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Review on *Abutilon indicum* - An Update



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ABSTRACT

The plant *Abutilon indicum* commonly known as country mallow is an important medicinal plant belongs to the family Malvaceae. Different parts of the plant such as leaves, flowers, seeds, roots, barks and fruits are used as drugs traditionally in both Ayurvedic and Unani systems. The phytochemical analysis showed the presence of phytoconstituents like β -sitosterol, caffeic acid, fumaric acid, vanillin, p-coumaric acid, p-hydroxybenzoic acid, sesquiterpenes including lactones, alantolactone and isalantolactone from different parts of the plant. The reported pharmacological activities of *Abutilon indicum* are anti stress, antithyroid, antimicrobial, reproductive, apoptotic ability, antipyretic, anxiolytic and antidepressant, anti-inflammatory, anti tuberculosis and anti diabetic activity. The present study provides an updated and scientific review on phytochemical analysis and pharmacological properties of *Abutilon indicum*.



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INTRODUCTION

India has an enormous biodiversity of medicinal plants. The world health organisation (WHO) estimated that up to 80% of people still rely mainly on traditional remedies such as medicinal plants for their medicines. India with its mega-biodiversity and knowledge of rich ancient traditional systems of medicines (Ayurveda, siddha, unani and local health traditions) provides a strong base for the utilisation of a large number of plants in general health care and alleviation of common ailments of the people. Natural products with medicinal value are generally gaining importance in clinical research due to their well-known property of no side effects as compared to drugs.¹

Abutilon indicum (Indian Abutilon, country Mallow) is a small perennial shrub in the Malvaceae family, native to tropic and subtropical regions and sometimes cultivated as an ornamental. This plant is often used as a medicinal plant and is considered invasive on certain tropical islands. It is extensively grown in Bangladesh, India, Pakistan, Sri Lanka. In traditional medicine, *Abutilon indicum* is used as a demulcent, aphrodisiac, laxative, diuretic, pulmonary, and sedative (leaves). The bark is astringent, diuretic, laxative, expectorant, and demulcent.²

Plant Description:

Perennial herbs or shrubs up to 3 m high. Leaves are ovate to orbicular, cordate, irregularly toothed or sub-entire. Flowers yellow or orange-yellow, axillary, solitary. Carpels 15-20 with short spreading awns. Seeds kidney shaped, dark brown or Black.³

Distribution:

Country mallow is found as weed in the sub-Himalayan and other hills up to 1200 m. Occur throughout the tropical and subtropical parts in India and Sri Lanka.³

Taxonomic status:

Kingdom : Plantae

Subkingdom: Tracheobionta

Division : Magnoliophyta

Class : Magnoliopsida

Subclass : Dilleniidae

Order : Malvales

Family : Malvaceae

Genus : Abutilon

Species : indicum⁴

Vernacular names:

Tamil : Nalla tutti, perundutti, Tutti

English : Country Mallow, Flowering maples

Malayalam : Katturam, Pitikkapattu, Tuvatti

Telugu : Adavibenda, Botlabenda, Dudi

Urudu : Kanghi

Hindi : Kandhi, Jhampi

Marathi : Akakai, Kansuli, Mudra

Sanskrit : Atibala, Balika, Balya

Uriya : Nakochoho

Tulu : Urki

Gujarati : Kansaki, Khapat

Punjabi : Kangi, Kangibooti⁵

Ethnomedicinal uses

The plant has its therapeutic uses as febrifuge, anthelmintic, anti-inflammatory and in urinary and uterine discharges, piles and lumbago. Bark is astringent, diuretic and used in strangury and urinary problems. Leaves are used as diuretic and demulcent and as an emollient fomentation and it is considered remedy for diarrhoea when used with ghee. They also used in piles and inflammation. The decoction of leaves is used as mouthwash in toothache and

tender gums, it is also reported to be useful in gonorrhoea, inflammation of bladder. It is used to wash the wounds and in ulcers and for enema and vaginal injection. Seeds considered as laxative and demulcent and used in chest troubles, piles, gonorrhoea, cough, gleet and chronic cystitis. Roots are nervine tonic and antipyretic and is given for piles. Mixed with honey, chaulmoogra oil and fresh paste of sandal wood, the root is used to be an efficacious treatment for leucoderma. Addition of bakuchi oil may improve the efficacy of the treatment. The root infusion is prescribed in fever as a cooling medicine and useful in strangury and haematuria. Decoction of root is given internally for stones in bladder and also applied as a wash in eye diseases. ⁶

Pharmacognostical review

Roots

Macroscopic - Tap roots; fairly long with a number of lateral branches; 1.5 – 2 cm in diameter; light brown in colour; the plant outer surface is smooth with dot like lenticels; thin bark and can be peeled off easily; feeble odour; astringent and bitter taste.

