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Research Article

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Quantitative and Qualitative Analysis of Leaf and Stem Extracts of *Datura metel*

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ABSTRACT

Introduction: *Datura metel* has been widely used in traditional medicine for its therapeutic properties. However, comprehensive phytochemical characterization of different plant parts remains limited. This study aims to analyze and compare the qualitative and quantitative phytochemical composition of *Datura metel* stem and leaf extracts to provide a scientific basis for its medicinal applications.

Methods: Phytochemical screening was conducted to identify key bioactive compounds, including alkaloids, flavonoids, phenols, tannins, saponins, and glycosides. Quantitative estimation of proteins, phenols, flavonoids, and alkaloids was performed using spectrophotometric methods.

Results: Qualitative analysis revealed that flavonoids were detected in the stem but absent in the leaves, whereas tannins and anthocyanins were found exclusively in the leaves. Quantitative analysis revealed that the leaf extract exhibited higher concentrations of proteins and phenols, whereas the stem extract contained higher levels of flavonoids and alkaloids. These variations suggest differential biosynthesis of bioactive compounds between plant parts, potentially influencing their medicinal efficacy.

Conclusion: The study confirms that *Datura metel* is a rich source of bioactive compounds, with distinct phytochemical profiles in the stem and leaves. These findings provide scientific validation for its traditional use and emphasize the need for further pharmacological and bioactivity studies to explore its therapeutic potential.

Key Words: Alkaloids, Bioactive compounds, *Datura metel*, Flavonoids, Phytochemical analysis, Saponins, Tannins

INTRODUCTION

The genus *Datura* (Family: *Solanaceae*) is widely distributed across the globe, with 14 known species, of which ten are found in India. Among these, *Datura metel*, *Datura Innoxia*, and *Datura stramonium* are recognized for their medicinal properties.[1] *Datura metel* is a perennial herbaceous plant that grows up to approximately 1.5 meters in height. It has simple, alternate, dark green leaves that are shallowly lobed and broadly ovate. The plant produces large, trumpet-shaped flowers that are fragrant and come in various colors, ranging from white and yellow to shades of purple. The fruit is an egg-shaped capsule covered with short spines, measuring about 5 cm in diameter. This species thrives in warm climates and is commonly found in tropical and subtropical regions.[2]

Datura metel is a herbaceous plant believed to have originated in the Americas, though it has long been naturalized in Asia and Africa. It is widely cultivated in tropical and subtropical regions. The plant can grow up to 200 cm in height and is characterized by hollow, green to purple-black stems with a distinct odor. Its leaves are simple, alternate, and petiolate, with margins that are either entire or deeply lobed. They can reach lengths of over 26 cm and widths of more than 21 cm. The plant has a branched taproot, unlike the fleshy roots found in perennial species such as *Datura innoxia* and *Datura wrightii*.

The flowers of *Datura metel* are large, trumpet-shaped, and highly fragrant, measuring between 15 and 20 cm in length. They exhibit significant variation in structure, appearing as single or double blooms. The corolla color ranges from white and cream to yellow, red, and violet. The seed capsule is distinct from other *Datura* species, as it does not split into four equal parts upon maturity but instead breaks open irregularly. The seeds are endospermous, aiding in their dispersal and germination.

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Historical records suggest that *Datura metel* was first described by Carl Linnaeus in 1753. Though it was previously believed to be native to India, modern studies indicate that it was introduced to the Indian subcontinent before the 4th century CE, predating European exploration of the Americas. The exact means of its introduction—whether through natural events or human activity—remains uncertain.[3] *Datura metel* has been traditionally recognized for its sedative properties and has been used in Ayurvedic medicine to treat hydrophobia. Additionally, in Thai traditional medicine, *Datura metel* leaves have been widely used for treating infectious skin conditions and cutaneous lesions, including abscesses, tinea infections, insect bites, and chronic wounds.[4] Furthermore, *Datura metel* leaves are rich in bioactive compounds, including alkaloids, terpenoids, and saturated fatty acids, which contribute to their medicinal properties. These bioactive substances play a significant role in the plant's pharmacological effects, such as anti-inflammatory, antimicrobial, and analgesic activities.[5,6,7]

