Volume 4, Issue 3, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

COMPARATIVE PROXIMATE PROFILING AND NUTRIENT ALLOCATION IN VEGETATIVE AND REPRODUCTIVE TISSUES OF WILD AND CULTIVATED *SOLANACEAE SPECIES* ACROSS ECOLOGICAL ZONES

Qurat Ul Ain*[1], Muhammad Fahad*[2], Zarnain Fatima[3], Niba Amanat[4], Tania Zahra[5]

*[1,*2,3,4,5]*Department of Botany, University of Agriculture Faisalabad, Pakistan*

*[1]anniebotanist@gmail.com, [2]fahadmian435@gmail.com

DOI: https://doi.org/10.5281/zenodo.22827599

Keywords

Solanaceae; proximate profiling; nutrient allocation; wild edible plants; agro-biodiversity; functional biomass; food security.

Article History

Received: 27 January 2026
Accepted: 12 March 2026
Published: 26 March 2026

Copyright @Authors

Corresponding Author: *
Qurat Ul Ain
Muhammad Fahad

Abstract

Wild and underutilized solanaceous taxa represent untapped reservoirs of essential nutrients and functional biocompounds, yet their organ-specific nutrient partitioning across contrasting ecological zones remains poorly characterized. This study evaluated the proximate composition and biomass allocation patterns in foliar and mature fruit tissues of 14 wild and cultivated Solanaceae species harvested across diverse ecological zones of Pakistan. Dried botanical tissues underwent standardized proximate quantification. Substantial interspecific and inter-organ metabolic divergence was observed across all measured nutritional fractions. Foliar tissues functioned as primary metabolic and inorganic sinks, showing markedly higher ash (12.94 ± 0.30% to 30.40 ± 0.72%), crude protein (14.00 ± 0.35% to 27.13 ± 0.58%), and crude fiber (7.22 ± 0.24% to 23.52 ± 0.64%) on a dry-weight basis. Peak foliar mineral reserves were sequestered by Lycium persicum (30.40%) and Hyoscyamus muticus (30.38%), whereas Datura innoxia and Solanum schimperianum yielded the highest protein contents (27.13%). In contrast, reproductive fruit tissues operated predominantly as low-mineral sink organs (ash: 0.001 ± 0.00% to 1.01 ± 0.03%; protein: 3.00 ± 0.08% to 6.50 ± 0.20%), channeling metabolic reserves into total carbohydrates (82.75 ± 0.50% to 89.08 ± 0.28%) and moderate lipid fractions (1.01 ± 0.03% to 5.00 ± 0.15%). Moisture remained low across both dried leaves (5.74-8.35%) and fruits (2.90-4.20%), indicating favorable stability for post-harvest valorization. These findings demonstrate pronounced source-sink physiological differentiation in Solanaceae and identify P. angulata, S. villosum, and L. persicum as promising candidates for dietary diversification, nutraceutical extraction, and indigenous bioresource valorization.

1- Introduction

The family *Solanaceae* is one of the most economically and pharmacologically important plant families, comprising approximately 98 genera and over 2,700 species distributed worldwide particularly in tropical and subtropical regions (Kushwaha and Tiwari, 2025; Jan *et al.*, 2024). Several members of this family, including *Capsicum annuum*, *Solanum* spp., and *Physalis angulata*, are widely utilized as food crops, while others such as *Datura* spp., *Hyoscyamus muticus*, and *Withania somnifera* are recognized for their medicinal properties. In addition to their ethnobotanical significance, Solanaceous species

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

are rich source of bioactive compounds, including alkaloids, flavonoids, and phenolics, which contribute to their nutritional and therapeutic value (Yadav and Koshi, 2022; Ralte *et al.*, 2021). Proximate analysis is a fundamental approach for evaluating the nutritional composition of plant materials, providing essential information on major constituents such as moisture, ash, crude protein, crude fat, crude fiber, and carbohydrates. These parameters are critical for assessing the dietary potential of plant species and their suitability for use in food, pharmaceutical, and industrial application. Variation in proximate composition are influenced by multiple factors, including species diversity, plant organ, environmental conditions, and geographical distribution (Shahid et al., 2023; Quadri *et al.*, 2021).

The flora of *Solanaceae* is diverse and adapted to wide range of ecological zones, from arid and semi-arid regions to more humid environments. Despite the abundance and traditional utilization of many solanaceous species in Sudanese communities, comprehensive data on their nutritional composition remain limited (Bhatla and Kathpalia; Uzoekwe, and Ezenwajiugo, 2023). This gap is particularly evident for wild and underutilized species. Whose potential contributions to food security and nutritional health have not been fully explored.

Leaves and fruits represent two functionally distinct plant organs with differing metabolic roles, which is often reflected in their chemical compositions (Aguirre et al., 2018). Leaves are generally associated with higher protein, mineral (ash), and fiber contents due to their involvement in photosynthesis and metabolic activity (Kumar *et al.*, 2022), whereas fruits tend to accumulate carbohydrates and water to support seed development and dispersal (Crang *et al.*, 2018; Parolin *et al.*, 2010). Therefore, comparative analysis of these organs provides valuable insights into the nutritional allocation strategies of plants.

The present study aims to evaluate the proximate composition of leaves and fruits of selected Solanaceous species collected from different regions using standard AOAC methods. By comparing the nutritional profiles of these species, this work seeks to highlight their potential as alternative source of nutrients and contribute to the growing body of knowledge on Pakistanies plant resources.

2- Materials and Methods

2.1. Collection Sites and Botanical Sampling

Fresh foliar and mature fruit samples of 14 representative Solanaceae species were collected during their peak vegetative and fruiting phenophases across diverse ecological zones of Pakistan as depicted in Figure 1. For each taxon, healthy disease-free specimens were harvested in triplicate from randomized multi-point sampling plots to obtain representative pooled biomass. Taxonomic identities were confirmed by plant taxonomists using the *Flora of Pakistan*, and authenticated voucher specimens were deposited in the herbarium for future reference. Georeferencing of each collection locality was executed on-site using a handheld GPS receiver (Garmin Montana 700; accuracy ±3 m) configured to the WGS-84 datum.

