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Phytochemical Screening and Proximate Analysis of *Dioscoreadeltoidea* Wall. Ex Griseb

Farah Naaz[1]*, Hidayatullah Tak[1], Showkat A. Ganai[2], M. Shaharyar Wani[3,4]
[1]Department of Zoology, University of Kashmir, Srinagar, Jammu and Kashmir, India
[2]Department of Clinical Biochemistry, University of Kashmir, Srinagar, Jammu and Kashmir,India
[3]Department of Mech. and Aero. Eng., Princeton University, Princeton, NJ, USA
[4]Princeton Materials Institute, Princeton University, Princeton, NJ, USA

Corresponding Author: **Farah Naaz**

Abstract: *Dioscoreadeltoidea* is a medicinal plant species traditionally used in Kashmir and globally for various therapeutic purposes. This study aimed to access the phytochemical profile of *D. deltoidea* rhizome extracts using different solvents (hexane, ethyl-acetate,ethanol, and methanol)and evaluate the nutritional composition of the rhizomes through proximate analysis. Phytochemical screening demonstrated the presence of diverse bioactive compounds, including polyphenols, steroids, alkaloids, flavonoids, tannins, saponins, glycosides, terpenoids, and anthraquinones. Proximate analysis revealed substantial moisture content (60.2 ± 0.3%), complemented by total ash (1.9 ± 0.1%), crude fiber (9.6 ± 0.03%), crude fat (2.8 ± 0.1%), crude protein (2.3 ± 0.08%), and total carbohydrates (22.8 ± 0.2%). These findings highlight the potential of *D. deltoidea* as both a promising source for novel pharmaceutical and therapeutic applications and a nutraceutical resource.

Keywords: *Dioscoreadeltoidea*, Medicinal plants, Phytochemical screening, Proximate analysis,Kashmir valley.

Introduction

Medicinal plants represent a significant reservoir of potential therapeutic compounds, offering extensive applications in treating various disorders. Plant-derived medicines are increasingly valued for their safety, accessibility, efficacy, cost-effectiveness, and minimal side effects[1]. Approximately 80% of the global population depends on plant-based medicines, with over 50% of modern clinical drugs being plant-derived. Traditional medicinal plant usage spans both informal (tribal, folk, native) and formal (Unani, Ayurveda) healthcare systems [2]. Recent decades have witnessed renewed global interest in ethnomedicinal practices, particularly concerning medicinal plant applications[3].Plant secondary metabolites or bioactive compounds demonstrate significant potential in disease prevention. The production of these compounds involves complex biosynthetic pathways influenced by the species' habitat and environmental conditions[4].

The Kashmir valley harbors diverse medicinal flora,extensively utilized in traditional therapeutic practices[5].*Dioscoreadeltoidea*(Dioscoreaceae), an indigenous tuberous plant species of Kashmir, holds significant ethnomedicinal value, particularly among the Gujjar and Bakarwal tribal communities. Traditional applications include antiparasitic treatments, ophthalmic infection management, vision enhancement, and its utilization as both a vegetable and a detergent[5,6]. The species exhibits widespread distribution across tropical and subtropical regions globally[7]. Beyond its ethnomedicinal significance in Kashmir, extensive surveys and studies have documented *D. deltoidea's* diverse therapeutic applications in various traditional medical systems worldwide. Traditional uses encompass treatments for gastrointestinal and urogenital disorders, helminthiasis, abdominal pain, diarrhea, anemia, arthralgia, wounds, ophthalmic conditions, and irritability[4]. Additionally, the species serves as a staple food source and is recognized for its nutraceutical properties[7].

Current limitations in pharmacological interventions necessitate the exploration of natural compounds with therapeutic and pharmacological potential. Phytochemical screening remains crucial for identifying novel pharmaceutical and therapeutic compounds of economic significance[1]. Therefore, this study aimed to evaluate the proximate composition and phytochemical profile of *Dioscoreadeltoidea*, a species widely employed for therapeutic purposes in Kashmir and globally.

