



Quantitative ethnobotanical analysis of plants used for livelihood maintenance of tribal communities in Baisipalli Wildlife Sanctuary, Odisha, India

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Research

Abstract

Background: Plant resources play crucial role in tribal life. Tribal inhabitants of Baisipalli Wildlife Sanctuary (BWS) in Odisha, India are depended on sanctuary forest for their livelihood. Present study was a quantitative ethnobotanical assessment to understand the dependency of tribal inhabitants of BWS on plant resources, identify plants of potential use and recognize plants at the risk of overexploitation.

Methods: The study was conducted through field observation, focused group discussion and semi-structured interviews. Data was collected from total of 306 informants and quantitative ethnobotanical indices relative frequency citation (RFC), use value (UV), plant part value (PPV), and category use value (UVk) were used to evaluate the useful plant species.

Results: The study recorded 137 useful plant species classified under 10 different use categories agriculture, food, fodder, fuelwood, house building, household essentials, medicine, ornamental, personal hygiene and religious activities. Highest number of species were used as medicine (27%), followed by food (25%) and fuel-wood (13%). Plant part value (PPV) of leaf (24.5) was highest followed by fruit (20.3) and wood (15.2). The use value (UVk) of food (0.75) was maximum followed by personal hygiene (0.74), religious need (0.67) and household essential (0.65). *Madhuca indica* and *Shorea robusta* were among the multipurpose species having possible risk of overexploitation.

Conclusions: BWS is a treasure of useful plant species, however overexploitation of resources may affect density, and natural regeneration of forest flora. Therefore, sustainable use and conservation of multipurpose species is essential.

Keywords: Ethnobotanical indices, use value, plant part value, use category, over exploitation

Background

Plants are one among the natural resources that forms the essence of subsistence and well-being of human civilization. Plant resources not only meet the basic human need such as food, fodder, fuel, wood, medicine but also cater the ecological,

cultural and religious aspects (Ishtiaq *et al.* 2024). Indigenous tribal communities are intricately associated with nature and obtain their sustenance from forest. The traditional knowledge of tribal communities passes to generations through experience, resulting gap in formal documentation of the valuable knowledge (Zhou *et al.* 2023). Ethnobotany is the study of interaction between human and plants, which strengthens the linkage of human beings with nature (Pei *et al.* 2020). Integration of traditional knowledge about useful plants with modern agricultural system can be a solution towards food security and sustainability (Monika & Vidya 2024). Ethnobotanical knowledge has interdisciplinary connectivity with agriculture, pharmacology, ecology and nutrition, and quantitative ethnobotany measures the value of plants across different cultures (Singh & Saxena 2026). Quantitative ethnobotanical studies have grabbed global attention to ensure effective use of plants to tackle the challenges of food security, climate change, human health and biodiversity conservation (Pei *et al.* 2020). Quantitative approach in ethnobotanical studies include various indices namely relative frequency citation (RFC), use value (UV), plant part value (PPV), category use value (UVk) etc. to evaluate significance of the plants (Phillips *et al.* 1994, Biara *et al.* 2021).

Tribal communities derive their livelihood need from the forest resources and use plant parts namely leaves, fruits, flowers, tubers, seeds etc. as food to fulfil their nutritional requirement (Sinha & Lakra 2005). Besides food, tribals meet their other livelihood essentials like medicinal, fodder, fuel, dye, fiber, tools, equipment, religious etc. from locally available plants (Halder *et al.* 2021). Recent published literature showed several quantitative ethnobotanical studies from different parts of Odisha. A study by Acharya *et al.* (2024) reported use of 32 seasonal plants as food and medicine in Kalahandi, Western Odisha through quantitative ethnobotanical indices frequency citation (FC) and RFC. Medicinal plants used by indigenous communities of Gandhamardan mountains chains at Bargarh district, Odisha was quantitatively analyzed from ethnobotanical knowledge of 85 participants for 70 plants by RFC, informant's consensus factor (ICF) and UV (Pandey *et al.* 2024). Quantitative ethnobotanical usage in Mayurbhanj district was assessed from 55 informants for 10 plants by RFC, ICF, fidelity level (FL%) and UV (Jena *et al.* 2025). The study showed high level of consensus among informants regarding medicinal use of the plants. Quantitative ethnobotanical study on plants used for gastrointestinal disorders in Balasore district reported 104 plants and analyzed by quantitative indices UV, Family use value (FUV) and RFC (Behera *et al.* 2026). Review of literature indicated recent trend of quantitative ethnobotanical analysis in Odisha.

Several reports are also available on ethnobotanical studies conducted in Nayagarh district, Odisha. An ethnomedicinal study in tribal village of Dasapalla (Mishra *et al.* 2015) reported 21 medicinal plants used to treat various ailments, where leaf was the most frequently used plant part followed by fruit. Study conducted by Halder *et al.* (2021) in Nayagarh Forest Division in tribal populated areas namely Panchirida, Mahipur, Gania, Nayagarh, Khandapada, Dasapalla and Odagaon, documented 159 ethnomedicinal plants to treat 65 diseases. Highest number of the documented plant species were used for skin diseases followed by joint pain, diabetes, toothache, bleeding and wound healing. Report by Nayak *et al.* (2024) identified 364 useful plant species from Sulia, Sapua, Gochha and Pokharigochha reserve forest of Nayagarh Forest Division. The documented plants were used under the category medicinal, economical, food, timber, fuel, cultural, ecological as cited by local people. A study on wild edibles of plants of Ranpur, Odogaon, Daspalla, Khandapada, Nayagarh blocks of Nayagarh district reported 103 plants and most popular. The study used quantitative ethnobotanical index RFC to find out most popular and diversified plant (Priyadarshini *et al.* 2024). Literature review indicated rich ethnobotanical knowledge of tribal communities in Nayagarh district. However, the mention studies are mostly qualitative ethnobotanical assessment and quantitative analysis are limited. Therefore, quantitative ethnobotanical analysis of the traditional knowledge of tribal communities in Nayagarh district is imperative to fill the research gap.

Wildlife sanctuaries are protected areas dedicated for conservation of wildlife and their habitat, classified as IUCN Category IV protected areas in India. Some degree of human activities such as tourism and sustainable resource use is allowed in wildlife sanctuary, providing it does not cause harm to wildlife and habitat. Assessment of local community dependency on forests is helpful to create awareness on sustainable use of resources and effective management habitat. A study in Pambikulam Tiger reserve reported 43.5% dependency of local communities on forest resources to maintain their livelihood (Soman & Anitha 2020). Baisipalli wildlife sanctuary (BWS) in Odisha is an undulated mountain system containing several small tribal settlements. The floristic composition of BWS includes 202 angiosperm plant species that constituting of 43% tree species, 34% herbs, 12% climbers and 11% shrubs (Pradhan *et al.* 2020). The inhabitants of BWS are dependent on the sanctuary forest for their livelihood. However, any systematic study on ethnobotanical aspect of BWS has not yet been reported. Hence, present study was designed for quantitative ethnobotanical assessment to understand the dependency of tribal inhabitants of BWS on plant resources of the sanctuary, to identify potential plant species under-utilized and to recognize plants at the risk of overexploitation.

Materials and Methods

Study area

State of Odisha in India, hosts a diverse range of tribal communities and officially recognized 62 tribes as Scheduled Tribes including 13 particularly vulnerable tribal groups (PVTGs). The tribal communities in Odisha constitute 22.8% total population of the state (Ota 2018). Current study was conducted in Baisipalli Wildlife Sanctuary (BWS), located in Nayagarh district of Odisha, India (20° 23.8' - 20° 31.3' N and 84° 35.4' - 84° 48.5' E). It was established in 1981 under India's Wildlife (Protection) Act, 1972. The total area of the sanctuary is 168.35 km² and boundary length is 91.692 km. The entire sanctuary is considered as core zone and the 3 km peripheral area around the boundary is regarded as buffer zone (Fig. 1). BWS is managed under the administrative control of Divisional Forest Officer (DFO), Mahanadi Wildlife Division, Nayagarh. For effective management, the total sanctuary area is divided into 2 ranges, 5 sections, 14 beats and 20 compartments. Topography of the sanctuary is undulated mountain system connected with several plains and valleys. The soil of the area is mainly alluvium type and rocks are generally Kondalite, Charnockite and Granulite. Forest in the sanctuary is typical 'dry deciduous Sal Forest' with *Shorea robusta* as dominant tree species. The BWS is home to several wild animals including elephant, leopard, bear, bison, tiger, barking deer, sambar, pangolin, hornbill, giant squirrel, mongoose, peacock etc. together with many rare and scheduled species. BWS contains 18 small revenue villages in core area and 43 in buffer area. Total population of BWS in core area is 2080 and that of buffer area is 10180. The local tribal communities inhabiting in BWS are *Kandha*, *Kharia*, *Saura*, *Gond* etc. among which *Kandha* represents the major tribe in the area. Primary livelihood of the tribal communities (90%) of BWS is agricultural farming, livestock rearing and collection of forest products. Small portion of population (5%) is engaged in sanctuary maintenance by sanctuary management authorities and young male population (5%) migrate to nearby cities as construction worker.

Field survey and data collection

Information about human settlements in sanctuary area was collected from forest range offices of BWS. Ethnobotanical survey was done after prior informed consent following Participatory Rural Appraisal (PRA) techniques such as field observation, focused group discussion and semi-structured interviews (Sontakki *et al.* 2019). Ethnobotanical data was collected from total of 306 informants (Table 1) from 12 villages of BWS namely Kuchumara, Senapari, Buriapaju and Nekaraganda from core zone, Banigochha, Jamusahi, Durgaprasad, Buguda, Takara, Makarprasad, Badasilinga and Dhipisahi from buffer zone. In each sampling site, village meeting was conducted in presence of village Pradhan (head-man) and purpose of survey was clearly appraised. Subsequently, individuals of age above 18 years (adult) including both male and female were approached for their consent to participate in the survey. Persons willing to share their traditional knowledge were included as informants. Ethical standard for informed consent, respect to privacy and cultural sensitivity were meticulously followed throughout the study. Discussion and interview with the informants (Fig. 2) were conducted in regional language *Odia*. Ethnobotanical information regarding useful plants were collected from informants by their vernacular name. Informants and evidences related to usefulness plants available with them were photographed after due consent of the informants. Photographs of the plants and useful plant parts were taken from the field. Voucher specimens were collected, labelled by their local names and herbarium was prepared following standard procedure. Taxonomic identification of the voucher specimens was done by the author (H.N. Subudhi) following local flora (Haines 1925, Saxena & Brahmam 1996, and Pullaiah *et al.* 2001, 2002). Authentication voucher specimens were deposited at the herbarium, Department of Botany, Utkal University, Bhubaneswar, Odisha. Systematic position of the plants was determined as per APG IV (2016) classification system and current nomenclature each species was referred from the database Plants of the World Online (<https://powo.science.kew.org/>). The IUCN conservation status (CS) and global population trend (GPT) of each species were collected from secondary sources (internet source: IUCN 2022, The IUCN Red List of Threatened Species Version 2021-3 <https://www.iucnredlist.org>). Data collected was analyzed in Microsoft Excel version 2021 and photographs were captured by camera model Nikon-3500.