Volume 4, Issue 3, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

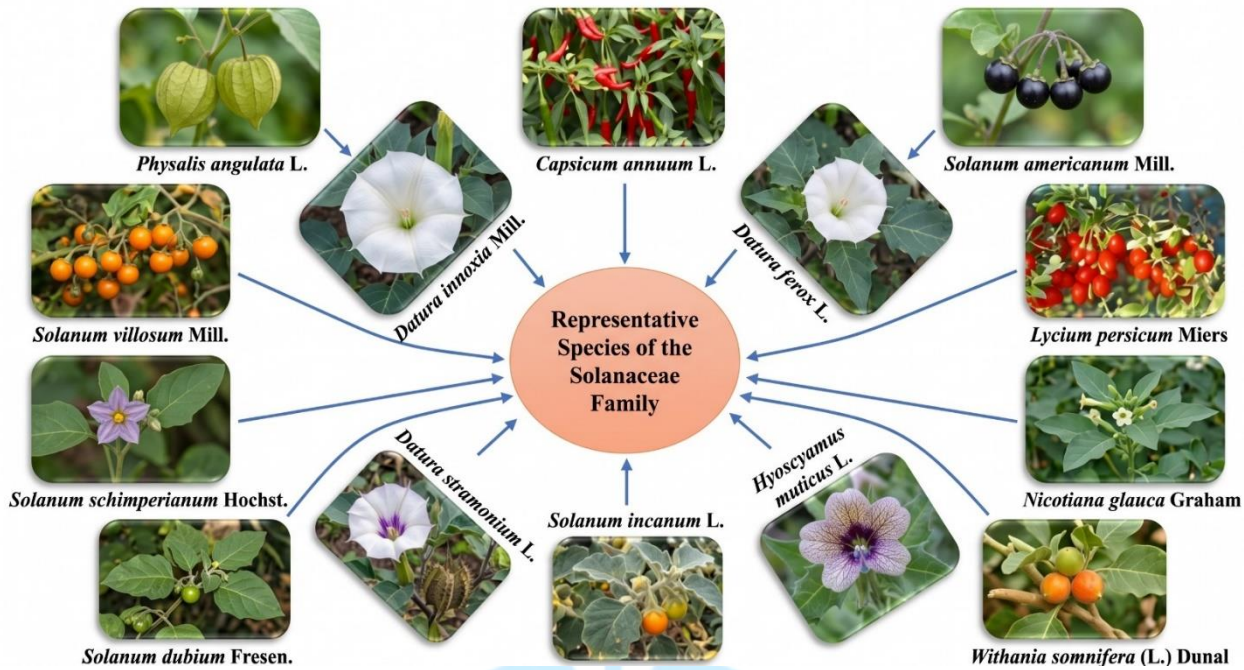


Figure 1: Schematic representation of foliar and fruit morphotypes of the fourteen *Solanaceae* species collected across diverse ecological zones of Pakistan

Table 1. Collection sites, ecological zones, and geographic coordinates of the studied Solanaceae species in Pakistan.

Solanaceae Species	Localities	Ecological Zone	Coordinates (WGS-84)	Elevation (m a.s.l.)
Capsicum annuum L.	Multan (Punjab)	Irrigated agricultural zone	30°11′52″ N, 71°28′11″ E	124
Datura ferox L.	Rawalpindi (Punjab)	Subtropical wasteland	33°35′50″ N, 73°03′45″ E	508
Datura innoxia Mill.	Bahawalpur (Punjab)	Arid wasteland	29°23′44″ N, 71°40′38″ E	116
Datura stramonium L.	Abbottabad (Khyber Pakhtunkhwa)	Temperate-subtropical foothills	34°09′22″ N, 73°13′18″ E	1,256
Hyoscyamus muticus L.	Sibi (Balochistan)	Hyper-arid stony plains	29°33′12″ N, 67°52′44″ E	134
Lycium persicum Miers	Chaghi (Balochistan)	Xeric desert plains	28°53′40″ N, 64°24′15″ E	845
Nicotiana glauca Graham	Islamabad (ICT)	Disturbed riparian slope	33°43′16″ N, 73°04′22″ E	540
Physalis angulata L.	Faisalabad (Punjab)	Cultivated field borders	31°25′16″ N, 73°04′41″ E	184
Solanum americanum Mill.	Lahore (Punjab)	Subtropical alluvial plain	31°32′59″ N, 74°20′37″ E	217
Solanum dubium Fresen.	Lasbela (Balochistan)	Coastal desert	25°52′18″ N, 66°35′49″ E	45

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Solanum incanum L.	Chakwal (Punjab)	Pothohar plateau	32°56′02″ N, 72°51′30″ E	498
Solanum schimperianum Hochst.	Khuzdar (Balochistan)	Subtropical dry rocky terrain	27°48′11″ N, 66°36′52″ E	1,230
Solanum villosum Mill.	Swat (Khyber Pakhtunkhwa)	Sub-Himalayan valleys	34°46′24″ N, 72°21′45″ E	980
Withania somnifera (L.) Dunal	Jhelum (Punjab)	Semi-arid open scrub	32°55′43″ N, 73°43′41″ E	234

2.2. Plant Materials

Healthy leaf and mature fruit samples were collected in triplicate from natural populations across designated ecological zones of Pakistan (Table 1). Preliminary identification was executed in the field using standard diagnostic taxonomic keys from the *Flora of Pakistan*. Definitive botanical verification was established by cross -referencing authenticated voucher sheets at the National Herbarium of Pakistan (RAW), Islamabad. Validated voucher specimens were assigned specific accession codes and deposited in the herbarium for permanent reference.

