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Research Article

QUANTITATIVE ASSESSMENT OF TRADITIONAL MEDICINAL PLANTS AND THEIR PHARMACOLOGICAL RELEVANCE IN BARUNEI HILL, ODISHA, INDIA

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ABSTRACT

Objectives: This study aimed to provide an extensive ethnobotanical survey and quantitative evaluation of medicinal plants to determine the pharmacological utility of the resources, evaluate proximate composition, and mineral content.

Methods: The study was completed in 18 months (March 2024–September 2025) in the field with a total of 156 traditional healers and knowledgeable informants, providing an ethnographic examination of their roles in the traditional healthcare of communities and the importance of their relevance to modern healthcare and science products. Quantitative ethnobotanical indices such as use value (UV), fidelity level (FL), relative frequency of citation, and cultural importance index were computed. All 39 recorded species were analyzed using nutritional analysis, comprising proximate composition and mineral analysis.

Results: The study recorded 39 species of medicinal plants belonging to 38 genera and 22 families. The UV (UV=0.89) of *Azadirachta indica* was highest with great application in skin disease, and the highest level of FL (FL=94.7) of *Tinospora cordifolia* was observed for fever. *Andrographis paniculata* leaves contained a high level of protein (18.7±1.1 g/100 g). This paper presents a numbers-driven outcome of the research that would be indicative of the therapeutic and nutritional importance of the traditional medicinal plants found within the Barunei Hill.

Conclusion: The potential of identified species in the pharmaceutical and nutraceutical industries is significant and a complete clinical assessment is necessary to develop them into a prospective researchable resource.

Keywords: Ethnobotany, Medicinal plants, Quantitative indices, Nutritional composition, Barunei hill.

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INTRODUCTION

In all countries of the world, the ancient healthcare systems are based on medicinal plants that are still used until nowadays to develop pharmaceuticals as well. It has been estimated that about 80% of the world population, especially in the developing nations, mainly dependent on plant-based medicine to meet their healthcare demands (World Health Organization, 2019). Over a quarter of current drugs can be traced to plants, either directly or indirectly, which makes them still relevant today in conventional medicine [1,2]. The pharmaceutical industry was inspired by ethnobotanical knowledge to extract modern drugs from natural products [3]. These medicinal plants serve as important sources of nutritional profile, which act in bettering the general well-being and averting illnesses. India is considered to be among the 17 megadiverse countries of the globe, with about 7% of the total world biodiversity, with more than 45,000 species of plants, of which almost 8000 species have been reported to have medicinal properties [4]. As a biodiversity hotspot, the Eastern Ghats, a discontinuous mountain range on the eastern part of India, is with specific floristic composition and high levels of endemic species [5]. Odisha is located along the Eastern Ghats, and it has a wide area of ecological variety that contains an abundance of medicinal plants, especially in highland regions, where the tribes are predominant. The traditional medicinal plants are rich in bioactive compounds, which have important therapeutic potential. Barunei Hill in Odisha is poorly documented in flora but possesses rich ethnobotanical biodiversity. The Barunei Hill that is found in the Khordha district of Odisha lies between 20°10′05.77″–20°09′12.99″ North latitudes and 85°37′10.99″–85°39′38.21″ East longitudes, and is among the main ecological and cultural landscapes. The tropical deciduous forests and lateritic soils have been existing along with rich ethnobotanical knowledge. Scientific literature on the documentation of medicinal plants, which is related to traditional knowledge, on Barunei Hill has not been published. However, there remains a significant research gap: No study has systematically integrated quantitative ethnobotanical indices with comprehensive nutritional profiling (proximate composition and mineral content) of the medicinal flora of Barunei Hill, limiting our understanding of both their cultural significance and their potential for pharmaceutical and nutraceutical development. Ethnobotanical surveys are also effective in initial documentation, as traditional surveys do not provide the nutritional composition and quantitative data that can support pharmacological studies and conservation [6]. Objective values of cultural significance and therapeutic reliability of plants are obtained by quantitative ethnobotanical methods that include standardized indices of use value (UV), fidelity level (FL), relative frequency of citation (RFC), and cultural importance index (CI) according to the meaning attributed to them in a particular culture. The nutritional assessment of medicinal plants is important as many provide significant dietary benefits and nutritional value, contributing to food security [7]. Plants highlight a significant link between traditional knowledge and modern nutritional science, serving for medicinal and nutritional purposes. The present investigation addressed the knowledge gaps by systematically documenting the medicinal plant diversity of Barunei Hill through ethnobotanical surveys, quantitative analysis of ethnobotanical indices, and nutritional analyses, including proximate composition and mineral content, of 39 documented species.

METHODS

Study area

Khordha district forest provides a rich habitat of flora and fauna, which includes Chandaka-Dampara Wildlife Sanctuary and Chilika Lake, the largest Coastal lagoon in India. Tribal groups such as the Kondha and Saora are present here. Barunei Hill, a majestic natural landmark in the Khordha district of Odisha, India, lies between 20°10’05.77” to 20°09’12.99” North latitudes and 85°37’10.99” to 85°39’38.21” East longitudes. Stretching approximately 5 km in length and 1.5 km in width, the hill has an elevation range of 80–300 m above mean sea level, offering a panoramic view of the surrounding landscape. Located about 32 km southwest of Bhubaneswar city center, Barunei Hill is renowned for its breathtaking beauty, rich ecological and historical significance (Fig. 1). The region experiences an annual rainfall of 1200–1400 mm, contributing to its lush greenery and diverse flora. A comprehensive ethnobotanical survey was conducted with the help of local communities to enhance the knowledge of medicinal plants present at Barunei Hill.

Ethnobotanical survey and data collection

A survey on the traditional use of the plants of Barunei Hill was conducted with support from local villagers and tribal people (Kondha and Saora) from March 2024 to September 2025. Data were collected through direct field visits and discussions with local people, tribal communities, and traditional healers. A total of 156 informants were interviewed, including traditional healers (Vaidya, n=47), herbal practitioners (n=38), elderly community members (n=51), and midwives (n=20). Individual semi-structured interviews were conducted in the local Odia language using a standardized questionnaire to record informant details, plant identification, parts used, preparation techniques, therapeutic uses, dosage, administration routes, and treatment duration [8]. Field visits were organized with knowledgeable informants for specimen collection and habitat documentation. Photographic documentation was maintained for all species in their natural habitat.