Data Analysis

Quantitative ethnobotanical analysis of the collected data was performed by calculating following quantitative ethnobotanical indices. Data were organized in MS-Excel spreadsheets and calculated using following standard formula.

RFC (Relative frequency citation): This value was used to measure the popularity of the plants among informants.

$$RFC = \frac{FC}{N}$$

Where, Frequency citation (FC) is the number of informants mentioning the use of a particular species. N is total number of informants participated (306) (Tardio & Pardo 2008).

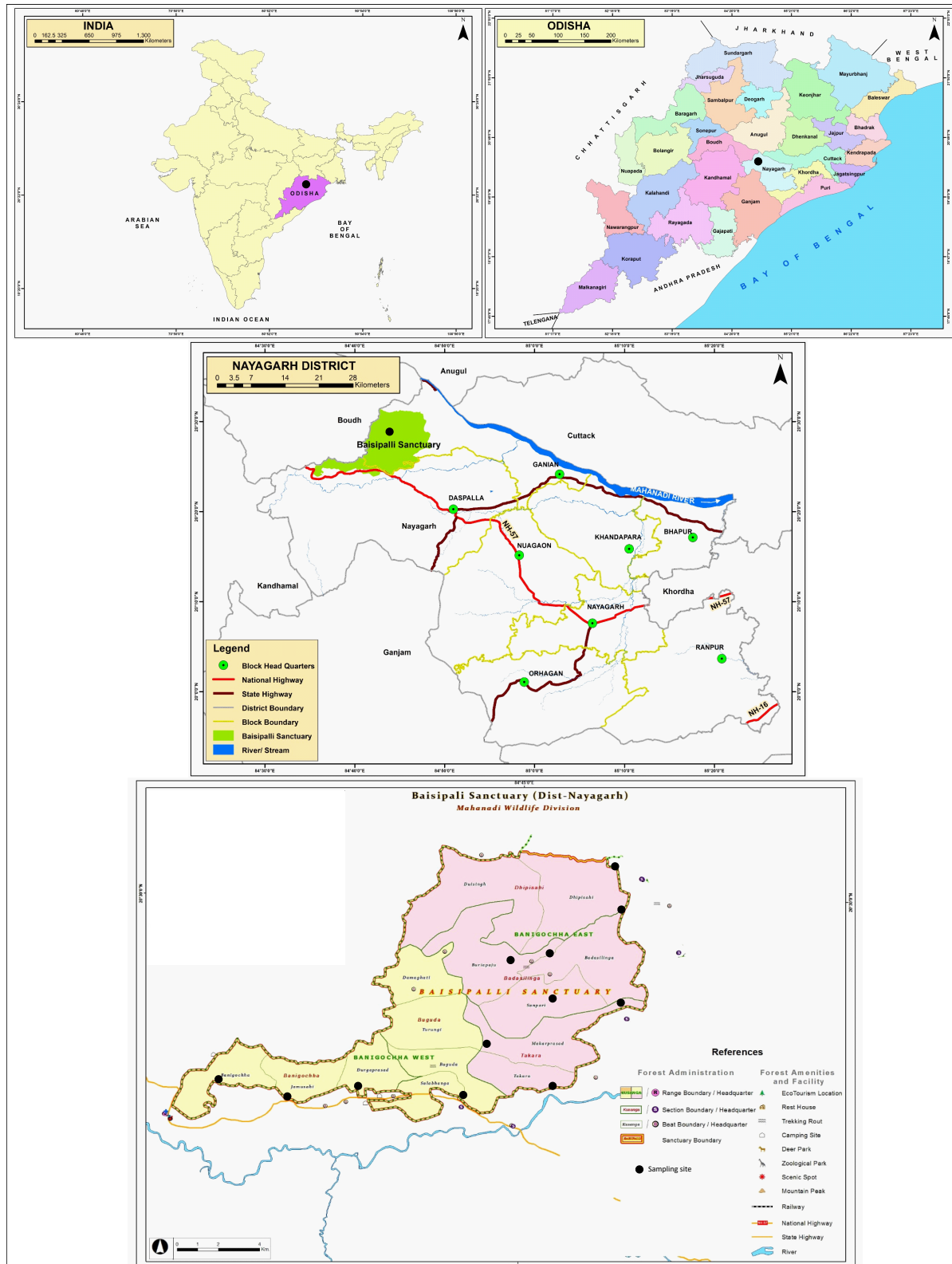


Figure 1. Map showing study area Baisipalli Wildlife Sanctuary, Nayagarh district, Odisha, India

UV (Use value): This value was used to estimate importance of each plant species.

$$UV = \frac{\sum RU_i}{N}$$

Where, reported use of species (RU_i) is the total number of uses of the plant species reported by each informant (i) (Phillips *et al.* 1994)

PPV (Plant part value): This value was used to find the highly used plant parts.

$$PPV = \frac{RU_{pp}}{\sum RU} \times 100$$

Where, Reported Use of plant part (RU_{pp}) is the total number of uses reported by all informants on the particular plant part of a particular species. $\sum RU$ is the total no. of reported uses for all species (Biara *et al.* 2021)

UV_k (Category use value): This value was used to understand the purpose for which plants are used by local communities.

$$UV_k = \frac{S_{ijk}}{N}$$

Where, 'S_{ijk}' is the Sum of citations by informant 'i' to specific use 'j' in the category 'k' (Phillips & Gentry 1993, Biara *et al.* 2021).

Table 1. Demography of informants

Villages sampled	Core zone: 4 (22.2%)	Buffer zone: 8 (18.6%)
Informants	Total: 306	Male: 144 (47%) Female: 162 (53%)
Age groups	20 and below	8% (Male: 5% Female: 3%)
(Year)	21 to 40	31% (Male: 14% Female: 17%)
	41 to 60	42% (Male: 19%, Female: 23%)
	61 and above	19% (Male: 9% Female: 10%)
Education level	No formal education	75% (Male: 35% Female: 40%)
	Primary school	17% (Male: 9% Female: 8%)
	High school	6% (Male: 5% Female: 4%)
	College	2% (Male: 1% Female: 1%)
Occupation	Agriculture	86% (Male: 39.5% Female: 46.5%)
	Local daily wage labour	8% (Male: 4% Female: 4%)
	Construction worker	5% (Male: 3% Female: 2%)
	Others	1% (Male: 0.5% Female: 0.5%)



Figure 2. Ethnobotanical survey in Baisipalli Wildlife Sanctuary. a. group discussion with informants b. focused group discussion with tribal healers c. personal interview at tribal mud house d. cattle shade made of wood log e. animal husbandry by local communities f. a tribal family showing usefulness of plants

Results

Useful plant species and plant parts used

The study recorded 137 useful plant species belonging to 112 genera and 51 families (Table 2). Useful species constituted of tree (49%), herb (26%), shrub (13%) and climber (12%). The family Fabaceae represented maximum number of useful species followed by Poaceae, and Lamiaceae. The plant parts bark, flower, fruit, inflorescence, leaf, leafy branch, root, seed, stem, tuber, wood were documented to have major use. Other plant parts having minor uses were latex, resin and rhizome. Most used plant parts of were leaves (34.3%) followed by wood (22.6%), fruit (21.9%) and stem (10.2%) (Fig. 3).

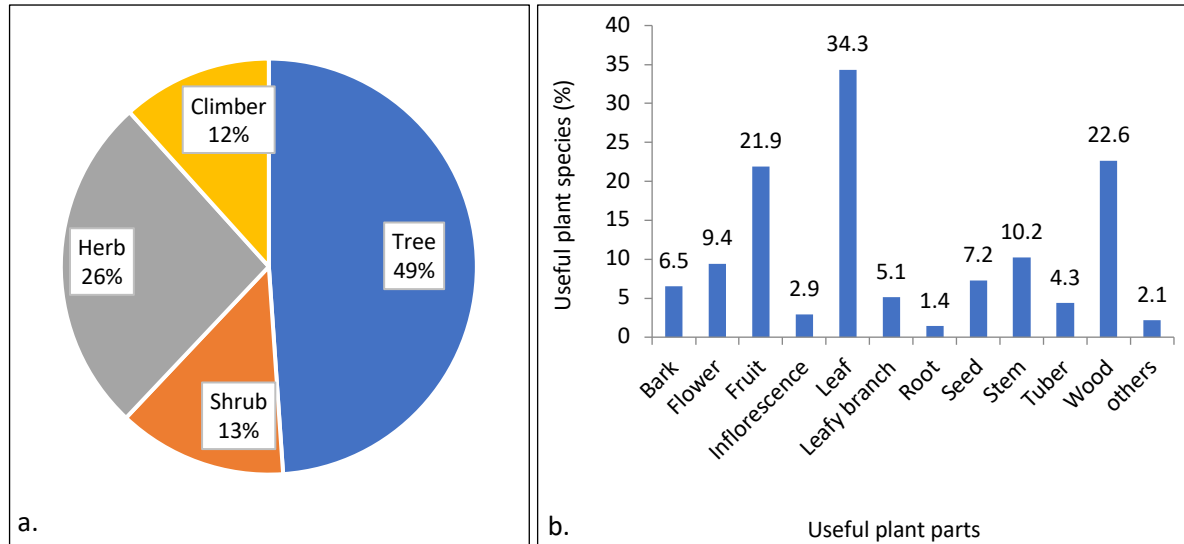


Figure 3. Useful plant species (%): a. plant habit wise, b. plant part wise

Use categories

The useful plant species were grouped in 10 use categories namely agriculture, fodder, food, fuelwood, house building, household essentials, medicine, ornamental, personal hygiene, and religious activities. The most use category was as medicine (27%) followed by food (25%), fuelwood (13%), and house building materials (8%) (Fig. 4). Tree species were majorly used under the category food, followed by fuelwood, medicine and house building. Shrub species were mostly reported to be used as medicine followed by personal hygiene, fuelwood, and household essentials. The plant parts of herbs were mostly used as medicine followed by food and fodder, whereas most of the climber species were used as food followed by medicine (Fig. 5).