Microscopic – Transverse section of root shows 4-7 layers of thin cork and more tangentially elongated rectangular cells. Single layered cork cambium at the lenticel regions followed by 2-3 layers of thin walled secondary Cortex, almost cubical or rectangular cells containing small clusters of calcium oxalate in most of cells. Phellogen is followed by 3-4 layers of thin walled cells of cortex and some cells of cortex which are above the conical strands of blast, crushed. Small sized starch grains, 6-9 micron in diameter present in some of the cells. Phloem in the transverse section of root forms the major portions of the bark and present as conical strands with their base towards the wood and with dilate distal ends of the primary medullary ray in between them. Fibres present in groups of 10-12 in these conical strands tangentially, alternating with thin walled phloem elements towards wood fibre groups. Elements in between the fibres mostly consist of phloem parenchyma and some cells contain cluster crystals of calcium oxalate. Some phloem cells towards periphery are compressed and crushed. Inner to phloem, cambium is present consisting of 1-2 rows of narrow, thin walled rectangular cells. Wood composed of vessels, wood fibres, wood parenchyma and medullary rays. Vessels vary in diameter and arranged in 2-4 radial groups, also occur in singles. Some cells show tyloses formation. Thick walled parenchyma is slightly wider than fibre cells, but less thickened. Single or rarely compound starch grains are present. Primary xylem present at the centre of the wood and uni or biseriate medullary rays widen much towards distal ends,

most of the ray cells contain starch grains and some contain cluster of calcium oxalate. Starch grains present in wood larger than those of bark regions, a few ray cells at centre of the root contain rhomboidal crystals.⁷

Leaves

The leaves are evergreen, cordate and stipulate. The petiole is 1.5 to 7 cm long, cylindrical, yellowish brown in colour, with stellate hairs. The lamina is reticulate, crenate, dentate, acute to acuminate, dull green in colour, minutely stellate, hairy above and glaucous below. Glandular hairs are present while the texture is coriaceous. The leaves are dorsiventral and covered with stellate, pitcher and flask shaped glandular hairs. The epidermal cells have straight anticlinal walls while the stomata are anomocytic. The distal end of the petiole shows isolated collateral vascular bundles.⁸

Stem

The transverse section of stem shows single layered quadrangular epidermal cells. Cortex is multilayered and has thin walled cellulosic parenchyma. Thin walled Pericyclic fibers and pith, lignified big polygonal parenchyma with intercellular space. The vascular bundles are composed of xylem and phloem cells.

The powder was characterized by its morphological features as yellowish in colour, odourless and sweet to characteristic taste in nature. The fine powder was stained with chloral hydrate to detect calcium oxalate crystals, they were prismatic. When stained with phloroglucinol and Conc. HCl. Vascular bundles, lignified fibers were observed.⁹

Bark

The outer surface is brownish grey in colour and inner surface is smooth, light yellow coloured. The bark is with bitter taste and characteristic odour. Rough Texture with 345.02 μ fibre length and the Diameter of starch grain was found to be 32.42 μ . Single layered epidermis with rectangular cells. The epidermis is covered with thick and smooth cuticles. The cork contains seven to nine layers of parenchymatous cells. The outermost layer is reddish brown and inner layer is colourless. Phelloderm contains 1-3 layers of radially arranged parenchymatous cells. The bark contains thick walled phloem fibres which are arranged as bundle of 15-18 fibres. The outer and inner part of each fibres contains cellulose and lignin. Each bundle of phloem fibres surrounded by a parenchymatous sheath. Phloem

parenchyma made up of thin walled parenchymatous cells. Medullary rays are biseriata and having parenchymatous cells. Abundant Prism of calcium oxalate crystals are present and Cambium strip have 12-14 layers of thin parenchymatous cells. Xylem vessels- 70-180 μ in diameter with thick, pitted or reticularly thickened lignified walls. Lignified Xylem fibres are also found. ¹⁰

