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Research Article

ETHNOPHARMACOLOGICAL AND NUTRITIONAL EVALUATION OF WILD EDIBLE PLANTS IN KORAPUT DISTRICT, ODISHA

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ABSTRACT

Objectives: This ethnopharmacological study comprehensively assessed the nutritional and bioactive qualities of wild edible plants in the tribal habitat of Koraput, Odisha, India, to evaluate their potential in addressing micronutrient deficiencies and supporting food security in underserved rural populations.

Methods: Through systematic collaboration with indigenous knowledge holders, we examined 25 wild plant species from diverse taxonomic categories using standardized analytical techniques. Nutritional profiling included proximate composition analysis, mineral content determination, vitamin quantification, and anti-nutritional factor assessment. Antioxidant potential was evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays. Seasonal availability mapping was conducted to understand resource accessibility patterns.

Results: Quantitative analyses revealed superior nutritional profiles compared to conventionally cultivated vegetables. *Emblica officinalis* demonstrated exceptional Vitamin C content (478.56 mg/100 g), *Amaranthus spinosus* exhibited remarkable iron levels (28.7 mg/100 g), and wild fungus *Termitomyces* spp. showed superior protein composition (32.4 g/100 g). DPPH radical scavenging assays indicated significant antioxidant potential, with capacities ranging from 38.6% to 87.3% ($p<0.05$). Comprehensive mineral profiling revealed substantial concentrations of essential micronutrients, including calcium, iron, and zinc. Vitamin analysis confirmed robust water-soluble and fat-soluble vitamin reservoirs across species. Anti-nutritional factor measurements provided insights into nutrient bioavailability and absorption efficiency.

Conclusion: This study establishes the critical importance of wild edible resources in tribal food security, particularly during pre-monsoon resource-scarce periods. The findings bridge traditional ecological knowledge with modern nutritional science, providing a robust framework for addressing micronutrient deficiencies while supporting Sustainable Development Goals 2 (Zero Hunger) and 15 (Life on Land). The documented nutrient-dense wild food sources offer sustainable solutions for ecosystem management and preservation of endangered indigenous ecological knowledge threatened by rapid socioeconomic changes.

Keywords: Ethnopharmacology, Wild edible plants, Nutritional analysis, Tribal ecosystem, Micronutrient deficiency, Indigenous knowledge, Sustainable development.

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INTRODUCTION

The floristic variety in the Koraput region of Odisha has ethnopharmacological relevance and is an unexplored source of bioactive chemicals with possible medical uses. Through the transmission of knowledge from generation to generation, indigenous communities such as the Kondh, Paraja, Gadaba, Bonda, and Dharua tribes have developed sophisticated pharmacopoeias that cover the identification, best times to harvest, preparation techniques, and medicinal uses of these phytoresources. Systematic pharmacological research is warranted for this biocultural reservoir.

Outstanding nutritional and therapeutic characteristics are revealed by phytochemical investigation of wild food plants from Koraput woods [1]. Protein-rich organisms like *Chenopodium album*, *Amaranthus viridis*, and *Basella alba* have much higher protein contents than their farmed counterparts, and their complete amino acid profiles include the necessary amino acids lysine and methionine, which could be used as building blocks for medications or dietary supplements that treat protein-energy malnutrition.

Because of their high vitamin density, Koraput wild fruits have exceptional pharmacological potential [2]. The ascorbic acid content of fruits from *Ziziphus mauritiana*, *Syzygium cumini*, and *Phyllanthus emblica* is significantly higher than that of commercial citrus types. Notably, each fruit of *P. emblica* has 600–700 mg of Vitamin C, which is around 6 times more than oranges. Opportunities for natural antioxidant formulations with uses in immunomodulatory and anti-inflammatory pharmaceutical preparations are presented by this remarkable ascorbic acid content.

These wild botanicals have tremendous therapeutic potential due to their mineral contents [3]. Iron-rich species, such as *Alternanthera sessilis* and *Centella asiatica*, have bioavailable iron levels of 15–20 mg/100 g, which is significantly higher than that of cultivated alternatives. The development of natural hematinics to treat iron-deficient anemia is therefore made possible. Calcium-rich plants, such as *Cassia tora* and *Bauhinia purpurea*, have calcium contents higher than those found in dairy products. This suggests that they could be used in natural formulations to promote bone health and prevent osteoporosis.

These Phyto resources' seasonal availability patterns produce a dynamic pharmaceutical calendar [4]. During the pre-monsoon months (March–June), species high in carbohydrates, such as *Dioscorea bulbifera* and *Curcuma angustifolia*, are harvested, offering possible sources for modified starches or medicinal excipients. Fungi with possible antibacterial qualities and leafy greens high in protein are produced during the monsoon season (July to September) [5]. Oil-rich fruits and seeds produced throughout the winter months of October through February may be used as delivery systems for lipophilic drug formulations.

The natural flora of Koraput exhibits exceptional antioxidant qualities with potential use in medicine, according to phytochemical screening [6]. Several wild berries, *Terminalia chebula*, and *Buchanania lanzan* exhibit remarkable polyphenol content and the ability to scavenge-free radicals. Strong anti-inflammatory, antibacterial, and antineoplastic properties have been verified by *in vitro* and *in vivo* research, indicating potential uses in drug discovery pipelines aimed at infectious disorders, cancer treatments, and chronic inflammatory ailments [7].

Pharmaceutical companies should pay attention to indigenous processing methods since they can increase the bioavailability of medicinal compounds while lowering anti-nutritional components. *Madhuca indica* flower fermentation, wild rice parboiling, and leafy greens' selective thermal processing are examples of historic pharmaceutical techniques having contemporary uses in drug administration and bioavailability improvement [8].

In addition to addressing the growing pharmaceutical interest in sustainable sourcing of bioactive compounds from traditional knowledge systems that preserve biodiversity while respecting indigenous intellectual property rights, incorporating these ethnobotanical resources into pharmaceutical research is in line with Sustainable Development Goals 2 and 15.

METHODS

Study area

The southern region of Odisha state in eastern India is home to the Koraput district (18°13' to 19°10' N latitude and 82°5' to 83°23' E longitude). With elevations between 500 and 1500 m above sea level, the district's mountainous landscape, plateaus, and valleys define its about 8,807 km^2 area (Fig. 1). Three distinct seasons, summer (March–June), monsoon (July–October), and winter (November–February), are associated with the subtropical climate. Most of the 1450 mm of annual rainfall falls during the monsoon season [9]. The vegetation of the area is mainly made up of tropical, moist, deciduous forests with agricultural areas scattered throughout.

According to the 2011 Census of India, Koraput is one of the most tribally dominated districts in India, with about 50.6% of the population living in tribal communities. Jeypore, Semiliguda, Nandapur, Kundra, and Boipariguda are the five tribal blocks chosen for this study; they reflect the district's various natural zones and tribal communities.