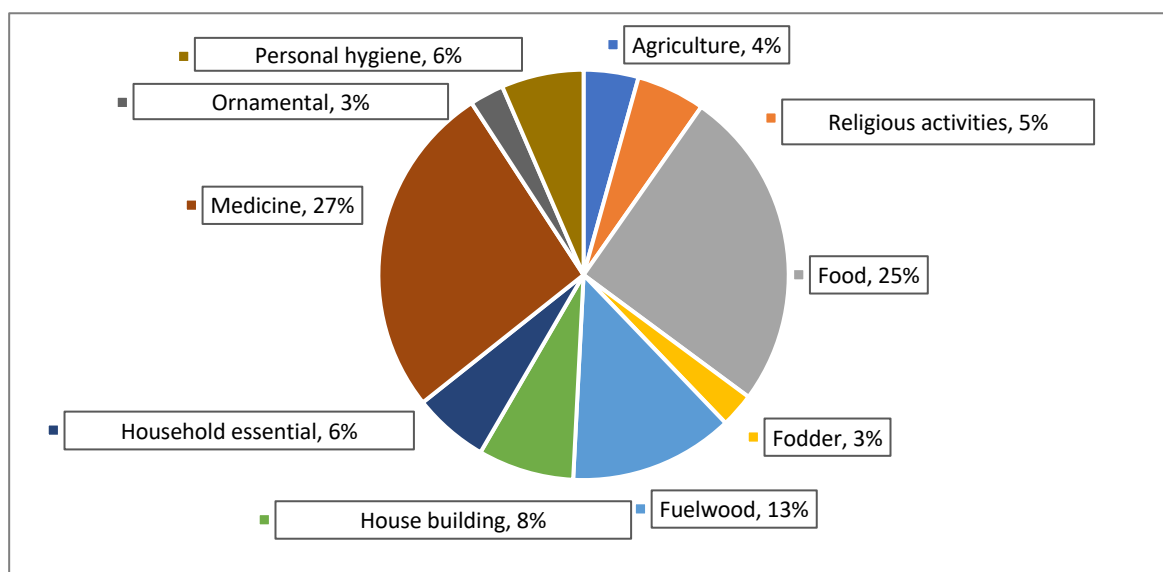


Figure 4. Composition of useful plant species (%) in different use categories

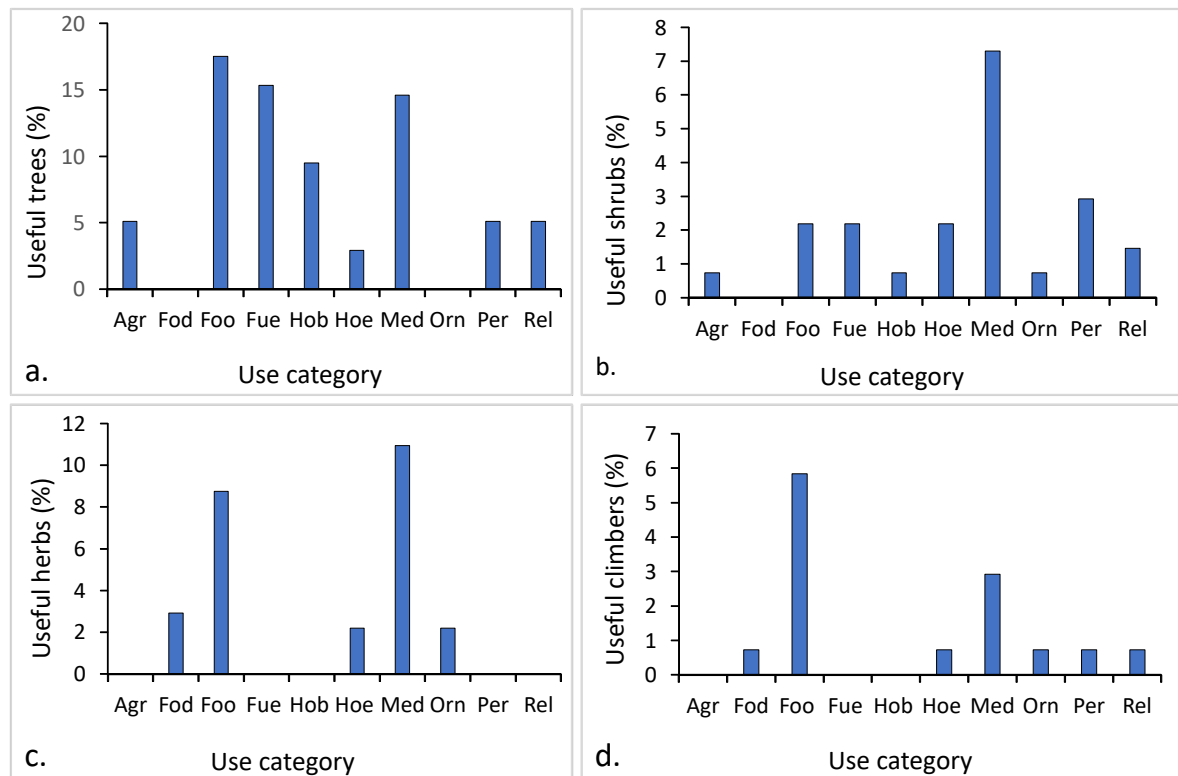


Figure 5. Habit wise comparison of useful plants (%) in different use categories (Agr-Agriculture, Foo-Food, Fod-Fodder, Fue-Fuelwood, Hob-House building, Hoe-Household essentials, Med-Medicine, Orn-Ornamental, Per-Personal hygiene, Rel-Religious)

Agriculture: Stems of *Dendrocalamus strictus*, *Bambusa bambos* and *Ziziphus oenopolia* were used for fencing around the cropland to protect crop from herbivores. For traditional farming the handmade wooden agricultural equipment used were made from wood of *Mitragyna parvifolia*, *Protium serratum*, *Pterocarpus marsupium*, and *Tectona grandis*.

Food: Ripen fruits of *Phyllanthus emblica*, *Syzygium cumini*, *Diospyros melanoxylon*, *Mangifera indica*, *Phoenix sylvestris*, *Semecarpus anacardium*, *Ziziphus oenopolia*, and *Ficus racemosa* were directly eaten as wild fruit. The tender leaves of *Amaranthus spinosus*, *Amaranthus viridis*, *Bauhinia purpurea*, *Senna tora*, *Celosia argentea*, *Cleome gynandra*, *Cleome monophylla*, and *Sphaeranthus indicus* were used as leafy vegetable. Roasted flowers of *Madhuca longifolia*, and seeds of *Tamarindus indica* were munched as snack. Tubers of *Dioscorea sp.* were boiled and consumed as food. Fermented inflorescence sap of *Phoenix sylvestris* and *Caryota urens* were drunk as alcoholic beverage. The traditional alcoholic drink prepared by fermenting the flowers of *Madhuca longifolia* (Fig. 6) was one of most popular beverages used in the rituals and social gatherings of tribal culture.

Fodder: Animal husbandry was observed as one of the prominent livelihood activities of tribal communities. Locals cut the grasses *Cynodon dactylon*, *Eleusine indica*, *Cajanus scarabaeoides* and *Chloris barbata* to feed their domestic animals.

Fuel wood: Local communities collect their fuelwood from forest. The dried stems of the tree *Shorea robusta*, *Terminalia elliptica*, *Ailanthus excelsa*, *Albizia lebbeck*, *Cleistanthus collinus*, *Mangifera indica*, *Semecarpus anacardium* etc. were preferred fuelwood. Among the shrubs *Ixora pavetta*, *Bridelia retusa*, *Casearia tomentosa*, *Holarrhena pubescens* and *Woodfordia fruticosa* were the source of fuelwood.

House building: Traditional tribal residences were the mud house, supported with wood logs and roof thatched with paddy straw or leaves (Fig. 2). Wood logs of *Dalbergia paniculata*, *D. sisso*, *Gmelina arborea*, *Mitragyna parvifolia*, *Protium serratum*, *Pterocarpus marsupium*, *Shorea robusta* and *Tectona grandis* are employed to make supporting wooden structures of mud houses. Stems of *Bambusa bambos* and *Dendrocalamus strictus* were used to make frame for roof of the houses. Leaves of *Phoenix acaulis*, *P. sylvestris* and *Borassus flabellifer* were utilized for thatching of mud houses.

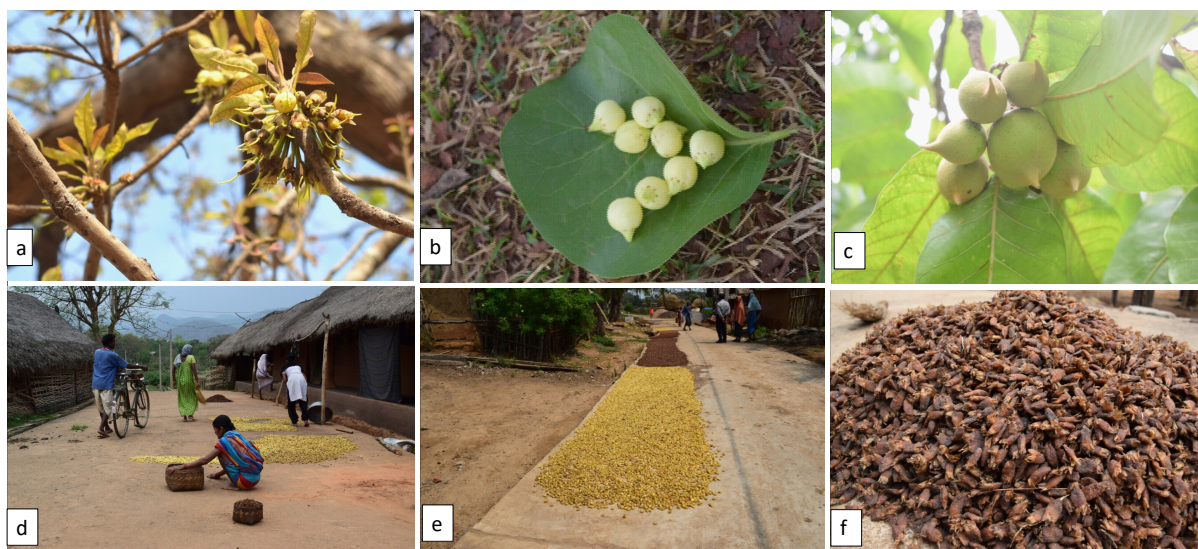


Figure 6. Useful plant *Madhuca longifolia* var. *latifolia*: a. inflorescence b. fresh flowers c. fruits d. tribal women drying flowers e. sun drying flowers along a village road f. dried flower

Household essentials: The household essential like broom, mat, rope, plate, bowl etc. were prepared from plant parts. Leaves of *Phoenix acaulis* (Fig. 7) and *P. sylvestris* were used for making broom and mat. Leaves of *Shorea robusta* and *Phanera vahlii* were used for making of single use leafy plates and bowls (Fig. 8). Bark of *B. vahlii* and leaves of *Eulaliopsis binata* were used to craft rope. Inflorescence of *Heteropogon contortus* and *Thysanolaena latifolia*, leafy twigs of *Sida acuta* were used for making of brooms. Flowers of *Woodfordia fruticosa* were used for making dye.