Flowers

Yellow to orange in colour, odourless, mucilaginous in taste, solitary, on jointed peduncles, often forming a panicle like terminal inflorescence due to reduction in leaves. The flowers are bisexual and pedicellate. Pedicels often 2.5-5 cm in length jointed very near the top. Calyx 12.8 mm in length divided to the middle, ovate and apiculate lobes. Corolla yellow coloured and measures 2.5 cm opening in the evening. Staminal tube is hairy at the base and the filaments are long. Carpels usually 15-20 longer than calyx with a distinct small acute point, hairy, ultimately shining and dark brown. ⁵

Phytochemical review

Individual chemical constituents of a medicinal plant is essential for understanding pharmacological activity as well as potential toxicity and optimising extraction procedure. *Abutilon indicum* has been explored phytochemically and found to possess number of chemical constituents.

Roots

An ethanolic extract of root yields mucilage which contains pentoses, methyl pentoses and hexoses. Pentosans, methyl pentosans and uronic acids are also present in the mucilage. Presence of Protein, carbohydrates, free amino acids, saponins, glycosides, sterols, tannin, resin, linoleic, stearic, palmitic, lauric, myristic, caprylic, capric acids, sitosterol and two new compounds Abutilin A, (R)-N-(1'-methoxycarbonyl-2'-phenylethyl)-4-hydroxybenzamide also reported. ^{11,12}

Seed

The seed contains (Dry basis), protein, 23.1; and semi drying oil 15.3%. The oil has the following fatty acid composition. Palmitic, 12.8; Stearic, 0.9; Oleic, 14.8; and linoleic, 60.9%, Malvalic, sterculic and 12,13-epoxyoleic acids. The seeds were also analysed for crude protein, pentosans and water soluble mucilage contents. Three HBr reactive fatty acids

viz., Cis-12,13-epoxyoleic (vernolic acid); 9, 10-methylene-octadec-9-enoic (sterculic acid) and 8,9-methylene-heptadec-8-enoic were identified in the seed oil.^{8,11}

Flowers

The petals contain cyanidin-3-rutinoside, gossypetin-8-glucoside and gossypetin-7-glucoside. The shoot and flowers showed the presence of saponins, flavonoids and alkaloids. Seven flavonoid compounds were isolated and identified from the flowers was found to be luteolin, chrysoeriol, luteolin 7-O- β -glucopyranoside, chrysoeriol 7-O- β -glucopyranoside, apigenin 7-O- β -glucopyranoside, quercetin 7-O- β -glucopyranoside, quercetin 3-O- α -rhamnopyranosyl (1-6)- β -glucopyranoside.^{8,13}

Leaves

The leaves yielded β -sitosterol and tocopherols. Preliminary chemical studies revealed the presence of leucoanthocyanidin, cyanogenetic glycosides, saponins, cardiac glycosides, tannins, phenolic compounds and alkaloids in the root, leaves and stem of both the species. The leaves also contains sterols, mucilage, organic acid, glucose, fructose and galactose. GC-MS & FT-IR analyses of ethyl acetate extract of leaves led to identification of 16 major chemical compounds: 1) Triamcinolone Acetonid, 2) acid ester, 3) 9,10-Anthracenedione, 1,4-diamino-2-methoxy, 4) 10-Methoxydihydrocorynantheol; 10-methoxycorynan-17-ol 5) Arabinitolpentaacetate 6) 4-Methylcholestan-3-ol-, (3 β ,4 α ,5 α)-; 4- α -Methyl-5- α -cholestan-3- β -ol 7) 10-Hydroxy-2 decenoic acid methyl ester 8) [1,1'-bicyclopropyl]-2-octanoic acid, 2'-hexyl-, methyl ester 9) 4 hydroxyphenylacetic acid methyl ester 10) 5-Thio-D-glucose 11) (E)-10-Heptadecen-8-ynoic acid methyl ester 12) 5-Allylsulfanyl-1-(4-methoxy-phenyl)-1H-tetrazole 13) Abutilin A 14) Z-11-Hexadecenoic acid 15) (R)-N-(1'-methoxycarbonyl-2'-phenylethyl)-4-hydroxybenzamide 16) 3 hydroxy beta ionol.¹⁴

Aerial parts

The aerial parts of the plant on extraction with petroleum ether led to the isolation of n-alkane mixture, an alkanol fraction and β -sitosterol; vanillic, p-coumaric, p-hydroxybenzoic, caffeic and fumaric acids; p- β -D-glucosyloxybenzoic acid and gluco-vanilloyl glucose.⁸