Plant collection and identification

During the field survey, plant specimens, including leaves, stems, flowers, and fruits, were collected. Each specimen was noted with detailed field notes, including the type of habitat and Global Positioning System location, with the date recorded, and had a separate collection number. Plant specimens were identified using standard taxonomic literature, including Flora of Odisha [9]. Voucher specimens were prepared following standard herbarium techniques, dried, mounted on herbarium sheets, and deposited in the herbarium of the Department of Botany, Centurion University of Technology and Management, with accession numbers CUTM/BOT/2024/04 to CUTM/BOT/2025/23 for future reference and verification.

Quantitative ethnobotanical analysis

Quantitative ethnobotanical analysis was conducted with the help of several indices in order to measure the cultural and therapeutic significance of the reported plant species. UV was estimated to determine the relative significance of the individual species in relation to the reported uses, and the calculation was $UV=\Sigma U/N$, with ΣU being the total use citations and N being the total number of informants. UV ranges between 0 (no record of use) and 1 (high importance). The local importance of every species was determined by way of RFC and was calculated as $RFC=FC/N$, where FC was the number of informants mentioning a species, and N was the total number of informants (156). FL was used to measure the percentage of informants who used a particular plant to treat a particular ailment specifically, and was calculated as $FL\ (\%)=(Np/N)\times 100$, where Np is the number of informants who reported using a plant with a specific purpose, namely to treat a specific ailment and N is the total number of informants who had used the plant. To examine the general cultural importance, the CI was used and given as $CI=\Sigma(UR\times RFC)$ (where Use Reports, i.e., the total number of informants citing each specific use category for a plant species). To determine the agreement between informants on various categories of ailments [10].

Nutritional analysis

All the 39 species of medicinal plants recorded were analyzed through a comprehensive nutritional analysis of fresh plant material in relation to the edible or medicinal parts that are traditionally utilized; these samples were collected, washed, and processed before analysis. Proximate composition, moisture content, crude protein, crude fat, crude fiber, ash content, and carbohydrates were determined using standard AOAC procedures [11]. Moisture content was determined by drying in an oven at 105°C until constant weight; crude protein was estimated using the Kjeldahl method [12]; crude fat was determined using the Soxhlet extraction with petroleum ether; crude fiber was analyzed through acid-alkaline digestion, and ash was measured by incineration in the muffle furnace at 550°C. Carbohydrates (undefined) were determined using the formula below: carbohydrates (%)=100-(moisture+protein+fat+fiber+ash), with

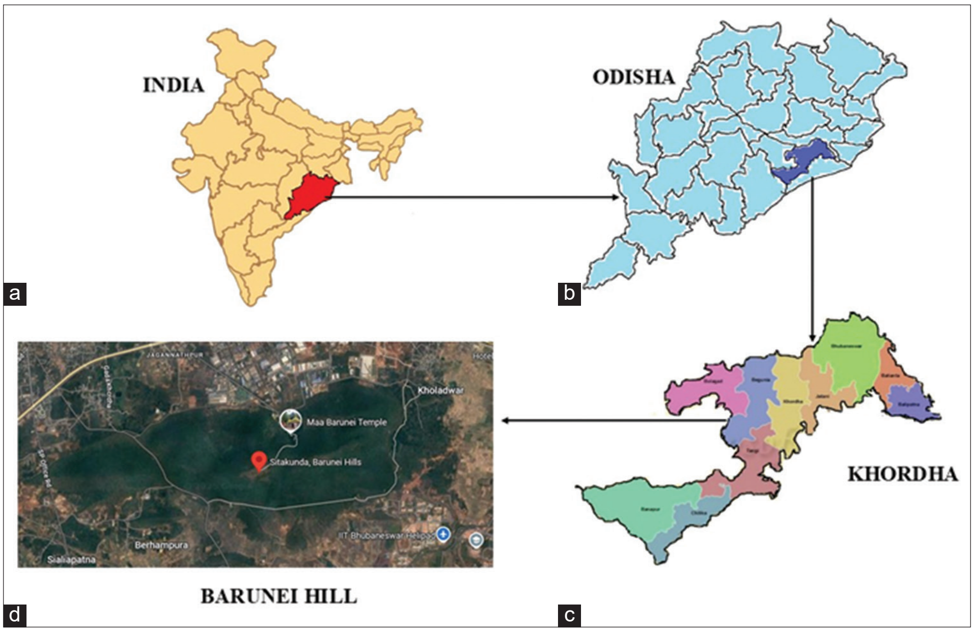

Fig. 1: Study area. (a) India, (b) Odisha, (c) Khordha district, (d) Barunei Hill

Table 1: Comprehensive ethnomedicinal documentation of medicinal plants from Barunei Hill, Odisha