Materials and Methods

Collection and Identification of Plant Material

Fresh rhizomes and other parts of mature *Dioscoreadeltoidea* (locally known as "Kreath" in Kashmiri)were collected from the forest regions of Gulmarg and Sonamarg, Kashmir, during October-November 2021[6]. Species selection was based on its established ethnomedicinal applications by Kashmir's nomadic tribes[5,6].Ethnobotanical information regarding medicinal and other applications was gathered through consultations with local Gujjar and Bakarwal tribes in the collection area. The specimens were transported to the University of Kashmir in polythene bags. Taxonomic identification and authentication were performed by Plant Taxonomist, Dr. Akhtar H. Malik at the Centre for Biodiversity and Taxonomy, Department of Botany, University of Kashmir. A voucher specimen (3134-KASH) was deposited in the Kashmir University Herbarium.

Morphological Description

D. deltoidea is a perennial, glabrous climber reaching heights of approximately 3 m, characterized by a clockwise-twining hairless vine. The leaves are alternate, triangular-ovate, heart-shaped, acuminate, membranous, and reticulate, measuring 5-11.5 cm in length and 4-10.5 cm in breadth, with 7-9 nerves. While the adaxial surface is glabrous, the abaxial nerves exhibit a velvety texture. Flowers are diminutive (~2 mm diameter), occurring either solitarily or in clusters, featuring inferior anthers and six stamens. Rhizomes are elongated, cylindrical, ligneous, horizontal, and branched (~10 cm), exhibiting a ginger-like morphology. They are characterized by hard, long filiform roots with tubers that are rigid, yellowish, and approximately 26 cm in length[4].Male inflorescences are present as slender spikes (8-40 cm), typically solitary, simple or branched, rarely paired. Female spikes are solitary (8-16 cm), bearing sparse flowers. Seeds are winged, exhibiting morphological variation, with wings occasionally unilateral[8].

Processing of Plant Material

The collected rhizomes of*D. deltoidea* were processed following standard protocols established by Kashmir University Herbarium. Surface debris was removed manually using a dry cloth, avoiding water-washing to prevent loss of water-soluble constituents. Initial drying was conducted under shade at room temperature (15-20°C) in a ventilated facility (Drying room, Department of Zoology, University of Kashmir) for approximately one week. Complete desiccation was avoided at this stage to prevent excessive hardening that could impede powder formation. The partially dried rhizomes were pulverized using an electric stainless-steel blender, followed by complete shade drying for an additional week. The resultant powder was stored in airtight plastic containers at 4°C pending extraction.

Preparations of extracts

Successive Soxhlet extraction was performed using solvents of increasing polarity to maximize the extraction of constituents with varying polarities. Powdered rhizomes (100 g) were sequentially extracted with 500 mL each of hexane, ethyl-acetate, ethanol, and methanol at their respective boiling temperatures (68°C, 77°C, 78°C, and 64°C) for 12-hour cycles per solvent. Between successive extractions, the rhizome powder was removed from the extraction chamber, spread on filter paper sheets, and dried before subsequent extraction with the next higher polarity solvent. All extracts were filtered through Whatman filter paper (Grade 1)and the solvents were evaporated using a rotary evaporator (R-201, Shanghai Shenzhen) under reduced pressure (21-26 mmHg) at 38°C. The resultant crude extracts were transferred to airtight glass containers and stored at 4°C pending analysis.

