REVIEW ARTICLE

Phytochemistry and pharmacology of *Tecomella undulata*

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Tecomella undulata (*Bignoniaceae*) is a monotypic genus and one of the most important deciduous, ornamental shrub or small tree of the acrid zone of India. Locally known as Rohida, Roheda in Hindi, Rakhtroda in Marathi, Dadimacchada, Chalachhada, Dadimapuspaka in Sanskrit mostly found in the *Thar* desert regions of India and Pakistan. The plant holds tremendous potential of medicinal value and is used in traditional and folklore system of medicines. It has been used traditionally in various ailments like syphilis, swelling, leucorrhoea and leucoderma, enlargement of spleen, obesity, tumours, blood disorders, flatulence and abdominal pain. *Tecomella undulata* has gained prominence due to presence of some prominent secondary metabolites of great therapeutic potential like stigmasterol, β-sitosterol, α-lapachone, tectol isolated from heartwood, bark and leaf. The present review presents the traditional information and recent scientific update on this plant with therapeutic potential.

Key words: Hepatoprotective, pharamacology, phytochemistry, *Tecomella undulata*

INTRODUCTION

From ancient times, plants have been a rich source of effective and safe medicines due to which, they are the main source of primary healthcare in many nations. About 80% of the world's population is still dependent on traditional medicines.[1,2] *Tecomella undulata* (Family, *Bignoniaceae*)[3] is known by vernacular names, that is Rugtrora in Hindi, Ragat Rohido in Gujarati, Rohira in Punjabi, Lohira in Pakistan, Rakhtroda in Marathi and Rohitak, Rohi, Daadimpushpaka, Daadimchhada, Plihaghna and Amoorarohituka in Sanskrit. It is a shrub or small tree with drooping branches considered important as agro-forestry tree in the western parts of India and used for the production of high quality timber, in addition to its use as fuel, wood and fodder.[4,5] It is widely distributed in Arabia, southern Pakistan and northwest India up to an elevation of 1200 meters. In Pakistan, it is found in Baluchistan and Sind.[3] It occurs on flat and undulating areas including gentle hill slopes and sometimes also in ravines well adapted to drain loamy to sandy loam soil having pH 6.5-8.0. The plant thrives very well on stabilised sand dunes, which experience extreme low and high temperatures.

Access this article online	
Quick Response Code:	Website: www.greenpharmacy.info
	DOI: 10.4103/0973-8258.126811

It plays an important role in ecology acting as a soil binding tree by spreading a network of lateral roots on the top surface of the soil and also as a wind break and helps in stabilising shifting sand dune.[6] The literature survey reveals that it is a multipurpose tree, valued for its timber, fuel wood, fodder and traditional medicine. The local people of different parts of India especially in the northern part and other countries use this plant or its parts to cure various diseases and some significant results are witnessed. But still unsatisfactory scientific work has been carried out to prove the folklore claims and to justify the full potential of this plant. The present review is written with a view to present the recent status of various scientific studies on phytochemical and pharmacological activities of *Tecomella undulata* plant and also to focus on the future potential this plant holds in its possession.

TRADITIONAL USES

Traditional usage on various plant parts of *Tecomella undulata* in indigenous system of medicines in India and other countries is outlined below:

The bark of young branches is useful as a remedy for syphilis in Sind.[7] Bark is also astringent, anthelmintic and refrigerant. It is used in enlargement of liver and spleen, urinary disorders, worms, leucoderma, leucorrhoea, fever,[8] piles and anorexia.[9] Ladies of tribal communities of *Samahni valley* (Pakistan) take bark powder with hot milk for abortion.[8] Bark is also used as muscle relaxant, cardiotonic and choleretic.[10]