S. No.	Botanical name	Family	Local name (Odia)	Medicinal uses	Mode of administration	Voucher specimen No.
1	*Abrus precatorius* L.	Fabaceae	Kaincha	Cough, bronchitis, skin diseases, wounds	Leaf paste applied topically, root decoction taken orally	CUTM/ BOT/2024/04
2	*Abutilon indicum* (L.) Sweet	Malvaceae	Pedipedika	Fever, urinary disorders, piles, toothache	Leaf juice or root decoction taken orally	CUTM/ BOT/2024/05
3	*Alangium salviifolium* (L.f.) Wangerin	Alangiaceae	Ankula	Rheumatism, skin diseases, snake bite, fever	Root bark paste applied externally, decoction taken internally	CUTM/ BOT/2024/06
4	*Allophylus serratus* (Roxb.) Kurz	Sapindaceae	Pita champa	Wounds, fractures, rheumatism	Leaf paste applied to the affected area, bark decoction for oral consumption	CUTM/ BOT/2024/08
5	*Alstonia scholaris* (L.) R.Br	Apocynaceae	Chatiana	Malaria, diarrhea, skin diseases, and fever	Bark decoction twice daily, latex applied to wounds	CUTM/ BOT/2024/12
6	*Alternanthera sessilis* (L.) DC.	Amaranthaceae	Madaranga saga	Anemia, eye disorders, liver problems, and night blindness	Whole plant consumed as cooked vegetable, juice extracted for eye drops	CUTM/ BOT/2024/29
7	*Ampelocissus latifolia* (Roxb.) Planch.	Vitaceae	Gua draksha	Bone fractures, joint pain, wounds	Stem crushed and applied as a paste, leaf juice for oral consumption	CUTM/ BOT/2024/37
8	*Andrographis paniculata* (Burm.f.) Wall. ex Nees	Acanthaceae	Bhuin nimba	Liver disorders, fever, diabetes, and digestive problems	Whole plant decoction or powder taken with water	CUTM/ BOT/2024/38
9	*Artocarpus heterophyllus* Lam.	Moraceae	Panasa	Diarrhea, diabetes, wounds, ulcers	Fruit consumed; leaf ash applied on wounds, and latex for treating ulcers	CUTM/ BOT/2024/39
10	*Atalantia monophylla* (Roxb.) A. DC.	Rutaceae	Ban nimbuli	Fever, cough, diabetes, digestive disorders	Leaf decoction or fruit juice taken orally	CUTM/ BOT/2024/40
11	*Azadirachta indica* A. Juss.	Meliaceae	Nimba	Skin diseases, diabetes, fever, wounds, and parasitic infections	Leaf juice, bark decoction, oil applied topically, leaves consumed	CUTM/ BOT/2024/41
12	*Benkara malabarica* (Lam.) Tir.	Rubiaceae	Phiriki	Wounds, skin infections, fever	Root bark paste applied externally, decoction taken for fever	CUTM/ BOT/2024/42
13	*Blepharis maderaspatensis* (L.) B Heyne ex Roth	Acanthaceae	Utangan	Cough, asthma, fever, urinary problems	Whole plant decoction taken twice daily	CUTM/ BOT/2024/43
14	*Bonnaya ciliata* (Colsm.) Spreng.	Plantaginaceae	Khetpapadi	Fever, wounds, skin diseases	Whole plant paste applied externally, juice taken internally	CUTM/ BOT/2024/44
15	*Borassus flabellifer* L.	Arecaceae	Tala	Heat stroke, digestive problems, urinary disorders	Fresh tender fruit juice consumed, pulp eaten, toddy (fermented sap)	CUTM/ BOT/2024/45
16	*Brachypterum scandens* (Roxb.) Wight and Arn. ex Miq.	Rubiaceae	-	Wounds, cuts, skin infections	Leaf paste applied to wounds and cuts	CUTM/ BOT/2024/46
17	*Bridelia retusa* (L.) A. Juss	Euphorbiaceae	Kasi	Diarrhea, diabetes, wounds, toothache	Bark decoction taken orally, leaf paste for wounds	CUTM/ BOT/2024/47
18	*Bridelia tomentosa* Blume	Euphorbiaceae	Khajuri	Diarrhea, dysentery, wounds	Bark and root decoction, leaf paste applied topically	CUTM/ BOT/2024/48
19	*Canscora diffusa* (Vahl) R.Br. ex Roem. and Schult.	Gentianaceae	-	Fever, digestive disorders	Whole plant decoction taken orally	CUTM/ BOT/2024/49
20	*Capparis brevispina* DC.	Capparaceae	Kaliara	Rheumatism, toothache, fever, snake bite	Root paste applied, bark decoction taken orally	CUTM/ BOT/2024/50
21	*Cardiospermum halicacabum* Linn.	Sapindaceae	Latakasturi	Rheumatism, earache, wounds, fever	Leaf juice for ear drops, root paste for joint pain, whole plant decoction	CUTM/ BOT/2024/51
22	*Cassia fistula* L.	Fabaceae	Sunari	Constipation, skin diseases, fever, wounds	Pod pulp consumed, leaf paste applied to wounds	CUTM/ BOT/2024/52
23	*Clerodendrum infortunatum* L.	Lamiaceae	Bhandira	Fever, malaria, wounds, skin diseases	Leaf juice or decoction taken orally, paste applied externally	CUTM/ BOT/2024/53
24	*Combretum roxburghii* Spreng	Combretaceae	Atundi	Diarrhea, dysentery, wounds	Bark decoction, leaf paste for wound healing	CUTM/ BOT/2024/54
25	*Elephantopus scaber* L.	Asteraceae	Mayurchandrika	Diarrhea, dysentery, kidney stones, fever	Whole plant decoction or powder with water	CUTM/ BOT/2024/55
26	*Gardenia latifolia* William Aiton.	Rubiaceae	Kumbhi	Wounds, ulcers, fever, skin diseases	Fruit pulp applied to wounds, bark decoction for fever	CUTM/ BOT/2024/56

(contd...)

Table 1: *(Continued)*

S. No.	Botanical name	Family	Local name (Odia)	Medicinal uses	Mode of administration	Voucher specimen No.
27	*Glycosmis pentaphylla* (Retz.) DC.	Rutaceae	Chauladhua	Rheumatism, wounds, fever, digestive problems	Root decoction, leaf paste applied on affected areas	CUTM/ BOT/2024/57
28	*Helicteres isora* L.	Malvaceae	Murimurica	Diabetes, diarrhea, dysentery, flatulence	Fruit powder or decoction taken with water	CUTM/ BOT/2024/58
29	*Holarrhena pubescens* Wall. ex G. Don	Apocynaceae	Kurchi	Diarrhea, dysentery, fever, intestinal worms	Bark powder or decoction taken orally	CUTM/ BOT/2024/59
30	*Mimosa pudica* L.	Fabaceae	Lajkuli	Wounds, piles, diabetes, and insomnia	Fresh leaf pastes on wounds, root decoction for diabetes	CUTM/ BOT/2024/60
31	*Murraya koenigii* (L.) Spreng.	Rutaceae	Bhrusanga patra	Diabetes, digestive disorders, dysentery, hair problems	Fresh leaves consumed, leaf paste applied on the scalp, and decoction taken orally	CUTM/ BOT/2025/01
32	*Senna tora* (L.) Roxb.	Fabaceae	Chakunda	Skin diseases, constipation, ringworm, eye problems	Leaf paste applied topically, seed decoction for eye wash	CUTM/ BOT/2025/02
33	*Sida cordata* (Burm.f.) Borss.Waalk.	Malvaceae	Bisiripi	Fever, wounds, rheumatism, urinary problems	Root decoction or leaf paste applied externally	CUTM/ BOT/2025/06
34	*Taxotrophis taxoides* (B.Heyne ex Roth) Chew ex	Moraceae	Jhumpudi	Wounds, cuts, skin infections	Latex applied to wounds, bark paste for skin infections	CUTM/ BOT/2025/09
35	*Tinospora cordifolia* (Willd.) Hook. f. and Thomson	Menispermaceae	Gulancha	Fever, diabetes, jaundice, and general debility	Stem decoction or fresh juice taken daily	CUTM/ BOT/2025/12
36	*Triumfetta pentandra* A.Rich.	Malvaceae	Jatajatia	Wounds, fever, diarrhea	Leaf paste applied on wounds, root decoction for fever	CUTM/ BOT/2025/13
37	*Vitex pinnata* L.	Lamiaceae	Bengunia	Rheumatism, headache, fever, wounds	Leaf paste for headache, root decoction for rheumatism	CUTM/ BOT/2025/19
38	*Zanthoxylum asiaticum* (L.) Appelhans, Groppo, and J. Wen	Rutaceae	Tundapada	Toothache, digestive problems, and fever	Seed powder for toothache, bark decoction for fever	CUTM/ BOT/2025/22
39	*Ziziphus oenoplia* (L.) Mill.	Rhamnaceae	Kanta bairi	Diarrhea, dysentery, wounds, fever	Fruit consumed; root decoction, leaf paste on wounds	CUTM/ BOT/2025/23