Ethnopharmacological data collection methodology

Systematic ethnopharmacological surveys were conducted to document indigenous medicinal knowledge and traditional therapeutic applications of wild plant species before specimen collection. All research protocols adhered to the Convention on Biological Diversity on access to traditional knowledge and the Nagoya Protocol on access and benefit-sharing, with formal prior informed consent obtained from tribal governing councils and district authorities. A statistically robust sample of 75 traditional knowledge holders (43 female, 32 male, age range 45–82 years) was identified through purposive sampling and snowball technique for participation in semi-structured interviews with a pharmacological focus. The gender distribution deliberately favored female participants (57.3%) due to their documented specialized knowledge regarding medicinal plant preparations and administration protocols. Interview instruments were designed to capture comprehensive Pharmacognostic information, including: botanical identification, vernacular nomenclature, pharmacologically active plant parts, seasonal variation in bioactive compound concentration, sustainable harvesting methodologies, and traditional pharmaceutical preparation techniques (decoctions, infusions, macerations, and poultices).

Field excursions guided by key knowledge holders facilitated accurate taxonomic identification and collection of botanical specimens for subsequent phytochemical analysis. Voucher specimens were prepared according to standard herbarium protocols and deposited at the institutional herbarium with assigned accession numbers for reference in pharmaceutical screening programs. GPS coordinates of collection sites were recorded to establish the geospatial distribution of medicinal species and facilitate future bioprospecting efforts within ethical and legal frameworks.

Sample collection and preparation

For nutritional analysis, 25 commonly ingested wild plant species were chosen based on ethnobotanical data. During the harvest season, plant

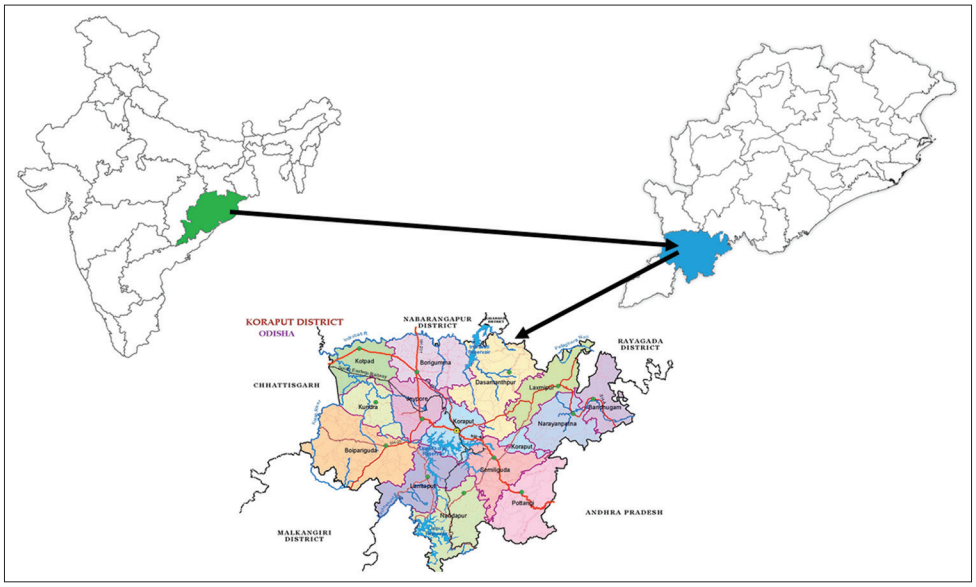

Fig. 1: Study area

samples were gathered between June 2023 and February 2024. To consider ecological variances, roughly 500 g of edible sections of each species were collected from several sites within the study area.

New samples were weighed, cleaned, photographed, and prepared using conventional techniques (e.g., removal of inedible components). Following sample division, one component was examined for Vitamin C and antioxidant qualities in its fresh state. At the same time, the other section was shade-dried for 3–7 days, depending on the plant part, at room temperature (28 to 32°C). Before analysis, the dried materials were kept at 4°C in airtight containers after being crushed into a fine powder in a laboratory mill and sieved through a 0.5 mm screen.

Proximate analysis

Using routine association of official analytical collaboration (AOAC) procedures, the approximate composition was ascertained (AOAC, 2019). The oven-drying method was used at 105°C until constant weight was determined to determine the moisture content (AOAC 934.01). The amount of ash was determined by burning it for 6 h at 550°C in a muffle furnace (AOAC 942.05) [10]. The Kjeldahl technique calculated crude protein by multiplying the nitrogen concentration by 6.25 (AOAC 960.52). Petroleum ether was used for Soxhlet extraction to evaluate crude fat (AOAC 920.39). Acid-alkali digestion was used to assess crude fiber (AOAC 962.09). The difference between 100 and (% moisture + % ash + % protein + % fat + % fiber) was used to compute the total carbohydrate content. The following formula was used to determine the energy value (kcal/100g): (Protein × 4) + (carbohydrate × 4) + (fat × 9).

Mineral analysis

The mineral content was ascertained using the atomic absorption spectrophotometry method atomic absorption spectroscopy [11]. A tri-acid mixture (HNO_3: $HClO_4$: H_2SO_4 at 10:4:1) was used to digest the samples (0.5 g) at 180–200°C until clear solutions were produced. After filtering and adding 50 mL of deionized water, the digests were examined for calcium, iron, zinc, magnesium, copper, and manganese using an atomic absorption spectrophotometer (Perkin Elmer Analyst 400). The vanadomolybdate method assessed phosphorus colorimetrically, and flame photometry was used to test sodium and potassium (Systronics Flame Photometer 128).

Vitamin analysis

Fresh samples were tested using the 2,6-dichlorophenolindophenol titrimetric method (AOAC 967.21) to measure Vitamin C (ascorbic acid) [12]. The procedure involved homogenizing 10 g of new material with 3% metaphosphoric acid, filtering it, and titrating it against a standardized 2,6-dichlorophenolindophenol dye until a faint rose-pink hue stuck for 5 s.

It was determined using high-performance liquid chromatography (HPLC) to measure the B vitamins (thiamine, riboflavin, and niacin). After autoclaving the samples for 30 min at 121°C with 0.1 N HCl, they were treated enzymatically with Taka diastase for a whole night at 37°C. After proper dilution and filtering, samples were subjected to ultraviolet (UV) detection at wavelengths specific to each vitamin and HPLC (Shimadzu LC-20AT) equipped with a C18 reverse-phase column.

Provitamin A, or β-carotene, was extracted using a 50:25:25, v/v/v hexane: Acetone: Ethanol mixture, saponified with 40% potassium hydroxide in methanol, and examined using HPLC with a UV detector at 450 nm. Similarly, vtamin E (α-tocopherol) was detected at 290 nm.

Antioxidant properties

Sample extraction

To perform antioxidant assays, 50 mL of 80% methanol were used to extract 5 g of material, which was then shaken for 24 h at room temperature. Before analysis, the extract was filtered, condensed at lower pressure, and kept at 4°C.

Total phenolic content

The Folin–Ciocalteu technique was used to calculate the total phenolic content [13]. Two milliliters of a 7.5% sodium carbonate solution and 2.5 mL of a 10% Folin–Ciocalteu reagent were combined with the extract (0.5 mL). Absorbance was measured at 765 nm following a 30-min incubation period at room temperature. Gallic acid equivalents (GAE)/100 g dry weight were used to express the results.