2.3. Proximate Analysis

The proximate analysis (carbohydrates, fats, proteins, moisture and ash) of all plant samples were determined by using AOAC methods (AOAC, 2019).

2.3.1. Determination of Moisture

Three gram of dry plant material was taken in a Petri plate and placed in oven at about 105 °C for 6 hours as described by Arif et al. (2026), cooled in desiccator and moisture content was calculated using the following formula;

$$\text{Moisture (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dry sample}}{Weight\ of\ sample} \times 100$$

2.3.2. Determination of Ash

1 g. of dried plant materials was taken in a weighted crucible and burnt over low flame. The crucible was then placed in furnace at 550 °C for 3 hours until white ash was obtained. The percent ash was calculated as;

$$\text{Ash (\%)} = \frac{\text{Weight of sample after ashing}}{Weight\ of\ sample} \times 100$$

2.3.3. Determination of Fats

Soxhlet extractor was used to get fat content of the sample. 5gm of plant material were put on paper thimble and run for six hours on heating mantle. The percent crude fat was determined by using formula (AOAC, 2019).

$$\text{Crude Fat (\%)} = \frac{\text{Weight of beaker with fat} - \text{Weight of empty beaker}}{Weight\ of\ original\ sample} \times 100$$

2.3.4. Determination of proteins

Plant sample was added to the digestion mixture (copper sulphate: Potassium sulphate: ferrous sulphate: 1:18.5:0.25 (w/w/w) and 20 mL of concentrated sulphuric acid was added to the flask and boiled for 2 hours. The digest was transferred to the distillation assembly and 10 mL of 40% sodium hydroxide solution was added to the digest in the assembly. This process was followed by titration to remove the ammonium borate formed in distillation process as described by Naqvi et al. (2025). The percent protein was calculated by the following formula;

$$\text{Protein (\%)} = \frac{1.4 \times 6.25 \times 0.1\text{N HCl} \times \text{Vol of H2 SO4}}{Weight\ of\ sample} \times 100$$

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

2.3.5. Determination of Carbohydrates

Carbohydrate was determined by using the formula;

Carbohydrate % = 100 - (% moisture content + % crude fat + % crude fiber + % Ash + % Protein)

2.4. Statistical Analysis

All proximate determinations and experimental assays were executed in triplicate (n = 3), and results were expressed as mean ± standard deviation (SD) on a dry weight basis as described by Urooj & Asif (2026a) and Shabbir et al. (2026). The generated proximate datasets were subjected to one-way ANOVA using Statistix (version 8.1) to test the significance of differences among the studied solanaceous taxa. Pairwise comparison of treatment means was accomplished using Tukey's Honest Significant Difference (HSD) post-hoc test at a significance of $p \leq 0.05$.

3- Results and Discussions

3.1 Proximate composition of leaves

The proximate composition of leaves across the 14 investigated solanaceous species demonstrated substantial interspecific variation on a dry weight basis as shown in Table 2 and Figure 2, representing taxon-specific metabolic allocation and physiological divergence.

Moisture content in dried leaf samples ranged from 5.74% in *Hyoscyamus muticus* to 8.35% in *Physalis angulata*, indicating generally low residual moisture favorable for post-harvest preservation and reduced microbial susceptibility. Ash content, serving as an index of total mineral matter, was remarkably high throughout the taxa, spanning from 12.94% in *Solanum schimperianum* to exceptional levels exceeding 30% in *H. muticus* (30.38%) and *Lycium persicum* (30.40%). Such elevated foliar ash values align with established physiological patterns where vegetative organs serve as principal accumulation sinks for macro- and micro-elements translocated via the transpirational stream (Lu et al., 2024; Song et al., 2024; Bhatla and Kathpalia, 2023). In particular, the values recorded in *L. persicum* and *H. muticus* highlight their strong inorganic ion sequestration capacity relative to other Solanaceae (Achuenu et al., 2024; Okoli et al., 2024).

Crude protein constituted a major organic fraction, ranging between 14.00% in *H. muticus* and 27.13% in both *Datura innoxia* and *S. schimperianum*, with *D. ferox* (26.41%), *P. angulata* (26.25%), and *D. stramonium* (25.38%) displaying comparably rich profiles. The concentration of crude protein in leafy tissues corresponds directly to their active role in photosynthetic apparatus maintenance, high-turnover enzymatic systems (such as RuBisCO), and primary nitrogen assimilation (Staveckienė et al., 2024; Tejada-Alvarado et al., 2023; Han et al., 2021). The prominent protein levels in *D. innoxia*, *S. schimperianum*, and *P. angulata* underscore their nutritional significance as concentrated nitrogenous biomass, provided toxic alkaloids typical of certain taxa (notably *Datura*) are properly accounted for.

Crude fat levels were modest across all species, varying from 1.74% in *Solanum dubium* to 5.86% in *Nicotiana glauca*, followed by *P. angulata* (4.50%). These low lipid contents are typical for non-oleaginous vegetative foliage, primarily representing membrane phospholipids, galactolipids, and cuticular waxes rather than storage triacylglycerols (Özcan et al., 2020; Konopka et al., 2023). Crude fiber exhibited wide variation, ranging from 7.22% in *D. innoxia* to peak values of 21.10% in *S. schimperianum* and 23.52% in *Solanum villosum*. This variation reflects structural cell-wall carbohydrate accumulation predominantly cellulose, hemicellulose, and lignin which contributes essential dietary roughage (Ma et al., 2023; Zhang et al., 2020). Total carbohydrates represented the predominant dry-matter component in most species, reaching from 24.21% in *L. persicum* to 40.54% in both *Solanum americanum* and *Solanum incanum*, serving as the primary source of metabolizable calories. Overall, the compositional diversity among the studied species underscores the combined effects of genetic heterogeneity and regional eco-geographical adaptation across Sudan's flora (García et al., 2025; Imran et al., 2024). The foliage of these solanaceous plants demonstrates substantial nutritional potential, marked especially by high crude protein in *Datura* and

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

specific *Solanum* species, pronounced mineral ash reserves in *L. persicum* and *H. muticus*, and substantial dietary fiber fractions in *S. villosum*.