Voucher specimens are deposited at the herbarium of Centurion University of Technology and Management, Odisha, India. All botanical names were verified using "Flora of Odisha" for taxonomic accuracy

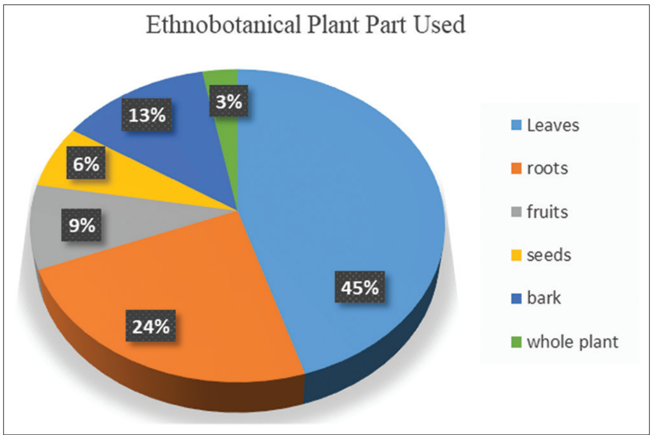

Fig. 2: Ratio (%) of plant parts used for medicinal purposes

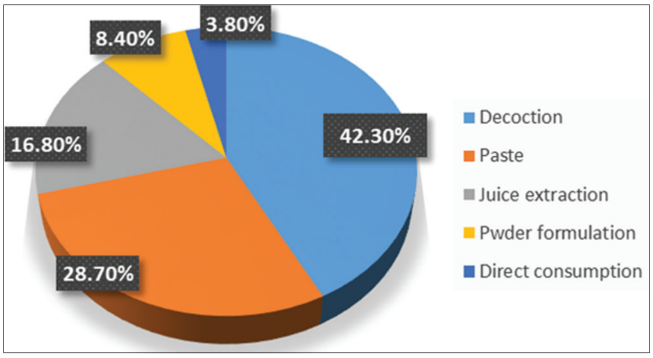

Fig. 3: Ratio (%) of traditional medicine preparation methods

energy value (kcal/100 g) approximated by use of Atwater factors as (protein×4)=(fat×9)=(carbohydrate×4). Mineral analysis was done using macro-minerals (calcium, phosphorus, magnesium, sodium, and potassium) and micro-minerals (iron, zinc, copper, and manganese) which were quantified using atomic absorption spectrophotometry (AAS) after wet digestion in a 3:1 mix of HNO_3, $HClO_4$ and in case of phosphorus, a separate method with ammonium molybdate was used with spectrophotometry technique [13]. All measurements were performed in triplicate (n=3). AAS model: (PerkinElmer AAnalyst 400), Digestion details: at 150–200°C for 2–3 h until complete digestion.

Statistical analysis

Analysis of data was done with the help of the Statistical Package for the Social Sciences 26.0, and descriptive statistics of frequencies, percentages, means, and standard deviations were calculated. The use of the Pearson correlation coefficient was done to evaluate the relationships among quantitative ethnobotanical indices. Nutritional parameters of the various plant families were compared using one-way analysis of variance, followed by Tukey's honestly significant difference *post hoc* test ($p<0.05$) [14].

RESULTS

Floristic diversity and taxonomic distribution

An ethnobotanical study registered 39 species of medicinal plants of 38 genera and 22 families (Table 1). There was significant variation in parts

Table 2: Quantitative ethnobotanical indices of documented medicinal plant species

S. No.	Botanical name	Use value (UV)	RFC	Cultural importance index (CI)	Fidelity level (%)	Primary application
1	*Azadirachta indica*	0.89	0.91	156.7	86.3	Skin diseases
2	*Tinospora cordifolia*	0.85	0.88	143.2	94.7	Fever
3	*Andrographis paniculata*	0.78	0.79	128.9	91.2	Liver disorders
4	*Cassia fistula*	0.74	0.77	118.4	88.5	Constipation
5	*Mimosa pudica*	0.71	0.73	112.6	84.6	Wound healing
6	*Zanthoxylum asiaticum*	0.68	0.76	108.3	82.1	Diabetes
7	*Murraya koenigii*	0.66	0.74	104.7	80.3	Diabetes
8	*Alternanthera sessilis*	0.65	0.72	98.7	78.9	Anemia
9	*Alstonia scholaris*	0.59	0.68	87.5	73.2	Malaria
10	*Holarrhena pubescens*	0.56	0.65	81.3	71.8	Diarrhea
11	*Helicteres isora*	0.54	0.63	76.8	69.4	Diabetes
12	*Borassus flabellifer*	0.52	0.61	72.4	67.2	Heat stroke
13	*Clerodendrum infortunatum*	0.49	0.58	68.1	65.8	Fever
14	*Senna tora*	0.47	0.56	64.3	63.5	Skin diseases
15	*Cardiospermum halicacabum*	0.44	0.53	59.7	61.2	Rheumatism
16	*Glycosmis pentaphylla*	0.42	0.51	56.2	59.4	Rheumatism
17	*Bridelia retusa*	0.39	0.48	52.8	57.1	Diarrhea
18	*Capparis brevispina*	0.37	0.46	49.5	55.3	Rheumatism
19	*Abrus precatorius*	0.35	0.44	46.2	53.8	Cough
20	*Artocarpus heterophyllus*	0.33	0.42	43.1	51.9	Diarrhea
21	*Elephantopus scaber*	0.31	0.4	40.3	50.2	Diarrhea
22	*Gardenia latifolia*	0.29	0.38	37.6	48.7	Wounds
23	*Atalantia monophylla*	0.27	0.36	34.9	47.1	Fever
24	*Ziziphus oenoplia*	0.26	0.34	32.4	45.6	Diarrhea
25	*Abutilon indicum*	0.24	0.32	29.8	44.2	Fever
26	*Sida cordata*	0.22	0.3	27.3	42.8	Fever
27	*Alangium salviifolium*	0.21	0.28	25.1	41.3	Rheumatism
28	*Bridelia tomentosa*	0.19	0.26	22.9	39.7	Diarrhea
29	*Combretum roxburghii*	0.18	0.25	21.2	38.5	Diarrhea
30	*Vitex pinnata*	0.17	0.23	19.4	37.1	Rheumatism
31	*Allophylus serratus*	0.15	0.21	17.6	35.9	Wounds
32	*Ampelocissus latifolia*	0.14	0.19	15.8	34.6	Fractures
33	*Benkara malabarica*	0.13	0.18	14.3	33.2	Wounds
34	*Blepharis maderaspatensis*	0.12	0.16	12.7	31.8	Cough
35	*Triumfetta pentandra*	0.11	0.15	11.4	30.5	Wounds
36	*Bonnaya ciliata*	0.1	0.14	10.1	29.3	Fever
37	*Canscora diffusa*	0.09	0.12	8.7	27.9	Fever
38	*Brachypterum scandens*	0.08	0.11	7.5	26.4	Wounds
39	*Taxotrophis taxoides*	0.07	0.09	6.2	25.1	Wounds