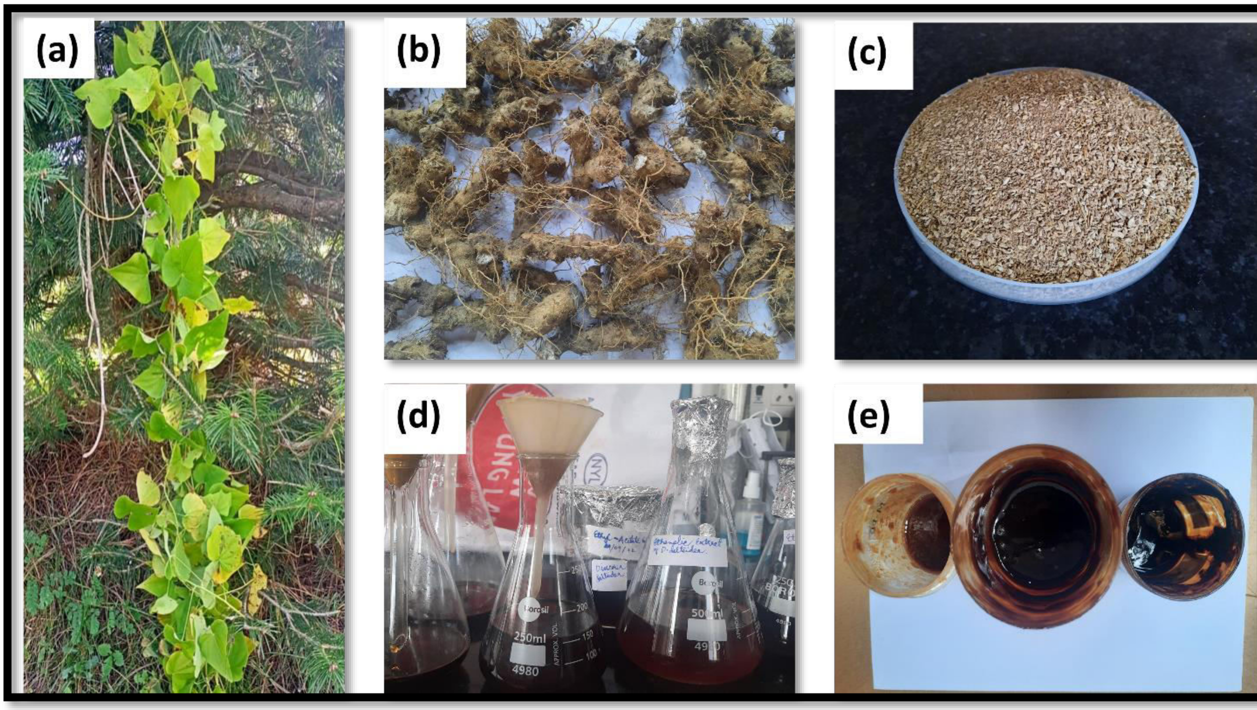

Figure1:(a)*Dioscorea deltoidea*in its natural habitat. **(b)**Dried rhizomes of *D.deltoidea*.**(c)***D. deltoidea* rhizome powder.**(d)**Extracts before solvent evaporation.**(e)**Extracts after solvent evaporation.

Yield Percentage

The yield percentage of the extracts was evaluated as the percentage of the weight of the extracts to the weight of the powdered raw material used, using the following formula:

Percentage yield = (Weight of the extract)/ (Weight of the sample) × 100

Phytochemical screening

Qualitative phytochemical screening of *D. deltoidea* crude extracts was performed to detect the presence of various bioactive compounds including polyphenols, steroids, alkaloids, flavonoids, tannins, saponins, glycosides, terpenoids, and anthraquinones following established protocols[9–11].

Proximate analysis

Proximate composition analysis of powdered *D. deltoidea* rhizomes, including moisture content, total ash content, crude fiber, crude fat, crude protein, and total carbohydrates, was conducted following standard protocols[12].

Statistical analysis

Inorder to ensure the reproducibility of the data, all the tests were performed in triplicates.Total yield of the plant extractsand the data from proximate analysis were expressed as a percentage and data from triplicate samples were expressed as Mean± SEM.

Results and Discussion

Total yield of Plant Extracts

Extraction yields of *D. deltoidea* crude extracts and rhizome raw material quantities used are presented in table 1. Different solvents yielded varying quantities of crude extracts, with ethyl-acetate producing the highest yield (4.55 ± 0.06%), followed by ethanol (3.78 ± 0.08%), hexane (3.62 ± 0.1%), and methanol (2.85 ± 0.00%). Theyield percentages were comparatively lower than those reported for other plant species using similar extraction solvents. For instance, *Carica papaya* leaves yielded 6%, 12%, 14.5%, and 15% for hexane, ethyl-acetate, ethanolic, and methanolic extracts, respectively [13]. Similarly, methanolic extracts of *A. lutea* and *P. harmala* demonstrated higher yields of 13.57% and 19.90%, respectively[14].

Table 1: Yield of crude extracts (Mean ± SEM)and weight of raw material of *D. deltoidea*rhizomes used (W/W)in grams.

Plant species	Raw material used (g)	Extract yield (g) / % Yield (Mean ± SEM)			
		Hexane	Ethyl-Acetate	Ethanol	Methanol
Dioscoread eltoidea	100	3.62 ± 0.1	4.55 ± 0.06	3.78 ± 0.08	2.85 ± 0.00

Phytochemical screening

Qualitative phytochemical screening of *D. deltoidea* rhizome extracts revealed diverse bioactive compounds, including polyphenols, steroids, alkaloids, flavonoids, tannins, saponins, glycosides, terpenoids, and anthraquinones. Polyphenols, steroids, flavonoids, and tannins were detected across all the four extracts. However, alkaloids, saponins, glycosides, and anthraquinones were absent in hexane extract, while alkaloids and anthraquinones were not detected in ethyl-acetate extract. Terpenoids were notably absent in ethanolic and methanolic extracts. Conversely, ethanolic and methanolic extracts demonstrated high quantities of polyphenols, flavonoids, tannins, saponins, and glycosides (Table 2).