Table 2: Proximate composition of leaves of the studied Solanaceae species (% on dry weight basis)

Solanaceae species	Moisture (%)	Ash (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Total Carbohydrates (%)
Capsicum annuum	5.79 ± 0.18^{f}	19.86 ± 0.45^{c}	23.63 ± 0.52^{d}	3.57 ± 0.12^{c}	9.52 ± 0.31^{h}	37.64 ± 0.78^{bc}
Datura ferox	7.80 ± 0.22^{b}	14.01 ± 0.38^{fg}	26.41 ± 0.61^{ab}	3.90 ± 0.15^{bc}	10.21 ± 0.28^{gh}	39.25 ± 0.85^{ab}
Datura innoxia	6.30 ± 0.15^{e}	14.94 ± 0.32^{ef}	27.13 ± 0.58^{a}	3.30 ± 0.10^{cd}	7.22 ± 0.24^{i}	38.12 ± 0.72^{b}
Datura stramonium	7.76 ± 0.21^{b}	14.10 ± 0.29^{fg}	25.38 ± 0.49^{bc}	2.61 ± 0.09^{de}	11.18 ± 0.35^{fg}	38.98 ± 0.69^{ab}
Hyoscyamus muticus	5.74 ± 0.14^{f}	30.38 ± 0.65^{a}	14.00 ± 0.35^{g}	2.64 ± 0.08^{de}	11.70 ± 0.41^{f}	35.54 ± 0.81^{cd}
Lycium persicum	7.34 ± 0.19^{cd}	30.40 ± 0.72^{a}	20.13 ± 0.44^{e}	2.03 ± 0.07^{ef}	15.90 ± 0.46^{d}	24.21 ± 0.63^{f}
Nicotiana glauca	6.24 ± 0.16^{e}	19.80 ± 0.41^{c}	21.00 ± 0.50^{e}	5.86 ± 0.18^{a}	11.19 ± 0.33^{fg}	35.91 ± 0.74^{c}
Physalis angulata	8.35 ± 0.25^{a}	16.11 ± 0.36^{d}	26.25 ± 0.55^{b}	4.50 ± 0.14^{b}	10.35 ± 0.30^{gh}	34.44 ± 0.70^{d}
Solanum americanum	7.14 ± 0.20^{d}	18.39 ± 0.48^{cd}	17.50 ± 0.42^{f}	2.19 ± 0.08^{ef}	14.24 ± 0.39^{e}	40.54 ± 0.89^{a}
Solanum dubium	6.08 ± 0.17^{ef}	20.33 ± 0.51^{bc}	20.13 ± 0.46^{e}	1.74 ± 0.06^{f}	19.65 ± 0.52^{c}	32.08 ± 0.68^{e}
Solanum incanum	7.14 ± 0.18^{d}	18.39 ± 0.39^{cd}	17.50 ± 0.38^{f}	2.19 ± 0.07^{ef}	14.24 ± 0.44^{e}	40.54 ± 0.82^{a}
Solanum schimperianum	7.65 ± 0.23^{bc}	12.94 ± 0.30^{g}	27.13 ± 0.62^{a}	2.61 ± 0.09^{de}	21.10 ± 0.58^{b}	28.57 ± 0.66^{f}
Solanum villosum	7.54 ± 0.20^{bc}	16.87 ± 0.44^{d}	18.38 ± 0.41^{f}	2.01 ± 0.07^{ef}	23.52 ± 0.64^{a}	31.69 ± 0.71^{e}
Withania somnifera	7.38 ± 0.19^{cd}	14.22 ± 0.33^{fg}	22.75 ± 0.51^{d}	2.42 ± 0.08^{e}	16.45 ± 0.47^{d}	36.78 ± 0.77^{bc}

3.2 Proximate composition of fruits

The proximate composition of fruits across the 12 investigated solanaceous taxa exhibited distinct interspecific patterns on a dry weight basis as presented in Table 3 and Figure 3, demonstrating how reproductive sink tissues allocate metabolic reserves.

Moisture content in the dried fruit samples ranged from 2.90% in *Physalis angulata* and *Solanum schimperianum* to 4.20% in *Solanum incanum*. Across all taxa, fruit moisture levels were consistently lower than those observed in vegetative foliage, which is favorable for extending post-harvest shelf life and minimizing microbial spoilage during storage.

Ash content was consistently low across all fruit samples, spanning from trace amounts of 0.001% in *S. schimperianum* and 0.0035% in *Withania somnifera* to a maximum of 1.01% (1.0095%) in *S. incanum*. This minimal inorganic fraction in

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

reproductive organs contrasts sharply with the substantial foliar accumulation (>30% in leaves), reflecting the selective physiological allocation of macro- and micronutrients. While leaves act as primary transpirational and metabolic sinks for minerals, fruits prioritize organic assimilates and non-mineral reserves to support seed maturation and animal dispersal (Lu et al., 2024; Song et al., 2024; Achuenu et al., 2024; Okoli et al., 2024).

Crude protein in fruits ranged from 3.00% in *Datura stramonium* to 6.50% in *Solanum dubium*, with *Datura innoxia* (6.10%), *Hyoscyamus muticus* (5.50%), and *Solanum americanum* (5.20%) also exhibiting notable levels. These values are markedly lower than foliar protein contents (up to 27.13%), consistent with the physiological reality that fruits are non-photosynthetic storage tissues with lower concentrations of active enzymatic machinery such as RuBisCO (Staveckienė et al., 2024; Tejada-Alvarado et al., 2023; Mibei, 2018). Nevertheless, species such as *S. dubium* demonstrate an appreciable nitrogenous fraction for wild fruit tissues.