UV: Use value, RFC: Relative frequency of citation, CI: Cultural importance index, FL: Fidelity level were calculated as described in materials and methods. Primary application refers to the ailment with the highest fidelity level (FL%) for each species

of plants used as therapeutics. The most commonly used category was leaves (45.2%), then roots (23.8%), then fruits (8.7%), seeds (6.5%), then bark (12.8%), and whole plant (3%) (Fig. 2). Of the methods of preparation, the most common was decoction (42.3%), then paste application (28.7%), juice extraction (16.8%), powder formulation (8.4%), and direct consumption (3.8%) (Fig. 3).

Ethnomedicinal documentation

Table 1 gives in-depth ethnomedicinal data of all the 39 species, i.e., botanical names,families, local names, modes of administration, and medicinal uses. The recorded plants are used to treat various diseases, including simple cases such as fever, coughing, and digestive complications, as well as chronic diseases, such as diabetes, high blood pressure, and arthritis. Odia language local terms show a strong correlation with the cultural assimilation of such plants in traditional medicine. A number of the species have various vernacular names in various communities, which implies that they are well recognized and used. The route of administration can be significantly different, such as oral administration (decoctions, powders, and juices), topical application (paste and oil), and, in some instances, ritual or spiritual use, along with the medicinal application.

Quantitative ethnobotanical indices

Analysis of quantitative data demonstrated a high level of variation in the ethnobotanical significance of species recorded (Table 2). *Azadirachta indica* (UV=0.89), *Tinospora cordifolia* (UV=0.85), *Andrographis paniculata* (UV=0.78), *Cassia fistula* (UV=0.74), and *Mimosa pudica* (UV=0.71) were recorded to have the highest UV. RFC analysis revealed that *A. indica* was the most cited (RFC=0.91), meaning that it is well recognized by the informants. Other species had a very high level of citation: *T. cordifolia* (RFC=0.88), *A. paniculata* (RFC=0.79), *C. fistula* (RFC=0.77), and many others. Computation of CI showed that *A. indica* (CI=156.7) has the highest cultural importance, which is followed by *T. cordifolia* (CI=143.2), *A. paniculata* (CI=128.9), and *C. fistula* (CI=118.4). It was found that UV and RFC, UV and CI, and RFC and CI had strong positive correlation (r=0.873, $p<0.001$; r=0.891, $p<0.001$, and r=0.856, $p<0.001$, respectively), and showed consistency and reliability in quantitative measurement.

Nutritional composition analysis

Proximate composition

There was a major variation in proximate composition on a comprehensive nutritional analysis of all 39 medicinal plant species (Table 3). The moisture content of the sample was 6.8±0.5% (*Terminalia chebula* fruits, dried) to 89.3±2.1% (*Borassus flabellifer* tender fruit). The protein content was found to have extraordinary variation with *A. paniculata* (18.7±1.1 g/100 g), *M. pudica* (16.3±0.9 g/100 g), and *Alternanthera sessilis* (15.8±1.2 g/100 g) recorded the highest protein content implying their potential to be used as a rich source of protein. The percentage of crude fiber was especially high in *C. fistula* leaves (24.3±1.8 g/100 g), *Helicteres isora* fruits (21.7±1.5 g/100 g),

Table 3: Proximate composition of documented medicinal plants (per 100 g edible portion)