Whole plant

The plant was found to contain gum resin and mucilage but was devoid of tannins. The petroleum extract of the plant yielded two sesquiterpene lactones identified as alantolactone and isoalantolactone and gallic acid.⁸

Pharmacological review

Anti-stress activity

Ethanol leaf extract of *Abutilon indicum* is used in this study to explore the In-vitro antioxidant characteristics, radiation induced DNA damage protection and quenching effect of the oxidative stress on human Peripheral blood lymphocytes (PBLs). PBLs were incubated with different concentrations of leaf extract of *Abutilon indicum* accompanied by pre and post treatment with hydrogen peroxide. MTT assay method were used to investigate the cell viability. Cytotoxic effect of hydrogen peroxide on PBLs were significantly reduced with leaf extract of *Abutilon indicum* pretreatment compared to post treatment in a dose dependent manner comparable with similar cytoprotective effect of Ascorbic acid. The plant extract has shown strong antioxidant effect in the scavenging of DPPH, superoxide anion, hydrogen peroxide and nitric oxide.¹⁵

Anti-bacterial activity

Chloroform, ethanol and aqueous extracts of the leaves of *Abutilon indicum* were investigated for antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Salmonella typhi* by using disc diffusion method. Among the various extracts ethanolic extract of *Abutilon indicum* showed the maximum antibacterial activity followed by chloroform extract. Thus, the study reveals that leaves of *Abutilon indicum* possesses significant antibacterial activity.¹⁶

Anti-thyroid activity

This study was carried out to investigate the In-vivo antithyroid activity of the methanolic extract of aerial parts of *Abutilon indicum* in male albino rats using thyroxine induced hyperthyroidism model. Thyroxine increased the levels of triiodothyronine and total thyroxine level while *Abutilon indicum* at the doses of 300 and 500 mg/kg decreased the elevated levels of triiodothyronine and thyroxine significantly. The results shows that *Abutilon indicum* exhibits dose dependent antithyroid effects.¹⁷

Hepatoprotective activity

The aqueous extract of *Abutilon indicum* was tested for hepatoprotective activity against carbon tetrachloride and paracetamol induced hepatotoxicities in wistar albino rats. *Abutilon indicum* exhibited significant hepatoprotective activity by reducing carbon tetrachloride and paracetamol induced change in biochemical parameters such as serum glutamic pyruvate transaminase, total bilirubin, direct bilirubin and liver glutathione that was evident by enzymatic examination. The plant extract may interfere with free-radical formation, which may conclude in hepatoprotective action.¹⁸

Aphrodisiac activity

The objective of the present study to evaluate a prodisiac activity of ethanolic and aqueous extracts of roots of *Abutilon indicum* in experimental rats. The ethanolic root extract of *Abutilon indicum* at higher concentration (400 mg/kg) showed significant aphrodisiac activity on male wistar albino rats as evidenced by an increase in number of mounts, hormonal analysis, mating performance, sperm count and testes body ratio. On the other hand, ethanolic extract at lower dose (200 mg/kg) and aqueous extract (400 mg/kg) showed moderate aphrodisiac property than ethanolic extract. Thus, the results of the present study suggest that the root extracts of *Abutilon indicum* exert significant aphrodisiac activity in experimental rats.¹⁹

Antimicrobial activity

The present study was conducted to investigate the anti-microbial activity of *Abutilon indicum* extracts against Gram-positive bacteria (*Staphylococcus aureus*), Gram-negative bacteria (*E. coli*), and Fungal species (*Candida albicans*). The antimicrobial activity was evaluated using agar well diffusion method. *Abutilon indicum* extracts produced potent antibacterial and antifungal effects against all the selected bacterial and fungal species. The plant extracts exhibited the growth inhibitory activity in a dose-dependent manner. The study reveals that *Abutilon indicum* shows good antimicrobial and anti-fungal properties.²⁰

Nephroprotective activity

The present study was to demonstrate the nephron protective effect of *Abutilon indicum* root in gentamicin induced acute renal failure in wistar albino rats. Animals treated with plant extract showed significant improvement in biochemical parameters and histopathological

changes compared to animal treated with gentamicin. The protective effect was highly significant in the dose of 300 mg/kg of plant extract. The ethanolic extract of *Abutilon indicum* root has nephron protective effect due to the antioxidant and other phytochemicals present in *Abutilon indicum* root.²¹