Crude fat levels varied from 1.01% (1.005%) in *Solanum villosum* to 5.00% in *S. americanum*, followed closely by *D. innoxia* (4.00%), *P. angulata* (4.00%), *Datura ferox* (3.90%), and *S. incanum* (3.90%). While generally low as expected for non-oilseed fleshy fruits (Özcan et al., 2020)—these lipid fractions reflect the inclusion of seed cuticular waxes and embryo storage lipids, which may supply valuable essential fatty acids in minor quantities (Bahadır et al., 2024; Konopka et al., 2023).

Crude fiber showed a narrow distribution across all species, varying only between 2.01% in *S. incanum* and 2.41% in *S. schimperianum*. Unlike leafy organs, where structural cellulose and lignin accumulate extensively to maintain plant architecture, fruit pericarp and pulp tissues maintain limited structural lignification, producing a uniform, low-fiber profile (Ma et al., 2023; Zhang et al., 2020).

Carbohydrate content constituted the primary dry-matter constituent of fruit samples, ranging from 3.00% in *W. somnifera* and 3.30% in *D. innoxia* to a maximum of 6.60% in *P. angulata*, with most species grouping between 4.90% and 5.40% (such as *Capsicum annuum*, *D. ferox*, *D. stramonium*, *H. muticus*, *S. americanum*, *S. dubium*, *S. incanum*, and *S. schimperianum*). This pattern corresponds to the primary functional role of fruit tissues as transient energy-storage reservoirs designed to facilitate frugivorous seed dispersal (Alves et al., 2021; Bayang et al., 2021).

These proximate profiles reflect the influence of genetic background and ecological adaptation to Sudan's arid and semi-arid environments (García et al., 2025; Imran et al., 2024; Buba et al., 2022). The fruit proximate data establish that while solanaceous fruits contribute lower protein and mineral loads than foliar tissues, species such as *P. angulata*, *S. dubium*, and *S. americanum* provide meaningful contributions of carbohydrates and lipids.

Table 3: Proximate composition of fruits of the studied Solanaceae species (% on dry weight basis)

Solanaceae species	Moisture (%)	Ash (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Total Carbohydrates (%)
Capsicum annuum	4.10 ± 0.12^{a}	1.01 ± 0.03^{a}	5.00 ± 0.15^{bc}	2.90 ± 0.09^{e}	2.23 ± 0.06^{b}	84.76 ± 0.45^{ab}
Datura ferox	4.10 ± 0.11^{a}	0.01 ± 0.001^{b}	4.50 ± 0.13^{cd}	3.90 ± 0.11^{b}	2.23 ± 0.07^{b}	85.26 ± 0.42^{a}
Datura innoxia	4.00 ± 0.10^{ab}	1.00 ± 0.02^{a}	6.10 ± 0.18^{ab}	4.00 ± 0.12^{b}	2.10 ± 0.05^{cd}	82.80 ± 0.47^{c}
Datura stramonium	3.10 ± 0.09^{cd}	1.01 ± 0.03^{a}	3.00 ± 0.08^{f}	3.50 ± 0.10^{c}	2.21 ± 0.06^{bc}	87.18 ± 0.36^{a}

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Hyoscyamus muticus	3.90 ± 0.10^{b}	1.01 ± 0.02^{a}	5.50 ± 0.14^{b}	3.10 ± 0.08^{d}	2.24 ± 0.07^{b}	84.25 ± 0.41^{b}
Physalis angulata	2.90 ± 0.08^{d}	1.01 ± 0.03^{a}	4.10 ± 0.11^{de}	4.00 ± 0.11^{b}	2.38 ± 0.08^{a}	85.61 ± 0.41^{a}
Solanum americanum	3.80 ± 0.11^{b}	1.00 ± 0.02^{a}	5.20 ± 0.16^{bc}	5.00 ± 0.15^{a}	2.25 ± 0.06^{b}	82.75 ± 0.50^{c}
Solanum dubium	3.90 ± 0.10^{b}	1.00 ± 0.03^{a}	6.50 ± 0.20^{a}	3.10 ± 0.09^{d}	2.16 ± 0.06^{bc}	83.34 ± 0.48^{bc}
Solanum incanum	4.20 ± 0.13^{a}	1.01 ± 0.02^{a}	4.90 ± 0.14^{c}	3.90 ± 0.12^{b}	2.01 ± 0.05^{d}	83.98 ± 0.46^{bc}
Solanum schimperianum	2.90 ± 0.07^{d}	0.001 ± 0.00^{b}	4.50 ± 0.12^{cd}	3.80 ± 0.10^{bc}	2.41 ± 0.07^{a}	86.39 ± 0.36^{a}
Solanum villosum	3.80 ± 0.09^{b}	0.01 ± 0.001^{b}	3.90 ± 0.10^{e}	1.01 ± 0.03^{f}	2.20 ± 0.06^{bc}	89.08 ± 0.28^{a}
Withania somnifera	4.00 ± 0.11^{ab}	0.004 ± 0.00^{b}	5.10 ± 0.15^{bc}	3.10 ± 0.09^{d}	2.10 ± 0.05^{cd}	85.69 ± 0.40^{a}