Botanical name	Part used	Moisture (%)	Protein (g)	Fat (g)	Fiber (g)	Ash (g)	Carbohydrates (g)	Energy (kcal)
Azadirachta indica	Leaves	68.4±2.1	7.8±0.6	1.3±0.2	11.7±0.9	8.9±0.7	1.9±0.3	51.3±3.2
Tinospora cordifolia	Stem	72.3±2.4	4.2±0.4	0.7±0.1	9.8±0.8	6.4±0.5	6.6±0.6	48.7±2.8
Andrographis paniculata	Leaves	65.7±1.9	18.7±1.1	2.1±0.3	8.9±0.7	14.3±0.9	11.0±0.8	139.3±5.6
Cassia fistula	Leaves	12.8±0.9	3.4±0.3	0.9±0.1	24.3±1.8	4.7±0.4	53.9±2.4	238.5±8.7
Mimosa pudica	Leaves	67.2±2.0	16.3±0.9	1.8±0.2	7.4±0.6	11.2±0.8	9.1±0.7	116.6±4.3
Murraya koenigii	Leaves	66.3±1.8	6.4±0.5	1.1±0.2	16.8±1.2	4.2±0.4	5.2±0.6	54.3±2.9
Alternanthera sessilis	Whole plant	85.7±2.5	15.8±1.2	1.3±0.2	6.4±0.5	18.9±1.1	12.0±0.9	123.7±5.4
Alstonia scholaris	Bark	11.4±0.8	4.7±0.4	0.8±0.1	28.4±2.1	7.3±0.6	47.4±2.3	217.6±7.8
Holarrhena pubescens	Bark	10.8±0.7	3.9±0.3	0.6±0.1	32.7±2.4	6.8±0.5	45.2±2.1	206.2±7.4
Helicteres isora	Fruits	9.3±0.6	5.6±0.5	1.4±0.2	21.7±1.5	5.9±0.5	56.1±2.6	259.8±9.1
Borassus flabellifer	Tender fruit	89.3±2.1	0.7±0.1	0.1±0.0	0.9±0.1	0.4±0.1	8.6±0.8	37.7±2.1
Clerodendrum infortunatum	Leaves	78.4±2.2	5.3±0.4	0.9±0.1	8.7±0.7	5.6±0.5	1.1±0.3	31.7±2.4
Senna tora	Seeds	8.7±0.6	9.8±0.8	5.4±0.5	11.3±0.9	3.4±0.3	61.4±2.8	326.2±11.4
Cardiospermum halicacabum	Seeds	7.4±0.5	8.9±0.7	7.4±0.6	9.8±0.8	4.2±0.4	62.3±2.9	344.6±12.1
Glycosmis pentaphylla	Leaves	71.3±2.0	4.8±0.4	0.8±0.1	12.4±1.0	6.3±0.5	4.4±0.5	42.4±2.6
Bridelia retusa	Bark	12.3±0.9	5.1±0.4	1.2±0.2	24.8±1.9	8.9±0.7	47.7±2.2	223.3±8.2
Capparis brevispina	Root	14.7±1.0	6.3±0.5	1.5±0.2	18.9±1.4	9.4±0.8	49.2±2.4	236.7±8.9
Abrus precatorius	Seeds	9.2±0.7	17.8±1.3	12.3±0.9	19.8±1.3	3.7±0.3	37.2±1.9	326.7±11.8
Artocarpus heterophyllus	Fruit	77.2±2.2	1.9±0.2	0.3±0.1	2.6±0.3	0.9±0.1	17.1±1.3	79.1±3.4
Elephantopus scaber	Whole plant	82.3±2.4	3.7±0.3	0.6±0.1	9.8±0.8	7.2±0.6	6.4±0.6	48.2±2.7
Gardenia latifolia	Fruits	71.8±2.1	2.4±0.2	0.5±0.1	8.3±0.7	3.9±0.4	13.1±1.0	66.5±3.1
Atalantia monophylla	Fruits	79.4±2.3	0.8±0.1	0.3±0.1	2.8±0.3	0.9±0.1	15.8±1.2	68.7±3.2
Ziziphus oenoplia	Fruits	75.3±2.2	1.3±0.2	0.4±0.1	3.6±0.4	1.1±0.2	18.3±1.4	81.6±3.6
Abutilon indicum	Leaves	73.6±2.1	4.9±0.4	1.1±0.2	10.7±0.9	7.8±0.6	1.9±0.3	34.3±2.5
Sida cordata	Leaves	74.8±2.2	5.2±0.4	1.0±0.1	9.4±0.8	6.9±0.5	2.7±0.4	38.6±2.6
Alangium salviifolium	Root bark	13.8±1.0	5.8±0.5	1.3±0.2	22.4±1.7	8.7±0.7	48.0±2.3	228.1±8.5
Bridelia tomentosa	Bark	11.9±0.8	4.6±0.4	1.0±0.1	26.3±2.0	7.9±0.6	48.3±2.3	220.6±8.1
Combretum roxburghii	Bark	12.4±0.9	4.3±0.4	0.9±0.1	25.8±1.9	7.4±0.6	49.2±2.4	223.5±8.3
Vitex pinnata	Leaves	69.7±2.0	6.7±0.5	1.4±0.2	11.3±0.9	8.2±0.7	2.7±0.4	47.8±2.8
Allophylus serratus	Leaves	72.4±2.1	4.6±0.4	0.9±0.1	10.8±0.9	6.7±0.5	4.6±0.5	43.3±2.7
Ampelocissus latifolia	Stem	76.8±2.2	3.2±0.3	0.6±0.1	8.9±0.7	5.4±0.4	5.1±0.6	38.2±2.5
Benkara malabarica	Root bark	14.3±1.0	5.4±0.5	1.1±0.2	21.7±1.6	8.3±0.7	49.2±2.3	231.5±8.6
Blepharis maderaspatensis	Whole plant	81.6±2.4	4.1±0.4	0.7±0.1	7.8±0.6	6.9±0.5	9.9±0.8	63.5±3.0
Triumfetta pentandra	Leaves	75.3±2.2	4.8±0.4	0.9±0.1	9.3±0.8	7.1±0.6	2.6±0.4	36.5±2.5
Bonnaya ciliata	Whole plant	83.7±2.4	3.6±0.3	0.6±0.1	6.8±0.5	6.2±0.5	9.1±0.7	58.2±2.9
Canscora diffusa	Whole plant	84.2±2.5	3.1±0.3	0.5±0.1	7.2±0.6	5.8±0.5	9.2±0.8	55.3±2.8
Brachypterum scandens	Leaves	76.4±2.2	3.9±0.3	0.7±0.1	9.6±0.8	6.3±0.5	3.1±0.4	34.7±2.4
Taxotrophis taxoides	Bark	13.7±0.9	4.9±0.4	1.0±0.1	23.6±1.8	7.8±0.6	49.0±2.3	226.6±8.4
Zanthoxylum asiaticum	Seeds	8.9±0.6	11.3±0.9	8.7±0.7	13.4±1.1	4.8±0.4	52.9±2.5	327.5±11.6

Proximate composition is expressed per 100 g edible portion on a fresh weight basis, unless otherwise specified. Data represent mean±SD (n=3). Carbohydrates were calculated by difference: 100-(moisture+protein+fat+ash+fiber). Energy was calculated using Atwater factors: (protein×4)+(fat×9)+(carbohydrate×4)

and *Abrus precatorius* seeds (19.8±1.3 g/100 g), which justifies their application in the traditional use in digestive health and constipation relief. The ranged carbohydrate was 12.4±1.1 g/100 g (*A. sessilis*) to 62.3±2.9 g/100 g (*B. flabellife*r endosperm), where several of these can offer high energy content above 300 kcal/100 g.

Most species (only a few exceptions) contained low fat levels (0.8–4.5 g/100 g), except for seeds of *A. precatorius* (12.3±0.9 g/100 g), *Zanthoxylum asiaticum* (8.7±0.7 g/100 g), and *Cardiospermum halicacabum* (7.4±0.6 g/100 g). The level of minerals in terms of their content was particularly high in *A. sessilis* (18.9±1.1 g/100 g) and *A. paniculata* (14.3±0.9 g/100 g).