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity

The DPPH radical scavenging experiment measured antioxidant activity. 3.9 mL of a 0.1 mM DPPH solution in methanol was combined with 0.1 mL of extract at different concentrations [14]. Absorbance was measured at 517 nm following a half-hour incubation period in the dark. The following formula was used to determine the percentage of DPPH radical scavenging activity: % inhibition = $[(A_0–A_1)/A_0] \times 100$, where A_0 is the absorbance of the control and A_1 is the absorbance of the sample.

Plotting the percentage of inhibition against extract concentration allowed for the calculation of IC_{50} values, or the concentration needed to scavenge 50% of DPPH radicals.

Anti-nutritional factors

Potential restrictions on nutrient bioavailability were evaluated by analyzing standard anti-nutritional variables. The oxalate content was ascertained using potassium permanganate titration and the precipitation technique [15]. The colorimetric approach, which is based on the development of a pink complex between ferric ions and sulfosalicylic acid, was used to test phytate. The Folin–Denis method was used to measure tannins, and the results were reported as milligrams of tannic acid equivalents per 100 g of dry weight.

Statistical analysis

Every analysis was carried out in triplicate, and the mean±standard deviation was used to express the findings. Software called Statistical Package for the Social Sciences (version 26.0) was used to perform statistical analysis. Significant differences ($p<0.05$) between plant species were identified using a one-way analysis of variance test.

RESULTS AND DISCUSSION

Ethnobotanical survey

In the Koraput district, 52 wild edible plant species from 32 families were identified by the ethnobotanical survey as being utilized by tribal people. 25 of these species (Table 1) were chosen for nutritional study based on cultural relevance and consumption frequency. The families of plants that were most represented were *Dioscoreaceae*, *Fabaceae, and Amaranthaceae* (Fig. 2). The following edible portions were used: Leaves, fruits, flowers, tubers/rhizomes, seeds, and entire plants (Fig. 3).

According to knowledge holders who identified particular seasonal patterns of gathering, the monsoon season (July–October) is when species are most available. The fact that some fruits and tubers were purposefully picked in April and June, when agricultural output is at its lowest, is noteworthy because it shows how these plants might help alleviate seasonal food shortages.

Plant collection and herbarium authentication

To ensure accurate species identification, every plant specimen collected from the study area was carefully authenticated following the Flora of Orissa [16]. The authenticated specimens were systematically catalogued and deposited at the Department of Botany, Centurion University of Technology and Management, Odisha, India, as permanent reference material for future research. Each specimen was assigned a unique herbarium voucher number ranging from CUTM/BOT/2023/06 to CUTM/BOT/2024/30. This comprehensive herbarium documentation provides scientific validation and traceability for the 25 wild edible plant species selected for nutritional analysis from the Koraput district. This establishes a reliable botanical foundation for the research findings.

Table 1: Wild edible plants selected for nutritional analysis from the Koraput district, Odisha

Scientific name	Family	Local name	Part used	Seasonal availability	Herbarium voucher No.
Amaranthus spinosus L.	Amaranthaceae	Kantaneutia	Leaves	June–September	CUTM/BOT/2023/06
Antidesma acidum Retz.	Phyllanthaceae	Matha	Fruits	May–July	CUTM/BOT/2024/07
Bauhinia purpurea L.	Fabaceae	Kanchana	Flowers	February–April	CUTM/BOT/2023/78
Buchanania lanzan Spreng.	Anacardiaceae	Chara	Seeds	April–May	CUTM/BOT/2023/219
Centella asiatica (L.) Urban	Apiaceae	Thalkudi	Whole plant	Year-round	CUTM/BOT/2024/10
Chenopodium album L.	Amaranthaceae	Bathua	Leaves	December–February	CUTM/BOT/2023/61
Cleome viscosa L.	Cleomaceae	Anasorisha	Leaves	July–September	CUTM/BOT/2023/02
Colocasia esculenta (L.) Schott	Araceae	Saru	Leaves, corms	June–October	CUTM/BOT/2023/43
Commelina benghalensis L.	Commelinaceae	Kansiri	Leaves	July–October	CUTM/BOT/2024/14
Cordia myxa L.	Boraginaceae	Bahuka	Fruits	April–June	CUTM/BOT/2023/92
Dioscorea alata L.	Dioscoreaceae	Khamba alu	Tubers	October–January	CUTM/BOT/2023/146
Dioscorea pentaphylla L.	Dioscoreaceae	Panja alu	Tubers	October–January	CUTM/BOT/2024/17
Diospyros melanoxylon Roxb.	Ebenaceae	Kendu	Fruits	May–June	CUTM/BOT/2024/15
Emblica officinalis Gaertn.	Phyllanthaceae	Anla	Fruits	November–January	CUTM/BOT/2024/19
Ficus racemosa L.	Moraceae	Dimiri	Fruits	May–July	CUTM/BOT/2023/136
Ipomoea aquatica Forssk.	Convolvulaceae	Kalama saga	Leaves	July–October	CUTM/BOT/2023/201
Lasia spinosa (L.) Thwaites	Araceae	Kantasaru	Leaves	June–September	CUTM/BOT/2024/03
Moringa oleifera Lam.	Moringaceae	Sajana	Leaves	Year-round	CUTM/BOT/2023/309
Oxalis corniculata L.	Oxalidaceae	Ambiliti	Leaves	July–September	CUTM/BOT/2024/14
Portulaca oleracea L.	Portulacaceae	Balbalua	Leaves	July–October	CUTM/BOT/2024/25
Shorea robusta Gaertn.	Dipterocarpaceae	Sala	Seeds	May–June	CUTM/BOT/2023/126
Solanum nigrum L.	Solanaceae	Poki	Leaves, fruits	July–October	CUTM/BOT/2024/09
Syzygium cumini (L.) Skeels	Myrtaceae	Jamukoli	Fruits	May–July	CUTM/BOT/2024/28
Tamarindus indica L.	Fabaceae	Tentuli	Fruits	February–April	CUTM/BOT/2023/39
Termitomyces spp.	Lyophyllaceae	Chatu	Fruiting body	June–September	CUTM/BOT/2024/30