The leaves of *Datura metel* exhibit potent antioxidant, anti-inflammatory, antibacterial, and antifungal properties. Additionally, previous studies have demonstrated their potential application in the treatment of cutaneous wounds, diabetic ulcers, and psoriasis, highlighting their therapeutic significance in traditional and modern medicine.[4,6,8] The medicinal applications of *Datura metel* include its analgesic, anti-inflammatory, and anthelmintic properties. It has been traditionally used to alleviate stomach and intestinal pain caused by worm infestations, as well as to relieve toothaches and fevers.[9]The leaves of *Datura metel* have been traditionally used as a topical treatment for rheumatic joint swellings, lumbago, sciatica, neuralgia, painful tumors, scabies, eczema, allergies, and glandular inflammations such as mumps. They are also applied externally for earaches and smoked to relieve spasmodic asthma. Throughout history, medicinal agents have been derived from natural products based on traditional knowledge. *Datura metel* has been widely used for pain relief and has been employed in treating epilepsy, skin diseases, fever with catarrh, hysteria, heart diseases, and diarrhea. In China and Vietnam, it is used to manage asthma, while its extracts have served as a general anesthetic and a treatment for chronic bronchitis. In India, it is believed to cure conditions such as cerebral complaints, catarrhal infections, elephantiasis, ear discharge, skin ailments, mad dog bites, and indigestion. In Brazil, *Datura metel* seeds are infused in tea for their sedative properties, and dried flowers are smoked. Additionally, young Nigerians regard it as a hallucinogenic agent.[10]

Despite the extensive traditional use of *Datura metel* in various medicinal applications, there is a lack of comprehensive scientific validation regarding its phytochemical composition. While previous studies have identified certain alkaloids, flavonoids, and other bioactive compounds, systematic analysis of its phytochemical constituents remains limited. Most research has focused on isolated compounds rather than whole-plant extracts, leading to an incomplete understanding of their synergistic effects. Additionally, variations in phytochemical content due to geographical and environmental factors have not been adequately explored. Moreover, existing studies have primarily focused on the leaves, while limited research has been conducted on the stem. Addressing these gaps is crucial for establishing a more robust scientific foundation for the therapeutic applications of *Datura metel*. This study aims to investigate the phytochemical composition of *Datura metel* stem and leaves through qualitative phytochemical analysis. The research seeks to identify key bioactive compounds such as alkaloids, flavonoids, phenols, tannins, and saponins. By providing a detailed phytochemical profile of both the stem and leaves, this study contributes to a better understanding of the medicinal potential of *Datura metel*, supporting its traditional use in herbal medicine.

MATERIALS AND METHODS

Collection and Preparation of Plant Material

Naturally growing *Datura metel* plants were collected from their natural habitat. The plant was carefully identified, and different parts, including the root, stem, leaves, and fruit with seeds, were separated. Each plant part was thoroughly washed with distilled water to remove any surface contaminants and then dried under shade for several days until completely moisture-free. The dried plant material was then ground into a fine powder using a mechanical grinder and stored in airtight containers for further analysis.

Preparation of Plant Extract

For the preparation of *Datura metel* extract, 5 grams of each powdered sample were taken and mixed with a solvent mixture consisting of 80 mL methanol and 20 mL distilled water. The mixture was left to macerate overnight at room temperature to allow the extraction of bioactive compounds. The next day, the extract was filtered using Whatman No.1 filter paper to remove solid residues. The obtained filtrate was stored in sterile containers at 4°C until further use in qualitative phytochemical analysis.

Qualitative Phytochemical Analysis

The qualitative phytochemical analysis of *Datura metel* extract was conducted using standard biochemical tests to determine the presence of various bioactive compounds, including proteins, carbohydrates, steroids, alkaloids, glycosides, tannins, saponins, phenols, anthocyanins, oils/fats, and flavonoids. To test for proteins, the Biuret test, Ninhydrin test, and Xanthoproteic test were performed, where the appearance of violet, pink/purple, and yellow

precipitates, respectively, indicated positive results. Carbohydrates were identified using Benedict's and Fehling's tests, where the formation of green color and red precipitate confirmed the presence of reducing sugars. Steroids were detected by adding chloroform and concentrated sulfuric acid, which resulted in a red color change. The presence of alkaloids was confirmed through Wagner's and Mayer's tests, indicated by brown and yellow precipitate formation, respectively.