Mineral composition

Mineral analysis showed that the medicinal plants that are documented are good sources of macro and micro-minerals (Table 4). The levels of calcium in *A. sessilis* (1,245±45 mg/100 g). The iron content, which is key to determining hemoglobin production and avoidance of anemia, was remarkably high in *A. sessilis* (15.8±0.9 mg/100 g), and *M. pudica* (12.7±0.8 mg/100 g). These values hold importance, bearing in mind that the level of iron-deficiency anemia among the rural populations of India is high. The *A. indica* had high levels of potassium (cardiovascular and blood pressure) (1,876±67 mg/100 g). The phosphorus, 145±12 mg/100 g–487±23 mg/100 g, were recorded with a maximum of 600 g on *A. paniculata*. Magnesium, which plays an enzymatic role and a role in metabolism, was well represented among species with a range of 89±8 mg/100 g to 368±19 mg/100 g. Zinc, which is necessary for immunity, was found especially high in *A. paniculata* (4.8±0.3 mg/100 g), *A. indica* (4.2±0.4 mg/100 g), as well as *T. cordifolia* (3.9±0.3 mg/100 g).

DISCUSSION

Ethnobotanical knowledge and cultural significance

The records of 39 medicinal flora species in the Barunei Hill highlight the high level of ethnobotanical diversity of the territory and the maintenance of the traditions of folk healing by local and indigenous people. The abundance of Fabaceae (15.38%) is in line with the worldwide ethnobotanical trends, as the family has been highly accepted in many geographical areas with regard to medicinal use due to high content of bioactive nitrogen compounds, especially alkaloids, non-protein amino acids, and lectins [15]. Furthermore, a high percentage of Fabaceae species exhibit nitrogen-fixing abilities, which increase the fertility of the soil and make them useful in promoting sustainable farming activity in the area. The quantitative indices calculated offer objective indices that are beyond descriptive ethnobotanical record keeping. *A. indica* proved to be the most culturally and therapeutically viable species because of the foremost UV (0.89), RFC (0.91), and CI (156.7).

Table 4: Mineral composition of documented medicinal plants (mg/100 g edible portion)

Botanical name	Part used	Calcium (mg/ 100 g)	Phosphorus (mg/100 g)	Magnesium (mg/100 g)	Iron (mg/ 100 g)	Zinc (mg/ 100 g)	Copper (mg/ 100 g)	Manganese (mg/ 100 g)	Sodium (mg/ 100 g)	Potassium (mg/ 100 g)
Azadirachta indica	Leaves	685±28	287±15	298±16	8.9±0.7	4.2±0.4	1.8±0.2	3.4±0.3	124±9	1876±67
Tinospora cordifolia	Stem	456±22	198±12	234±14	6.7±0.5	3.9±0.3	1.4±0.2	2.8±0.3	98±7	987±45
Andrographis paniculata	Leaves	893±35	487±23	368±19	11.4±0.8	4.8±0.3	2.1±0.2	4.7±0.4	156±11	1432±58
Cassia fistula	Leaves	389±19	234±14	187±11	5.3±0.4	2.8±0.3	1.2±0.1	2.1±0.2	87±6	892±41
Mimosa pudica	Leaves	967±38	312±17	289±15	12.7±0.8	3.6±0.3	1.9±0.2	3.9±0.3	143±10	1298±54
Murraya koenigii	Leaves	834±32	376±19	312±16	9.8±0.7	3.7±0.3	1.7±0.2	4.1±0.3	167±12	1654±58
Alternanthera sessilis	Whole plant	1245±45	398±20	345±18	15.8±0.9	4.1±0.3	2.3±0.2	5.2±0.4	189±13	1543±61
Alstonia scholaris	Bark	567±25	212±13	198±12	7.8±0.6	2.9±0.3	1.3±0.1	2.6±0.2	112±8	734±36
Holarrhena pubescens	Bark	523±24	189±12	176±11	6.9±0.5	2.6±0.2	1.1±0.1	2.3±0.2	98±7	687±34
Helicteres isora	Fruits	412±20	267±15	203±12	5.7±0.4	3.1±0.3	1.4±0.2	2.5±0.2	94±7	823±39
Borassus flabellifer	Tender fruit	67±6	89±8	54±5	0.8±0.1	0.6±0.1	0.3±0.0	0.5±0.1	23±3	287±15
Clerodendrum infortunatum	Leaves	543±24	234±14	187±11	7.2±0.5	2.8±0.3	1.3±0.1	2.9±0.3	134±9	1123±48
Senna tora	Seeds	378±18	456±22	289±15	8.3±0.6	4.3±0.3	1.9±0.2	3.2±0.3	76±6	967±44
Cardiospermum halicacabum	Seeds	289±15	512±24	312±16	7.6±0.6	4.7±0.4	2.1±0.2	2.9±0.3	68±5	876±40
Glycosmis pentaphylla	Leaves	623±27	267±15	198±12	6.8±0.5	2.9±0.3	1.4±0.2	3.1±0.3	145±10	1198±51
Bridelia retusa	Bark	487±23	198±12	167±10	6.3±0.5	2.4±0.2	1.1±0.1	2.2±0.2	89±6	654±32
Capparis brevispina	Root	534±24	223±13	189±11	7.1±0.5	2.7±0.3	1.2±0.1	2.5±0.2	102±7	723±36
Abrus precatorius	Seeds	456±21	534±25	298±15	9.4±0.7	5.1±0.4	2.3±0.2	3.6±0.3	54±5	1087±47
Artocarpus heterophyllus	Fruit	145±11	167±12	123±9	1.9±0.2	1.2±0.2	0.6±0.1	1.1±0.1	45±4	398±20
Elephantopus scaber	Whole plant	512±23	189±12	167±10	6.4±0.5	2.6±0.2	1.2±0.1	2.7±0.2	123±9	987±45
Gardenia latifolia	Fruits	234±14	156±11	134±9	3.2±0.3	1.8±0.2	0.8±0.1	1.5±0.2	67±5	567±28
Atalantia monophylla	Fruits	198±12	134±10	98±8	2.1±0.2	1.3±0.2	0.6±0.1	1.0±0.1	43±4	412±21
Ziziphus oenoplia	Fruits	212±13	145±11	112±9	2.4±0.2	1.5±0.2	0.7±0.1	1.2±0.1	51±4	456±23
Abutilon indicum	Leaves	578±26	223±13	176±11	6.9±0.5	2.8±0.3	1.3±0.1	2.8±0.3	128±9	1054±46
Sida cordata	Leaves	589±26	234±14	187±11	7.1±0.5	2.9±0.3	1.4±0.2	3.0±0.3	132±9	1098±48
Alangium salviifolium	Root bark	498±23	187±12	156±10	6.7±0.5	2.5±0.2	1.1±0.1	2.3±0.2	95±7	678±34
Bridelia tomentosa	Bark	476±22	178±12	149±10	6.4±0.5	2.3±0.2	1.0±0.1	2.1±0.2	91±6	643±32
Combretum roxburghii	Bark	467±22	172±11	145±9	6.2±0.5	2.2±0.2	1.0±0.1	2.0±0.2	88±6	623±31
Vitex pinnata	Leaves	612±27	245±14	198±12	7.3±0.6	3.0±0.3	1.4±0.2	3.2±0.3	139±10	1143±49
Allophylus serratus	Leaves	534±24	212±13	167±10	6.6±0.5	2.7±0.3	1.2±0.1	2.7±0.2	119±8	987±44
Ampelocissus latifolia	Stem	423±20	167±11	143±9	5.4±0.4	2.3±0.2	1.0±0.1	2.1±0.2	97±7	765±37
Benkara malabarica	Root bark	489±23	189±12	156±10	6.5±0.5	2.4±0.2	1.1±0.1	2.2±0.2	93±7	667±33
Blepharis maderaspatensis	Whole plant	467±21	178±12	145±9	5.9±0.4	2.4±0.2	1.1±0.1	2.4±0.2	109±8	876±40
Triumfetta pentandra	Leaves	523±24	198±12	163±10	6.5±0.5	2.6±0.2	1.2±0.1	2.6±0.2	116±8	923±42
Bonnaya ciliata	Whole plant	445±21	167±11	138±9	5.6±0.4	2.3±0.2	1.0±0.1	2.3±0.2	104±7	823±39
Canscora diffusa	Whole plant	412±20	156±11	129±9	5.2±0.4	2.1±0.2	0.9±0.1	2.1±0.2	97±7	765±37
Brachypterum scandens	Leaves	478±22	182±12	151±10	6.1±0.5	2.4±0.2	1.1±0.1	2.4±0.2	111±8	854±39
Taxotrophis taxoides	Bark	492±23	191±12	159±10	6.6±0.5	2.4±0.2	1.1±0.1	2.2±0.2	92±7	671±33
Zanthoxylum asiaticum	Seeds	387±19	523±24	287±15	8.9±0.7	5.4±0.4	2.4±0.2	3.4±0.3	62±5	1023±46

