59] isolated chemical compound from *H. indicus* roots viz., acyclic triterpenic acid; acyclic diterpenic ester and monocyclic sesterterpene ester. Nutan *et al*. (2020) [49] determine the physicochemical composition, bioactive compounds and antioxidant activity of *H. indicus.* The plant roots extracted with ethyl acetate, petroleum ether and methanol and discovered flavonoid and phenolic compounds. Further phytochemical compound isolation was carried out and isolated Lupeol.

Phytochemical study of *Decalepis hamiltonii*

A number of phytochemical compounds have been isolated from *Decalepis hamiltonii*; of these, 2-hydroxy-4-methoxy benzaldehyde (HMB) is rich aromatic bioactive compound with greater biological importance (Kumar *et al*., 2015; Reddy and Murthy, 2013) [29, 57]. Rajani *et al*., (2016) [54] investigated that phytochemical constituents of the root, leaf and stem extracts of *Decalepis hamiltonii*. The presences of phytochemical constituents are alkaloids, flavonoids,

phenols, steroids, tannins, terpenoids, saponins and glycosides. Devi and Latha (2012) [13] screened were phytochemically presence of secondary metabolites in the various root extracts of *Decalepis hamiltonii.*

Mohan *et al*., (2016) [41] studied that qualitative and quantitative of various phyto-constituents *viz*; alkaloids, flavonoids, phenols, steroids and terpenoids. By GC-MS quantitative analysis of flavonoids and phenols were also carried out. In addition, 14-amino tetradecanoic acid, 4-hydroxyisopthalic acid, 4-(1-hydroxy-1-methylethyl)-1-methyl-1,2-cyclohexanediol, 2,4,8-trihydroxy bicycle (3.2.1) octan-3-one, 2-(hydroxymethyl)-3-ethoxy benzaldehyde, bis-2,3,4,6-galloyl-α/β-D-glucopyranoside, ellagic acid and borneol have been identified in *Decalipes hamiltonii* according to Boonchird and Flegel (1982) and Laxmi *et al*., (2011) [7, 32]. Pradeep *et al*. (2019) [52] studied *D. hamiltonii* of different habitat and explore the influence on total phenolics, flavonoids, flavour compound 2-hydroxy-4-methoxy benzaldehyde (2H4MB) and antioxidant potential of tubers. Samydurai and Thangapandian (2012) [61] studied that phytochemical analysis of the different parts of *Decalepis hamiltonii crude* extracts of petroleum ether, methanol and aqueous extracts revealed the presence of tannins, saponins, phlobatannins, flavonoids, terpenoids, steroids, cardiac glycosides and reducing sugar in this investigated plant. But phlobatannins were absent in methanol extract of the root.

Conclusion

Hemidesmus indicus is a significant medicinal plant and widely used in Ayurvedic and Unani system of medicine. The phyto-chemistry and pharmacology of *H. indicus* and its substitute *D. hamiltonii* has been extensively investigated but the studies on toxicology of the extracts of the plant parts in different solvents are very few. Evidence from the above literature shows that the plant possess anti-inflammatory, antidiarrheal, analgesic, antigenotoxic, antipyretic, antiacne, anticonvulsant, antioxidant, antiarthritic, antiepileptic, antivenom, antileprotic, antipsychotic, antinociceptive, antiangiogenic, wound healing, antiulcer, antithrombotic, anticarcinogenic, antimicrobial activities, hepatoprotective, nephroprotective etc. This review collects a list of Ayurvedic preparations and commercial provisions where *H. indicus* and *D. hamiltonii* has been used as an active constituent. Serious efforts for high quality studies is required to identify the novel clinical properties of the plant, the identification and isolation of the particular compound responsible for the specific activity. Further, the pharmacokinetics and bioavailability studies of this plant are very much urgent and necessary to fully understand the mode of action of the potential bioactive molecules for development of new drugs in future.

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