**QUANTITATIVE ANALYSIS AND PHARMACOLOGICAL IMPLICATIONS OF TOTAL FREE AMINO ACIDS IN SELECTED WILD SOLANACEAE SPECIES FROM THE MENAL FOREST REGION OF RAJASTHAN**

ABSTRACT

The total amino acid content of a few Solanaceae species—*Datura fastuosa, Datura innoxia, Physalis angulata, Physalis minima, and Solanum virginianum*—collected from the Menal Forest region in Chittorgarh, Rajasthan, is examined in this study. The ninhydrin colorimetric method was used to estimate the total amino acids in plant samples that had undergone acid hydrolysis. The findings showed notable interspecific variation, with the highest levels of amino acids found in Physalis minima and Solanum virginianum. These species are valued for their biochemical potential and ethnomedical significance. The results support the relevance of wild Solanaceae in pharmaceutical and nutraceutical applications and advance knowledge of their nutritional value.

INTRODUCTION

The phytochemistry of Solanaceae species has been extensively studied over the past four decades, revealing a rich diversity of bioactive compounds such as alkaloids, flavonoids, and amino acids. Early foundational research in the 1980s and 1990s (Moore and Stein, 1983; Rathore and Sharma, 1987; Shankar and Khare, 1995) focused on the chemical profiling of *Datura* and *Solanum* species, emphasizing their medicinal properties. Bates et al. (1992) and Vyas and Sharma (2000) investigated amino acid metabolism in response to environmental stress, highlighting their adaptive significance. Sharma et al. (2005) further documented essential amino acids in wild *Physalis* taxa. Subsequent studies (Patel et al., 2011; Karpagasundari and Kulothungan, 2014) confirmed amino acid presence in *Physalis minima* through chromatographic techniques. Investigations into *Physalis peruviana* revealed high essential amino acid content beneficial for nutrition (Puente et al., 2011; Ramadan, 2011; Mokhtar et al., 2018). Other studies (Lim, 2012; Georgiev et al., 2013) have supported the therapeutic potential of Solanaceae due to their amino acid and secondary metabolite richness. From 2015 onwards, Singh and Rawat (2016), Kumar et al. (2017), and Mishra et al. (2018) have expanded biochemical profiling of *Solanum* species, while Sharma and Kumar (2018) reported amino acid quantification in *Datura fastuosa* related to its pharmacological uses. Yadav et al. (2019) highlighted amino acid variation in *Physalis angulata* under abiotic stress, and Verma and Singh (2020) emphasized the nutraceutical potential of wild Solanaceae species. More recent biochemical investigations (Almeida et al., 2021; Jaiswal and Dubey, 2022) further validated the antioxidant and amino acid content in *Solanum nigrum* and *Datura stramonium*. Gupta et al. (2022) and Reddy et al. (2023) focused on amino acid profiling of forest-origin Solanaceae species in semi-arid regions, underscoring their ecological and nutritional importance. A 2024 study analyzed amino acid changes during maturation in *Solanum* fruits, revealing variations in essential and nonessential amino acid content across ripening stages . Additionally, a 2025 review provided insights into the pharmacology and phytochemistry of *Solanum nigrum*, highlighting its therapeutic potential. Despite this growing body of knowledge, detailed amino acid estimation in selected Solanaceae species from the Menal Forest region, Rajasthan remains limited. The present study addresses this by quantifying total amino acids in *Datura fastuosa*, *Datura innoxia*, *Physalis angulata*, *Physalis minima*, and *Solanum virginianum* using acid hydrolysis and ninhydrin colorimetric methods, thus contributing to the biochemical and nutritional characterization of these ecologically and pharmaceutically important plants.

MATERIAL AND METHODS

The ninhydrin method, as outlined by Moore and Stein (1948), was used to estimate the amount of free amino acids. 20 g of ninhydrin dissolved in 500 ml of methyl cellosolve was mixed with 0.8 g of reagent-grade stannous chloride (SnCl₂) that had been dissolved in 500 ml of citrate buffer (pH 5). 200 mg of dried material from each organ was mixed with 10 ml of 80% isopropanol to homogenize the plant samples. The mixture was then centrifuged, and the residue was extracted again using 10 ml of 80% isopropanol. The residue was then re-extracted using an additional 10 milliliters of 80% isopropanol after centrifugation. Following a chloroform and water treatment to eliminate chlorophyll pigments from the combined supernatants, the aqueous phase was utilized to estimate the amount of amino acids. One milliliter of the ninhydrin reagent was added to a measured aliquot of this aqueous extract, and the mixture was then heated in boiling water for twenty minutes. The optical density was measured at 570 nm after cooling and adding 5 ml of diluent (50% isopropanol). The calibration curve for the measurement of total free amino acids was created using alanine as the standard.

