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Quantitative Estimation of Bioactive Compounds and Antioxidant Activities of Some Selected Wild Tuberous Plants of Odisha, India

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Abstract

Tuberous plants are the source of many useful bioactive compounds. It is suggested that they may protect us against pathogens. Antioxidants play a major role to protect the cell from oxidative stress. The study was designed to examine the antioxidant properties and total phenol contents of methanol and acetone extracts of some common species of Yam found in Odisha, India, namely, *Dioscorea belophylla*, *Dioscorea esculenta*, *Dioscorea glabra*, *Dioscorea oppositifolia*, *Dioscorea tomentosa*, *Dioscorea wallichii*, *Dioscorea hamiltonii,* and *Dioscorea hispida* var. *daemona*. These tuberous plants were collected from peripheral areas of Similipal Biosphere Reserve, Khurda, Cuttack, and Dhenkanal districts of Odisha, India. Phenolic compounds, tannin, and saponin are found as prime bioactive compounds in all tuber extracts of selected plants. The antioxidant activities were determined by 1-1-diphenyl-2-pycrilhydrazyne radical scavenging assay and metal chelating activities. The results of antioxidant activities showed their sound scavenging potential. The present study highlights the nutraceutical values of wild tuberous plants.

Keywords: Antioxidant properties, Bioactive compounds, *Dioscorea*, Odisha, Oxidative stress, Total phenol

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Introduction

Tuberous plants are the oldest known plants having food as well as medicinal values.[1] They are the major sources of energy in many developing countries such as India and China.[2] These wild food plants provide nutritionally valuable supplements as they are rich in proteins, starch, vitamins, and minerals, hence used as staple food in many countries. Some edible products are highly priced for their delicacies, medicinal values, and industrial uses.[3] Among the tuberous plants, *Dioscorea* or Yam is a genus having over 650 species of climbing herb with rhizomatous rootstock, belonging to the family Dioscoreaceae.[4,5] Asia, South America, and West Africa show the extensive growth of Yam species. In India, it is widely available, and in Odisha, these species are generally found throughout the state and abundantly present in the regions of Similipal Biosphere Reserve Forest, Karlapat Sanctuary (Kalahandi), Gajapati, Ganjam, Keonjhar, etc.[6,7] About 13 species of *Dioscorea* are reported from Odisha, namely, *Dioscorea belophylla* (DB), *Dioscorea esculenta* (DE), *Dioscorea glabra* (DG), *Dioscorea oppositifolia* (DO), *Dioscorea tomentosa* (DT), *Dioscorea wallichii* (DW), *Dioscorea hamiltonii* (DH), *Dioscorea hispida*, *Dioscorea bulbifera*, *Dioscorea alata,* etc. [Figure 1].[8] These tuberous plants having both sound pharmacological and ethnomedicinal properties with nutritive and antioxidant content. Most of the tubers of *Dioscorea* are potential against birth control and various skin infections.[8] Diosgenin is the chemical compound found in *Dioscorea* root which is one of the costliest and important steroidal drugs used worldwide.[9,10] These plants are broadly used in pharmaceutical products, horticulture, and household purposes and are also ecologically important as it is a good indicator of environmental conditions (present study). They are traditionally used in China, Europe, North American, and India to cure illness of cardiovascular system, tonsillitis, bronchitis, tympanitis, skin diseases, inflammatory diseases, cardiovascular diseases, aging disorders, menopause, cancers and osteoporosis, and burns.[11,12] They also possess anticancer and antimicrobial activity due to their unique chemical constituents.[13] The above cited medicinal and pharmacological values indicated that these tuberous plants provide a baseline to screen the new antimicrobial compounds to fight against the antimicrobial resistance (AMR). AMR creating a permanent loss of antibiotics which indicates the need of reverse pharmacological research.[14] Keeping all this in view, an attempt has been made to detect and estimate the secondary metabolites present in selected tuberous plants available in Odisha DB, DE, DG, DO, DT, DW, DH, and *D. hispida* var. *daemona* (DHD) and their antibacterial activity. The present paper highlights the nutraceutical importance of these tuberous plants.