Figure 7. Useful plant *Phoenix acaulis*: a. the plant b. a hut thatched with leaves c. broom made of leaves d. edible fruits

Medicine: Leaf, bark, fruit, seed and root were the mostly used plant parts for medicinal purpose. Leaves of *Azadirachta indica* and *Andrographis paniculata*, oil extracted from seeds of *Azadirachta indica*, *Pongamia pinnata*, and *Schleichera oleosa* were used to treat skin diseases. Leaves of *Abutilon indicum*, *Achyranthes aspera*, *Alangium salvifolium*, *Andrographis paniculata*, *Kalanchoe pinnata*, and *Tridax procumbens*, bark of *Cassia fistula*, latex of *Holarrhena pubescens*, seeds of *anacardium*, root of *Careya arborea* were used to were used for wound healing. Leaves of *Justicia adhatoda*, *Ocimum americanum* and *O. tenuiflorum*, fruits of *Terminalia bellirica* and *T. chebula* were used to cure cough and cold. Leaves of *Nyctanthes arbortristis* and *Rauvolfia serpentina*, stem of *Cuscuta reflexa* were used to reduce fever. Leaves of *Elephantopus scaber* and *Andrographis paniculata*, bark of *Terminalia arjuna* and *Careya arborea* were used to treat diarrhoea and dysentery (Fig. 9).



Figure 8. Household essentials made of leaves. a. *Phanera vahlii* plant b. stitching of leaves c. leafy plate and bowl made of *P. vahlii* leaves d. *Shorea robusta* tree e. sun drying of leafy plates f. leafy plate and bowl made of *S. robusta* leaves

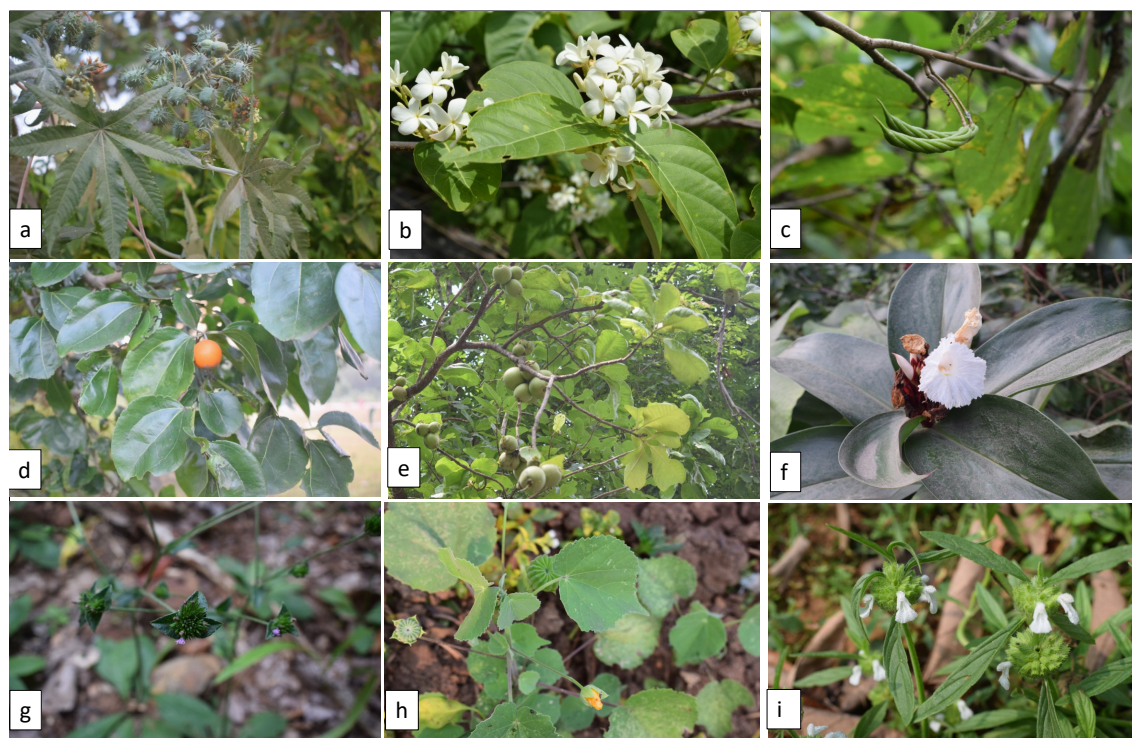


Figure 9. Medicinal plants. a. *Ricinus communis* b. *Holarrhena pubescens* c. *Helicteres isora* d. *Strychnos nux-vomica* e. *Careya arborea* f. *Hellenia speciosa* g. *Elephantopus scaber* h. *Abutilon indicum* i. *Leucas aspera*

Leaves of *Cissampelos pareira*, *Solanum virginianum* and *Vanda tessellata* were used to reduce inflammation in body. Fruit of *Helicteres isora* was used to reduce body pain in kids and oil extracted from seeds of *Ricinus communis* was applied to ease muscle and body pain in adults. Leaves of *Calotropis gigantea*, *C. procera*, *Datura metel*, *Eclipta prostrata*, *Mangifera indica*, and *Paederia foetida* were used as remedy for joint pain. Leaves of *Leucas aspera* and bark of *Madhuca longifolia* were used to reduce toothache. Leafy branch of *Phyllanthus fraternus* and tuber of *Asparagus racemosus* was used to treat jaundice. Leaves of *Aegle marmelos*, bark of *Shorea robusta* and seeds of *Strychnos nux-vomica* were used to treat gastrointestinal and urinary ailments. Bark of *Saraca asoca* and root of *Soymida febrifuga* was used to cure gynaecological disorders.

Ornamental: Young tribal women beautify themselves with flowers from ornamental plants. Wild flowers of *Barleria prionitis*, *Butea superba*, *Clerodendrum infortunatum*, *Barleria cristata*, and *Barleria strigosa* were used by young women for decoration and beautification during festive seasons.

Personal hygiene: Different plant parts were used for personal hygiene like oral health, skin and hair care. Semi-woody stem of *Azadirachta indica*, *Cipadessa baccifera*, *Flemingia chapper*, *Lantana camara*, *Mangifera indica*, *Pongamia pinnata*, *Shorea robusta*, *Smilax zeylanica*, *Streblus asper* and *Vitex negundo* were used as toothbrush. Oil extracted from seeds of *Madhuca longifolia* and *Ricinus communis* by traditional methods were used for moisturization of skin and hair care.

Religious activities: Cultural and religious practices are the integral part of tribal life style. Leafy branches of *Diospyros melanoxylon*, *Ficus benghalensis*, *Ficus religiosa* and *Mangifera indica* were used in different spiritual and social rituals. Leaves of *Aegle marmelos*, flowers of *Butea monosperma*, *Calotropis gigantea*, *Clitoria ternatea* and *Datura stramonium* are offered to God during worship. Resin exudes collected from matured trees of *S. robusta* were used for fumigation during religious activities.

Quantitative ethnobotanical indices

Relative frequency citation (RFC)

The RFC value 1 indicates highest popularity of the plant among the informants. There were 15 plant species recorded to have highest RFC, among which plant part of 12 species were used as food. Plants showing high RFC with multiple useful plant parts were *Annona squamosa*, *Diospyros melanoxylon*, *Madhuca longifolia*, *Mangifera indica*, *Phoenix sylvestris*, *Ricinus communis*, *Semecarpus anacardium*, *Shorea robusta*, and *Tamarindus indica*. *Madhuca longifolia* was found to have highest popularity among local communities for its useful flowers and seeds (Fig.6g). The plants having RFC 1 but only one useful plant part were *Amaranthus spinosus* (leaf), *A. viridis* (leaf), *Bauhinia purpurea* (leaf), *Phyllanthus emblica* (fruit), and *Syzygium cumini* (fruit) used as food. *Thysanolaena latifolia* was popular with RFC 1 for its inflorescence used in making broom.

Use value (UV)

The use value (UV) estimates importance of each plant species based on their number of uses reported. Higher the use value of a plant, greater is its importance for the community. Out of 137 useful plant species, 29 species showing high UV (≥ 1) included 16 tree species, followed by 8 shrubs, 3 herbs and 2 climbers. Based on UV, top five important plant species were *Shorea robusta* (4.77), *Madhuca longifolia* (4.55), *Bambusa bambos* (3.25), *Phoenix sylvestris* (3.2) and *Azadirachta indica* (3.08). Among the high UV species, 89.6% were used in multiple use categories, mostly for food and medicine. All the 15 species showing highest RFC (1) were recorded to have higher use value (UV).

Plant part value (PPV%)

The PPV was derived to understand the dependency of local communities on various plant parts for different purpose. There were 11 major useful plant parts recorded in the present study. Plant part value of leaf (24.5) was found to be highest and followed by fruit (20.3), wood (15.2), stem (11.6), seed (8.32), flower (6.25), tuber (3.69), stem (3.15), inflorescence (3.1) and bark (1.93) (Fig.4). The lowest PPV was recorded for root and others (rhizome / latex / resin). Leaves showing highest PPV were mostly used as food (leafy vegetables), medicine, household essential (leafy plate and bowls, mat, broom etc.) and house building materials (thatching). Fruit having second highest PPV were used as food and medicine (Fig. 10).