RESULTS

Total free amino acids were estimated in different organs—leaf, stem, and root—of five selected Solanaceae species of the same age collected from the Menal Forest region, Chittorgarh, Rajasthan. The results (Table 1) reveal clear interspecific and organ-specific variations in amino acid content. Among the species studied, *Datura innoxia* consistently exhibited the highest amino acid concentrations across all organs, particularly in leaves (68.09 mg/g dry weight), stems (54.07 mg/g), and roots (35.08 mg/g), indicating its superior metabolic activity and potential adaptability to the semi-arid forest environment. *Solanum virginianum* and *Datura fastuosa* also showed relatively high amino acid levels in leaves (57.07 mg/g and 56.03 mg/g, respectively), stems (46.03 mg/g and 49.05 mg/g), and roots (31.05 mg/g and 28.09 mg/g), reflecting their biochemical richness and possible roles in stress tolerance and physiological functions. Conversely, the lowest amino acid content was found in *Physalis angulata* (48.06 mg/g in leaves) and *Physalis minima* (35.04 mg/g in stems and 20.03 mg/g in roots), which may be due to differences in metabolic pathways or ecological adaptations. Notably, leaves of all species contained the highest amino acid concentrations, underscoring their primary role in amino acid biosynthesis and overall plant metabolism. The average total free amino acid content across all organs was highest in *Datura innoxia* (52.41 mg/g), followed by *Solanum virginianum* (44.72 mg/g), and lowest in *Physalis angulata* (35.38 mg/g). These findings highlight the nutritional and pharmacological potential of these wild Solanaceae species, supporting their traditional uses and encouraging further exploration of their bioactive compounds for pharmaceutical and nutraceutical applications. Among the five Solanaceae species studied, *Datura innoxia* demonstrated the highest amino acid content, supporting its established use in traditional medicine for treating pain, asthma, inflammation, and muscle spasms, owing to its antispasmodic, anti-inflammatory, and analgesic properties. *Solanum virginianum*, a well-known Ayurvedic herb (Kantakari), is widely used in managing respiratory disorders, liver ailments, and bacterial infections, and is a key component of classical formulations like Dashmool and Chyawanprash. *Datura fastuosa* (syn. *D. metel*) is valued for its effectiveness in treating neurological conditions such as epilepsy and convulsions, supported by the presence of alkaloids like scopolamine and atropine. *Physalis angulata*, though lower in amino acid content, is traditionally employed by tribal communities for its antimalarial, anti-asthmatic, and anti-inflammatory benefits. Lastly, *Physalis minima*, despite its relatively low biosynthetic profile, holds ethnomedicinal importance in the treatment of fever, hepatitis, and urinary tract infections, likely due to its rich reservoir of withanolides and flavonoids.

Top of Form

Bottom of Form

**Table 1: Total free amino acids (mg/g dry weight) in different organs of selected Solanaceae species from the Menal Forest region, Chittorgarh, Rajasthan**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | | **Name of species** | | | | | **Leaf** | | **Stem** | | | **Root** | | **Total in**  **entire plant** | |
| 1. | | *Datura fastuosa* | | | | | 56.03 | | 49.05 | | | 28.09 | | 44.39 | |
| 2. | | *Datura innoxia* | | | | | 68.09 | | 54.07 | | | 35.08 | | 52.41 | |
| 3. | | *Physalis angulata* | | | | | 48.06 | | 36.03 | | | 22.04 | | 35.38 | |
| 4. | | *Physalis minima* | | | | | 55.07 | | 35.04 | | | 20.03 | | 36.71 | |
| 5. | | *Solanum virginianum* | | | | | 57.07 | | 46.03 | | | 31.05 | | 44.72 | |
|  | |  | | | | |  | |  | | |  | |  | |
|  | | | |  |  |  | | | | |

**GRAPH 1: TOTAL FREE AMINO ACIDS (MG/G DRY WEIGHT) IN DIFFERENT ORGANS OF SELECTED SOLANACEAE SPECIES FROM MENAL FOREST, CHITTORGARH**

DISCUSSION

Significant interspecific and organ-specific differences are found when the total free amino acids of five wild Solanaceae species from the Menal Forest region are analyzed. Among all the organs, *Datura innoxia* had the highest amino acid content, indicating its high metabolic activity and versatility. Additionally, *Datura fastuosa* and *Solanum virginianum* showed increased levels, confirming their established therapeutic uses. However, because of other bioactive substances, *Physalis angulata* and *Physalis minima* had lower concentrations of amino acids, despite their continued significance in traditional medicine. The highest amino acid content was consistently found in leaves, confirming their crucial function in biosynthesis. These differences demonstrate the species' pharmacological significance and encourage further research into phytomedicine.

CONCLUSION

According to their total free amino acid profiles, the five wild Solanaceae species that were studied—*Datura fastuosa, Datura innoxia, Physalis angulata, Physalis minima, and Solanum virginianum*—all have medicinal value. The observed significant interspecific and organ-specific variations support the species' innate pharmacological and metabolic variability. With the highest biosynthetic activity, *Datura innoxia* and *Solanum virginianum* show great promise for therapeutic uses, particularly in respiratory, antispasmodic, and anti-inflammatory therapies. Additionally, *Datura fastuosa* has potential, especially in the field of neuropharmacology. Further investigation into the phytochemical composition of *Physalis angulata* and *Physalis* *minima* is justified by their established traditional uses, despite their lower amino acid content. All things considered, the biochemical knowledge gathered from this research lends credence to the ongoing pharmacognostic assessment of wild Solanaceae species as important sources for drug development based on natural products.

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