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Materials and Methods

Collection of wild *Dioscorea* species for experimental works

The samples were collected from different parts of Odisha and kept in polybags tagged with the botanical name and sorted out as per standard sampling procedure and passport description.[15]

Preparation of extracts

Soxhlet method and percolation were adopted to obtain the different extracts.[16] The collected experimental plant materials were dried at room temperature or under shade and were powdered after drying using mechanical devices. The powdered material of the experimental plant was kept in thimble and extraction was carried out using the Soxhlet apparatus. The residues were collected and left for air drying and dried crude extracts were stored in refrigerator for further phytochemical analysis and antibacterial activities.

Quantification of secondary metabolites

The quantitative analysis of the plant extracts was carried out using standard methods for the assessment of medicinal values of the used experimental plants. Total phenol,[17] tannin,[18] and saponin were determined.[17]

Estimation of antioxidant activity

1-1-diphenyl-2-pycrilhydrazyne (DPPH) free radical scavenging assay

The test was performed by taking 2 mL of DPPH solution was added to about 0.1 mL tuber extract.[19] The sample was shaken properly and was kept at room temperature in dark for 30 min. The absorbance was then measured at 517 nm. The radical scavenging activity was measured as a decrease in the absorbance of DPPH and calculated. Butylated hydroxytoluene (BHT) was taken as standard.

Metal chelating activity

The metal chelating activity of the tuber extracts was determined.[20] About 1 mL of plant extract added to a solution of 0.5 mL ferrous chloride ($FeCl_2$) (0.2 mm). Then, about 0.2 mL of Ferozin (5 mm) was added to it. The mixture was vigorously shaken and incubated at room temperature for 10 min. The absorbency of the solution was measured at 562 nm. BHT was taken as standard solution. The main aim is to reduce reactive oxygen species generation that is associated with redox active metal catalysis involves chelating of the metal ions.

Figure 1: Common *Dioscorea* species in Odisha. (a) *Dioscorea wallichii*; (b) *Dioscorea oppositifolia*

Results and Discussion

The present study highlights the phytochemistry and the pharmacological properties of the wild tuberous plants. Results of quantitative analysis of bioactive compounds justify their medicinal importance. It was noted that tannin and saponin content was high in DH (8.68 mg/100 g and 6.20 mg/100 g). Total phenol was estimated in higher amount of 89.00 ± 0.50 mg/100 g in DHD. Minimum amount of tannin with 5.39 mg/100 g and saponin with 4.19 mg/100 g was noted from DE. Lowest amount of total phenol was noted in DT and DW [Table 1 and Figure 2].

Table 2 highlights the antioxidant activity of eight wild tuberous plants. DPPH scavenging activity and metal chelating activity were estimated. Methanol extract of DH showed maximum DPPH scavenging activity while DG showed minimum. Acetone extract of DH showed maximum DPPH scavenging activity while DG showed minimum. Methanol extract of DT showed maximum metal chelating activity while DB showed minimum. Acetone extract of DHD showed maximum metal chelating activity while DG showed minimum [Table 2 and Figures 3 and 4].

Flavonoids, phenolic compounds, saponin, and tannin exert a wide range of pharmacological activities including antifungal

Table 1: Estimation of polyphenolic secondary metabolites of experimental plants of dry weight (mg/100 g, mean±SD, *n*=3)

Plant name	*Tannin*	*Saponin*	*Total phenol*
DB	5.50±0.07	5.82±0.02	75.00±0.10
DE	5.39±0.20	4.19±0.10	65.00±0.10
DG	5.75±0.15	5.41±0.10	68.00±0.20
DO	5.65±0.04	5.86±0.05	59.00±0.50
DT	6.20±0.02	5.60±0.05	45.00±0.10
DW	5.11±0.20	5.11±0.10	45.00±0.10
DH	8.68±0.50	6.20±0.10	88.00±0.50
DHD	8.00±0.50	5.49±0.05	89.00±0.50