Table 2: Phytochemical analysis ofcrude extracts of*D. deltoidea* rhizomes collected from Kashmir valley, India.

Phytoconstituent	Hexane Extract	Ethyl-Acetate Extract	Ethanolic Extract	Methanolic Extract
Polyphenols	+	+	+++	+++
Steroids	+++	++	+	+
Alkaloids	-	-	+	+
Flavonoids	+	++	+++	+++
Tannins	+	+	+++	+++
Saponins	-	++	+++	++
Glycosides	-	+	++	+++
Terpenoids	+++	++	-	-
Anthraquinones	-	-	++	++

Keys:+ represents: Present in low quantity, **++** represents: Present in moderate quantity, **+++** represents: Present in high quantity, **-** represents: Absent.

Phytochemical screening of numerous therapeutic plants has revealed diverse bioactive constituents. Analysis of acetone and methanolic extracts from 14 plant species across different families demonstrated the presence of steroids, tannins, saponins, and cardiac glycosides[15]. Methanol and aqueous extracts of *Euphorbia heterophylla* contained flavonoids, diterpenes, saponins, and phorbol esters [16]. Various extracts of *Oxalis corniculata* leaves exhibited phenols, phytosterols, glycosides, carbohydrates, and tannins [17]. Additionally, eight bioactive compounds were isolated from ethanolic and aqueous extracts of *Cnidoscolusaconitifolius* leaves [18].

Flavonoids facilitate bodily responses against viral allergens and carcinogens, demonstrating antifungal, anti-inflammatory, antibacterial, and antimicrobial properties[19]. Polyphenols and flavonoids serve as rich sources of natural antioxidants with free radical scavenging capabilities [20]. The methanolic extract *of D. deltoidea* has demonstrated significant antioxidant activity in DPPH radical scavenging (19.9%) and reducing power assays (25%) [21]. Additionally, various extracts of fresh *D. deltoidea* rhizomes exhibited substantial antioxidant activities across multiple assays, including hydrogen peroxide scavenging (H_2O_2), DPPH, ferrous ion chelating (Fe^{2+}), OH^{-} radical scavenging, phosphomolybdenum complex assays, and ferric reducing antioxidant power (FRAP) [22]. These notable antioxidant properties may be attributed to the plant's flavonoid and polyphenolic constituents.

Tannins elicit physiological responses following animal consumption without demonstrating toxicity [23]. However, they exhibit toxic effects against filamentous fungi, bacteria, and yeasts. The presence of tannins in medicinal plants suggests potential antioxidant, antifungal, antidiarrheal, and antihemorrhoidal properties[24].

Alkaloids demonstrate antimicrobial and anti-diarrheal properties, suggesting their potential role in *D. deltoidea's* traditional applications for treating wounds, ophthalmic infections, and diarrhea. Additional properties of alkaloids, including anti-fibro genic, anti-hypertensive, anti-fungal, and anti-inflammatory activities, may contribute to various other therapeutic effects observed in *D. deltoidea*[25.] Various extracts from fresh *D. deltoidea* rhizomes have exhibited significant antimicrobial efficacy against multiple microbial strains, including *E. coli, Enterobactergergoviae, P. aeruginosa, Streptococcus pyogenes, S. aureus, Staphylococcus epidermidis, Klebsiella pneumonia, A. flavus, Shigellaflexneri, Bacillus cereus, C. albicans, Salmonella entericatyphi,* and *A. parasiticus*[26], potentiallyattributable to their alkaloid content. Saponins offer various health benefits, including anti-carcinogenic and antimalarial properties, while glycosides are associated with cardioprotective effects [27]. These bioactive compounds may contribute significantly to the diverse therapeutic properties associated with*D. deltoidea*.