Based on gross PPV top 10 species were *Shorea robusta* (4.34), *Madhuca longifolia* (4.14), *Bambusa bambos* (2.96), *Phoenix sylvestris* (2.91), *Azadirachta indica* (2.8), *Phoenix acaulis* (2.78), *Mangifera indica* (2.75), *Tamarindus indica* (2.48), *Phanera vahlii* (2.33) and *Semecarpus anacardium* (2.26). Highest PPV showing tree species were *S. robusta* and *Madhuca longifolia*, shrub was *P. acaulis* and climber was *B. vahlii*. The trees were found to have greater values of PPV followed by herb, shrub and climbers.

Category use value (UV_k)

Category use value is an index that measures the degree of indigenous knowledge among local communities for a specific use category. Useful plant species were grouped in 10 use categories (food, medicine, fodder, fuelwood, personal hygiene, religious activities, household essentials, house building, agriculture and ornamental). Among them UV_k of food (0.75) was highest, followed by personal hygiene (0.74), religious activities (0.67), household essentials (0.65) and fuelwood (0.56) (Fig. 11). Local communities were considerably knowledgeable on using plants for food. Fruit, leaves, tubers were used as food. Alcoholic beverages were prepared from flower and sap of certain plants. For personal hygiene stems were used as tooth brush, oil extracted from seeds were used for skin and hair care. Tribals are nature worshippers and familiar about use of

specified leaves, flowers, fruit, stem, resin etc. for religious rituals. Though greater number plant parts were reported medicinal use, UVK of medicine (0.36) showed low value than others. Because, traditional knowledge on medicinal plants was restricted to certain old-aged person and traditional healers only. The middle age and young individuals particularly were not aware about towards traditional knowledge on medicinal plants.

Multipurpose species and their conservation status

Plant species used in multiple use categories were considered as multipurpose species. The study recorded 21 trees (68%), 8 shrubs (26%), 1 herb (3%) and 1 climber (3%) as multipurpose species. They showed high UV and great degree of popularity as evident from RCF. Multiple plant parts are used for more than one use category. Such multipurpose species were *Shorea robusta*, *Madhuca longifolia*, *Phoenix sylvestris*, *Mangifera indica*, *Semecarpus anacardium*, *Diospyros melanoxylon*, *Aegle marmelos*, *Phoenix acaulis*, *Ziziphus oenopolia* and *Phanera vahlii*. As per IUCN *Aegle marmelos* and *Pterocarpus marsupium* were enlisted in the near threatened (NT) category and have decreasing global population trend (GPT).

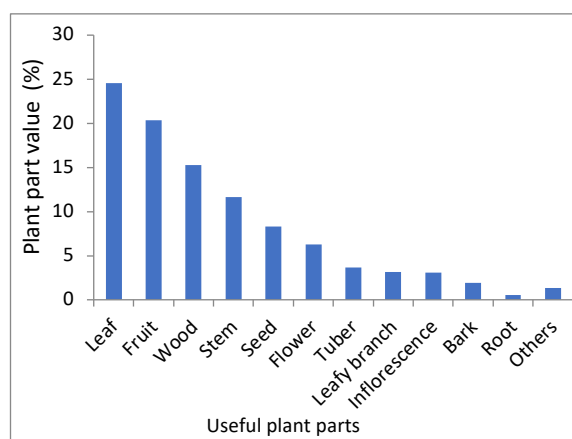


Figure 10. Plant part value (%) of useful plant parts

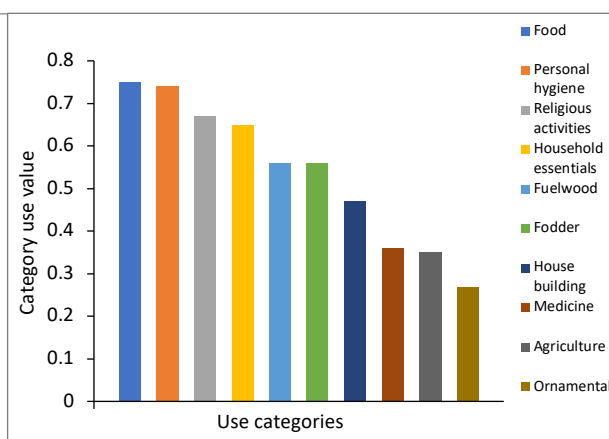


Figure 11. Category use value of useful species used in different

Discussion

Present study revealed that tribal communities of BWS depend on local plant resources tree, shrub and herbs for their livelihood maintenance. Tree species are most used plants and highest number of useful plants belong to the family Fabaceae. Floristic survey in BWS (Pradhan *et al.* 2020) reported the dominance of tree species and Fabaceae family in the sanctuary. Phytodiversity study in reserve forests of Nayagarh districts showed maximum number of tree species and Fabaceae represented highest number of plant species (Nayak *et al.* 2024). Ethnobotanical studies of Jessore Wildlife Sanctuary, Banaskantha, Gujarat, India reported 47 medicinal plants used for treatment different ailments. Most commonly used plant parts are leaves followed by fruit, seed, bark, stems and flower (Patel & Khare 2023). Floristic and ethnobotanical studies of Kuldiha wild life sanctuary, Odisha reported 236 plant species plants 45% (106) trees, 20% (48) shrubs, 18% (43) herbs and 17% (39) climbers used for various purpose by the Santhal tribes and natives of the area dwell in the sanctuary. The study categorized the variety of uses broadly as medicinal, wild edibles, fodder, timber, fibre, fuel and other miscellaneous uses which are similar to the current study (Saravana & Sujana 2025). An ethnobotanical study in Sunabeda Wildlife Sanctuary, Nuapada, Odisha reported 37 leafy vegetables used for medicinal purpose of which highest percentage of plants belongs to Fabaceae family (Bhoi & Ahiwar 2025b). Tree species have several useful plants parts namely wood, bark, stem, leaf, flower, fruit, seed etc., which are used for different purposes. Dry and arid climate are known to support the growth of Fabaceae species (Pennington *et al.* 2006), justify their predominance in dry deciduous forest of BWS. As tribal communities fulfill their needs from the surrounding resources, the prevalence of trees and Fabaceae species in BWS, turn out them to be the most used plants. The findings showed, leaves as most frequently used plant part under multiple use categories as medicine, food in form of leafy vegetables, house hold essentials, religious offerings etc. Leaves are available throughout the year and can be harvested easily. As the leaves regenerated quickly and can be collected without damaging plant, they serve as renewable and sustainable natural resource (Flores *et al.* 2025). Over harvest of leaves reduces the vegetative and reproductive health of the species in future (Lopez-Toledo *et al.* 2018). Therefore, leaf harvest should be regulated to allow the plants for fruiting and ensure natural regeneration of plant species by the availability of seeds in each year (Dossou *et al.* 2025). It is crucial to reduce the rate of overharvest inside a protected area for the conservation of plant species (Souza & Prevedello 2020).

Table 2. Floristic composition of useful species of Baisipalli Wildlife Sanctuary, Odisha, India

Plant species/ Family	Local name	Habit	Plant part used	Use category	RFC	UV	CS	GPT
<i>Abutilon indicum</i> (L.) Sweet (Malvaceae)	Pedi pedika	H	Le	Med	0.11	0.11	*	*
<i>Achyranthes aspera</i> L. (Amaranthaceae)	Apamaranga	H	Le	Med	0.48	0.48	*	*
<i>Aegle marmelos</i> (L.) Corr. (Rutaceae)	Bela	T	Le, Fr	Rel, Med, Foo	0.94	2.4	NT	Decr
<i>Ailanthus excelsa</i> Roxb. (Simaroubaceae)	Mahalimba	T	Wo	Fue	0.17	0.17	*	*
<i>Alangium salvifolium</i> (L.f.) Wang. (Cornaceae)	Ankula	T	Le	Med	0.31	0.31	*	*
<i>Albizia lebbeck</i> (L.) Benth. (Fabaceae)	Siriso	T	Wo	Fue	0.2	0.2	LC	Stab
<i>Amaranthus spinosus</i> L. (Amaranthaceae)	Kanta saga	H	Le	Foo	1	1	*	*
<i>Amaranthus viridis</i> L. (Amaranthaceae)	Khada saga	H	Le	Foo	1	1	*	*
<i>Andrographis paniculata</i> (Burm.f.) Wall.ex Nees (Acanthaceae)	Bhuin nimba	H	Le	Med	0.85	0.85	*	*
<i>Annona reticulata</i> L. (Annonaceae)	Ramphala	T	Fr	Foo	0.99	0.99	*	*
<i>Annona squamosa</i> L. (Annonaceae)	Ata	S	Se, Fr	Med, Foo	1	1.04	*	*
<i>Antidesma acidum</i> Retz. (Phyllanthaceae)	Nunnunia	T	Fr	Foo	0.46	0.46	LC	Stab
<i>Asparagus racemosus</i> Willd. (Asparagaceae)	Satamuli	C	Tu	Med	0.05	0.05	*	*
<i>Azadirachta indica</i> A Juss. (Meliaceae)	Limba	T	Se, Le, Fl, St	Med, Foo, Per	0.88	3.08	LC	Stab
<i>Bambusa bambos</i> (L.) Voss (Poaceae)	Kanta baunsa	T	St	Foo, Agr, Hob	0.94	3.25	*	*
<i>Barleria cristata</i> L. (Acanthaceae)	Daskarada	H	Fl	Orn	0.26	0.26	*	*
<i>Barleria prionitis</i> L. (Acanthaceae)	Daskeranta	H	Fl	Orn	0.31	0.31	LC	Unkn
<i>Barleria strigosa</i> Willd. (Acanthaceae)	Banamalli	H	Fl	Orn	0.25	0.25	*	*
<i>Barringtonia acutangula</i> (L.) Gaertn. (Lecythydaceae)	Hinjal	T	Wo	Fue	0.32	0.32	LC	Unkn
<i>Bauhinia purpurea</i> L. (Fabaceae)	Barada	T	Le	Foo	1	1	LC	Stab
<i>Boerhavia diffusa</i> L. (Nyctaginaceae)	Kharkharia	H	Le	Foo	0.12	0.12	*	*
<i>Bombax ceiba</i> L. (Malvaceae)	Simili	T	Fr	Hoe	0.12	0.12	LC	Stab
<i>Borassus flabellifer</i> L. (Arecaceae)	Tala	T	Fr, Le	Foo, Hob	0.48	0.9	*	*
<i>Boswellia serrata</i> Roxb. (Burseraceae)	Salai	T	Ba	Med	0.27	0.27	*	*
<i>Bridelia retusa</i> (L.) A.Juss. (Phyllanthaceae)	Kashi	T	Wo	Fue	0.45	0.45	LC	Stab
<i>Buchanania lanzan</i> Spreng. (Anacardiaceae)	Chara	T	Fr	Foo	0.97	0.97	*	*
<i>Butea monosperma</i> (Lam.) Kuntze. (Fabaceae)	Palasa	T	Fl	Rel	0.35	0.35	LC	Unkn
<i>Butea superba</i> Roxb. ex Willd. (Fabaceae)	Lata palasa	C	Fl	Orn	0.27	0.27	*	*
<i>Cajanus scarabaeoides</i> (L.) Thours (Fabaceae)	Bana kulathi	C	Lb	Fod	0.12	0.12	LC	Stab
<i>Calotropis gigantea</i> (L.) W.T.Aiton (Apocynaceae)	Arakha	S	Le, Fl	Med, Rel	0.91	1	*	*
<i>Calotropis procera</i> (Aiton) W.T.Aiton (Apocynaceae)	Arakha	S	Le	Med	0.11	0.11	*	*
<i>Careya arborea</i> Roxb. (Lecythydaceae)	Kumbhi	T	Ba, Ro	Med	0.55	0.99	*	*
<i>Caryota urens</i> L. (Arecaceae)	Salpa	T	In	Foo	0.99	0.99	LC	Stab
<i>Casearia tomentosa</i> subsp. <i>tomentosa</i> (Salicaceae)	Khakada	T	Wo	Fue	0.93	0.93	*	*
<i>Cassia fistula</i> L. (Fabaceae)	Sunari	T	Ba, Le	Med, Hoe	0.54	0.75	LC	Stab
<i>Celosia argentea</i> L. (Amaranthaceae)	Lobanga	H	Le	Foo	0.58	0.58	LC	Unkn
<i>Centella asiatica</i> (L.) Urban (Apiaceae)	Thalkudi	H	Le	Foo	0.13	0.13	LC	Stab