Fertility enhancing activity

In this study, the impact of coadministration of the methanolic root extract of a plant *Abutilon indicum* in mitigating the toxic impact of lead on the reproductive system of rats was evaluated. Wistar rats were exposed to lead acetate in drinking water and the resulted reproductive toxicity is compared with animals administered with plant root extract. After 45 days of exposure, the animals were killed and the reproductive toxicity was assessed by sperm parameters, hormone and antioxidant enzyme assays, and testis histopathology. The toxic impact of lead was seen by Significant reduction in testis weight, sperm count, testosterone levels, and antioxidant enzymes levels such as Superoxide Dismutase, Catalase, and Glutathione peroxidase in lead-treated animals. The administration of *Abutilon indicum* was found to bring the studied parameters close to the levels seen in control animals indicates that protective nature of *Abutilon indicum* against lead-induced reproductive toxicity in a dose-dependent manner.²²

Antidiarrhoeal activity

The present study is aimed to evaluate the anti-diarrhoeal activity of leaf extracts of *Abutilon indicum* using albino rats. Anti-diarrhoeal activity of *Abutilon indicum* was evaluated by gastro intestinal motility, castor oil-induced diarrhoea and prostaglandin E₂-induced enteropooling in rats and the obtained results are compared with standard drug Loperamide. The study reveals that, the methanolic and aqueous extract possesses significant antidiarrhoeal activity in castor oil-induced diarrhoea and prostaglandin E₂-induced diarrhoea compared to Loperamide.²³

Wound healing activity

The ethanolic extract of *Abutilon indicum* was investigated for wound healing activity using incision, excision and dead space wound models in albino rats. The extract was studied at a dose of 400 mg/kg which showed significant increase in wound contraction rate, skin breaking strength, granuloma strength and dry granuloma weight. The decrease in epithelisation period was observed in test animals as compared to control and standard. The

pro healing effect of the plant extract may be due to increase in collagenation deposition as well as better alignment and maturation. The plant extract treated group observed complete healing of wounds with almost normal architecture of the collagen, reticulin. The ethanolic extract of *Abutilon indicum* increases the collagen synthesis thus increasing the collagen concentration which heals the wound.²⁴

Antipyretic activity

The study was designed to evaluate antipyretic activity of various extracts of *Abutilon indicum* leaves. Oral administration of different leaf extracts of *Abutilon indicum* at a dose of 400 mg/kg body weight shows significant reduction in elevated body temperature. Alcoholic, aqueous and chloroform leaf extracts showed moderate antipyretic activity as compared to standard drug.²⁵

Anti-venom activity

The present study investigates the In-vitro anti venom potential of *Abutilon indicum* leaves extract against *Echis carinatus* (Saw Scaled Viper) venom. The leaf extracts of *Abutilon indicum* were used to evaluate the enzyme inhibiting activity on protease, phosphomonoesterase, phosphodiesterase, acetylcholinesterase, phospholipase A2, hyaluronidase and L-amino acid oxidase present in snake venom. The methanolic extract inhibited the activity of all enzymes present in the venom and showed promising results in its anti venom activity.²⁶

Anxiolytic and antidepressant activity

This study investigates the antidepressant potential of crude methanolic extracts of leaves and barks of *Abutilon indicum*. The anxiolytic effect produced by plant extract is compared with Diazepam or fluoxetine as standard drug. Light and Dark Exploration (LDE), The Elevated Plus Maze (EPM) and Hole Board (HB) test methods were used to evaluate the anxiolytic activity. Forced swim and tail suspension model were used to evaluate the antidepressant potential of *Abutilon indicum* extract. Results showed that mice spent more time in light; passed more duration in open arms and raised number of head poking in respective anxiolytic tests. Likewise, mobility time was raised in forced swim and tail suspension antidepressant testing. This study proves that the *Abutilon indicum* has significant dose dependent antidepressant and anxiolytic potential, which peaks at highest dose (100 mg/kg).²⁷