DB: *Dioscorea belophylla*, DE: *Dioscorea esculenta*, DG: *Dioscorea glabra*, DO: *Dioscorea oppositifolia*, DT: *Dioscorea tomentosa*, DW: *Dioscorea wallichii*, DH: *Dioscorea hamiltonii* and DHD: *Dioscorea hispida* var. *daemona*

Table 2: Antioxidant activity of experimental plants (100 µg/mL)

Plant extract	*DPPH scavenging activity*		*Metal chelating activity*	
	Methanol extract	*Acetone extract*	*Methanol extract*	*Acetone extract*
DB	32.07±0.50	33.30±0.30	31.40±0.50	33.32±0.10
DE	32.24±0.50	35.96±0.50	33.81±0.10	33.61±0.50
DG	30.13±0.50	32.72±0.30	33.38±0.10	30.37±0.50
DO	42.74±0.15	39.82±0.50	36.10±0.50	34.16±0.55
DT	44.78±0.03	46.60±0.50	38.43±0.50	33.42±0.62
DW	40.41±0.39	41.47±0.10	36.52±0.50	35.17±0.08
DH	47.69±0.53	47.40±0.10	33.00±0.36	33.14±0.32
DHD	42.97±0.38	44.12±0.50	38.27±0.10	36.33±0.20
BHT	96.66±0.50		91.80±0.50	

BHT: Butylated hydroxytoluene, mean±SD, *n*=3, DB: *Dioscorea belophylla*, DE: *Dioscorea esculenta*, DG: *Dioscorea glabra*, DO: *Dioscorea oppositifolia*, DT: *Dioscorea tomentosa*, DW: *Dioscorea wallichii*, DH: *Dioscorea hamiltonii* and DHD: *Dioscorea hispida* var. *daemona*. DPPH: 1-1-diphenyl-2-pycrilhydrazyne

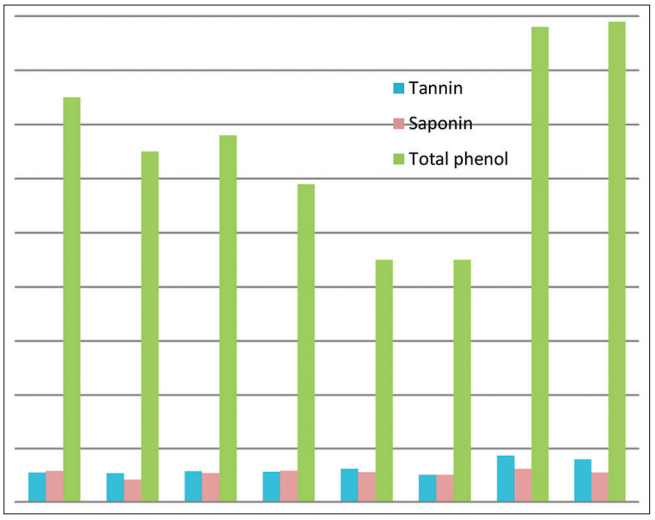

Figure 2: Tannin, saponin, and total phenol content in *Dioscorea* species

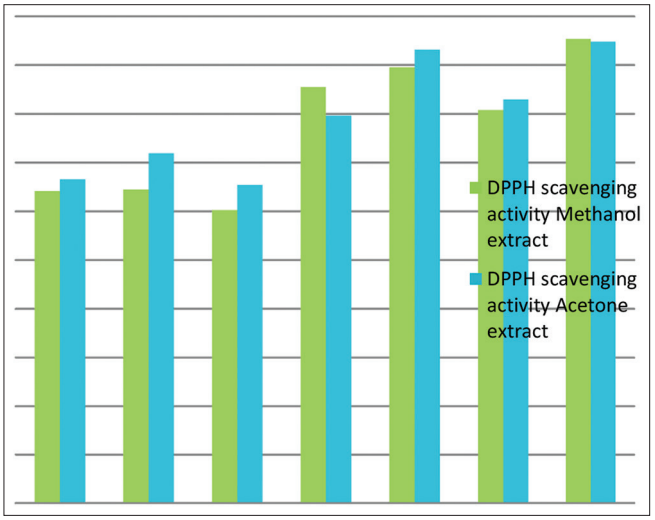

Figure 3: 1-1-diphenyl-2-pycrilhydrazyne scavenging activity of *Dioscorea* species