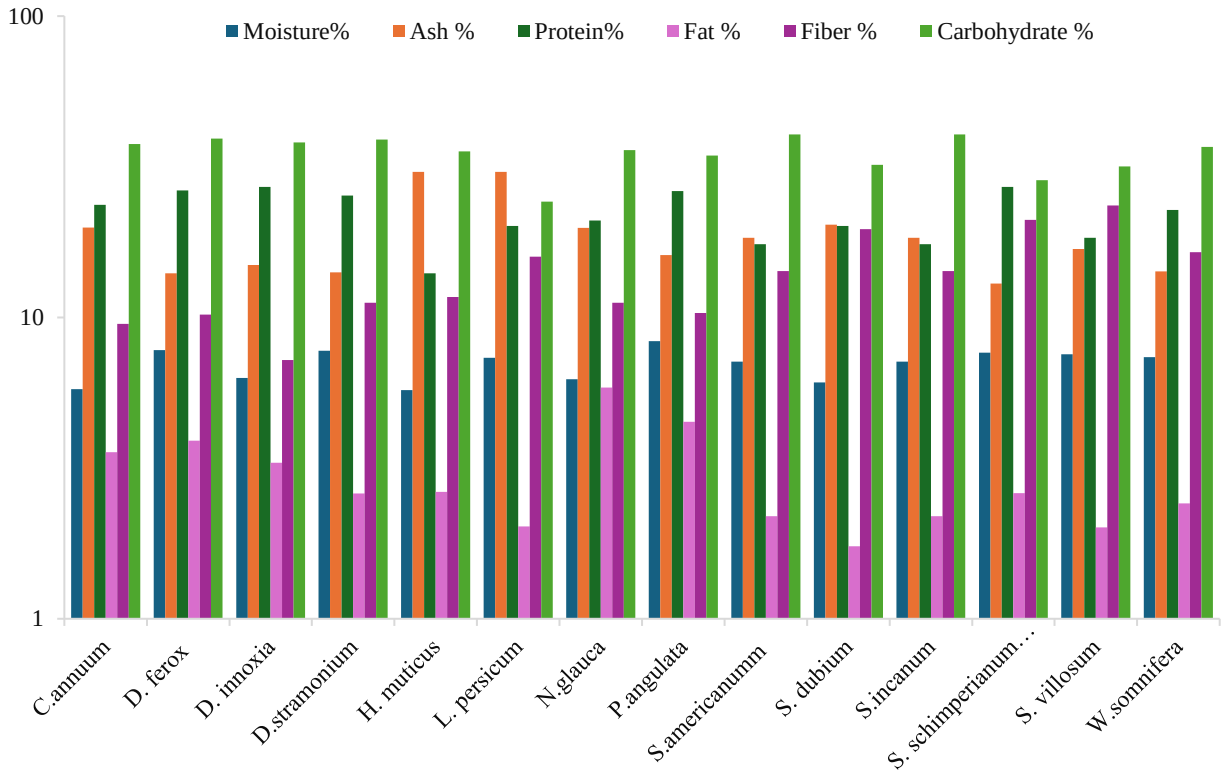


Figure 2: leaves proximate analysis of the studied solaneaous species (moisture, ash, protein, fat, fiber, and carbohydrate contents on a dry weight basis)

Volume 4, Issue 3, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

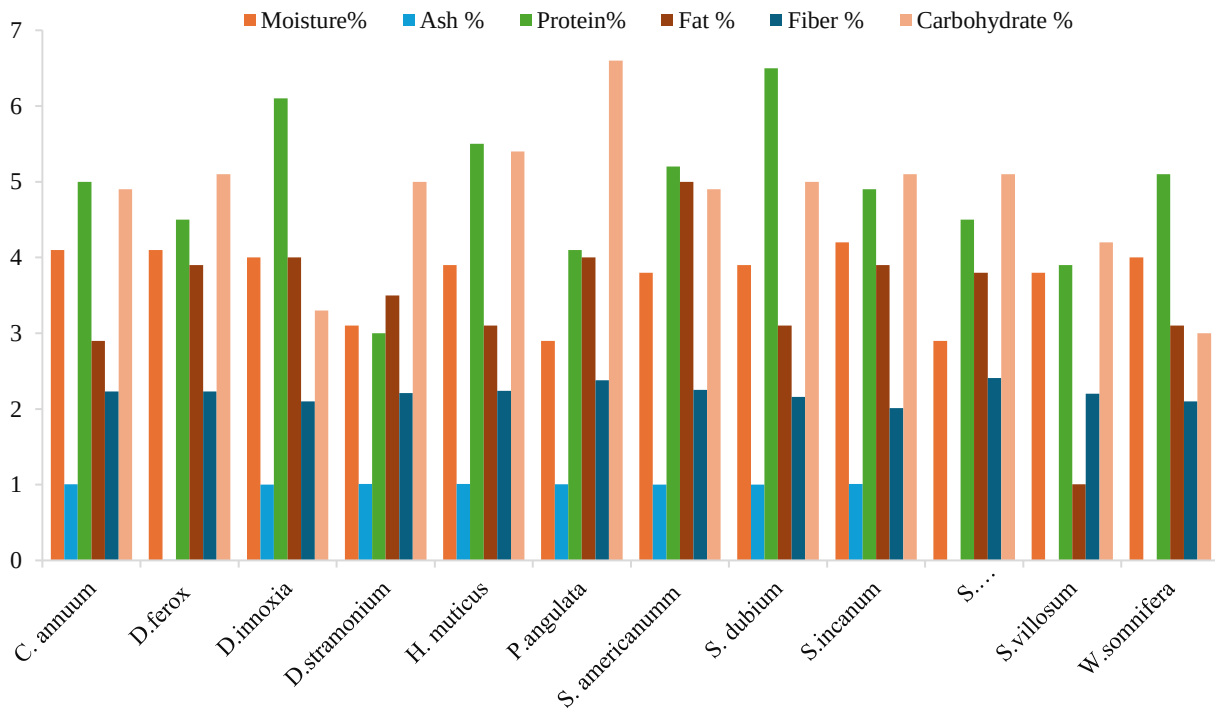


Figure 3: Fruits proximate analysis of the studied solaneaous species (moisture, ash, protein, fat, fiber, and carbohydrate contents on a dry weight basis)

4- Conclusion

This study provides a comparative assessment of proximate composition of leaves and fruits across wild and cultivated Solanaceae species, elucidating distinct organ-specific nutrient allocation patterns. The findings demonstrate that vegetative foliage is nutritionally superior to reproductive fruit tissues, characterized by markedly higher concentrations of crude protein (up to 27.13%), total mineral ash (exceeding 30%), and dietary fiber (up to 23.52%). Species such as *Datura innoxia*, *Solanum schimperianum*, *Lycium persicum*, and *Hyoscyamus muticus* exhibit notable potential as concentrated reservoirs of plant-based protein and inorganic minerals. Conversely, fruit tissues function predominantly as low-mineral sink organs that contribute moderate carbohydrate and lipid fractions. The substantial interspecific variability observed underscores the strong influence of genetic divergence and eco-geographical adaptation across the collection zones. Overall, these wild and underutilized solanaceous taxa possess significant dietary and phytopharmaceutical value, though further toxicological evaluations regarding their characteristic alkaloid content remain essential prior to commercial or nutritional exploitation.