Anti-cancer activity

The present work, investigates the anticancer activity of crude methanolic extract of *Abutilon indicum* leaves. The Methanolic extract of leaves and its sub-fractions, obtained by partition separation using chloroform and ethyl acetate, were tested on human breast carcinoma cell lines (MDA-MB-231) along with normal cell line (HEK 293) by MTT [3-(4, 5-dimethylthiazole-2-yl)-2, 5-diphenyl tetrazolium bromide] assay at different concentrations (20-60µg/ml). A decrease in the growth of cancer cells was observed with increasing concentrations of leaf extracts. The results were compared with a reference compound Quercetin, which showed 31.16 % growth inhibition of cancer cells at 60µg/ml. The study provides evidence for a highly significant in vitro anticancer effect of leaves of *Abutilon indicum*.²⁸

Anti-inflammatory activity

The present study designed to evaluate the Anti inflammatory activity of ethanolic extracts of whole plant of *Abutilon indicum*. The plant extract was evaluated for its anti-inflammatory activity at doses of 250, 500 and 750 mg/kg using the carrageenan-induced paw oedema model in healthy Wistar albino rats. Results showed that the ethanolic extract of *Abutilon indicum* showed significant anti inflammatory activity in a dose dependent manner, which is comparable to the reference standard ibuprofen.²⁹

Anti-arthritic activity

The present study reveals the In-vitro anti-arthritic potential of *Abutilon indicum*. Various in-vitro anti-arthritic pharmacological models such as, inhibition of protein denaturation, effect of membrane stabilization and proteinase inhibitory action were studied. Aqueous herbal extract with two different concentrations (100mcg/ml and 250mcg/ml.) was used and results were compared with standard compound acetyl salicylic acid (250mcg/ml.). The herbal extract showed dose dependent anti arthritic activity which was found to be better than that of acetyl salicylic acid.³⁰

Anthelmintic, analgesic and neuropharmacological activity

The present study was conducted to evaluate the anthelmintic, analgesic and neuropharmacological activity of the methanolic extracts of barks of *Abutilon indicum*. Anthelmintic activity was evaluated using earthworm (*Pheretima posthuma*) with fresh leaf

extract of the plant. In anthelmintic activity test, the time of paralyse for leaf extracts was range from 25 to 65 minutes whereas the time ranges for standard drug albendazole was 31 to 75 minutes. Time of death starts from 31 to 72 minutes for leaf extract and for albendazole the time of death starts from 39 to 84 minutes at different dose which indicate highly significant anthelmintic activity. Analgesic activity was evaluated using two thermal (hot plate and tail immersion) and one chemical (acetic acid induced writhing test) methods at the dose of 200 and 400 mg/kg. In hot plate and tail immersion analgesic tests, the latency time of thermal threshold was prolonged, whereas it was inhibited by acetic acid induced writhing test. Thus the bark extract of the *Abutilon indicum* showed moderate analgesic activity. Neuropharmacological activity of the plant extract was evaluated by open field, hole cross, and dark/light box tests at the doses of 200 mg/kg and 400 mg/kg. The extract significantly decreased the locomotor activity in the open field, hole cross test which indicate highly significant antidepressant activity. The study also showed similar activity in dark/light box test.³¹

Anti-ulcer activity

The study was performed to demonstrate the anti ulcer activity of *Abutilon indicum* leaves on animal models. The antiulcer activity was performed using models such as aspirin + pylorus ligation induced, ethanol induced and acetic acid induced ulcer model and results are compared with standard drug Famotidine. From the result, it was observed that the treatment with *Abutilon indicum* leaf extract showed significant reduction in the ulcer index. Thus the study reveals that *Abutilon indicum* leaf extract has gastro protective activity.³²

Larvicidal activity

Larvicidal activity of crude hexane, ethyl acetate, petroleum ether, acetone and methanol extracts of five medicinal plants, *Abutilon indicum*, *Aegle marmelos*, *Euphorbia thymifolia*, *Jatropha gossypifolia* and *Solanum torvum* were assessed for their toxicity against the early fourth-instar larvae of *Culex quinquefasciatus*. The highest larval mortality was found in petroleum ether extract of *Abutilon indicum* while other extracts showed a moderate larvicidal activity. In the present study, bioassay-guided fractionation of *Abutilon indicum* led to the separation and identification of a beta-sitosterol as a potential new mosquito larvicidal compound. Results of this study shows that the petroleum ether extract of *Abutilon indicum* may be considered as a potent source and beta-sitosterol as a new natural mosquito larvicidal agent.³³