Mineral contents are expressed as mg/100 g dry weight. Data represent mean±SD (n=3). ND: Not detected. Analysis was performed via atomic absorption spectrophotometry (PerkinElmer AAnalyst 400) after wet digestion with HNO_3:$HClO_4$ (3:1) at 150–200°C for 2–3 h until complete digestion

Nutritional significance and dual functionality

The nutritional assessment conducted reveals that most of the medicinal plants recorded have an outstanding nutritional characteristic that ensures that they can serve both curative and nutritive purposes, striking the traceable concept in ethnopharmacological studies [16]. The dual functionality is specifically important in resource-limited rural areas where medicinal plants can be used in a variety of ways, and they can be used to increase both healthcare security and nutritional security [17]. The high level of protein observed in *A. paniculata* (18.7 g/100 g), *M. pudica* (16.3 g/100 g), and *A. sessilis* (15.8 g/100 g) preordains these plants as good protein supplements, especially at the rural level, where protein malnutrition is currently a problem, as the populace is mainly vegetarians. *A. sessilis* (15.8 mg/100 g), and *M. pudica* (12.7 mg/100 g) have high levels of iron, especially considering the iron-deficiency anemia prevalence in India. The customary use of these plants can play a major role in the dietary iron values. It is promising that *A. sessilis* (1245 mg/100 g) and *Mimosa pudica* species (967 mg/100 g) are rich sources of calcium, which can help to prevent bone diseases and osteoporosis. This level of values is much higher than the calcium content in dairy products (around 120 mg/100 g in milk), and such plants are excellent sources of calcium for lactose-intolerant people and vegan groups.

Study limitations and future research directions

This study has some limitations that need to be identified. The research was performed in one given geographical area, and the findings might not fully be an entire depiction of the larger Odisha or Eastern Ghats ethnobotanical perspectives. They did not thoroughly examine seasonal changes in phytochemical and nutritional composition, and yet seasonal changes in chemistry and nutrients have been known to have a substantial impact on the phenotype of plants. Although the nutritional analysis is detailed, the analysis of anti-nutritional factors (oxalates, phytates, and tannins), which could influence the nutrient bioavailability, was not carried out. The research captured existing traditional knowledge yet failed to examine the historical evolution of patterns in the utilization of plants, or even failed to explore the knowledge loss among the younger generations, relevant details in knowledge preservation planning.

CONCLUSION

This is a detailed ethnobotanical study of Barunei hill in Odisha, which gave 39 medicinal plant species with detailed ethnomedicinal applications, quantitative indices, and nutritional character parameters. Nutritionally, these samples produced outstanding phenotypes with several of them having protein contents matching that of legumes (15–19 g/100 g), calcium contents greater than that of dairy (>1,000 mg/100 g), and adequate levels of iron to treat anemia (12–16 mg/100 g). This finding supports the historic notion of food as medicine, which emphasizes two factors of medicinal plants to combat malnutrition and micronutrient deficiency: the therapeutic and nutritional properties. Combining the information of both nutritional and phytochemical analysis, it is proposed that not individual active compounds, but the synergistic status of macro and micronutrients, determines therapeutic effectiveness, which is consistent with the philosophy of the traditional theories of holism. A good level of high fidelity (79.8–94.7) and factor of informant consensus (0.72–0.91) demonstrates good, empirically tested ethnomedicinal knowledge. It highlights the importance of preservation of biocultural heritage, sharing of benefits equitably, and sustainable management of the resources, as well as offers a solid ground for future pharmacological, nutraceutical, and conservationist-oriented research.

AVAILABILITY DATA AND MATERIALS

All data and materials are included in this paper.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

All authors have read and approved the content of this manuscript for the Asian Journal of Pharmaceutical and Clinical Research.

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AUTHOR CONTRIBUTIONS

SB: Performed the experiment, wrote the manuscript, and collected the research data. SJ: Helped in writing and performing the experiments. SRP: Helped in field visit, Voucher Specimen collection, and Herbarium preparation. AB: Designed the experiment, finalized the manuscript, and interpreted the experimental data.

CONFLICT OF INTEREST

All authors have no conflicts of interest for this publication.

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