Glycosides were tested using the Dragendorff's and Keller-Killani tests, where reddish coloration and reddish-brown formation confirmed positive results. Tannins were identified by the addition of 5% ferric chloride, leading to a blue-green or black color change. The foam test was used to confirm the presence of saponins, as the formation of persistent foam indicated a positive result. Phenols were detected using the Folin–Ciocalteu reagent, which resulted in a purple color change. The presence of anthocyanins was confirmed by treating the extract with 2N hydrochloric acid, followed by ammonia, where a pink-red color turning purplish-blue indicated a positive reaction. Oils and fats were tested using the translucent spot test, where the appearance of a translucent oily mark on filter paper indicated their presence. Finally, flavonoids were confirmed by mixing the extract with 2N sodium hydroxide, leading to the development of a yellow color, indicating a positive result.

This comprehensive phytochemical screening provides valuable insight into the bioactive compounds present in *Datura metel*, supporting its potential medicinal applications.

RESULTS

The qualitative and quantitative analysis of *Datura metel* revealed the presence of various bioactive compounds in the leaf and stem extracts. The findings highlight differences in the distribution of these phytochemicals, suggesting their potential medicinal significance. The results, as summarized in Table 1, indicate that the leaf extract of *Datura metel* contains a higher concentration of phytochemicals compared to the stem extract. Both extracts exhibited the presence of essential secondary metabolites such as alkaloids, glycosides, saponins, phenols, and proteins. However, there were notable differences in the distribution of certain compounds between the leaf and stem.

Alkaloids and Glycosides: Alkaloids, known for their pharmacological significance, were detected in both leaf and stem extracts, with a higher presence in the leaf. Similarly, glycosides, which exhibit cardioprotective and antimicrobial properties, were detected in both extracts, with the stem showing a slightly higher concentration.

Phenolic Compounds and Tannins: Phenols, known for their antioxidant properties, were highly abundant in the leaf extract compared to the stem. Interestingly, tannins were present only in the leaf extract, which could contribute to its wound-healing and antimicrobial properties.

Flavonoids and Anthocyanins: Flavonoids were detected in the stem extract but were absent in the leaf. Conversely, anthocyanins were found only in the leaf extract. Flavonoids are well known for their antioxidant and anti-inflammatory properties, while anthocyanins contribute to various pharmacological activities, including anti-cancer and neuroprotective effects.

Saponins and Steroids: Saponins, known for their immune-boosting and antimicrobial properties, were present in both extracts, although in lower amounts in the stem. Steroids, which play a role in anti-inflammatory and hormonal activities, were absent in both extracts.

Carbohydrates and Proteins: Carbohydrate tests confirmed the presence of reducing sugars in both leaf and stem extracts, with the leaf showing a higher concentration. Protein tests were positive for both extracts, confirming the presence of essential amino acids that may contribute to the plant's medicinal effects.

Comparison Between Leaf and Stem Extracts

The qualitative analysis reveals that the leaf extract of *Datura metel* is richer in phytochemicals compared to the stem extract. The presence of tannins and anthocyanins exclusively in the leaf suggests that it may have stronger antioxidant and antimicrobial properties. On the other hand, the stem extract contains flavonoids, which are absent in the leaf, indicating its potential for anti-inflammatory and cytoprotective applications.

Medicinal Significance of the Phytochemicals in *Datura metel*

The presence of alkaloids, phenols, glycosides, and flavonoids suggests that *Datura metel* possesses significant medicinal properties. Traditionally, *Datura metel* has been used in the treatment of various ailments, including pain relief, skin diseases, and respiratory disorders. The current findings provide scientific support for these traditional applications by confirming the presence of bioactive compounds that exhibit antimicrobial, analgesic, and anti-inflammatory activities.

Table 1: Qualitative analysis of phytochemicals in leaf and stem extracts of *Datura metel*

Sl. No	Tests	Leaf Extract	Stem extract
1	Protein test		
i	Biuret test	-	-
ii	Ninhydrin test	+++	+++
iii	Xanthoprotic test	-	++
2	Carbohydrate test		
i	Benedict's test	+++	++
ii	Fehling's test	+	+
3	Steroids	-	-
4	Alkaloids test		
i	Wagner test	+++	++
ii	Mayer's test	++	-
5	Glycosides		
i	Dradendroff's test	++	+++
ii	Keller-Killani test	+++	++
6	Tannins	++	-
7	Saponins	++	+
8	Phenol	+++	++
9	Anthocyanin	++	-
10	Oil/fat		
i	Translucent spot	+	+
11	Flavonoids	-	++

(+++) High presence ; (++) Moderate presence ; (+) Low presence; (-) Absent

Quantitative Analysis of Phytochemicals in *Datura metel*

A quantitative analysis of proteins, phenols, flavonoids, and alkaloids was performed on the leaf and stem extracts of *Datura metel*. The findings provide insights into the bioactive compound concentrations in different plant parts, contributing to a deeper understanding of their potential medicinal applications.