Conflict of Interest

Authors declared that there were no conflicts of interest.

Funding

This research has received no funding towards the conduct, authorship, or publication of this manuscript.

References

Achuenu, C., Emesi, I. C., Dashe, R., Edah, A. O., & Mshelia, S. S. (2024). Investigation on the comparative proximate and elemental compositions of the fruit and leaf of *Solanum aethiopicum* cultivated in Jos. *FUDMA Journal of Sciences*, *8*(6), 380–384.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Aguirre, M., Kiegle, E., Leo, G., & Ezquer, I. (2018). Carbohydrate reserves and seed development: An overview. *Plant Reproduction*, *31*(3), 263–290.

Alves, E., Simões, A., & Domingues, M. R. (2021). Fruit seeds and their oils as promising sources of value-added lipids from agro-industrial byproducts: Oil content, lipid composition, lipid analysis, biological activity and potential biotechnological applications. *Critical Reviews in Food Science and Nutrition*, *61*(8), 1305–1339.

AOAC International. (2019). *Official methods of analysis of AOAC International* (G. W. Latimer, Jr., Ed., 21st ed.). AOAC International.

Arif, T., Urooj, A., & Shafqat, A. (2026). Development, characterization, and therapeutic evaluation of functional cocofee gummies for type 2 diabetes management in Wistar albino rats. *Policy Research Journal*, 4(6), 77–78. https://doi.org/10.5281/zenodo.20605895

Bahadır, S., Abdulla, M. F., Mostafa, K., Kavas, M., Hacıkamiloğlu, S., Kurt, O., & Yıldırım, K. (2024). Exploring the role of FAT genes in Solanaceae species through genome-wide analysis and genome editing. *The Plant Genome*, *17*(4), e20506.

Bayang, J. P., Laya, A., Kolla, M. C., & Koubala, B. B. (2021). Variation of physical properties, nutritional value and bioactive nutrients in dry and fresh wild edible fruits of twenty-three species from Far North region of Cameroon. *Journal of Agriculture and Food Research*, *4*, 100146.

Bhatla, S. C., & Kathpalia, R. (2023). Essential and functional mineral elements. In *Plant physiology, development and metabolism* (pp. 25–49). Springer Nature Singapore.

Botey, H. M. (2022). *Environment, physiological and biochemical effects on seed germination characteristics of African eggplant (Solanum aethiopicum L.)* (Doctoral dissertation, University of Eldoret).

Buba, U. M., Abdul, S. D., & Ibrahim, H. (2022). Genetic diversity studies, heritability, correlation and proximate analysis among acha (*Digitaria exilis*) accessions. *Journal of Agripreneurship and Sustainable Development*, *5*(2), 11–24.

Crang, R., Lyons-Sobaski, S., & Wise, R. (2018). Fruits, seeds, and seedlings. In *Plant anatomy: A concept-based approach to the structure of seed plants* (pp. 649–678). Springer International Publishing.

García, L., Veneros, J., Bolaños-Carriel, C., Guadalupe, G. A., Garcia, H., Mori-Zabarburú, R. C., & Chavez, S. G. (2025). Agro-morphological traits, proximate composition, and phenotypic plasticity of *Coffea arabica* in contrasting and very close environments in northern Peru. *Agronomy*, *15*(11), 2465.

Haliński, Ł. P., Topolewska, A., Rynkowska, A., Mika, A., Urasińska, M., Czerski, M., & Stepnowski, P. (2019). Impact of plant domestication on selected nutrient and anti-nutrient compounds in Solanaceae with edible leaves (*Solanum* spp.). *Genetic Resources and Crop Evolution*, *66*(1), 89–103.

Han, M., Opoku, K. N., Bissah, N. A., & Su, T. (2021). *Solanum aethiopicum*: The nutrient-rich vegetable crop with great economic, genetic biodiversity and pharmaceutical potential. *Horticulturae*, *7*(6), 126.

Imran, M., Lee, S. G., Park, S. Y., Park, H. M., Kim, E. H., Oh, S. W., ... & Kim, M. J. (2024). Influence of environmental factors and genotype on natural variation in the chemical composition of maize seeds. *Sustainability*, *16*(23), 10451.

Jan, S., Iram, S., Bashir, O., Shah, S. N., Kamal, M. A., Rahman, S., ... & Jan, A. T. (2024). Unleashed treasures of Solanaceae: Mechanistic insights into phytochemicals with therapeutic potential for combatting human diseases. *Plants*, *13*(5), 724.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Konopka, I., Tańska, M., Dąbrowski, G., Ogrodowska, D., & Czaplicki, S. (2023). Edible oils from selected unconventional sources—A comprehensive review of fatty acid composition and phytochemicals content. *Applied Sciences*, *13*(23), 12829.

Kumar, R., Joshi, R., Kumar, R., Srivatsan, V., Satyakam, Chawla, A., ... & Kumar, S. (2022). Nutritional quality evaluation and proteome profile of forage species of Western Himalaya. *Grassland Science*, *68*(3), 214–225.

Kumar, S., Kumar, S., & Mohapatra, T. (2021). Interaction between macro-and micro-nutrients in plants. *Frontiers in Plant Science*, *12*, 665583.

