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Dendrophthoe falcata (L.f) Ettingsh: A Consensus Review

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ABSTRACT

Herbal medicine is used by up to 80% of the population in developing countries. *Dendrophthoe falcata* (L.f) Ettingsh is a popular hemiparasitic plant and is used in folklore medicine for ailments including ulcers, asthma, importence, paralysis, skin diseases, menstrual troubles, pulmonary tuberculosis and wounds. Scientific evidence suggests its versatile biological functions such as it's potentiality in immunomodulation, reducing the tumor volume, male contraception, urolithiasis and wound healing. A comprehensive account of the morphology, tissue culture, phytochemical constituents, ethnobotany and biological activities, are included in view of the recent findings of importance on the plant, *Dendrophthoe falcata*.

Key words: *Dendrophthoe falcata*, hemiparasite plant, tissue culture, anti-tumor, review.

INTRODUCTION

A world health organization survey indicated that about 70 – 80% of the world's populations rely on non-conventional medicine, mainly of herbal sources, in their primary healthcare. This is especially the case in developing countries where the cost of consulting a western style doctor and the price of medication are beyond the means of most people (1,2). There has been an explosion of scientific information concerning plants, crude plant extracts and various substances from plants as medicinal agents during last 20 – 30 years. Although herbal medicine has existed since the dawn of time, our knowledge of how plants actually affect human physiology remains largely unexplored. Numbers of plants are claiming various medicinal uses and many researches are going on in this view.

Among them parasitic plants are well known. One can categorize parasitic plants according to their evolutionary relationships or according to their nutritional mode. Among the various unrelated families of parasitic plants, two basic types of parasitism exist: hemi parasites and holo parasites. Hemi parasites are chlorophyllus and photosynthetic (at least during some portion of the life cycle) yet they obtain water and nutrients via haustorial connections to the host plant. Hemi parasites can be further divided into two types, facultative and obligate, depending upon their degree of dependence upon the host. Facultative hemiparasites do not require a host to complete their life cycle but are photosynthetic and, when presented with host roots, invariably form haustorial connections. When attached to host roots, these parasites extract water and dissolved minerals via direct, cell-to-cell connections to the xylem. Facultative hemiparasites can be found in several root-parasitic families. Obligate parasites require host plant through out its life. Obligate parasites are again of two type primitive parasites and advanced parasite. *Dendrophthoe falcata* (L.f) Ettingsh, belonging to family Loranthaceae is a primitive subtype obligate parasite. This is a chlorophyllous, photosynthetic, stem parasite and xylem feeder only (3).

Hemiparasitic mistletoes of the Loranthaceae tap the xylem vessels of their hosts to obtain water and minerals but produce, to at least a certain extent, their own supply of assimilate (4, 5). Trees that carried a greater number of mistletoe plants in the branch showed a reduction in diameter and growth. The development of mistletoe plants on the host tree is a dynamic process which necessarily leads to the death of the host tree. The whole process may last for a decade or so. Mistletoes, considered to be hemiparasites, infect trees by tapping into the host xylem to gain access to water and nutrients. Often, mistletoes have higher nutrient concentrations than their host (6, 7). Basal epicortical roots formed secondary haustorial connections to the host and initiated new shoots. Additional evidence that host tissue proliferation may be involved in development of the solitary union comes from the mounds of host tissue that form in some species at sites of secondary haustoria (Fig 1). These contact areas where *Dendrophthoe falcata* penetrate host branches are considered secondary because they develop away from the site of initial infection (8).

There are 20 different species belonging to the genus *Dendrophthoe* found all over the world, seven of which are found in India. The hemiparasite, *Dendrophthoe falcata* (L. f.) Ettingsh is one of the seven species present in India. Hemiparasites have been reported to exist on more than 300 host plants (9). They are also known as potential pests, due to the severe damage which they cause to many economically important plants.

In this review, a comprehensive account of morphology, tissue culture, phytochemistry, ehthnomedicinal uses and pharmacological activities are included in view of the many recent findings of importance on this plant.

Hierarchy of *Dendrophthoe falcata* (L.f.) Ettingsh

Kingdom - *Plantae*

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Phylum - *Angiosperms*
Class - *Mognolitae*
Sub class - *Rosidae*
Order - *Santalales*
Family - *Loranthaceae*
Genus - *Dendrophthoe*
Species - *falcata*

Vernacular Names (10, 11, 12)

English – Loranthus
Sanskrit – Vando
Hindi – Banda
Bengali – Baramanda
Tamil – Pulluri
Gujurati – Vando
Punjabi – Banda
Telugu – Badanika, Jiddu
Oriya – Bridhango
Kondha – Vahulia banda

GROWTH & DISTRIBUTION

Dendrophthoe falcata (L.f.) Ettingsh is a perennial climbing woody parasitic plant. It is indigenous to tropical regions especially in india, Srilanka, Thailand, China, Australia, Bangladesh, Malayasia and Myanmar. In India it is widely distributed through out upto 900 m (12, 13, 14).

