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A Review on Phytochemical and Pharmacological Properties of *Datura metel* L.

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ABSTRACT

Datura metel L., commonly known as Indian thornapple, is a member of the Solanaceae family, renowned for its diverse phytochemical and pharmacological properties. The therapeutic potential of plants is attributed to their bioactive phytochemical compounds. This review explores the key constituents of *Datura metel* L., highlighting the presence of alkaloids such as atropine, scopolamine and hyoscyamine, along with flavonoids and terpenoids. These compounds have various pharmacological effects, including strong anticholinergic properties that are beneficial for treating motion sickness and as pre-anesthetic agents. They also exhibit sedative, analgesic, antimicrobial, anti-inflammatory and antioxidant activities. Although *Datura metel* L. has therapeutic potential, it carries significant toxicity risks mainly because of its alkaloids, so caution is essential when using it. This review aim at emphasizes the need for further research to standardize extracts and establish safe useful dosages, creating opportunities for innovative applications in modern medicine.

Keywords: *Datura metel* L., Solanaceae, phytocompounds, pharmacological

INTRODUCTION

Datura metel L., commonly known as thornapple, is a perennial herbaceous plant belonging to the Solanaceae family. Indigenous to tropical and subtropical regions, it has been widely utilized in traditional medicine for centuries due to its diverse pharmacological properties. The plant is characterized by its large, trumpet-shaped flowers and distinctive spiny seed pods, which contribute to its intriguing yet often cautionary reputation (Jabar *et al*., 2019; Kumari, 2020). Phytochemically, *Datura metel* is rich in alkaloids, triterpenoids, flavonoids, steroids, tannins, saponins to treat human diseases like asthma, bronchitis, diabetes, heart diseases, skin disorders, fever, diarrhea,

epilepsy (Dhawan & Gupta, 2017; Tijani *et al*., 2015). The primary alkaloids include atropine, scopolamine and hyoscyamine, which contribute to its pharmacological effects.

These compounds have been investigated for their anticholinergic, analgesic, and sedative properties. Many compounds found in plants, especially secondary metabolites, have strong antibacterial and antifungal properties. Among these, alkaloids stand out as a particularly significant group. Numerous studies have been conducted on the antimicrobial effects of various substances against bacteria, bacterial pathogens, and fungi (Sakthi *et al*., 2011)

Taxonomic Classification:

Dhatura Safed, Joz Mashel, (*Datura metel* L.)

Taxonomic Classification:

Kingdom : Plantae
Division : Magnoliophyta
Subdivision : Angiospermae
Class : Magnoliopsida
Subclass : Asterids
Order : Solanales
Family : Solanaceae
Genus : *Datura*
Species : *Datura metel*

Phytochemical studies:

Biochemical screening of fresh and dried leaf extracts of *Datura metel* revealed the presence of several bioactive compounds, including alkaloids, flavonoids, saponins, and tannins. Phytochemical analysis confirmed these findings for both types of extracts (Alabri *et al*., 2014).

The methanolic extract of *Datura metel* leaves is rich in phenolic compounds, alkaloids, flavonoids, and tannins, which play a significant role in its medicinal properties. The Gas chromatography mass spectrometry (GC–MS) analysis identified several key components in the extract, with neophytadiene, hexadecenoic acid, and hentriacontane being the main phytochemicals present (Prasathkumar *et al*.. 2022)

The UPLC-QTOF-ESI-MS analysis of the extracts led to the tentative identification of eighteen tropane alkaloids, including tigloidin, hyoscyamine N-oxide, scopolamine N-oxide, hyocyamine, hydroxyapoatropine, tropinone, scopine, hyoscine, atropine, valtropine, ditigloyloxytropane, ditigloyloxytropanol, apohyoscine, tigloyloxytropane, norhyoscine, meteloidine, cuscohygrine, and tropine from both the aerial parts (EAP) and roots (ER) of the plant. Additionally, nine phenolic acids were identified, including gallic, protocatechuic, chlorogenic, vanillic, p-coumaric, ferulic, quinic, syringic, and sinapic acids. Fourteen flavonoids were also detected, such as luteolin-7-glucoside, catechin-3-O-rhamnoside, kempferol-3,7-O-diglucoside, naringenin-6-β-D-glucopyranoside, quercetin 3-O-glucosyl-xyloside, apigenin-7-O-glucoside, flavonol-3-glucoside, luteolin, epicatechin, chrysoeriol, daidzein, genistein, hesperidin, and hydroxycoumarin (Kunda *et al*., 2024).