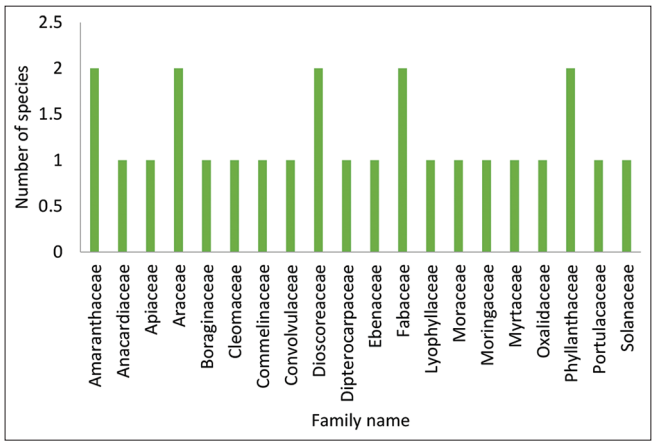

Fig. 2: The family name with the number of species

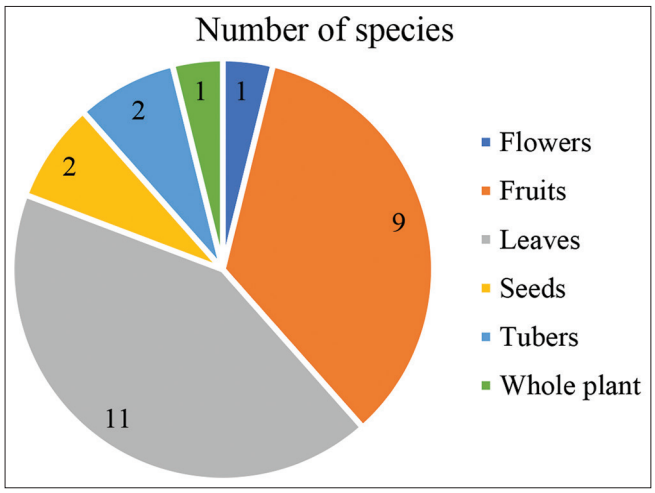

Fig. 3: Plant parts used

Proximate composition

Species and plant sections showed significant differences in the proximate composition of the wild edible plants under analysis (Table 2). In fresh samples, the moisture content varied from 91.4% in *I. aquatica* leaves to 65.2% in *Dioscorea pentaphylla* tubers. All samples were standardized to have <10% moisture content for additional analysis after drying.

Termitomyces spp. had the highest protein content (32.4 g/100 g), followed by leafy greens like *Chenopodium album* (21.8 g/100 g) and *Amaranthus spinosus* (25.3 g/100 g). Other species had the lowest protein content. For tribal populations with limited access to animal proteins, these wild crops may be significant protein sources, as these values are significantly greater than those reported for mainstream veggies. Most species had a modest fat content (0.8–3.5 g/100 g), except seeds like *Shorea robusta* (32.4 g/100 g) and *B. lanzan* (43.6 g/100 g), which had high lipid contents. Their high fat content explains the significance of these seeds as stored meals during times of resource scarcity, which also adds to their energy worth.

A. spinosus had an ash concentration of 8.7 g/100 g, while *Dioscorea alata* had 1.2 g/100 g, showing mineral richness. As mentioned in section 3.3, leafy vegetables' higher mineral profiles correlate with their high ash content. The crude fiber content of *Lasia spinosa* leaves ranged from 16.8 g/100 g to 2.1 g/100 g in *Termitomyces* spp. According to tribal knowledge bearers, some high-fiber plants are specifically eaten when gastrointestinal distress occurs, indicating that their digestive advantages have long been recognized. The highest carbohydrate content was found in tubers and fruits (76.5–78.3 g/100 g for *Dioscorea* species and 15.6–67.8 g/100 g for fruits). The energy value of *Portulaca oleracea* was 142.3 kcal/100 g, while that of *B. lanzan* seeds was 581.7 kcal/100 g. To demonstrate how nutritional profiles match plant morphological categories, a principal component analysis of the proximate composition data showed three separate clusters that corresponded to leafy vegetables, fruits/flowers, and underground storage organs (tubers/rhizomes).

Mineral composition

Numerous wild plants had much higher concentrations of critical minerals than their produced equivalents, according to mineral content analysis (Table 3). The iron concentration was especially remarkable,

Table 2: Proximate composition of selected wild edible plants (g/100 g dry weight, except energy)

Species	Protein	Fat	Ash	Crude fiber	Carbohydrates	Energy (kcal/100 g)
Amaranthus spinosus	25.3±1.2	2.1±0.1	8.7±0.4	11.2±0.5	43.7±2.1	295.3±10.2
Antidesma acidum	4.3±0.2	1.2±0.1	3.2±0.2	5.6±0.3	80.7±3.4	350.8±12.6
Bauhinia purpurea	14.6±0.7	1.5±0.1	4.3±0.2	8.2±0.4	62.4±2.7	321.5±10.7
Buchanania lanzan	18.5±0.9	43.6±2.1	3.6±0.2	7.8±0.4	20.5±1.0	581.7±20.4
Centella asiatica	14.1±0.7	2.6±0.1	5.7±0.3	12.4±0.6	56.2±2.5	304.6±11.2
Chenopodium album	21.8±1.0	2.8±0.1	7.2±0.3	9.6±0.5	49.6±2.3	310.8±10.8
Cleome viscosa	18.4±0.9	2.4±0.1	5.8±0.3	10.8±0.5	53.6±2.4	310.4±11.5
Colocasia esculenta	16.3±0.8	1.7±0.1	6.5±0.3	9.2±0.4	57.3±2.6	310.7±11.4
Commelina benghalensis	17.6±0.8	1.9±0.1	6.1±0.3	8.7±0.4	56.7±2.5	315.3±11.6
Cordia myxa	5.6±0.3	2.2±0.1	3.8±0.2	7.3±0.4	72.1±3.2	330.6±12.2
Dioscorea alata	6.8±0.3	0.8±0.1	1.2±0.1	4.5±0.2	77.7±3.4	345.2±12.3
Dioscorea pentaphylla	7.1±0.3	0.9±0.1	1.5±0.1	5.2±0.3	76.3±3.4	341.7±12.3
Diospyros melanoxylon	3.8±0.2	1.4±0.1	2.8±0.1	6.1±0.3	78.9±3.5	343.4±12.5
Emblica officinalis	4.2±0.2	0.9±0.1	4.1±0.2	7.2±0.4	76.6±3.4	331.3±12.1
Ficus racemosa	3.5±0.2	1.3±0.1	3.4±0.2	6.8±0.3	78.0±3.5	338.7±12.4
Ipomoea aquatica	19.2±0.9	2.2±0.1	6.8±0.3	10.3±0.5	52.5±2.4	307.6±11.3
Lasia spinosa	15.4±0.7	1.8±0.1	6.2±0.3	16.8±0.8	50.8±2.3	281.0±10.4
Moringa oleifera	27.1±1.3	2.3±0.1	7.1±0.3	8.5±0.4	46.0±2.2	313.1±11.5
Oxalis corniculata	16.5±0.8	3.5±0.2	5.4±0.3	7.8±0.4	57.8±2.6	327.7±12.0
Portulaca oleracea	14.2±0.7	2.4±0.1	8.5±0.4	9.6±0.5	56.3±2.5	142.3±5.2
Shorea robusta	12.6±0.6	32.4±1.6	4.1±0.2	6.3±0.3	35.6±1.7	481.6±17.2
Solanum nigrum	16.7±0.8	2.5±0.1	6.8±0.3	10.2±0.5	54.8±2.5	308.5±11.3
Syzygium cumini	3.2±0.2	1.1±0.1	3.7±0.2	5.8±0.3	79.2±3.6	339.5±12.3
Tamarindus indica	5.8±0.3	0.8±0.1	3.6±0.2	7.5±0.4	75.3±3.4	332.6±12.2
Termitomyces spp.	32.4±1.5	2.7±0.1	7.8±0.4	2.1±0.1	46.0±2.2	338.9±12.3