Anti-diabetic activity

The present study investigates the anti diabetic potential of *Abutilon indicum* on Streptozotocin induced diabetic rats. The effects of daily oral administration of chloroform extract of *Abutilon indicum* (50 mg/kg) for 21 days on blood glucose, lipid profile, glycosylated haemoglobin, total haemoglobin and plasma insulin in normal and Streptozotocin induced diabetic rats are compared. Chloroform fraction at a dose of 50 mg/kg significantly reduced the blood sugar level in diabetic rat when compared with diabetic control rats. These results gave evidence to the significant anti diabetic potential of chloroform extract of *Abutilon indicum*.³⁴

Diuretic activity

The present study was carried out to investigate the diuretic effect of *Abutilon indicum* leaf extract in wistar rats. The ethanolic and aqueous extracts were administered to the animal orally and the results are compared with Furosemide as standard. The rats treated with aqueous and ethanolic leaf extracts in a dose of 200 mg/kg and 400 mg/kg showed higher urine volume compared with control group. Aqueous leaf extracts significantly increased the excretion of electrolytes than control group. This study gives evidence to the diuretic potential of leaves of *Abutilon indicum*.³⁵

Anti-tuberculosis activity

The present study is an attempt to evaluate the anti-TB potential of commonly available, and well-known medicinal plants, namely, *Lantana camara*, *Euphorbia hirta*, *Mukia maderaspatana*, *M. Roem*, and *Abutilon indicum* known to have proven antimicrobial activity. The anti-tuberculosis activity of methanolic extracts of the plants was tested against multi-drug resistant (MDR) clinical isolates of *Mycobacterium tuberculosis* (*Mtb*) and *Mtb* H37Rv using luciferase reporter phage (LRP) assay. The minimum inhibitory concentration (MIC) of the plant extracts was estimated using the broth dilution method. The LRP assay revealed the significant inhibitory activity of methanolic crude extracts and individual fractions against the tested clinical and laboratory *Mtb* strains. The four medicinal plants examined as potential sources for anti-tuberculosis treatment.³⁶

Anticonvulsant activity

The present study investigates the anticonvulsant activity of *Abutilon indicum* leaves extracts on PTZ and MES induced convulsion models in wistar albino rats. The plant extracts of different concentrations 100 mg/kg and 400 mg/kg of ethanolic and aqueous extracts were given orally. The latency of seizures, death time and % of mortality were observed. The ethanolic extract gave significant protection against the PTZ (pentylene tetrazole) and MES (maximal electro shock) induced convulsions. Thus the study reveals that the leaf extract of *Abutilon indicum* has anticonvulsant property.³⁷

Antigout activity

This study is to investigate the xanthine oxidase inhibiting potential of constituents reported from the *Abutilon indicum* through *in silico* studies. The plant *Abutilon indicum* has the traditional claim supporting the use of the plant in treating gout. About 33 constituents of *Abutilon indicum* plant were chosen for the study and their drug likeness were identified using online application SwissADME, Molecular docking studies were done in Autodock version 1.5.6 and the docked samples were observed using Molegro Molecular Viewer 2.5.0. and Pymol. The docking scores of the plant constituents were compared with standard drug Allopurinol. Efficient binding energies were found for 19 constituents against 3AX7 protein. 6 compounds such as luteolin, beta-amyrin, 1-lycoperodine, chrysoeriol, quercetin and flavone possesses binding energies greater than 8 and good inhibition constant values. The constituents of *Abutilon indicum* possesses good xanthine oxidase inhibiting potential and can further be developed into a drug candidate against gout.³⁸

Antioxidant activity

The present study was carried out to investigate the antioxidant activity of methanolic leaf extracts of *Abutilon indicum* L. (Malvaceae). The methanolic extract was screened for *in vitro* antioxidant activities using Ferric Reducing Antioxidant Power (FRAP) assay model. The reducing power of methanolic leaf extract of *Abutilon indicum* was markedly enhanced with the increasing concentrations. Thus, the study evidently indicates the antioxidant potential of methanolic leaf extract of *Abutilon indicum*.³⁹

Sedative activity

This study evaluates the sedative activity of ethanolic and aqueous extracts of stem of *Abutilon indicum*, using phenobarbitone-induced sleeping time test in mice. Ethanolic extract

produced a significant and dose dependent reduction in the onset of sleeping and aqueous extracts was significant in prolonging the sleeping time. These results suggest that the aqueous extract of stem of *Abutilon indicum* possesses sedative activity.⁴⁰