MORPHOLOGY

It is Evergreen shrubs, usually aerial hemiparasitic or other seed plants; stems much branched, often jointed. Leaves 7.6 – 25.4 cm long and 1.3—12.7 cm wide, alternate or sub opposite, petioles flattened above and rounded beneath, inflorescence racemose and spicate ,sub umbellate, sometimes pubescent. Flowers 2.5 – 10.2 cm long, brightly colored (red - orange), regular and bisexual, bracteates often 2 or more bracteoles, Stamens are many, Anthers basified or dorsifixed, ovary inferior and single celled usually without distinct planate, style short or long, stigma simple. Fruit a 1-seeded berry or drupe with fleshy pericarp and often viscid mesocarp. Seed solitary, without distinct testa, albumen fleshy, and about 1.3cm in diameter (Fig. 2) (11, 12).

TISSUE CULTURE

In-vitro culture of parasitic plants is important for many reasons. Morphological studies can be done on the endophytic system, various host-parasite relationships (mechanism, physiology, biochemistry, signals and receptors) can be examined, and physiological studies leading to the control of the more destructive parasitic plants can be investigated. Secondary metabolite production (i.e., cancer drugs) can be studied, along with the micropropagation and genetic improvement of plants with commercial value. In tissue culture, explants taken from parasitic plants may produce callus, shoots, roots, seedlings, somatic embryos, haustoria, and floral buds. Explants or callus have been used to derive cell suspensions and protoplasts. Regenerated plants can be obtained from somatic embryos or shoots developing from callus (Fig. 3). The various tissue culture media that have been used are, B5 (15), Basal medium, C1 (16), Hoagland's solution, Harvey's medium (17,18), K medium (MS salts + B5 vitamines) (19, 15), Knop's medium (20), Linsmaier and Skoog medium (21), with White's medium being the most widely used for all families of parasitic plants.

Most mistletoes (largely shoot hemiparasites) occur in tropical and subtropical climates worldwide and attack hardwood forest trees, shade trees, and gymnosperms (juniper, cypress) as well as coffee, cacao, rubber, apple, cherry, and citrus (22). Although mistletoes are very destructive, little is known about their growth, physiology, or aspects of the host-parasite relationship (23). During seed germination, a radicle emerges which attaches to the host and produces a pad (holdfast) (Fig. 4) from which the endophyte that penetrates the host is produced. The plumule (embryonic shoot) emerges from between the two cotyledons (23). The dependency of the parasite on host stimulus for seed germination and the chemical factors initiating haustorium formation were studied in tissue culture (24).

Dendrophthoe is a stem hemiparasite on teak, mango, citrus, custard apple, eucalyptus, apple, peach, and guava in India (25). The nutritional requirements for parasite growth and induction of polyembryony (26) and factors promoting embryo development were studied to elucidate the physiology and nature of the host-parasite relationship (27). Undifferentiated and embryogenic callus, embryoids, buds (shoot, floral), and seedlings with holdfasts and haustorial discs developed on White's medium. Haustorial formation was induced by adjusting the ratio of cytokinin to auxin, and high cytokinin (low auxin) resulted in shoots and low cytokinin (high auxin) resulted in development of haustoria (28).

In vitro culture of endosperm of *Dendrophthoe falcata* on medium supplemented with various auxins (Indole-3-acetic acid, Indole-3-butyric acid, Naphthalene-1-acetic acid and 2,9,-Dichlorophenoxyacetic acid), cytokinins (6- furfurylaminopurine, 6-benzylaminopurine and adenine) and casein hydrolysate, resulted in the formation of a number of shoot buds. The buds develop either by division of epidermal cells or from callus formed from epidermal cells (29).