Protein Estimation (Lowry's Method): The Lowry's method was used to estimate protein content using BSA (Bovine Serum Albumin) as the standard as shown in figure 1. The results indicate that both leaf and stem extracts contain measurable amounts of protein, with the leaf extract showing a higher concentration. This suggests that the leaf extract may have a greater potential for nutritional and enzymatic applications.

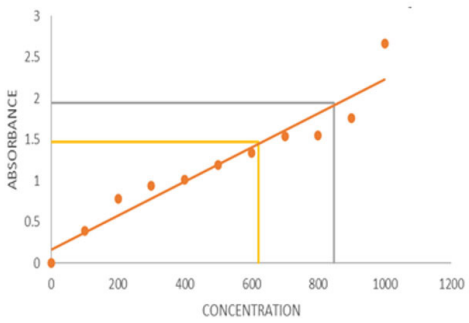

Figure 1: Estimation of protein from leaf and stem of *D. Metel*. Concentration is in mg/ml and absorbance at 640nm. yellow line : stem extracts, gray line: leaf extract; black line: BSA(Bovine serum albumin)

Phenol Estimation: The phenolic content was determined using Folin-Ciocalteu (F.C) reagent, followed by sodium carbonate treatment. The optical density (O.D) was measured at 650 nm. Phenols are known for their antioxidant properties, which contribute to free radical scavenging and anti-inflammatory effects. The leaf extract exhibited a significantly higher phenol content compared to the stem extract, suggesting its stronger potential for antioxidant applications.

The leaf extract exhibited a higher protein and phenol content compared to the stem extract as shown in figure 2. Phenolic compounds are known for their strong antioxidant activity, which may contribute to the medicinal value of *D. Metel* leaves in treating oxidative stress-related disorders. The higher protein content in leaves suggests their importance in enzymatic and structural functions within the plant.

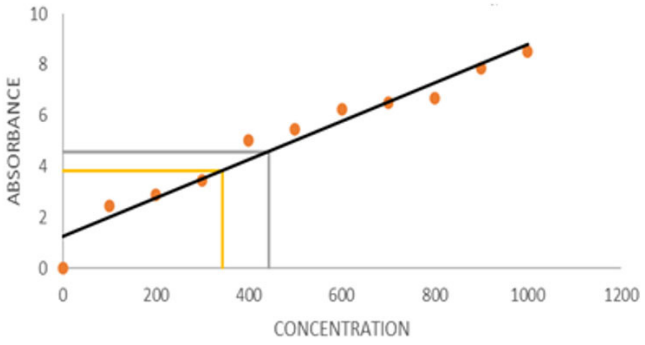

Figure 2: Estimation of phenol from leaf and stem of *D. Metel*. Concentration is in mg/ml and absorbance at 650nm. yellow line : stem extracts, gray line: leaf extract; black line: standard sample.

Flavonoid Estimation: Flavonoid content was estimated using a colorimetric method involving sodium nitrite, aluminum chloride, and sodium hydroxide, with absorbance measured at 510 nm. Flavonoids are well known for their anti-inflammatory and antimicrobial properties. The leaf extract contained a moderate amount of flavonoids, while the stem extract had a slightly higher concentration as shown

in figure 3. This indicates that the stem may have enhanced bioactive potential for therapeutic applications.

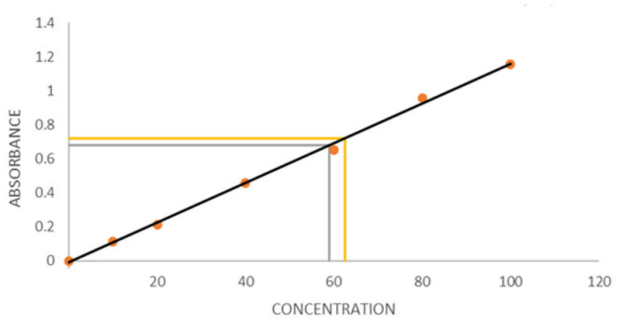

Figure 3: Estimation of flavonoids from leaf and stem of *D. Metel*. Concentration is in mg/ml and absorbance at 510nm. yellow line: stem extracts, gray line: leaf extract; black line: standard sample.