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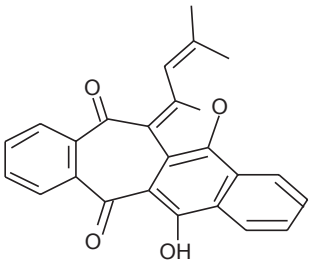
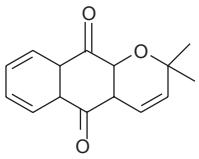
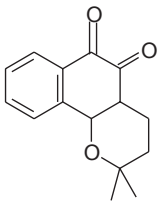
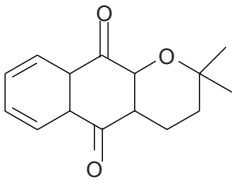
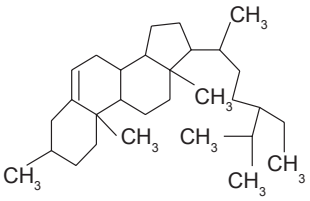
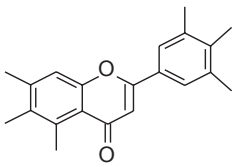
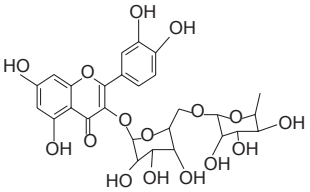
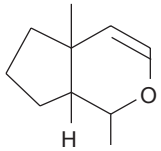
Received: 09-10-2013; **Accepted:** 18-10-2013

The seeds are acrid, refrigerant, laxative, anthelmintic and useful in ulcers, diseases of blood, eye, ear and also in muscular pain. These possess mild relaxant and cardio tonic activities. Seeds are also used against abscess[11] and in the treatment of eczema. *Tecomella undulata* seeds crushed with pinus leaf extract are taken to cure haemorrhoids.[8] Leaves of the plant are used to treat migraine.[12] The paste of *Tecomella undulata* root is given internally in leucorrhoea some times its pulp is given along with rice water.[13] Tea of flower is useful for sterile women and to reduce thirst.[12] The whole plant is used in folklore system in different types of allergies and old wounds.[14,15]

PHYTOCHEMISTRY

Tecomella undulata has number of pharmacological activities, so this plant has received attention by the researcher to know phytoconstituents present in its different extracts. Phytochemical studies have been performed to investigate the composition of different plant extracts, leading to the isolation and identification of pharmacologically relevant compounds such as the heartwood contains radermachol,[16] lapachol,[17] cluytyl frulate,[18] β-lapachone,[19] α-lapachone,[20] Dehydro-α-lapachone.[4,5] Leaves of the plant possess cirsimaritin and cirsili.[21] The bark contains β-sitosterols,[10] iridoid glucosides[22] tecomelloside,[23] rutin, quercetin, luteolin-7-glycoside and β-sitosterol.[24] Root contains lapacol, tricontanol-1, β-sitosterol, tectol, veratric acid and 6-O-veratryl catalposide[25] and quinines.[20] The fruit shell of *Tecomella undulata* contains aphanamixin lactone and aphanamixolide.[13] The seeds contain 7.14%, tannin and seed oil contains linoleic acid (53%) along with lauric acid. The kernels yield 44.5% of fatty oil.[26] Structure of some chemical constituents present in *Tecomella undulata* Linn. is shown in Table 1 and their pharmacological profile in Table 2, respectively.

Table 1: Structure of some chemical constituents present in *Tecomella undulata* Linn

Phytoconstituents	Structure
Radermacol	
Dehydro-α-lapachone	
β-lapachone	
α-lapachone	
β-sitosterol	
Rutin	
Quercetin	
Undulatin	 R=Glu(4-p-coumaroyl)

Contd...

PHARMACOLOGY

In recent years many researchers have examined the effect of *Tecomella undulata* used traditionally by indigenous healers and herbalists to support function of various body parts and treat diseases in humans and animals. In most cases, research has confirmed traditional claims. The various pharmacological activities reported are:

Hepatoprotective

Rana *et al.*, studied carbon tetrachloride-induced hepatotoxicity to establish the effectiveness of methanolic extract of bark of *Tecomella undulata.* The positive finding were further investigated and proved by different researchers using different pharmacological models and biochemical parameters.[42] Khatri *et al.*, studied stem bark of *Tecomella undulata* for liver disorders against

Table 1: Contd...