Karunaichamy *et al* (4) in 1999, worked on biomas and nutrient and nutrient dynamics of mistletoe (*Dendrophthoe falcata*) and neem (*Azadirachta indica*) seedlings. Growth and tissue concentration of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) were measured for *Dendrophthoe falcata* (L.f.) Ettingsh., which is the hemiparasitic mistletoe growing on its host *Azadirachta indica* seedlings, or neem seedlings. The shoot length and root length of the host seedlings were significantly reduced ($P < 0.05$) after mistletoe infection. Biomass of the infected *A. indica* seedling components (leaves, stem and root) was also significantly ($P < 0.05$) reduced. Mineral nutrient concentrations of N, P, K, Mg and Na were significantly higher ($P < 0.05$) in mistletoe leaves than in the leaves of both uninfected and infected host, whereas Ca concentration in mistletoe leaves was significantly higher ($P < 0.05$) than in the leaves of its host. Continued mistletoe growth kills the host and the mistletoe as well.

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Table 1: Flavonoids from Dendrophthoe falcata parasitic on different hosts

Host plant	Flavonoids identified
Murraya koeinii (Rutaceae)	Quercetin, kaempferol, queretagetin, quercitrin, hyperoside (quercetin- 3-O galactoside), and acyl xylosideof quercetin
Nerium indicum (Apocyanaceae)	Quercetin, myricetin, quercitrin, myricitrin (myricetin-3-O-α-L rhamnoside), meratin
Punica granatum (Punicaceae)	Quercetin, myricetin, quercitrin, hyperoside and acyl xylosideof quercetin
Mangifera indica (Anacardiaceae)	Quercetin, kaempferol, quercitrin and rutin
Scolopia cremata (Bixaceae)	Quercetin, kaempferol, quercitrin, hyperoside and rutin
Albizzia lebbeck (Fabaceae)	Quercetin, kaempferol, quercitrin, hyperoside and acyl xylosideof quercetin

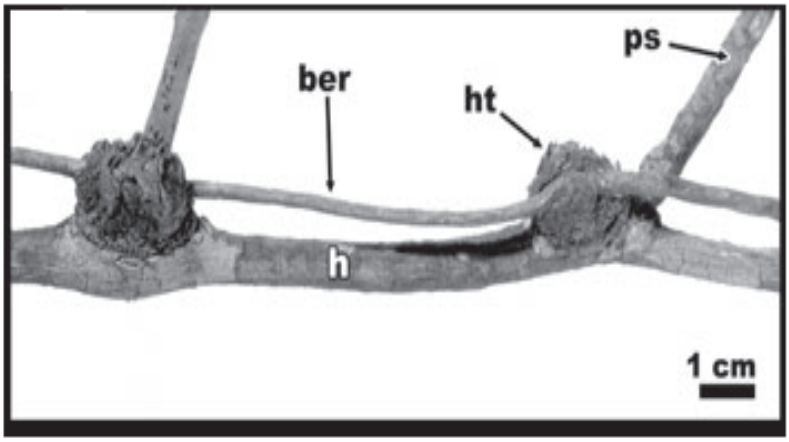

Figure 1: Basal epicortical root of Dendrophthoe falcata showing secondary haustorial attachments, parasite shoots and proliferation of host tissue. ber: basal epicortical root, ht: host tissues, ps: parasite stem

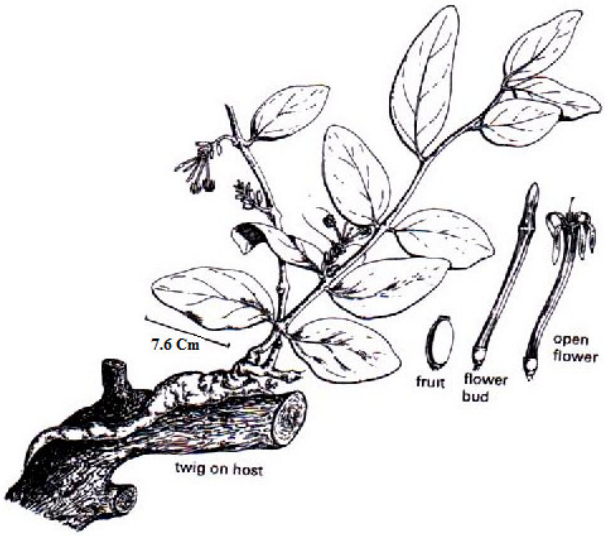

Figure 2: Different parts of Dendrophthoe falcata.