Kushwaha, M., & Tiwari, P. (2025). Unveiled assets of Solanaceae family plants: Mechanistic understanding of phytochemicals with therapeutic efficacy in addressing human ailments. *International Journal of Environmental Pollution and Environmental Modelling*, *8*(2), 99–112.

Lu, Y., Luo, Z., Sun, Q., Deng, Q., Wu, L., Liao, J., ... & Yuan, J. (2024). The stoichiometry of soil macro and microelements plays a critical role in regulating *Camellia oleifera* nutrient accumulation and production. *Journal of Soils and Sediments*, *24*(4), 1680–1693.

Ma, Y., Wang, Z., Li, Y., Feng, X., Song, L., Gao, H., & Cao, B. (2023). Fruit morphological and nutritional quality features of goji berry (*Lycium barbarum* L.) during fruit development. *Scientia Horticulturae*, *308*, 111555.

Mibei, E. K. (2018). *Application of metabolomics in assessment of functional diversity and quality traits of selected African Solanaceae accessions* (Doctoral dissertation, JKUAT).

Naqvi, S. N. U. A., Anwar, A., Almas, I., Khalid, I., Muzammal, S. F., Urooj, A., & Arif, A. (2025). Exploring the Storage Effect on the Physicochemical and Microbiological Properties of Peach-Plum Juice. *RADS Journal of Biosciences*, 4(1), 12-19. https://doi.org/10.37962/jfbs.v4i1.49

Okoli, N. A., Nwafor, I. C., Ihegboro, M., Emma-Okafor, L. C., Nwosu, B. O., Onwuchekwa, C. U., & Ibeawuchi, I. I. (2024). Integrated application of wood ash and inorganic fertilizer sources on vegetative growth, fruit yield, and nutrient quality of *Solanum aethiopicum* L. *International Journal of Recycling of Organic Waste in Agriculture*, *13*(3).

Orangi, B. K. (2024). *Effect of nitrogen rates and sources on plant growth, yield, quality and nitrogen use efficiency on African nightshade varieties (Solanum spp) in Kenya* (Doctoral dissertation, JKUAT).

Özcan, M. M., Al Juhaimi, F., Ahmed, I. A. M., Babiker, E. E., & Ghafoor, K. (2020). Antioxidant activity, fatty acid composition, phenolic compounds and mineral contents of stem, leave and fruits of two morphs of wild myrtle plants. *Journal of Food Measurement and Characterization*, *14*(3), 1376–1382.

Parolin, P., Waldhoff, D., & Piedade, M. T. (2010). Fruit and seed chemistry, biomass and dispersal. In *Amazonian floodplain forests: Ecophysiology, biodiversity and sustainable management* (pp. 243–258). Springer Netherlands.

Quadri, A. L., Njinga, N. S., Kola-Mustapha, A. T., Amusa, T. O., Atolani, O., Oladiji, A. T., ... & Kambizi, L. (2021). Elemental composition and proximate analysis of five commonly used African medicinal plants. *Plant Archives*.

Ralte, L., Bhardwaj, U., & Singh, Y. T. (2021). Traditionally used edible Solanaceae plants of Mizoram, India have high antioxidant and antimicrobial potential for effective phytopharmaceutical and nutraceutical formulations. *Heliyon*, *7*(9).

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Shabbir, A., Asif, H., Shakoor, S., Hussain, M., Fatima, A., Fatima, I., Urooj, A., & Asif, M. (2026). Development and characterization of flat bread incorporated with Moringa powder for nutritional, biofunctional, and sensory evaluation. *Policy Research Journal*, 4(4), 233–246. https://doi.org/10.5281/zenodo.19606314

Shahid, M., Singh, R. K., & Thushar, S. (2023). Proximate composition and nutritional values of selected wild plants of the United Arab Emirates. *Molecules*, *28*(3), 1504.

Song, J., Yang, J., & Jeong, B. R. (2024). Characterization of physiology, photosynthesis, and nutrition based on induced deficiencies of macro-and micronutrients in basil (*Ocimum basilicum* L.). *Agronomy*, *14*(1), 208.

Staveckienė, J., Kulaitienė, J., Levickienė, D., & Vaitkevičienė, N. (2023). Changes in fatty acid content in *Solanum* spp. fruits during ripening. *Plants*, *12*(2), 268.

Staveckienė, J., Medveckienė, B., Vaštakaitė-Kairienė, V., Kulaitienė, J., & Jarienė, E. (2024). Amino acid changes during maturation in *Solanum* fruit. *Agriculture*, *14*(6), 802.

Tejada-Alvarado, J. J., Meléndez-Mori, J. B., Vilca-Valqui, N. C., Neri, J. C., Ayala-Tocto, R. Y., Huaman-Huaman, E., ... & Goñas, M. (2023). Impact of wild Solanaceae rootstocks on morphological and physiological response, yield, and fruit quality of tomato (*Solanum lycopersicum* L.) grown under deficit irrigation conditions. *Heliyon*, *9*(1).

Urooj, A., & Asif, M. (2026a). Formulation and characterization of polyphenol-rich functional porridge: A preliminary pilot randomized trial in patients with *Helicobacter pylori*-associated peptic ulcer disease. *Journal of Food Innovation, Nutrition, and Environmental Sciences, 3*(3), 304–326. https://doi.org/10.70851/jfines.2026.3(3).304.326

Uzoekwe, N. M., & Ezenwajiugo, C. E. (2023). Phytochemicals, elemental and proximate analyses of *Piper guineense* leaves. *Journal of Applied Sciences & Environmental Management*, *27*(4).

Yadav, S. A., & Koshi, F. S. (2022). Phytochemicals from Solanaceae family and their anticancer. *Medicinal Plants*, 231.

Zhang, Q., Wang, L., Wang, Z., Liu, Z., Zhao, Z., Zhou, G., ... & Liu, P. (2020). Variations of the nutritional composition of jujube fruit (*Ziziphus jujuba* Mill.) during maturation stages. *International Journal of Food Properties*, *23*(1), 1066–1081.