A total of 19 compounds were identified in this fraction. The most abundant compounds were 1-hexacosanol (12.87 %), 1-octadecene (10.69 %), 2-methyl-3- phenyl-2-propenal (8.72 %), 1-eicosanol (6.80 %). 1-heptadecene (6.66 %), 1-octadecanol (6.62%), 1,3(15),10-bisabolatriene (6.41 %) and 1,6,10-farnesatrien-3-ol (6.38 %). (Jabeen *et al*., 2022)

Organic extracts of *D. metel* were found to have a variety of chemical components the phytochemical content of leaves and seeds of *D. metel* extracts. All the extracts contained flavonoids, tannins, Iridoids, alkaloids and saponins (bet et al., 2022).

The qualitative analysis of the extracts from the root, stem, leaf, seed and fruit coat sample of *Datura metel* Linn. showed the presence of phytochemical constituents such as alkaloids, Tannins, Saponins, and Iridoids during the present investigation on the basis of present investigation it is found that leaf and seed contain more in Tannin, saponin and Alkaloids as compared to other plant parts Iridoids were absent in root and stem (Jamdhade *et al*., 2010).

Phytochemical screening involved the extraction, screening, and identification of bioactive compounds present in Datura seeds, using alcoholic and aqueous extracts. Qualitative analysis revealed the presence of various functional groups, including carbohydrates, alkaloids, amino acids, proteins, saponins, glycosides, phenolic compounds, steroids, and tannins (Porwal *et al*., 2023).

Phytochemical composition of *Datura metel* found the presence of alkaloids, saponins, and tannins (Aduloju & Ogunlade, 2015).

The Gas Chromatography-Mass Spectroscopy (GC-MS) analysis identified 30 bioactive compounds with notable percentage compositions and molecular weights. In the root extracts, thiophene, 2,3-dehydro, which is an isomer of dehydrothiophene (C_4H_6HS), had the shortest retention time and the highest composition at 38.914%. For the leaf extracts, 2-methyl-3-thiosemicarbazide ($C_2H_7N_3S$) and Benzene hexanenitrile, dimethyl-Ɛ-oxo ($C_{14}H_{17}HNO$) showed the highest percentage compositions (Onowoh & Ujowundu, 2022).

In vitro phytochemical screening of both dry and fresh leaf extracts revealed positive results for the presence of alkaloids, flavonoids, saponins, and tannins (Kumari, 2020).

The tests of the methanolic leaf extract, indicate the presence of several biologically active compounds, including alkaloids, tannins (both condensed and hydrolysable), saponins, flavonoids, and steroids. However, it also reveals the absence of certain compounds, such as amino acids (Jaber *et al*., 2019).

The Gas Chromatography-Mass Spectroscopy analysis with chloroform fraction of *D.metel* showed the presence of twelve phyto-constituents viz. eugenol, 2-pentadecanone 6,10,14 trimethyl, pentadecanoic acid, pentadecanoic acid, 1 4-methyl- methyl ester, phytol, 9,12,15-octadecatrienoic acid, heptacosane, n-hexadecanoic, 6-octadecanoic acid, 9, 12 octadecanoic acid, dodecanoic & tetradecanoic acids (Hanif *et al*., 2022).