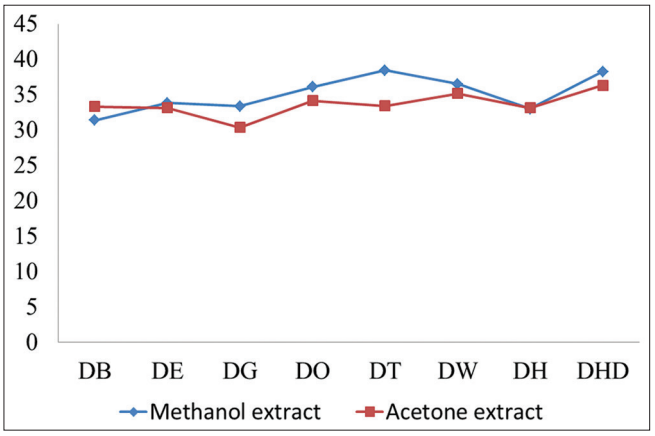

Figure 4: Metal chelating activity of *Dioscorea* species

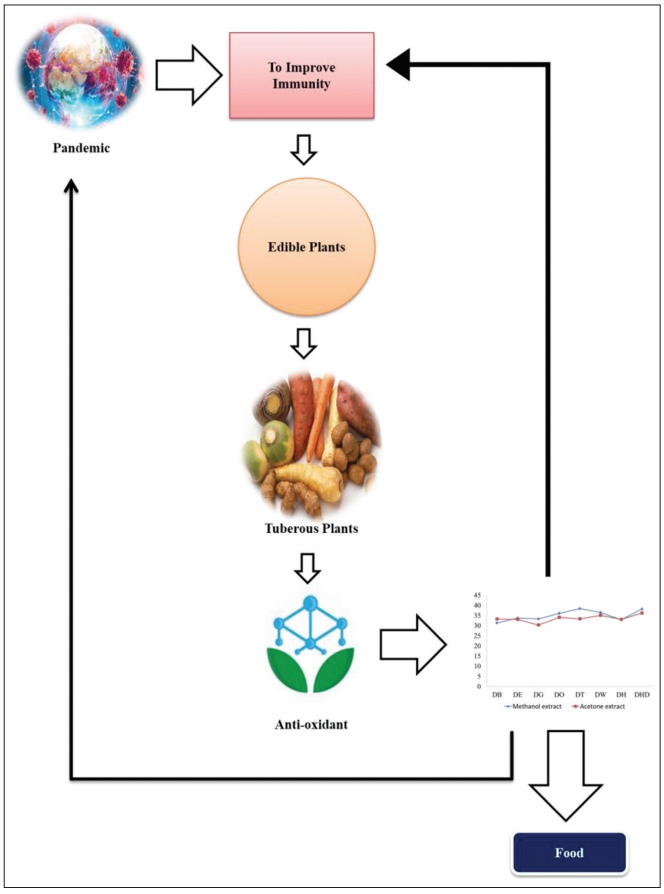

Figure 5: Importance of wild tuberous plant as a nutraceutical

and antibacterial activities.[21] Tannin is astringent, bitter plant polyphenolic compound which gives protein precipitates and various other organic compounds including amino acids and alkaloids.[22] Plants are the major sources of tannin. They have been reported to be responsible for decrease in feed intake and feed efficiency. Tannins act as antioxidant, antifungal, anticarcinogenic, antimicrobial, and antifungal agents.[19] There has been increasing interest in the research of flavonoids from dietary sources, due to growing evidence of the versatile health benefits of flavonoids. Flavonoids are directly associated with human daily dietary intake of antioxidants. They are shown to have free radical scavenging capacity. They help in coronary heart disease prevention and have antifungal and antibacterial activity.[23]

Conclusion

Wild tuberous plants are good source of antioxidant agent which needs to maintain the body health. The present study highlights the importance of wild tuberous plants as they are rich source of polyphenols. The present study showed that they have antioxidant potential. Therefore, they could be a sound nutraceuticals [Figure 5].

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