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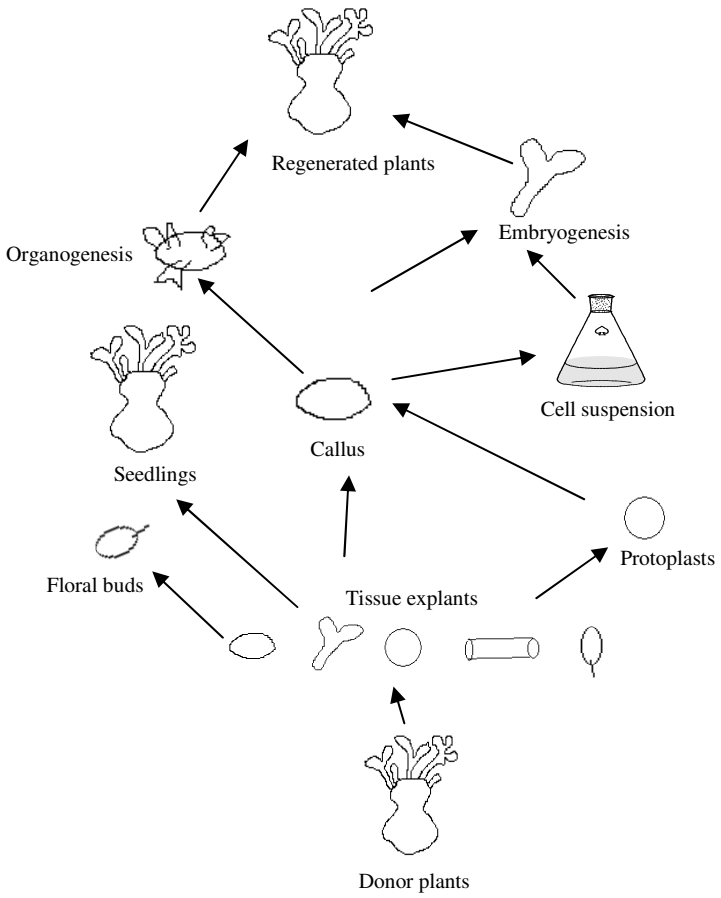

Figure 3: Potential response of parasitic plants to tissue culture conditions

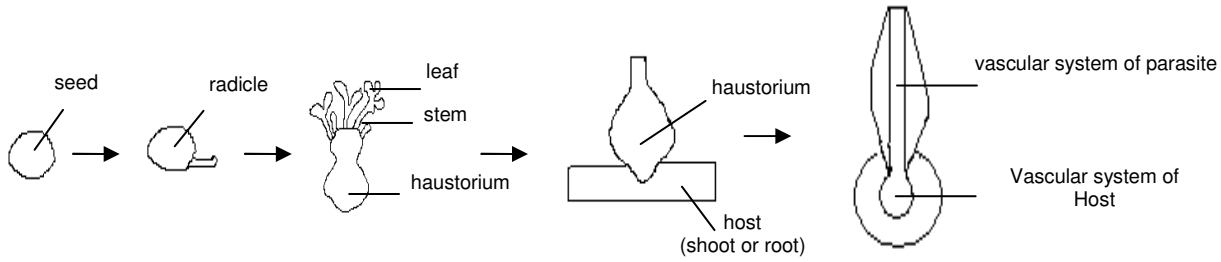

Figure 4: Schematic representation of parasite seed germination and parasite-host interactions for Dendrophthoe falcata.

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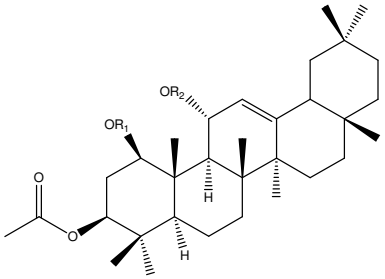
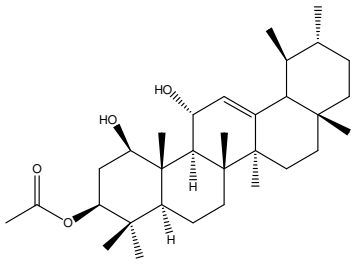
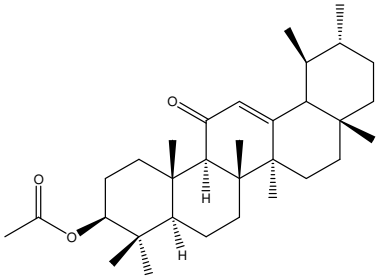


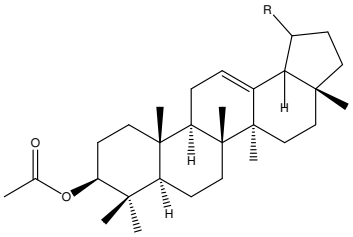
I; $R_1 = C(CH_3)_2OH$, $R_2 = H$
II; $R_1 = H$, $R_2 = Et$
III; $R_1 = H$, $R_2 = Me$
IV; $R_1 = R_2 = H$