Alkaloid Estimation: The alkaloid content was determined using bromocresol green (BCG) with phosphate buffer, followed by chloroform extraction. The absorbance of the complex in chloroform was measured at 470 nm. Alkaloids are significant bioactive compounds with analgesic, antimicrobial, and neuropharmacological effects. The leaf extract showed a higher concentration of alkaloids as shown in figure 4 compared to the stem extract, suggesting its potential application in pain management and antimicrobial treatments.

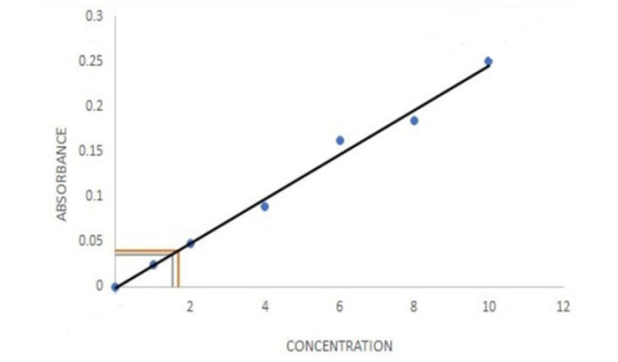

Figure 4: Estimation of alkaloids from leaf and stem of *D. Metel*. Concentration is in mg/ml and absorbance at 470nm. yellow line : stem extract; gray line: leaf extracts; black line: standard sample.

DISCUSSION

The present study provides a comparative phytochemical analysis of *Datura metel* leaf and stem extracts, revealing significant variations in the presence and concentration of bioactive compounds. These findings highlight the plant's medicinal potential and the necessity of targeted utilization of its different parts in therapeutic applications.

The qualitative analysis confirmed the presence of various bioactive compounds in both leaf and stem extracts. Notably, flavonoids were detected in the stem but absent in the leaves, whereas tannins and anthocyanins were exclusive to the leaves. The presence of alkaloids, glycosides, saponins, and phenols in both extracts suggests that *Datura metel* possesses a broad spectrum of bioactive properties, supporting its traditional medicinal use. The higher presence of tannins and anthocyanins in leaves could contribute to their antioxidant and anti-inflammatory activities, while the flavonoid-rich stem may offer antimicrobial benefits.

The quantitative estimation of key bioactive compounds further demonstrated significant differences between the leaf and stem extracts:

Proteins and Phenols: The leaf extract exhibited a notably higher concentration of proteins and phenols compared to the stem extract. Phenols are well known for their potent antioxidant activity, which helps mitigate oxidative stress-related disorders. The higher phenolic content in leaves suggests a stronger potential for applications in antioxidant therapy and free radical scavenging. The greater protein concentration in the leaf extract also implies a crucial role in structural and enzymatic functions, making it a valuable component for nutritional and medicinal applications.

Flavonoids: The stem extract contained a higher flavonoid concentration than the leaf extract. Flavonoids are associated with anti-inflammatory, antimicrobial, and cardiovascular protective properties. This suggests that the stem may be more beneficial in antimicrobial treatments and immune-modulating therapies.

Alkaloids: The alkaloid content was found to be higher in the leaf extract. Alkaloids have been extensively studied for their analgesic, antimicrobial, and neuropharmacological effects. The higher concentration in leaves suggests their potential for pain management and antimicrobial drug development.

CONCLUSIONS

The findings of this study highlight the rich phytochemical composition of *Datura metel*, particularly in its leaves. The differential distribution of bioactive compounds between the leaf and stem suggests that different plant parts may have distinct therapeutic applications. Further quantitative analysis and bioactivity studies are recommended to explore the full medicinal potential of this plant.

The quantitative phytochemical analysis of *Datura metel* root and seed extracts reveals their rich bioactive compound content. The seed extract exhibits higher phenolic and flavonoid

concentrations, suggesting strong antioxidant potential, while the root extract is rich in alkaloids, indicating possible medicinal applications. Further studies, including *in vitro* and *in vivo* bioactivity assays, are recommended to explore the therapeutic potential of these bioactive compounds.

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Conflict of Interest

None

Authors' Contribution

All authors have equal contribution in bringing out this research work

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