Antimycotic activity

Methanolic extracts of *Abutilon indicum* were tested for their potential to inhibit the causative agents of dermal fungal infections in humans. The screening for the antimycotic activity was performed by testing Minimum Inhibitory concentration and Disc diffusion method which shows that methanolic extract of leaves of *Abutilon indicum* shows remarkable antifungal activity against *Trichophyton rubrum*. This study provides the evidence to determine the antimycotic properties of *Abutilon indicum*.⁴¹

Anti-Alzheimer's activity

The study was designed to evaluate the memory retention and cognitive enhancement ability of methanolic extract of *Abutilon indicum* whole plant against Aluminium chloride induced Alzheimer's disease in rats. The disease was induced in Sprague-dawley rats by administration of Aluminium chloride (4.2mg/kg orally) for 28 days. Efficiency of *Abutilon indicum* whole plant extract at the dose range of 400 mg/kg and 600 mg/kg was estimated using various behavioural models and by estimating brain acetylcholinesterase enzyme level. Methanolic extract of *Abutilon indicum* significantly decreased the Transfer Latency in all learning and memory models indicating its promising effect in reversing the cognitive impairment caused by Aluminium chloride and thus improving memory. Biochemical estimation of brain homogenate also proved the decrease in level of brain acetylcholinesterase enzyme in drug treated rats suggesting improvement in cholinergic function. From the above results it can be concluded that methanolic extract of *Abutilon indicum* shows protective effect against Aluminium chloride induced Alzheimer's disease in rats, due to its anti-inflammatory, anti-oxidant and acetylcholinesterase enzyme inhibitory activity.⁴²

Anti-asthmatic activity

The present study was to investigate the efficacy of aerial parts of *Abutilon indicum* in bronchial asthma. The powdered drug of aerial parts of *Abutilon indicum* was administered to the patients with mild to moderate bronchial asthma with or without concurrent medication at

the dose of 1 gm. The respiratory functions were evaluated using spirometer prior to and after four weeks of the treatment. At the end of the treatment efficacy of the drug in improving clinical symptoms and severity of asthmatic attacks was evaluated by physical and hematological examination. The drug showed statistically significant improvement in various parameters of pulmonary functions in asthmatic patients. Significant improvement in the clinical symptoms and severity of asthmatic attacks also observed. Hence the study suggest that the plant *Abutilon indicum* has potential to be used as anti-asthmatic without any adverse effects.⁴³

Immunomodulatory activity

The present study to investigate the immunomodulatory activity of aqueous and ethanol extracts of leaves of *Abutilon indicum* on albino mice. The ethanolic and aqueous extract of leaves of *Abutilon indicum* was administered orally at the dosage levels of 200 and 400 mg/kg body weight in mice. The investigation of immunomodulatory activity on specific and non-specific immunity were evaluated by heamagglutination antibody titer, delayed type hypersensitivity (DTH), neutrophil adhesion test and carbon clearance test. In order to induce immunosuppression the mice were administered with cyclophosphamide (100 mg/kg) and levamisole (50 mg/kg) used for immunostimulation. The plant extract significantly increased the production of circulating antibody titre in response to sheep red blood cells (SRBCs). A significant increase in both primary and secondary HA titre was observed when compared to control group, whereas the drug significantly increased the HA titre in cyclophosphamide treated group. The *Abutilon indicum* plant extract showed significant potentiation in DTH reaction by increasing the footpad thickness response to SRBCs in sensitized mice. *Abutilon indicum* also evoked a significant increase in percentage neutrophil adhesion to nylon fibers and phagocytic activity. The study tells us that the *Abutilon indicum* triggers both specific and non-specific responses to a greater extent.⁴⁴

CONCLUSION

The plant *Abutilon indicum* has many phytoconstituents responsible for its various pharmacological properties. It has been used since centuries as an analgesic, antipyretic and anti-inflammatory, larvicidal, anti-ulcer, anti-asthma, anti-diarrheal and as an anti-convulsant. The whole plant contains mucilaginous substances and asparagines, Saponins, flavonoids, alkaloids, hexoses, n-alkane mixtures (C22-34), alkanol .The present review summarizes

some updated pharmacological studies on *Abutilon indicum* and phytochemical investigations and isolated principles from them, which can be investigated further to achieve lead molecules in the search of novel herbal drugs.

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