V

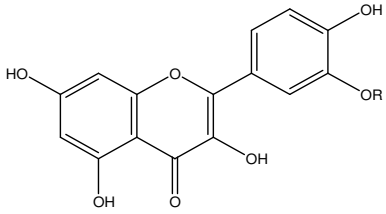


VI

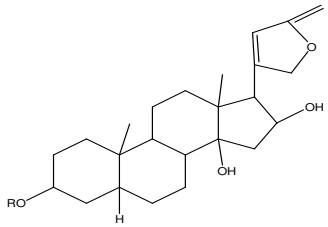


VII; $R = C(=CH_2)CH_3$
VIII; $R = COCH_3$
IX; $R = CH(CH_3)COOH$

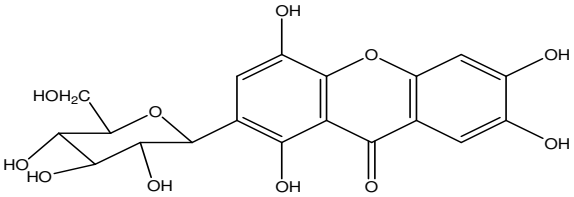
Figure 5*: Structures of the triterpenes isolated from D. falcata; I = 3β -acetoxy-1β -(2- hydroxy-2-propoxy)-11α -hydroxy-olean-12-ene; II = 3 β -acetoxy-11 α -ethoxy-1β -hydroxy-olean- 2-ene; III = 3 β-acetoxy-1β -hydroxy-11α -methoxy-olean-12-ene; IV = 3β-acetoxy-1β,11α- dihydroxy-olean-12-ene; V = 3β-acetoxy-1β,11α-dihydroxy-urs-12-ene; VI = 3β-acetoxy-urs-12-ene-11-one; VII = 3β-acetoxy-lup-20(29)-ene; VIII = 30-nor-lup-3β -acetoxy-20-one; IX = (20S)-3β-acetoxy-lupan-29-oic acid.*



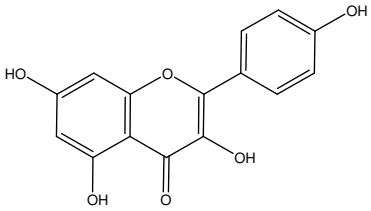
Rutin; R = rhamno-glucosyl



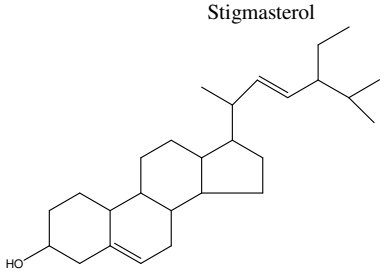
Strospeside; R = 6-deoxy-3-O-methyl-D-galactose
Odoroside; R = β-D-Glucosyl-D-(3-O-methyl)glucose



Mangiferin



Stigmasterol



Kaempferol

Figure 6: Structures of the compounds isolated from Dendrophthoe falcata*.*

PHYTOCHEMISTRY

Work is done by many scientists in the field of phytochemical investigation of the plant (Fig. 5 & 6). The reported chemical examination of *D. falcata* growing on *Terminali tomentosa* has revealed the presence of gallic, ellagic and chebulinic acid (30). The bark of *D. falcata* has yielded (+) – catechin and leucocyanidin (31). Different flavonoids were isolated from *D. falcata* parasitic on six different host plants (Table 1). Quercitrin (Quercitin - 3 - O - Rhamnoside) was found to be the major common constituent in *D. falcata* on different host plants (13, 32). These points, to the relevance of quercitrin as a taxonomic 'marker' of the species.

Extensive chromatographic screening of extracts of the fruits of the Indian Ayurvedic plant, *Dendrophthoe falcata*, resulted in the isolation of some triterpenes, 3ß -acetoxy-1ß -(2-hydroxy-2-propoxy)-11α-hydroxyolean-12-ene(**I**), 3ß -acetoxy-11α-ethoxy-1ß-hydroxy-olean-12-ene(**II**), 3ß-acetoxy-1ß-hydroxy-11α-methoxyolean-12-ene(**III**), 3ß-acetoxy-1ß,11α-dihydroxy-olean-12-ene(**IV**), 3ß-acetoxy-1ß,11α-dihydroxy-urs-12-ene(**V**), 3ß-acetoxy-urs-12-ene-11-one(**VI**), 3ß-acetoxy-lup-20-ene(**VII**), 30-nor-lup-3ß-acetoxy-20-one(**VIII**), (20S)-3ß-acetoxy-lupan-29-oic acid(**IX**) (33).