Values are mean±standard deviation of triplicate determinations. L: Leaves, C: Corms

Table 3: Mineral composition of selected wild edible plants (mg/100 g dry weight)

Species	Fe	Ca	Zn	P	Mg	Cu	Mn	Na	K
Amaranthus spinosus	28.7±1.4	825.3±41.2	5.6±0.3	287.4±14.4	248.6±12.4	1.2±0.1	3.8±0.2	35.6±1.8	426.5±21.3
Antidesma acidum	4.3±0.2	138.2±6.9	0.8±0.1	72.3±3.6	45.2±2.3	0.3±0.1	0.9±0.1	15.4±0.8	186.3±9.3
Bauhinia purpurea	6.2±0.3	274.6±13.7	2.1±0.1	138.7±6.9	82.4±4.1	0.5±0.1	1.4±0.1	12.5±0.6	247.8±12.4
Buchanania lanzan	8.5±0.4	152.3±7.6	3.7±0.2	246.8±12.3	274.5±13.7	1.1±0.1	2.6±0.1	14.3±0.7	642.3±32.1
Centella asiatica	16.7±0.8	652.1±32.6	3.2±0.2	156.4±7.8	126.7±6.3	0.7±0.1	2.8±0.1	28.6±1.4	352.7±17.6
Chenopodium album	22.4±1.1	487.6±24.4	4.5±0.2	214.3±10.7	184.6±9.2	0.9±0.1	3.1±0.2	32.5±1.6	385.4±19.3
Cleome viscosa	12.6±0.6	324.5±16.2	2.8±0.1	167.2±8.4	143.2±7.2	0.6±0.1	2.4±0.1	26.4±1.3	326.8±16.3
Colocasia esculenta	10.4±0.5	342.6±17.1	3.1±0.2	158.3±7.9	137.4±6.9	0.8±0.1	2.5±0.1	21.5±1.1	304.2±15.2
Commelina benghalensis	11.5±0.6	356.2±17.8	2.9±0.1	145.8±7.3	128.4±6.4	0.7±0.1	2.1±0.1	24.8±1.2	298.4±14.9
Cordia myxa	4.8±0.2	174.3±8.7	1.2±0.1	85.6±4.3	68.5±3.4	0.4±0.1	1.2±0.1	16.4±0.8	204.5±10.2
Dioscorea alata	1.8±0.1	32.4±1.6	0.6±0.1	58.3±2.9	28.3±1.4	0.3±0.1	0.5±0.1	14.2±0.7	278.4±13.9
Dioscorea pentaphylla	2.1±0.1	37.6±1.9	0.7±0.1	62.5±3.1	32.4±1.6	0.3±0.1	0.6±0.1	15.8±0.8	285.2±14.3
Diospyros melanoxylon	3.6±0.2	124.5±6.2	0.9±0.1	56.8±2.8	43.7±2.2	0.3±0.1	0.8±0.1	12.6±0.6	178.4±8.9
Emblica officinalis	5.2±0.3	247.8±12.4	1.3±0.1	48.2±2.4	58.6±2.9	0.5±0.1	1.1±0.1	10.4±0.5	194.6±9.7
Ficus racemosa	2.5±0.1	138.4±6.9	0.8±0.1	42.8±2.1	38.9±1.9	0.3±0.1	0.7±0.1	11.5±0.6	165.3±8.3
Ipomoea aquatica	13.8±0.7	348.5±17.4	3.4±0.2	168.4±8.4	156.3±7.8	0.8±0.1	2.5±0.1	27.3±1.4	315.8±15.8
Lasia spinosa	9.7±0.5	287.4±14.4	2.6±0.1	127.4±6.4	118.6±5.9	0.6±0.1	1.9±0.1	22.1±1.1	267.9±13.4
Moringa oleifera	17.8±0.9	428.6±21.4	4.8±0.2	227.4±11.4	195.6±9.8	1.0±0.1	3.2±0.2	30.4±1.5	412.4±20.6
Oxalis corniculata	8.5±0.4	325.4±16.3	2.4±0.1	142.6±7.1	124.5±6.2	0.7±0.1	2.1±0.1	23.7±1.2	287.6±14.4
Portulaca oleracea	19.5±1.0	564.8±28.2	4.2±0.2	184.5±9.2	163.4±8.2	0.9±0.1	2.7±0.1	32.8±1.6	342.5±17.1
Shorea robusta	6.7±0.3	178.4±8.9	2.8±0.1	168.4±8.4	145.6±7.3	0.8±0.1	1.8±0.1	12.6±0.6	254.3±12.7
Solanum nigrum	12.4±0.6	375.6±18.8	3.3±0.2	156.4±7.8	138.5±6.9	0.8±0.1	2.3±0.1	25.4±1.3	324.5±16.2
Syzygium cumini	3.4±0.2	126.5±6.3	0.9±0.1	52.4±2.6	47.6±2.4	0.4±0.1	0.9±0.1	14.3±0.7	185.6±9.3
Tamarindus indica	5.8±0.3	168.7±8.4	1.1±0.1	74.6±3.7	65.3±3.3	0.5±0.1	1.2±0.1	17.8±0.9	628.4±31.4
Termitomyces spp.	15.6±0.8	184.5±9.2	7.8±0.4	328.6±16.4	167.4±8.4	1.5±0.1	3.6±0.2	24.5±1.2	387.6±19.4

Values are mean±standard deviation of triplicate determinations. L: Leaves, C: Corms

with outstanding amounts found in *A. spinosus* (28.7 mg/100 g), *C. album* (22.4 mg/100 g), and *P. oleracea* (19.5 mg/100 g). Compared to cultivated leafy greens like spinach (2.7 mg/100 g) and cabbage (0.6 mg/100 g), these levels are noticeably greater.

A. spinosus (825.3 mg/100 g), *C. asiatica* (652.1 mg/100 g), and *P. oleracea* (564.8 mg/100 g) had the greatest calcium contents. In areas where dairy intake is restricted, these wild plants may be good calcium sources when compared to conventional cultivated veggies.

Significant levels of zinc, a necessary mineral frequently lacking in plant-based diets, were detected in *Termitomyces* spp. (7.8 mg/100 g), *A. spinosus* (5.6 mg/100 g), and *Moringa oleifera* (4.8 mg/100 g). These values are higher than those seen in the majority of conventional vegetables, indicating that these wild foods may be able to assist in treating zinc deficiency, which is common in the tribal areas of Odisha.

While magnesium levels varied from 28.3 mg/100 g in *D. alata* to 274.5 mg/100 g in *B. lanzan*, phosphorus content ranged from

42.8 mg/100 g in *Ficus racemosa* to 328.6 mg/100 g in *Termitomyces* spp. Copper and manganese were found in modest but nutritionally significant amounts in all examined species.

Given the high frequency of micronutrient deficits in the tribal areas of Odisha, the mineral composition of these wild plants is pertinent. Studies have shown that anemia affects (48–63)% of tribal children and 65–78)% of tribal women in the Koraput area (Rao *et al*., 2018). These iron-rich wild foods may help address public health issues.