<i>Chloris barbata</i> Sw. (Poaceae)	-	H	Lb	Fod	0.6	0.6	*	*
<i>Cipadessa baccifera</i> (Roth. ex Roth) Miq. (Meliaceae)	Nahalmali	S	St	Per	0.62	0.62	LC	Stab
<i>Cissampelos pareira</i> L. (Menispermaceae)	Okanabindu	C	Le	Med	0.21	0.21	*	*
<i>Cleistanthus collinus</i> (Roxb.) Benth. ex Hook.f. (Phyllanthaceae)	Karada	T	Wo	Fue	0.82	0.82	VU	Unsp
<i>Cleome gynandra</i> L. (Cleomaceae)	Gandhali	H	Le	Foo	0.5	0.5	*	*
<i>Cleome monophylla</i> L. (Cleomaceae)	Ranga sorisa	H	Le	Foo	0.59	0.59	*	*
<i>Clerodendrum infortunatum</i> L. (Lamiaceae)	Madhvi	S	Fl	Orn	0.27	0.27	*	*
<i>Clitoria ternatea</i> L. (Fabaceae)	Aparajita	C	Fl	Rel	0.85	0.85	*	*
<i>Coccinia grandis</i> (L.) Voigt (Cucurbitaceae)	Kunduri	C	Fr	Foo	0.87	0.87	*	*
<i>Commelina benghalensis</i> L. (Commelinaceae)	Kaniseera	H	Le	Foo	0.32	0.32	LC	Stab
<i>Cuscuta reflexa</i> Roxb. (Convolvulaceae)	Nirmuli	C	St	Med	0.04	0.04	LC	Decr
<i>Cynodon dactylon</i> (L.) Pers. (Poaceae)	Duba	H	Le	Med, Fod	0.97	1.33	*	*
<i>Cyperus corymbosus</i> Rottb. (Cyperaceae)	Mutha	H	Lb	Fod	0.22	0.22	*	*
<i>Dalbergia lanceolaria</i> subsp. <i>paniculata</i> (Roxb.) Thoth. (Fabaceae)	Barabakulia	T	Wo	Hob	0.08	0.08	*	*
<i>Dalbergia sissoo</i> Roxb. ex DC. (Fabaceae)	Shishu	T	Wo	Hob	0.04	0.04	LC	Unkn
<i>Datura metel</i> L. (Solanaceae)	Kaladudura	S	Le	Med	0.12	0.12	*	*
<i>Datura stramonium</i> L. (Solanaceae)	Dudura	S	Fr, Fl	Med, Rel	0.61	0.7	*	*
<i>Dendrocalamus strictus</i> (Roxb.) Nees (Poaceae)	Salia baunsa	T	St	Hob, Agr	0.88	2.39	*	*
<i>Dillenia pentagyna</i> Roxb. (Dilleniaceae)	Bada rai	T	Fr	Foo	0.9	0.9	*	*
<i>Dioscorea alata</i> L. (Dioscoreaceae)	Khabma alu	C	Tu	Foo	0.99	0.99	*	*
<i>Dioscorea oppositifolia</i> L. (Dioscoreaceae)	Pani alu	C	Tu	Foo	0.85	0.85	*	*
<i>Dioscorea pentaphylla</i> L. (Dioscoreaceae)	Kadaba alu	C	Tu	Foo	0.79	0.79	*	*
<i>Dioscorea pubera</i> Blume (Dioscoreaceae)	Kosa alu	C	Tu	Foo	0.76	0.76	*	*
<i>Dioscorea wallichii</i> Hook.f. (Dioscoreaceae)	Tunga alu	C	Tu	Foo	0.62	0.62	LC	Stab
<i>Diospyros malabarica</i> (Desr.) Kostel. (Ebenaceae)	Mankadakendu	T	Wo	Fue	0.41	0.41	*	*
<i>Diospyros melanoxylon</i> Roxb. (Ebenaceae)	Kendu	T	Wo, Fr, Le	Fue, Foo, Rel	1	2.42	*	*
<i>Eclipta prostrata</i> (L.) L. (Asteraceae)	Bhrungaraj	H	Le	Med	0.04	0.04	LC	Stab
<i>Elephantopus scaber</i> L. (Asteraceae)	Mayurachulia	H	Le	Med	0.72	0.72	*	*
<i>Eleusine indica</i> (L.) Gaertn. (Poaceae)	Ana mandia	H	Lb	Fod	0.9	0.9	LC	Stab
<i>Eulaliopsis binata</i> (Retz.) C.E.Hubb (Poaceae)	Sabai	H	Le	Hoe	0.63	0.63	*	*
<i>Ficus benghalensis</i> L. (Moraceae)	Bara	T	Lb	Rel	0.5	0.5	*	*
<i>Ficus racemosa</i> L. (Moraceae)	Dimiri	T	Fr	Foo	0.98	0.98	LC	Stab
<i>Ficus religiosa</i> L. (Moraceae)	Osta	T	Lb	Rel	0.57	0.57	*	*
<i>Flemingia chapper</i> Buch.-Ham. ex Benth. (Fabaceae)	Rani dantakathi	S	St	Per	0.91	0.91	*	*
<i>Gmelina arborea</i> Roxb. ex Sm. (Lamiaceae)	Gambhari	T	Wo	Hob, Fue	0.27	0.48	LC	Unkn
<i>Grewia tiliifolia</i> Vahl (Malvaceae)	Dhamana	T	Wo	Fue	0.17	0.17	*	*
<i>Helicteres isora</i> L. (Malvaceae)	Modimodika	S	Fr	Med	0.52	0.52	*	*
<i>Hellenia speciosa</i> (J.Koenig) S.R.Dutta (Costaceae)	Gaigendalia	H	Rh	Med	0.29	0.29	*	*
<i>Heteropogon contortus</i> (L.) P.Beauv. (Poaceae)	Sinkula	H	In	Hoe	0.42	0.42	*	*
<i>Holarrhena pubescens</i> Wall.ex G.Don. (Apocynaceae)	Kurei	S	La, Wo	Med, Fue	0.72	1.04	LC	Unkn
<i>Ixora pavetta</i> Andrews (Rubiaceae)	Telakuruma	T	Wo	Fue	0.94	0.94	*	*