Isolation of three cardiac glycosides, *viz.* strospeside, odoroside F and neritaloside, are reported from the leaves of *D. falcata* growing on *Nerium oleander*(34). Oleanolic acid, its acetate and methyl ester acetate, b -sitosterol, and stigmasterol are reported to be present in the stems of *D. falcata* growing on *Mangifera indica* (35).

The enzyme hexokinase was isolated from the leaves of *Dendrophthoe falcata* optimum *p*H for the enzyme was 8.5. The enzyme was sensitive to pCMB and the inhibition could be reversed by 2-mercaptoethanol. The optimum temperature was 40^0 C and energy of activation 6900 cal/mol. The enzyme had an absolute requirement for a divalent metal ion. Although Mg^{2+} was the preferred metal, it could be partially replaced by Mn^{2+} and Ca^{2+}. ATP was the most effective phosphoryl donor. Glucose was the best substrate, the K_m values of 0.14 and 0.26 mM were obtained at saturated and sub-saturated ATP concentration (36). The sugar substrate specificity for loranthus enzyme was quite broad. The activity with 2-deoxy-glucose and glucosamine indicates that modifications on position 2 of glucose is non-critical Ribose and xylose, both five carbon sugars, can also be phosphorylated by the enzyme, although poorly compared to glucose. This together with the fact that glucose-6-phosphate is not inhibitory could be interpreted that the C-6 of glucose is not necessary for hexokinase activity of Loranthus (37). Phosphorylation coefficients show the following order of reactivity of sugars: glucose > mannose > 2deoxy o-glucose > fructose > glucosamine > galactose > ribose. The K_m value for ATP was 0.16 mM, which increased to 0.35 mM in the presence of 0.5 mM ADP. ADP and 5-AMP were competitive inhibitors with respect to ATP, and K_f values were 0.4 and 1.2 mM respectively (36). Except that other enzymes such as L-Threonine dehydratase, and Glucan phosphatase were also reported to be present in the plant (38,39).

D. falcata sample obtained from a host, *Mangifera indica*, contained mangiferin, a C-glucosyl xanthone, and some unidentified flavonoids was confirmed by HPTLC flavonoid patterns. The data indicated that the hosts significantly affected total phenolics and total flavonoids in a hemiparasite. This was the first report of transfer of mangiferin from *M. indica* to the hemiparasite. Further investigations reported on the possible role of transferred phenolics either as mediators of host defense, host defense compounds utilized as cues of identification of the host by the hemiparasite or compounds taken up by the parasites to support their defense against rejection by the hosts (40).

Inhibition of glucan phosphorylase in the leaves of *Dendrophthoe falcata*

The activity of α-glucan phosphorylase was very low in the leaves of *Dendrophthoe fulcata* infecting *Mangifera indica*. On mixing a homogenate of the parasite leaves with a standard source of glucan phosphorylase, the activity of the latter was powerfully inhibited, suggesting the presence of inhibitor(s) in the former. The inhibitor(s) was present in the parasite growing on all trees examined and was identified as phenolic. Maximal enzyme activity and simultaneous solubilization were achieved by developing a novel technique of grinding the parasite tissue in two stages with different media. The first stage was aimed at preferential solubilization of phenolics, with minimum solubilization of enzyme or protein and was effected with an 'elimination medium' made up of Tris-cysteine-EDTA. In the second stage, the tissue residue was ground with an 'extraction medium' made up of Tris-cysteine-EDTA-Triton X-100, which resulted in solubilizing 85 percent of the enzyme activity and 60 percent of tissue protein (41). Some general inhibitors of phosphorylase in crude biological systems are vacuolar acids, phytic acid and tannin (42,43,44) and phenolic compound as the likely inhibitors (41).

Therapeutic Uses as depicted by Ethnobotanical Studies

It is interesting to note that the medicinal properties of this parasitic plant are greatly influenced by the host plant. For example, when grown on *Calotropis gigantea*, this parasitic plant is considered useful for improving cognitive function. However, when *D. falcata* is grown on *Tamarindus indicus*, it is used to treat impotence (45) and the plant grown on *Shorea robusta* (Sal tree) is used to treat paralysis by the tribes of the Bihar state of India (46). In addition to its medicinal value, the fruit of *D. falcata* tastes sweet and is consumed as a food (12). The entire plant is medicinally important and is used extensively in traditional medicine as an aphrodisiac, astringent, narcotic, diuretic, and for the treatment of asthma, wounds, ulcer and pulmonary tuberculosis (47).