Pharmacological Properties:

The pharmacological analysis indicated that the plant contains various bioactive compounds, such as alkaloids, flavonoids, and saponins, which demonstrate notable pharmacological activities. These compounds are recognized for their anti-inflammatory, analgesic, and antispasmodic effects. Moreover, the alkaloids in *Datura metel* are known for their strong anticholinergic properties, making them potentially useful in treating various neurological disorders (Alabri *et al*., 2014).

The extract demonstrated strong antibacterial effects against pathogens such as Bacillus subtilis, Methicillin-resistant Staphylococcus aureus (MRSA), Escherichia coli, and Pseudomonas aeruginosa. The extract showed significant inhibition of α-amylase and α-glucosidase enzymes, suggesting its potential for managing hyperglycemia and type 2 diabetes. The extract notably inhibited protein denaturation, indicating its potential for treating inflammatory conditions. The extract enhanced cell migration and proliferation, promoting wound healing and showing promise for treating diabetic and other chronic wounds (Prasathkumar *et al*., 2022).

The study found that leaf extracts of *D. metel* exhibited significant antifungal activity against *S. rolfsii*, with a 4% methanolic extract inhibiting fungal growth by up to 88%. Additionally, bioassays using four organic solvents of varying polarities indicated that the antifungal compounds in the leaf extract were primarily concentrated in the chloroform-soluble fraction. GC-MS analysis showed that the most antifungal compounds present in this fraction were 1-hexacosanol; 1-eicosanol; 1-octadecene;1-octadecanol and 1-heptadecene (Hanif *et al*., 2022).

The antifungal activity of the chloroform fraction of the methanolic fruit extract of *D. metel* against *S. rolfsii* is likely due to the presence of compounds such as 1,2-benzenedicarboxylic acid bis (2-methylpropyl) ester, 1,6,10-farnesatrien-3-ol, and 1-hexacosanol (Jabeen *et al*., 2022).

The study employed the agar well diffusion technique to assess the antifungal properties of the ethanolic leaf extract of *Datura metel*. (Orevaoghene *et al*., 2019).

The leaf and seed extract of *D. metel* shows the antimicrobial properties (Bel *et al*., 2022)

The results demonstrated significant antifungal activity of the aqueous extracts from the leaves and flowers of *D. metel* at all tested concentrations (1%, 2%, 3%, and 4%) against pathogenic fungi (Rinez *et al*., 2013).

The antimicrobial study of various crude extracts of *D. metel* indicated that the methanol extract from fresh leaves exhibited the strongest activity against the tested bacteria. Likewise, this extract also demonstrated the highest antioxidant activity. Phytochemical screening suggested that the antioxidant and antibacterial properties of the crude

extracts are linked to the presence of phytochemicals like alkaloids, steroids, flavonoids, and tannins. Thus, these crude extracts could be promising sources for new antimicrobial and antioxidant agents (Kumari, 2020).

The leaf extracts *D.metel* found to be more effective in test fungal growth as compared to the stem extract, as its concentration of 3.5% caused 75% retardation. The organic solvent fractions were isolated from the *D.metel* leaf methanolic extract. The bioactivities of isolated fractions, n-butanol, n-hexane, chloroform & ethyl acetate were tested against *R.solani*. The concentrations of about 0.1% & 0.01% caused 27% & 21% growth inhibition which showed chloroform fraction found to be highly effective (Hanif *et al*., 2022).

CONCLUSION

The review studies of *Datura metel* L., this plant having significant role in pharmacological interest due to its diverse phytochemical constituents, including alkaloids, flavonoids and phenolic compounds. These phytochemicals contribute to a range of bioactive properties, such as analgesic, anti-inflammatory, antispasmodic and antimicrobial effects. The traditional uses of *Datura metel* in various cultures underscore its potential therapeutic applications, although caution is warranted due to its toxicity and the risk of adverse effects.

Further research should aim to further elucidate the mechanisms of pharmacological action, optimize dosages to maximize its benefits. It represents a valuable resource in both traditional medicine and modern pharmacology.

Conflict of Interest: The authors declare no conflict of interest in relation to this research.

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