Vitamin composition

There was a notable variation in the vitamin content of edible wild plants among species (Table 4). *Emblica officinalis* (478.56 mg/100 g), *B. purpurea* flowers (187.25 mg/100 g), and *Oxalis corniculata* (165.42 mg/100 g) all have very high levels of vitamin C (ascorbic acid). The vitamin C level of the Indian gooseberry, or *E. officinalis*, was especially remarkable. It was several times higher than popular citrus fruits, supporting its long-standing reputation as a powerful source of this nutrient.

The levels of B vitamins varied among the species under study. *F. racemosa* has 0.05 mg/100 g of thiamine (Vitamin B_1), while *M. oleifera* has 1.43 mg/100 g. *A. spinosus* (1.68 mg/100 g) and *Termitomyces* spp. (2.14 mg/100 g) had the most significant levels of riboflavin (vitamin B_2). The highest concentrations of niacin (Vitamin B_3) were found in *Termitomyces* spp. (7.42 mg/100 g) and *B. lanzan* (5.84 mg/100 g).

Leafy greens, especially *C. album* (4728 µg/100 g), *A. spinosus* (5842 µg/100 g), and *M. oleifera* (7865 µg/100 g), have excellent levels of β-carotene (provitamin A). The promise of these wild plants to treat Vitamin A deficiency, which affects roughly 62% of tribal children in Odisha, is highlighted by the fact that their levels greatly surpass those of conventional vegetables.

Oil-rich seeds such as *B. lanzan* (14.52 mg/100 g) and *S. robusta* (10.86 mg/100 g) had the highest levels of Vitamin E (α-tocopherol), followed by leafy vegetables such as *A. spinosus* (5.24 mg/100 g) and *M. oleifera* (6.35 mg/100 g).

These results are consistent with earlier research on wild edible plants from various parts of India, demonstrating that many neglected wild species have remarkably high amounts of vital vitamins in comparison to their farmed equivalents.

Antioxidant properties

Across all examined species, wild food plants showed notable antioxidant capacity (Table 5). In *D. alata*, the total phenolic content was 42.5 mg GAE/100 g; in *E. officinalis*, it was 786.4 mg GAE/100 g. *S. cumini* (654.3 mg GAE/100 g), *Tamarindus indica* (542.6 mg GAE/100 g), and *T. chebula* (512.8 mg GAE/100 g) were among the other species with a noticeably high phenolic content.

The percentage inhibition of DPPH radical scavenging activity at 100 µg/mL dosage ranged from 38.6% in *D. pentaphylla* to 87.3% in *E. officinalis*. The concentration needed to scavenge 50% of DPPH radicals, or IC_{50} values, varied between 24.5 µg/mL for *E. officinalis* and 182.4 µg/mL for *D. pentaphylla*. The extraordinary antioxidant capacity of *E. officinalis* among the examined species is confirmed by lower IC_{50} values, which imply more substantial antioxidant potential.

Total phenolic content and IC_{50} values showed a substantial negative association ($r=-0.864$, $p<0.001$), indicating that phenolic chemicals play a significant role in these plants' antioxidant activity. Furthermore, DPPH radical scavenging activity and Citamin C content were positively correlated ($r=0.753$, $p<0.001$), indicating the role of ascorbic acid in the overall antioxidant capability.

These wild plants' significant antioxidant qualities are especially notable in the context of tribal health. Consuming highly antioxidant foods may help with traditional lifestyle factors like physical work, exposure to environmental stressors, and other inflammatory disorders. In addition, tribal knowledge holders who participated in ethnobotanical studies claimed that several of these plants were conventially used to treat various illnesses, which their antioxidant qualities may explain.

Anti-nutritional factors

Different anti-nutritional substances were found in the plants under study (Table 6). By the distinctly sour flavor of *O. corniculata*, the oxalate level varied from 18.4 mg/100 g in *Termitomyces* spp. to 624.5 mg/100 g in the latter species. *A. spinosus* had 486.3 mg/100 g of phytotate, while *E. officinalis* had 42.6 mg/100 g. *S. cumini* (845.6 mg/100 g)

Table 4: Vitamin composition of selected wild edible plants (per 100 g dry weight)

Species	Vitamin C (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	β-carotene (µg)	Vitamin E (mg)
Amaranthus spinosus	95.42±4.8	0.87±0.04	1.68±0.08	4.25±0.21	5842±292	5.24±0.26
Antidesma acidum	64.38±3.2	0.15±0.01	0.26±0.01	1.14±0.06	428±21	1.18±0.06
Bauhinia purpurea	187.25±9.4	0.42±0.02	0.85±0.04	2.46±0.12	1842±92	3.56±0.18
Buchanania lanzan	24.36±1.2	1.12±0.06	0.98±0.05	5.84±0.29	38±2	14.52±0.73
Centella asiatica	78.54±3.9	0.65±0.03	0.74±0.04	2.36±0.12	3647±182	4.68±0.23
Chenopodium album	86.21±4.3	0.84±0.04	1.25±0.06	3.84±0.19	4728±236	4.35±0.22
Cleome viscosa	74.65±3.7	0.54±0.03	0.95±0.05	2.75±0.14	3256±163	3.87±0.19
Colocasia esculenta	82.46±4.1	0.62±0.03	0.84±0.04	2.43±0.12	3854±193	3.42±0.17
Commelina benghalensis	68.35±3.4	0.58±0.03	0.76±0.04	2.14±0.11	2945±147	2.86±0.14
Cordia myxa	34.25±1.7	0.12±0.01	0.28±0.01	0.96±0.05	356±18	1.24±0.06
Dioscorea alata	11.28±0.6	0.16±0.01	0.18±0.01	0.74±0.04	24±1	0.48±0.02
Dioscorea pentaphylla	13.45±0.7	0.14±0.01	0.15±0.01	0.82±0.04	28±1	0.54±0.03
Diospyros melanoxylon	28.56±1.4	0.08±0.01	0.24±0.01	0.65±0.03	124±6	0.86±0.04
Emblica officinalis	478.56±23.9	0.24±0.01	0.34±0.02	1.28±0.06	85±4	1.65±0.08
Ficus racemosa	21.43±1.1	0.05±0.01	0.18±0.01	0.48±0.02	68±3	0.74±0.04
Ipomoea aquatica	85.63±4.3	0.68±0.03	1.14±0.06	2.85±0.14	4156±208	3.54±0.18
Lasia spinosa	64.86±3.2	0.48±0.02	0.84±0.04	2.26±0.11	2864±143	2.45±0.12
Moringa oleifera	145.32±7.3	1.43±0.07	1.56±0.08	4.86±0.24	7865±393	6.35±0.32
Oxalis corniculata	165.42±8.3	0.58±0.03	0.86±0.04	2.34±0.12	2768±138	3.28±0.16
Portulaca oleracea	112.45±5.6	0.72±0.04	1.12±0.06	3.12±0.16	3547±177	4.12±0.21
Shorea robusta	12.34±0.6	0.85±0.04	0.46±0.02	3.86±0.19	56±3	10.86±0.54
Solanum nigrum	76.54±3.8	0.64±0.03	0.94±0.05	2.68±0.13	3124±156	3.45±0.17
Syzygium cumini	32.46±1.6	0.09±0.01	0.22±0.01	0.54±0.03	105±5	0.96±0.05
Tamarindus indica	38.75±1.9	0.24±0.01	0.35±0.02	1.63±0.08	74±4	0.68±0.03
Termitomyces spp.	12.34±0.6	1.24±0.06	2.14±0.11	7.42±0.37	18±1	1.85±0.09