Leaf paste is used in skin diseases and also taken for abortion (48,49). Leaf paste of *D. falcata* with *Urtica doica* (Sisnu) are used to treat bone fractures (50). Bark juice/decoction is employed for menstrual problems and asthma (51,52,53,54) and paste is applied on boils, extracting pus and setting dislocated bones (55). Fruit is taken as flavor, edible (56,57,58), paste is applied on fractures (59,60) and other medicinal purposes (61). Nectar is food for Hair Crested Drungo and Sunbirds (62).

Biological Activities

Anti-lithiatic and diuretic activity - Aqueous and alcoholic

extracts of the plant were tested in rats for their anti-lithiatic and diuretic activities. Significant increase in the volume of urine and excretion of Na^+, K^+ and Cl^- was recorded when aqueous extract was administered. Alcohol extract was found to be more effective than aqueous extract. Significant decrease in the weight of magnesium ammonium phosphate stones was observed after treatment with the alcoholic extract in rats with urolithiasis induced by implantation of Zn disc in urinary bladder (63).

Cytotoxic and Immunomodulatory activities of Loranthus extract

The extract prepared from a species of Loranthas syn. *Dendrophthoe falcata* grown on the host tree *Mangifera indica* has found to have Cytotoxic and tumor reducing prpperty. Administration of the extract Balb/c mice was found to increase the total number of WBC and polymorphonuclear leukocytes. The injection of Loranthus extract also enhanced the antibody forming cells and the antibody titers (64).

Anti-tumor activity on 7,12- Dimethylbenz[a]anthracene-induced rat mammary tumor model

The aqueous extract was prepared from the leaves of a hemi-parasitic plant *D. falcata*, growing on the host plant *Shorea rubasta*, and its anti tumor activity was evaluated on 7,12-Dimethylbenz[a]anthracene(DMBA)-induced rat mammary tumor model. Wister female albino rats (50days old 100-150 gm at the start of experiment) were orally intubated 7,12-dimethylbenz[a]anthracene with a single dose of 50mg/kg . Tumor sizes were determined by palpation, comparing the volume of each tumor to that of preformed plasticine models. After 12 weeks of induction, the total weight of tumor were calculated assuming a density of 1gm/ml, were randomly divided into four groups of six animal in each having suitable tumors (2-6 mg. wt.) and treated with control (0.3% w/v Na CMC), treatment (400 mg/kg of aqueous extract of *Denrophthoe falcata*) and standard (50 µg/day of tamoxifen) for three weeks. The tumor reducing property was assessed by calculating the reduction in tumor size and finally, histopathology of the breast tumor tissue was also assessed. The aqueous extract of *D. falcata* revealed 24.934% reducing the tumor size at the dose level of 400mg/kg, but its tumor reducing activity is less than that of standard and drug tamoxifen which exhibited the reduction of 62.865%. Results of histopathological studies of breast tumor tissue, showed cellular sheets of poorly diffentiated adenocarcinoma cells. The results obtained that, *D. falcata* could be a source for anticancer drugs (65).

Male contraceptive activity

Adult proven fertile male rats were gavaged methanol extract of *D. falcata* stem at 50, 100 and 200 mg/rat/day for 60 days. The activity was compared with standard drug, i.e. Lonidamine. On day 61 the animals were autopsied and the testes, epididymides, seminal vesicle and ventral prostate were dissected out and weighed. Sperm motility and density and serum testosterone level were assessed. The sperm motility and density were significantly reduced. Animals treated with *D. falcata* methanol stem extract showed a remarkable depression of spermatogenesis which is primarily attributed by decreased testicular weight and reduced seminiferous tubular diameter, which may be due to wide spread cellular damage and androgen deprivation (66). Reduction in the testosterone level in the rats treated with *D. falcata* is due to decrease in number of Leydig cell, as testosterone is produced by Leydig cells (67). The histo-architecture of testes revealed degenerative changes in the seminiferous tubules, arrest of spermatogenesis at the stage of round spermatid. Serum testosterone levels were decreased significantly in all treatment groups. It is concluded that *D. falcata* methanol stem extract showed a significant effect on fertility in male rats as reported in folk remedies (68).