<i>Justicia adhatoda</i> L. (Acanthaceae)	Basanga	S	Le	Med	0.12	0.12	LC	Stab
<i>Kalanchoe pinnata</i> (Lam.) Pers. (Crassulaceae)	Amarpoi	S	Le	Med	0.04	0.04	*	*
<i>Lagerstroemia parviflora</i> Roxb. (Lythraceae)	Sidha	T	Wo	Fue	0.15	0.15	*	*
<i>Lantana camara</i> L. (Verbenaceae)	Naguari	S	St, Wo	Fue, Per	0.52	0.83	*	*
<i>Leucas aspera</i> (Willd.) Link (Lamiaceae)	Goyosa	H	Le	Med	0.76	0.76	*	*
<i>Limonia acidissima</i> L. (Rutaceae)	Kaitha	T	Fr	Foo	0.84	0.84	*	*
<i>Litsea glutinosa</i> (Lour.) C.B.Rob. (Lauraceae)	Jayasandha	T	Ba	Med	0.08	0.08	LC	Unkn
<i>Madhuca longifolia</i> var. <i>latifolia</i> (Roxb.) A.Chev. (Sapotaceae)	Mahula	T	Ba, Fl, Wo, Se	Med, Foo, Fue, Per	1	4.55	*	*
<i>Mangifera indica</i> L. (Anacardiaceae)	Amba	T	Le, Fr, St, Wo	Med, Rel, Fue, Foo, Per	1	3.02	DD	Unkn
<i>Mimusops elengi</i> L. (Sapotaceae)	Baula	T	Fr	Foo	0.15	0.15	LC	Stab
<i>Mitragyna parvifolia</i> (Roxb.) Korth. (Rubiaceae)	Mitikinia	T	Wo	Agr, Hob	0.3	0.52	*	*
<i>Momordica charantia</i> L. (Cucurbitaceae)	Kalara	C	Le, Fr	Foo	0.96	1.42	*	*
<i>Naringi crenulata</i> (Roxb.) Nicolson (Rutaceae)	Benta	T	Wo	Fue	0.46	0.46	*	*
<i>Nyctanthes arbor-tristis</i> L. (Oleaceae)	Gangashiuli	T	Le	Med	0.92	0.92	*	*
<i>Ocimum americanum</i> L. (Lamiaceae)	Bana tulasi	H	Le	Med	0.59	0.59	*	*
<i>Ocimum tenuiflorum</i> L. (Lamiaceae)	Tulasi	H	Le	Med	0.96	0.96	*	*
<i>Oxalis corniculata</i> L. (Oxalidaceae)	Ambiliti	H	Le	Foo	0.27	0.27	*	*
<i>Paederia foetida</i> L. (Rubiaceae)	Prasaruni	C	Le	Med	0.15	0.15	*	*
<i>Phanera vahlii</i> (Writh & Arn.) Benth. (Fabaceae)	Siali	C	Se, Le, Ba	Foo, Hoe	0.92	2.56	*	*
<i>Phoenix acaulis</i> Roxb. (Arecaceae)	Bana khajuri	S	Fr, Le	Foo, Hoe, Hob	0.94	3.06	*	*
<i>Phoenix sylvestris</i> (L.) Roxb. (Arecaceae)	Khajuri	T	Le, In, Fr	Hob, Hoe, Foo	1	3.2	*	*
<i>Phyllanthus emblica</i> L. (Phyllanthaceae)	Anla	T	Fr	Foo	1	1	LC	Decr
<i>Phyllanthus fraternus</i> G.L.Webster (Phyllanthaceae)	Bhuinanla	H	Le	Med	0.05	0.05	*	*
<i>Pongamia pinnata</i> (L.) Pierre (Fabaceae)	Karanja	T	St, Se	Per, Med	0.92	1.65	LC	Stab
<i>Protium serratum</i> (Wall. ex Colebr.) Engl. (Burseraceae)	Nimburumoi	T	Wo	Hob, Agr	0.31	0.56	*	*
<i>Pterocarpus marsupium</i> Roxb. (Fabaceae)	Piashala	T	Wo	Agr, Hob	0.17	0.28	NT	Decr
<i>Pterospermum xylocarpum</i> (Gaertn.) Oken (Malvaceae)	Giringa	T	Wo	Agr, Hob	0.16	0.29	*	*
<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz (Apocynaceae)	Patalagaruda	H	Le	Med	0.12	0.12	*	*
<i>Ricinus communis</i> L. (Euphorbiaceae)	Jada	S	Se	Med, Per	1	1.94	*	*
<i>Saraca asoca</i> (Roxb.) W.J.de Wilde (Fabaceae)	Ashoka	T	Ba	Med	0.1	0.1	VU	Unsp
<i>Schleichera oleosa</i> (Lour.) Oken (Sapindaceae)	Kusuma	T	Fr, Se	Foo, Med	0.92	1.47	LC	Stab
<i>Semecarpus anacardium</i> L.f. (Anacardiaceae)	Bhalia	T	Wo, Se, Fr	Fue, Med, Foo	1	2.49	LC	Unkn
<i>Senna tora</i> (L.) Roxb. (Fabaceae)	Dhala chakunda	H	Le	Foo	0.42	0.42	*	*
<i>Shorea robusta</i> C.F.Gaertn. (Dipterocarpaceae)	Sal	T	Ba, Re, Wo, Le, St	Med, Rel, Hob, Per, Hoe, Fue	1	4.77	LC	Unsp
<i>Sida acuta</i> Burm.f. (Malvaceae)	Bajramuli	H	Lb	Hoe	0.55	0.55	*	*
<i>Smilax zeylanica</i> L. (Smilacaceae)	Mutri	C	St	Per	0.46	0.46	*	*
<i>Solanum nigrum</i> L. (Solanaceae)	Nunununia	H	Fr	Foo	0.24	0.24	*	*
<i>Solanum virginianum</i> L. (Solanaceae)	Beji baigana	H	Le	Med	0.03	0.03	*	*
<i>Soymida febrifuga</i> (Roxb.) A.Juss. (Meliaceae)	Rohini/Suama	T	Ro	Med	0.01	0.01	*	*
<i>Sphaeranthus indicus</i> L. (Asteraceae)	Gudur	H	Le	Foo	0.68	0.68	LC	Stab

<i>Spondias pinnata</i> (L.f.) Kurz (Anacardiaceae)	Ambada	T	Fr	Foo	0.5	0.5	*	*
<i>Streblus asper</i> Lour. (Moraceae)	Sahada	T	St	Per	0.37	0.37	LC	Stab
<i>Strychnos nux-vomica</i> L. (Loganiaceae)	Kochila	T	Se	Med	0.08	0.08	*	*
<i>Syzygium cumini</i> (L.) Skeels (Myrtaceae)	Jamu	T	Fr	Foo	1	1	LC	Stab
<i>Tamarindus indica</i> L. (Fabaceae)	Tentuli	T	Wo, Se, Fr	Fue, Foo	1	2.73	LC	Stab
<i>Tectona grandis</i> L.f. (Lamiaceae)	Shaguan	T	Wo	Hob, Agr	0.1	0.19	*	*
<i>Terminalia anogeissiana</i> Gere & Boatwr. (Combretaceae)	Dhaura	T	Wo	Fue	0.77	0.77	*	*
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight. & Arn. (Combretaceae)	Arjuna	T	Ba	Med	0.05	0.05	*	*
<i>Terminalia bellirica</i> (Gaertn.) Roxb. (Combretaceae)	Bahada	T	Fr	Med	0.59	0.59	LC	Decr
<i>Terminalia chebula</i> Retz. (Combretaceae)	Harida	T	Fr	Med	0.78	0.78	LC	Unkn
<i>Terminalia elliptica</i> Willd. (Combretaceae)	Sahaja/Asana	T	Wo	Fue	0.9	0.9	*	*
<i>Terminalia pendula</i> var. <i>pendula</i> (Combretaceae)	Phasi	T	Wo	Fue	0.34	0.34	*	*
<i>Thysanolaena latifolia</i> (Roxb. ex Hornem.) (Poaceae)	Phulajhadu	S	In	Hoe	1	1	*	*
<i>Tridax procumbens</i> L. (Asteraceae)	Bishalyakarani	H	Le	Med	0.92	0.92	*	*
<i>Vanda tessellata</i> (Roxb.) Hook. ex G.Don (Orchidaceae)	Malanga	H	Le	Med	0.02	0.02	LC	Decr
<i>Vitex negundo</i> L. (Lamiaceae)	Begunia	T	St	Per	0.68	0.68	LC	Stab
<i>Woodfordia fruticosa</i> (L.) Kurz (Lythraceae)	Dhatuki	S	Fl, Wo	Hoe, Fue	0.84	1.03	LC	Unsp
<i>Ziziphus mauritiana</i> Lam. (Rhamnaceae)	Barakoli	T	Fr	Foo	0.99	0.99	*	*
<i>Ziziphus oenopolia</i> (L.) Mill. (Rhamnaceae)	Kantei koli	S	St, Fr	Agr, Foo	0.97	1.19	*	*

(H- Herb, S- Shrub, T-Tree, C-Climber; Ba-Bark, Fl-Flower, Fr-Fruit, In-Inflorescence, Le-Leaf, Lb-Leafy branch, La-Latex, Ro-Root, Re-Resin, Rh-Rhizome, St-Stem, Se-Seed, Tu-Tuber, Wo-Wood; Agr-Agriculture, Foo-Food, Fod-Fodder, Fue-Fuelwood, Hob-House building, Hoe-Household essentials, Med-Medicine, Orn-Ornamental, Per-Personal hygiene, Rel-Religious; NE-Not Evaluated, NT-Near Threatened, LC-Least Concern, VU-Vulnerable, DD-Data Deficient; Decr-Decreasing, Stab- Stable, Unkn- Unknown, Unsp- Unspecified, * no results by IUCN)

Medicinal Plants

An ethnomedicinal study in Nayagarh district reported *Justicia adhatoda* and *Ocimum tenuiflorum* for cough and cold, *Elephantopus scaber* to treat dysentery, *Nyctanthes arborescens* for fever, *Helicteres isora* fruit to cure body pain in babies, *Paederia foetida* for joint pain and *Madhuca longifolia* for toothache (Halder *et al.* 2021) are similar to our findings. Use of *Azadirachta indica*, *Andrographis paniculata*, *Pongamia pinnata* and *Schleichera oleosa* for skin diseases by the tribal people of Kuchinda in Sambalpur district, western Odisha has been reported (Nath & Behera 2018). Ethnomedicinal study among tribals of Kuldiha Wild Life Sanctuary documented 81 medicinal plant species, where *Azadirachta indica* and *Andrographis paniculata* are reported to cure skin diseases (Mohapatra & Satapathy 2021). Another study in Kuldiha wildlife sanctuary has recorded 111 medicinal plant species, where use of oil of *Schleichera oleosa* seeds and bark of *Cassia fistula* in skin diseases, *Alangium salvifolium* and *Holarrhena pubescens* in wounds, leaf of *Calotropis gigantea* in joint pain, and leaf of *Aegle marmelos* in gastro-intestinal problems have been cited (Saravanan & Sujana 2025) that supported current study. Previous reports on usefulness of *Saraca asoca* in gynecological ailments (Sahu *et al.* 2010, Panda *et al.* 2018), oil of *Ricinus communis* for relieving muscle pain (Rout *et al.* 2013), leaves of *Abutilon indicum* and *Tradax procumbens* to cure cuts and wounds (Mishra *et al.* 2016), *Andrographis paniculata* in skin diseases, *Cassia fistula* bark for wounds healing, *Terminalia chebula* in cough, *Cissampelos pareira* leaves in inflammation and *Phyllanthus fraternus* in jaundice (Sahu *et al.* 2010) corroborate present findings.

The highest use of leaves as the medicinal plant part in our study is support by similar findings from Gandhamardan mountain ranges (Pandey *et al.* 2024) and Kuldiha wildlife sanctuary (Saravanan & Sujana 2025). The presence of phytochemicals as bioactive secondary metabolites alkaloids, terpenoids, phenolics, flavonoids, tannins and essential oils in leaves make them suitable for medicinal use (Sharma *et al.* 2017, Kumar *et al.* 2021). Laboratory wound healing experiments showed effectiveness of *Achyranthes aspera* (Edwin *et al.* 2008) and *Alangium salvifolium* (Inayathulla 2010), justify our findings. Wound healing cream formulated with *Kalanchoe pinnata* leaf extract tested in rat excision model confirmed that flavonoid major play role in wound healing (Coutinho *et al.* 2021). Ethno-medicinal knowledge of tribal communities is important for identification and isolation of potential bioactive compounds. Integration of traditional knowledge with modern science along with conservation medicinal plants are crucial for innovation in drug discovery and sustainable development (Bhoi & Ahirwar 2025a). Quantitative ethnomedicinal information highlights the most used effective plants based on their high usage. Such plants can be recommended for further research and development of alternative drugs (Laldingiani *et al.* 2022). As wild herbaceous plants are mostly used as medicine, sensitization for sustainable harvest, avoiding complete uprooting of plants, and leaving propagules for next season are essential to conserve medicinal plants for future generations (Awoke *et al.* 2024).