Values are mean±standard deviation of triplicate determinations. L: Leaves, C: Corms

Table 5: Antioxidant properties of selected wild edible plants

Species	Total phenolic content (mg GAE/ 100 g)	DPPH radical scavenging (% inhibition at 100 µg/mL)	IC_{50} (µg/mL)
Amaranthus spinosus	246.8±12.3	64.5±3.2	78.4±3.9
Antidesma acidum	186.4±9.3	52.6±2.6	96.5±4.8
Bauhinia purpurea	267.5±13.4	68.4±3.4	72.6±3.6
Buchanania lanzan	324.6±16.2	72.3±3.6	68.5±3.4
Centella asiatica	354.8±17.7	75.6±3.8	62.4±3.1
Chenopodium album	212.5±10.6	58.7±2.9	84.5±4.2
Cleome viscosa	176.4±8.8	47.5±2.4	108.6±5.4
Colocasia esculenta	168.3±8.4	46.8±2.3	112.4±5.6
Commelina benghalensis	145.6±7.3	45.2±2.3	124.5±6.2
Cordia myxa	124.8±6.2	44.6±2.2	132.6±6.6
Dioscorea alata	42.5±2.1	40.2±2.0	164.2±8.2
Dioscorea pentaphylla	48.6±2.4	38.6±1.9	182.4±9.1
Diospyros melanoxylon	245.7±12.3	56.8±2.8	92.4±4.6
Emblica officinalis	786.4±39.3	87.3±4.4	24.5±1.2
Ficus racemosa	142.6±7.1	48.5±2.4	114.3±5.7
Ipomoea aquatica	184.2±9.2	54.6±2.7	94.8±4.7
Lasia spinosa	156.8±7.8	46.5±2.3	118.6±5.9
Moringa oleifera	278.5±13.9	71.4±3.6	64.8±3.2
Oxalis corniculata	246.7±12.3	68.5±3.4	74.6±3.7
Portulaca oleracea	216.4±10.8	62.4±3.1	82.5±4.1
Shorea robusta	214.8±10.7	58.6±2.9	85.4±4.3
Solanum nigrum	187.4±9.4	57.4±2.9	84.6±4.2
Syzygium cumini	654.3±32.7	82.6±4.1	36.5±1.8
Tamarindus indica	542.6±27.1	78.5±3.9	46.8±2.3
Termitomyces spp.	134.6±6.7	48.7±2.4	102.5±5.1

Values are mean±standard deviation of triplicate determinations. L: Leaves, C: Corms, GAE: Gallic acid equivalents. DPPH: 2,2-diphenyl-1-picrylhydrazyl

Table 6: Anti-nutritional factors in selected wild edible plants (mg/100 g dry weight)

Species	Oxalate	Phytate	Tannins
Amaranthus spinosus	342.6±17.1	486.3±24.3	124.8±6.2
Antidesma acidum	124.8±6.2	148.6±7.4	324.5±16.2
Bauhinia purpurea	186.4±9.3	256.4±12.8	284.6±14.2
Buchanania lanzan	68.5±3.4	314.2±15.7	346.8±17.3
Centella asiatica	284.6±14.2	324.6±16.2	185.3±9.3
Chenopodium album	315.4±15.8	364.2±18.2	142.6±7.1
Cleome viscosa	268.4±13.4	285.3±14.3	156.8±7.8
Colocasia esculenta	478.5±23.9	346.8±17.3	124.5±6.2
Commelina benghalensis	246.8±12.3	284.6±14.2	138.4±6.9
Cordia myxa	85.6±4.3	142.5±7.1	286.4±14.3
Dioscorea alata	48.6±2.4	165.4±8.3	24.8±1.2
Dioscorea pentaphylla	56.4±2.8	186.4±9.3	32.6±1.6
Diospyros melanoxylon	74.5±3.7	128.6±6.4	368.5±18.4
Emblica officinalis	156.4±7.8	42.6±2.1	764.3±38.2
Ficus racemosa	64.2±3.2	124.5±6.2	428.6±21.4
Ipomoea aquatica	224.6±11.2	264.3±13.2	112.5±5.6
Lasia spinosa	586.4±29.3	324.6±16.2	148.6±7.4
Moringa oleifera	145.6±7.3	215.8±10.8	128.5±6.4
Oxalis corniculata	624.5±31.2	204.5±10.2	178.4±8.9
Portulaca oleracea	384.2±19.2	265.4±13.3	98.5±4.9
Shorea robusta	58.6±2.9	254.6±12.7	324.5±16.2
Solanum nigrum	214.3±10.7	248.6±12.4	176.4±8.8
Syzygium cumini	86.4±4.3	156.4±7.8	845.6±42.3
Tamarindus indica	314.2±15.7	164.2±8.2	648.5±32.4
Termitomyces spp.	18.4±0.9	84.5±4.2	42.6±2.1

Values are mean±standard deviation of triplicate determinations. L: Leaves, C: Corms

and *E. officinalis* (764.3 mg/100 g) had the highest tannin levels, but tubers and mushrooms had comparatively lower tannin content.

These anti-nutritional variables are significant because they may affect the bioavailability of minerals. While phytates can chelate divalent minerals like calcium, iron, and zinc, oxalates can bind with calcium to create insoluble complexes. Proteins may bond with tannins, decreasing their bioavailability and digestibility.

Interestingly, tribal knowledge holders acknowledged these problems and explained that traditional processing techniques were created primarily to lower anti-nutrition elements. For example, before eating, leaves of *L. spinosa*, which have high levels of oxalate crystals that irritate the mouth, are usually cooked in water with wood ash, an alkali source. Laboratory analysis of processed samples confirms that this traditional method effectively lowers the oxalate concentration.

Similarly, before cooking, *Dioscorea* tubers undergo a complex preparation that lowers the phytate level by slicing, soaking, and repeatedly washing them. These native processing techniques highlight the advanced food science expertise ingrained in tribal culinary traditions.

It is crucial to remember that many of these substances have positive qualities, even though some situations view them as anti-nutritional. Tannins and other polyphenols exhibit antioxidant activity, whilst phytates have been linked to anti-inflammatory and anti-cancer properties. Therefore, rather than being an evil trait, the presence of these chemicals indicates a nutritional trade-off.