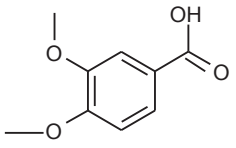
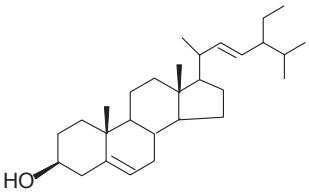
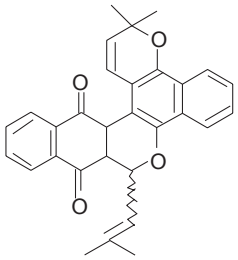
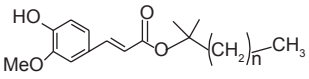
Phytoconstituents	Structure
Betulinic acid	
Stigmasterol	
Techomaquinone	
Clutyl ferulate	 13, *N*=26

Table 2: Pharmacological profile of some chemical constituents present in *Tecomella undulata* Linn

Name of phytoconstituent	Plant's part	Pharmacological uses	References
Radermacol	Heartwood	Anti-inflammatory	[16]
Lapachol	Heartwood Root	Anti-cancer Anti-bacterial Anti-fungal Anti-virus Anti-tumour	[27] [28] [29]
Dehydro-α-lapachone	Heartwood	Anti-vascular	[30]
β-lapachone	Heartwood	Anti-cancer	[31]
α-lapachone	Heartwood	Anti-neoplastic	[32]
β-sitosterol	Bark Heartwood Root Leaf	Anti-inflammatory Anti-pyretic Anti-neoplastic Immunomodulatory	[33]
Rutin	Flower	Treatment of various diseases related to vascular system	[34]
Quercetin	Flower	Anti-carcinogenic, Anti-bacterial Anti-viral Anti-inflammatory	[35,36] [37,38]
Undulatin	Leaves	Tumour Anti-septic	[39]
Betulinic acid	Leaves	Potent anti-human Immunodeficiency virus (HIV virus) Hepatoprotective	[40,41]

thioacetamide-induced hepatotoxicity with ethanolic extract of the plant using albino rats.[43] Further Patel *et al.*, studied the bark part of plant for hepatoprotective effect by using paracetamol-induced hepatotoxic effect using its etahnolic extract. The plant shows significant hepatoprotective effect against this model.[44] Singh *et al.*, carried out studies on the leaves of plant to validate the hepatoprotective activity against 30% alcohol and paracetamol-induced hepatic damage. The methanol soluble fraction was potent and showed significant hepatoprotective activity. The biochemical results have been compared with the standard drug Silymarin. These findings indicate the hepatoprotective potential of *Tecomella undulata* leaves.[45] The hepatoprotective effect has also been studied on its Ayurvedic formulations and it gets revealed that the effect is due to *Tecomella undulata* as one of its constitutent. Goyal *et al.*, has investigated that Rohitaka ghrita, which is an Ayurvedic formulation and is recommended to be used in various clinical conditions including jaundice, cirrhosis and cholestasis. It has a significant hepatoprotective potential against Paracetamol-induced hepatocellular damage in rats. Till date there are no systematic studies to identify the active compound(s) in *Tecomella undulata* extracts, which are responsible for hepatoprotection.[46] Considering this, hepatoprotective of *Tecomella undulata* stem bark extract has been evaluated by Jain *et al.*; using five organic fractions of *Tecomella undulata*, screened for *in vitro* hepatoprotective potential methanolic and ethyl acetate fractions were found to be the most potent. Hence, the same are carried forward for *in vivo* evaluations. Lapachol isolated from *Tecomella undulata* stem did not show hepatoprotective potential, whereas betulinic acid has been tested positive in this regard. Oral administration of betulinic acid (75 or 100 mg/kg) significantly prevented carbon tetrachloride (CCl_4)-induced elevation in plasma markers of hepatic injury and improved hepatic anti-oxidant status and histopathological damage.[41]

Analgesic Activity

Ahmad *et al.*, studied analgesic activity of *Tecomella undulata*. Methanolic extract of whole plant has been evaluated using the hot water tail immersion test in mice. Results are comparable to that of standard drug, acetylsalicylic acid. However, further studies are required on characterisation of active principle from *Tecomella undulata* extract and its subsequent use as an analgesic agent.[47]

Anti-inflammatory

Ahmad *et al.*, also studied anti-inflammatory activity of *Tecomella undulata*. Methanolic extract of whole plant has been evaluated using Carrageenan-induced rat paw oedema as experimental model. Authors reported that oral administration of *Tecomella undulata* extract reduced paw oedema volume in a dose dependent manner. These results are comparable to that of standard drug aspirin-treated rats. But even this study lacks phytochemical characterisation of *Tecomella undulata* extract.[47]