Proximate Analysis

Proximate analysis of *D. deltoidea* rhizome flour revealed significant contents of moisture, total ash, crude fiber, crude fat, crude protein, and total carbohydrates (table 3).The crude fiber content (9.6 ± 0.03%) was comparable to that found in*Cnidoscolusaconitifolius* (9.81%) [28], higher than in*Piper guineensis* (2.00%) and *Aframomummalagueta* (4.00%) [27], but lower than in*Osciumgratissimum* (22.02%) and *Parquetinnigrescen* (22.05%) [19]. The significant fiber content suggests potential health benefits, as dietary fiber intake is associated with reduced hypertension, serum cholesterol levels, heart disease, diabetes, and constipation[19].

Table 3: Proximate analysis of *D. deltoidea*rhizomes collected from Kashmir valley, India.

Proximate	**% (Mean ± SEM)**
Moisture content	60.2 ± 0.3
Total ash	1.9 ± 0.1
Crude fiber	9.6 ± 0.03
Crude fat	2.8 ± 0.1
Crude protein	2.3 ± 0.08
Total carbohydrate	22.8 ± 0.2

The moisture content (60.2 ± 0.3%) in *D. deltoidea* exceeded than that reported for *Cnidoscolusaconitifolius* (5.35%) [28]and *Nymphaea lotus* rhizome (48.83%) [29], but was lower than that found in*Veroniaamgydalina* (79.20%), *Parquetinnigrescen* (70.01%), *Morindalucida* (70.20%), and *Chenopodiumambrosiodes* (89.40%)[19]. Minimal moisture content is crucial for preventing microbial growth during storage and enhancing the shelf life of medicinal preparations[16]. Total ash content (1.9 ± 0.1%) in *D. deltoidea* was comparable to that present in*A. sativum* (4.84%) but lower than that in *Adansoniadigitata* (9.00%), *Khayasenegalensis* (6.00%), *Momordicabalsamina* (12.55%), and *Pavettacrassipes* (9.30%) [7,27,30]. Ash content serves as an indicator of mineral element composition in plant materials [19].

D. deltoidea exhibited a crude fat content of 2.8 ± 0.1%, which was comparable to that observed in*Gnetumafricanum* (3.15%)[31], but lower than that present in*Momordicabalsamina* (6.42%) and *Pavettacrassipes* K. Schum (7.99%) [7]. Dietary fats contribute to flavor retention and enhanced food palatability[19]. The crude protein content (2.3 ± 0.08%) in *D. deltoidea* was similar to that found in*Morindalucida* (2.28%), *Alstoniaboonei* (3.33%), and *Aframomummelegueta* (3.85%) [27]. This value exceeded that of *Garcinia kola* (1.40%) [32] but was lower than *Phyllanthusamarus*Schumach (14.45%), *Aloe vera* (16.24%)[7], *Piper guineensis* (8.75%), *Eugenia caryophyllus* (5.60%), *Adansoniadigitata* (4.55%) [33], *Momordicabalsania* L. (11.29%), and *Telfariaoccidentalis* (7.00%) [32].

Total carbohydrate content (22.8 ± 0.2%) in the rhizomes of *D. deltoidea* was comparable to that found in*Sennaobstusfolia* (23.70%) [33] but lower than that found in *A. sativum* (57.28%)[30] and *Nymphaea lotus rhizome* (35.44%)[29]. Carbohydrates represent an essential class of naturally occurring organic compounds crucial for maintaining plant and animal life, while also serving as industrial raw materials [19].

These findings indicate that *D. deltoidea* rhizomes possess substantial nutritional value, suggesting their potential as an alternative food source.

Conclusion

*D. deltoidea*contains diverse bioactive compounds with significant health-promoting properties, indicating therapeutic potential against various ailments. These findings support its potential utilization as a source of novel and sustainable pharmaceuticals and therapeutics at a commercial scale.The species demonstrates substantial nutritional composition, suggesting its potential as a valuable nutraceutical and alternative food source. Future research should focus on isolation and characterization of pure compounds from this species for potential drug development, targeting a broad spectrum of diseases.

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Ethical statement: Not applicable.

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Author contributions: CRediT

Farah Naaz: Writing – original draft, Writing – review & editing, Methodology, Formal analysis, Data curation, Resources, Conceptualization, Project administration. **HidayatullahTak:** Writing – review & editing, Supervision,Validation. **Showkat A. Ganai:** Writing – review & editing, Supervision, Validation. **M. ShaharyarWani:**Writing – review & editing, Formal Analysis, Supervision, Validation.

Competing interests: The authors declare no competing interests.

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