Wound healing, antimicrobial and *in-vivo* antioxidant activity

The ethanolic extract of aerial parts of *D. falcata* was investigated for the evaluation of its healing efficiency on excision and incision wound models in rats. The results showed that *D. falcata* extract has potent wound healing capacity as evident from the wound contraction and increased tensile strength. Hydroxyproline and hexosamine expressions were also well correlative with the healing pattern observed. Three of the fractions petroleum ether, chloroform and ethanol obtained from the extract exhibited significant antimicrobial activity against the organisms: *Staphylococcus aureus, Staphylococcus pyogenes, Staphylococcus epidermidis, Micrococcus luteus, Bacillus subtilis, Bacillus cereus, Klebsiella pneumoniae, Enterobacter aerogenes, Pseudomonas aeroginosa, Serratia marcescens,* and five fungi *Candida albicans, Candida tropicalis* – dimorphic fungi, *Aspergillus fumigatus, Aspergillus niger* – systemic fungi, and some infectious bacteria *Escherichia coli,* and *Salmonella typhi*. The results also indicated the extract possesses potent antioxidant activity by inhibiting lipid peroxidation, reduced glutathione, superoxide dismutase levels and increased the catalase activity (69). The antioxidant activity may be due to potent-radical-scavenging activity of the phenolics present in the extract. The activity of phenolics is mainly due to their redox properties, which allow them to act as reducing agents, hydrogen donors, and singlet oxygen quenchers (70). They may also have a metal chelating potential, hence the synergistic effect of both antimicrobial and antioxidant activity accelerated the wound healing process

***In-vitro* antioxidant, antinociceptive activity and general toxicity**

Ethanolic extract from *Dendrophthoe falcata* of Bangladeshi origin screened for their Antioxidant, antiinociceptive activity and general toxicity. The extract showed potent antioxidant activity (IC_{50} 5.1µg/ml) using DPPH radical scavenging assay, which is comparable to the standard ascorbic acid (IC_{50} 4.6 µg/ml) (71). Acetic acid is a pain stimulus and intraperitoneal (i.p.) administration of acetic acid (0.7% v/v) causes localized imflammation, which causes contraction of the body in mice and referred to as 'writhing'. Such pain stimulus causes the release of free arachidonic acid from tissue phospholipids by the action from tissue phosphorylase A_2 and other acyl hydrolases. There are three major pathways in the synthesis

of eicosanoids with ring structures that is the prostaglandins, thromboxanes and prostacyclines are synthesized via the cyclooxygenase pathway. The leucotrienes, HETEs (hydroxyeicosatetraenoic acids) and HPETEs (hydroperoxyeicosatetranoic acids) are hydroxylated derivatives of straight-chain fatty acids and are synthesized via the lipooxygenase pathway (72). The extract significantly and dose dependently inhibited the acetic acid induced writhing in mice (71.2%, $p<0.001$ and 28%, $p<0.05$ for 500 and 250mg/kg body weight, respectively). Although the actual mechanism of antinociceptive activity of the extract is not known. A general toxicity was assayed by a simple and low cost assay using brine shrimp lethality as an indicator. The extract showed low level of toxicity (LC_{50} 100 µg/ml) (71).

Hepatoprotective activity

The hepatoprotective effect of ethanol and aqueous extracts of leaves using carbon tetrachloride induced liver damage in wistar albino rats was studied. The study revealed that both ethanol and aqueous extracts significantly reduced AST, ALT, alkaline phosphatase, total bilirubin levels and increased the total protein and albumin levels. These biochemical observations were supplemented by histopathological examination of liver sections. The liver histology of the ethanolic extract treated group showed microfatty changes with a dense collection of lymphoid cells suggesting evidence of very little necrosis or degeneration. The present findings suggest that the leaves of *D. falcata* possess potential hepatoprotective activity. The high phenolic compounds and flavonoids in the ethanol extract of leaves of *D.falcata* are responsible for the hepatoprotective activity (73).

CONCLUSION

Mistletoe seeds germinated and holdfasts were formed in culture, indicating that these stages were not dependent upon contact with a living host. The objective of tissue culture experiments has varied, depending on the parasitic plant being studied(24). Mistletoe (*Dendrophthoe falcata*) was cultured to investigate anatomy and development, host-parasite interaction, germination, polyembryony, the effect of hormones and nutrients. The survey of lirerature revealed that *Dendrophthoe falcata* is source of many therapeutically important chemical constituents, as quercitrin, catechin, chebulinic acid, gallic acid, ellagic acid, triterpenes, rutin, myrcetin, etc. Studies have revealed its use in urolithiasis, immunomodulation, tumor suppesion, wound healing and hepatoprotection. However not much information is there to prove the use of this plant for ulcer, paralysis, asthma, pulmonary tuberoculosis and menstrual troubles. There fore further studies may be carried out to prove the potential of this plant. Besides this, some preliminary work has been done of the use on this plant as an antitumor agent, but the detail studies to explore the mechanism are in progress by our research team.

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