Anti-proliferative

The bark of plant was investigated for potential anti-tumour activity, thereby validating the traditional claim. Quercetin, known to have anti-cancer activity, has been reported and quantified for the first time from the bark of the plant.[48] Anti-tumour potential of *Tecomella undulata* extract (chloroform) was explored using chronic myeloid leukemic cell line (K562). Recently, Savjiyani *et al.*, studied anti-cancer potential of polyherbal formulation prepared from the extract of stem bark of *Tecomella undulata*, Bauhinia variegate, Oroxylum indicum and leaves of Indigofera tinctoria using *in-vitro* and *in-vivo* experimental models.[49]

Anti-HIV Potential

Azam has reported that leaves of *Tecomella undulata* contain some phytoconstituents, which have anti-HIV potential. Octadimethyl succinate derivatives of oleanolic acid and betulinic acid have been reported to be 24 times more active as compared with Zidovudine drug (most frequently used drug to check spread of HIV). However, further studies are required to know the underlying mechanism of *Tecomella undulata* in curing AIDS and formulation of this herb.[50]

Anti-diabetic and Anti-oxidant

Kumar *et al.*, used ethanolic extract of *Tecomella undulata* for anti-diabetic profile by streptozotocin-nicotinamide-induced type-2 diabetic rats. The extract has shown significant blood glucose lowering effect in the oral glucose tolerance test. The blood glucose level, cholesterol, glycogen content, glycosylated haemoglobin and anti-oxidant parameters malondialdehyde and glutathione level estimation by standard kits show both anti-hyperglycaemic and anti-oxidant effect.[51]

Anti-microbial

Parkash *et al.*, worked on *Tecomella undulata* for anti-microbial activity on selected strains. Study claims that only methanolic extract has potential effect.[52] Further, Danya *et al.*, used whole plant for anti-microbial study by using disk diffusion and minimum inhibitory concentration method on selected microorganisms. *Tecomella undulata* has shown significant anti-microbial effect on bacterial strains like *Salmonella paratyphi, Salmonella paratyphi-a, Bacillus subtilis, Bacillus thuringiensis* and fungal strains *Aspergillus niger* and *Aspergillus flavus*.[53] Suganya *et al.*, studied the anti-bacterial activity on nanofibre mat containing crude bark extract of *Tecomella undulata* (chloroform: Methanol, 4:1). Activity has been tested against standard strains of *Pseudomonas aeruginosa* MTCC 2297, *Staphylococcus aureus* ATCC 933, *Escherichia coli* (IP-406006). Extract loaded PCL/PVP nanofibre mat are able to inhibit the growth of the bacterial strains.[54]

Anti-obesity

Alvala *et al.*, investigated the anti-obesity property of *Tecomella undulata* bark, preliminary studies were performed on 3T3-L1 cells. Ethyl acetate extract has shown better inhibition of adipocyte differentiation than other two extracts (data not shown) hence, column fractionation of ethyl acetate extract was performed and resulted in seven fractions. Adipogenesis assay has been performed for all the seven fractions. First fraction shows the best results for adipogenesis.[55]

Ayurvedic Formulations

Tecomella undulata is used in various commercial formulations for hepatoprotection like amylcure, herboliv, hepato-100, himoliv, liv-52, livo-plus, rohitakghrita, rohitakarishtha.[47,56]

Conclusion and Future Scope

Present review is a compilation of the research work carried out on various parts of *Tecomella undulata* and its folklore practices. It reveals that this plant has great scope for future research as it has some very interesting phytochemicals moreover, isolation and purification of pure compounds should be carried out. Thereby, scientific validation of these pure compounds with traditional claims will be very potential for finding therapeutically significant newer molecules. Pre-clinical toxicological evaluation of various biologically active *Tecomella undulata* extracts and bioactive compounds is also desirable. Since this plant is in endangered species, the cultivation aspects and plant tissue culture techniques can be developed for constant supply of the phytoconstituents present in this plant.

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How to cite this article: Rohilla R, Garg M. Phytochemistry and pharmacology of *Tecomella undulata*. Int J Green Pharm 2014;8:1-6.

Source of Support: Nil, **Conflict of Interest:** None declared.