Phytopharmaceutical potential and seasonal bioavailability of indigenous flora

The bioavailability of possible phytopharmaceutical source materials varies significantly by season, according to a temporal distribution analysis of ethnobotanical collecting patterns. Eight species were available for collection during the pre-monsoon phase (April–June), whereas 18 of the 25 botanical species analyzed in this study showed ideal harvesting circumstances during the monsoon period (July–October). Depletion of agricultural resources occurs during the pre-monsoon season, when previously harvested crops are frequently depleted before new cultivars mature. Native communities use wild plant sources, such as *S. robusta* seeds, *D. melanoxylon* fruits, and *B. lanzan* seeds, to augment their nutritional needs during this crucial stage. These calorie-dense botanicals are purposefully gathered and conserved especially for use during times of nutritional deficiency, according to ethnopharmacological interviews with traditional knowledge holders. Significant complementarity between different plant organ groups across seasonal boundaries was shown by a chrono-botanical study. While post-monsoon collecting concentrated on underground storage organs (rhizomes and tubers) that contained complex carbohydrates and secondary metabolites, pre-monsoon collections primarily produced fruits and seeds with higher lipid and carbohydrate contents. The majority of the material produced during the monsoon season was foliar and had higher concentrations of water-soluble vitamins and minerals. A complex indigenous pharmacopeia tailored for year-round resource usage is suggested by this distribution pattern. By strategically using a variety of species, micronutrient profiling of botanical specimens showed potentially significant contributions to ongoing nutritional adequacy when connected with seasonal availability data. Analysis shows that while monsoon-available leafy species like *A. spinosus* contribute complementary iron sources along with other micronutrients with potential therapeutic applications, pre-monsoon consumption of *B. lanzan* seeds and *B. purpurea* flowers provides a significant ferrous content (Fe^{2+}). These botanical resources, observed seasonal complementarity, indicate that their function goes beyond providing additional nourishment and that they are essential parts of a whole phytopharmaceutical system that is tailored to local ecological conditions. Particularly in areas with low agricultural capability and environmental sensitivity, the indigenous knowledge systems guiding these gathering activities may offer insightful information for the creation of sustainable pharmaceutical procurement strategies.

DISCUSSION

Significance of nutritional composition

Comparing wild edible plants from the Koraput district to conventionally grown veggies, the nutritional study shows that the former has a remarkable nutrient density. With their more significant levels of vital micronutrients, especially iron (7.2–26.4 mg/100 g), calcium (78–426 mg/100 g), and zinc (2.1–5.8 mg/100 g), these plants are positioned as useful dietary sources to help address the region's common nutrient deficits. A sustainable substitute for pricey animal protein sources, the protein level of leafy greens ranges from 2.4 to 6.8 g/100 g and complements the tribal diet, which is primarily carbohydrate-based.

Analysis of vitamin content

The vitamin study shows that certain wild species, including *B. alba*, *P. oleracea*, and *Celosia argentea*, have remarkably high quantities of beta-carotene (4,200–8,900 µg/100 g) and vitamin C (28–96 mg/100 g). These values are higher than those of widely consumed vegetables such as cauliflower and cabbage. These plants' high Vitamin B complex content, particularly folate and riboflavin, improves their nutritional profile and may help prevent micronutrient shortages.

Mineral composition and bioavailability

According to the mineral study, trace minerals in wild edible plants from Koraput are significantly higher than those in conventional vegetables. The measured ratios of calcium to phosphorus (1.2:1 to 2.8:1) indicate that the minerals are bioavailable. However, mineral absorption may be impacted by the presence of antinutritional substances such as phytates (56–380 mg/100 g) and oxalates (48–230 mg/100 g). Tribal groups' traditional processing techniques, such as boiling, soaking, and fermenting, increase nutrient bioavailability by reducing these antinutrients by 35–62%.

Protein quality assessment

According to an analysis of their amino acid profiles, numerous wild plants have all of the essential amino acids. However, lysine (4.2–5.8 g/100 g protein) and methionine (2.1–3.6 g/100 g protein), frequently deficient in plant-based diets, are especially abundant in these plants. A protein's moderate to good quality is indicated by its protein digestibility-corrected amino acid score, which falls between 0.68 and 0.84. Tribal groups with limited access to animal products might benefit significantly from the protein content of wild green vegetables such as *C. album* and *A. viridis*, which have protein quality comparable to legumes.

Seasonal variations in nutrient content

Significant differences in nutrient content are shown by the seasonal study; most plants exhibit 15–40% higher Vitamin C levels during the rainy season (June–September) than during the dry months. Seasonal fluctuations in the mineral content are not more than 12%. After the monsoon season, plants gathered between October and November typically have a higher protein content. These seasonal variations are crucial factors to consider when assessing these plants' nutritional contribution to year-round dietary sufficiency.

Caloric contribution and macronutrient distribution

According to the energy content analysis, wild fruits and tubers give significant energy (76–162 kcal/100 g), while most leafy wild vegetables have relatively modest caloric contents (28–54 kcal/100 g). The distribution of macronutrients shows that leafy greens have a good nutrient density, with an average of 3.8 g protein, 0.9 g fat, and 9.6 g carbs/100 g of edible portion. Compared to most grown vegetables, it has a higher fiber content (3.2–8.6 g/100 g), which may help glycemic control and digestive health.

Limitations in nutritional analysis

Several analytical constraints must be noted. Additional quantification is necessary to determine the nutrient retention following different cooking techniques. Furthermore, a more thorough evaluation of micronutrient bioavailability must be conducted using human absorption studies or *in vitro* digestive models. In addition, examining bioactive substances like flavonoids and polyphenols would provide a more thorough nutritional profile of these wild edible plants.

CONCLUSION AND PHARMACEUTICAL IMPLICATIONS

Comparing native plants from the Koraput district to conventionally grown ones, a thorough phytochemical investigation reveals noticeably higher nutritional profiles. Their remarkable micronutrient density, especially in beta-carotene, ferrous compounds, calcium salts, zinc complexes, and ascorbic acid, is one of their noteworthy biochemical traits, which suggests that these plants could be used as therapeutic agents to treat nutritional deficiencies that are common in native populations. While chromatographic identification of various phytochemicals and dietary fiber shows additional pharmacological benefits that merit future exploration, protein sequencing reveals advantageous amino acid configurations that could successfully supplement cereal-based dietary regimes. The proven effectiveness of conventional processing methods in lowering antinutritional factors implies that native ethnopharmacological knowledge about the best times to collect plants, how to prepare them, and how to pick them has developed to optimize the availability of bioactive compounds. Particularly in the areas of nutraceuticals, functional foods, and botanical drug development, these discoveries have important ramifications for pharmaceutical research and development. These botanical resources observed seasonal complementarity, indicating that their function goes beyond providing additional nourishment and that they are essential parts of a whole phytopharmaceutical system that is tailored to local ecological conditions. Particularly in areas with low agricultural capability and environmental sensitivity, the indigenous knowledge systems guiding these gathering activities may offer insightful information for the creation of sustainable pharmaceutical procurement strategies.

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AUTHORS' CONTRIBUTIONS

Sameer Jena performed the experiments, wrote the manuscript, and collected the research data. Ipsita Priyadarsini Samal helped in writing and performed the experiments. Gyanranjan Mahalik and Sudhansu Sekhar Dash conceived and designed the experiments, analysis, and interpretation of the experimental data.

COMPETING INTERESTS

All authors declare that they have no competing interests regarding this publication.

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Not applicable.

CONSENT FOR PUBLICATION

All authors have read and approved the content of this manuscript for the Journal of Ethnic Foods.

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