Timber yielding plants

Timber yielding plants *Dalbergia paniculata*, *D. sissoo*, *Gmelina arborea*, *Mitragyna parvifolia*, *Protium serratum*, *Pterocarpus*, *Shorea robusta* and *Tectona grandis* are used for house building purpose. High UV and RFC of timber yielding plants indicate chances for population depletion, as timber extraction causes large scale deforestation. Study in Thailand reported forest loss in protected areas is mainly associated to their accessibility, human population depending on forest for livelihood, and difficulties to enforce laws for illegal logging (Liu *et al.* 2022). Therefore, forest dweller must be made aware about the protection of timber yielding plants and must be provided with alternative to timber (Saravanan & Sujana 2025).

Food, fodder and fuel wood from plants

The present study has recorded highest relative frequency citation (RFC) for plant parts used as food. In wildlife sanctuary, collection of wild edibles from forest area is a common practice of forest dwellers. The finding of the present study showed similar results with a previous study on Nayagarh district, as greater percentage of wild edible fruits of trees and are the highly used plant parts followed by leaves. A study in various tribal dominated districts of Odisha has documented 193 wild edible food plants, where fruits are highly used part followed by leaves and tuber (Mallick *et al.* 2020). *Phyllanthus emblica*, *Ficus racemosa*, *Diospyros melanoxylon*, *Semecarpus anacardium*, *Syzygium cumini*, *Phoenix sylvestris* and *Ziziphus oenoplia* are common wild fruits of Eastern India, corroborated with our study. Wild edibles are very good alternative for qualitative nutrient at low cost and can contribute to food security through proper management (Asfaw *et al.* 2023). The edible fruit bearing plants are naturally growing in their self-maintained ecosystem and most of them are trees (Bajgai *et al.* 2023). Wild fruits contain antioxidants, anticancer, antimicrobial, anti-inflammatory and several bioactive compounds. So, wild fruits have higher potential to develop pharmaceuticals and food products to prevent or treat chronic diseases (Li *et al.* 2016). Besides wild fruits, leafy vegetable from herbaceous plants are reported high use value. Leaves are the edible part of the leafy vegetables, whereas their roots are used as medicine (Bhoi & Ahirwar 2025a). Selling of wild edibles as non-timber forest product (NTFP) can improve economic status and livelihood of local communities (Saravanan *et al.* 2020, Priyadarshini

et al. 2024). Despite their importance as source of food, wild edible plants are threatened by firewood collection and deforestation. It is imperative to safeguard both wild edible plants and traditional knowledge for broader aspects of food security (Gebre *et al.* 2025). Cultivation of highly used wild edible plants can improve socioeconomic status of local communities by diversifying their food resources (Leisembi *et al.* 2024). Cultivation of wild edibles in agroforestry is suggested to conserve the edible species (Mallick *et al.* 2020).

Dry twigs and branches of trees and shrubs are usually preferred as fuel wood by the tribals of BWS. Interestingly, the invasive species *Lantana camara* is used as fuel wood. The locals must be made aware about the invasive species in the sanctuary and the threat to native flora. BWS management authorities must have watch on fuelwood collection to reduce the risk of cutting down of trees and deforestation. Grasses are generally provided as fodder for grazing domestic animals during pre and post monsoon. However, study Kuldiha wild life sanctuary reported the use of leaves *Dalbergia lanceolaria*, *Ficus benghalensis* and *Madhuca longifolia* as fodder (Saravanan & Sujana 2025).

Household essential

Household essential is the 4th ranked use category as evident from current study. Leaves of *Shorea robusta* and *Phanera vahlii* are used to make biodegradable use and throw plates and bowls, popularly used during feasts in social and religious gatherings. It is an eco-friendly practice that reduce the use of non-biodegradable single use plastic cutleries, which should be adopted by others main stream community. The tribal communities of Odisha and other states of India use leaves of *Phoenix acaulis* and *Sida acuta* in making of traditional broom. *Sida acuta* brooms acts as the revenue generating product of Garo hill tribes in Meghalaya, as each broom costs Rs. 15 -25/- in the local markets (Mohanty *et al.* 2011, Shil & Shaw 2025). Brooms made of *Phoenix sylvestris* are very common in India, especially in the states such as Madhya Pradesh, Uttar Pradesh, Rajasthan and Chhattisgarh. A study in Madhya Pradesh has reported that five brooms are made from the leaves of a single mature tree in a year, and the market price of each broom is Rs. 10-15/ (Chavan *et al.* 2017). In the present study fibrous bark of *Phanera vahlii* and leaf of *Eulaliopsis binata* are used in rope making. A study conducted at Mayurbhanj, Keonjhar, Koraput, Deogarh, Sundargarh, and Rayagada district of Odisha has mentioned these two species as the potential fiber yielding plants (Sahu *et al.* 2013). *E. binata* grass is used in rope making which is further employed in the crafting of traditional cot, sofa, chair, mat etc., whereas *P. vahlii* bark is utilized to fabricate ropes. Tribal communities earn good income by selling ropes and crafts of *E. binata* (Saravanan & Sujana 2025).

Ornamental and personal hygiene

In BWS the beautiful flowers of *Barleria cristata*, *B. prionitis*, *B. strigosa* were popularly used for ornamental purpose which bloom during rainy season. *Barleria* sp. grows as wild plants in many tropical and subtropical countries. However, in India these are grown as commercial plants because their flowers are used in making of garlands, hair accessory for women (Gajra) and loose flowers are used in some ceremonial offerings. It is a high profitable crop for commercial production due to its low maintenance and heavy demand in floriculture (Naik *et al.* 2024, Gowtham *et al.* 2026). The bright flowers of *Butea superba* and *Clerodendrum infortunatum* were collected by local people for decoration in traditional functions. These flowers can be commercialized for organic dye and pharmaceutical use of their phytochemicals (Mizuki *et al.* 2014, Atef *et al.* 2026). The present study has documented 10 plant species used as toothbrush by the local communities of BWS. Studies showed indigenous communities of Assam (Hazarika *et al.* 2018) and Odisha (Mohanty *et al.* 2012) commonly use young woody stems of *Azadirachta indica*, *Lantana camara*, *Mangifera indica*, *Pongamia pinnata*, *Smilax zeylanica*, *Shorea robusta*, *Streblus asper*, and *Vitex negundo* for brushing tooth and oral care, corroborate our findings. Reports on use of *Cipadessa baccifera* by Paraja and the Gadaba tribes in Koraput district (Nayak *et al.* 2023) and use of *Flemingia chapper* by tribals from Sundargarh, Mayurbhanj, Angul and Bolangir district (Singh *et al.* 2013) of Odisha, India as tooth brush are also available. Oil extracted from the seeds of *Ricinus communis* and *Madhuca longifolia* are multipurpose oil. It scored highest rank because of its wider application in joint pain, rituals, bone fracture and as fuel (Behera *et al.* 2025).

Plants with religious and cultural significance

Indian culture is deeply associated with plants used in several rituals. Finding of the present study is similar with previous report workers that mentioned the use of leaves of *Aegle marmelos*, *Mangifera indica*, *Ficus benghalensis*, *Ficus religiosa* and flowers of *Butea monosperma* used as offering to several deities (Abraham 2015). A study in Malkangiri district of Odisha documented the use of *Diospyros melanoxylon*, *Madhuca longifolia* and *Shorea robusta* to attract good vibes on the marriage ceremony of tribal people. Leaves of *Agel marmelos* and *Mangifera indica* are sourced for decoration of the whole house during the festive occasions (Bala *et al.* 2020). Resin (Jhuna) of *Shorea robusta* employed as incense during socio-religious activities (Saravanan & Sujana 2025).

Multipurpose plant species

The study reported 21 multipurpose plant species in BWS, majority of which are tree species. Multipurpose species showed high UV and mostly used as food and medicine. Greater number of tree species are exploited for fuelwood, house building and household essentials. Among multipurpose species *A. marmelos* and *P. marsupium* are showing near threatened (NT) in IUCN category with decreasing values in IUCN-global population trend (GPT). *Madhuca longifolia* and *Shorea robusta* are most popular useful plants among local communities as evident from high RFC and UV. Exploitation of the selected and highly valued species is termed as 'opportunistic exploitation' and such exploitation can lead to population decline (Turner *et al.* 2021). Multipurpose woody species reported to face overexploitation due to their higher rate of local use (Kisangau *et al.* 2021). Therefore, assessment of population status these plants in BWS is required to plan their sustainable use and conservation.

Potential plants for commercialization of non-timber forest products (NTFP)

Based on high use value (UV>2) and high relative frequency citation (RFC=1) are *Shorea robusta*, *Madhuca longifolia*, *Tamarindus indica*, *Diospyros melanoxylon* and *Semecarpus anacardium* are considered as popular plants for their use. *Shorea robusta* (Sal) is a keystone species in deciduous forests of India. It has a blend of cultural, health and economic importances in tribal livelihood of Odisha (Mishra *et al.* 2025). Sal forest in India is gradually thinning due to high use and slow regeneration. Hence, establishment of Sal-based non-timber forest product (NTFP) cottage industries can support livelihood of forest dwellers (Thombare *et al.* 2024). A study has highlighted the importance of *S. robusta* seed oil as an alternative to edible oil suitable to use in food industry. Commercialization of Sal oil can uplift rural economy by the proper use of their seeds (Thapa *et al.* 2015). *Madhuca longifolia* (Mahula) is a boon in the tribal culture and economy because of its several useful plant parts. Flower of *M. longifolia* is used for traditional liquor 'Mahuli' production, very popular among the tribals of Odisha. The sweet fragrant flowers bloom at night and fall from tree are collected in the morning, dried and sold in the market. There is scope for value-added product development by fermentation such as wine, brandy, acetone, lactic acid, citric acid etc. from the flower. The non-fermented products like jam, jelly, cakes, sweet etc. can also be produced using mahua flower (Mishra & Poonia 2014). Oil extracted from seeds of *M. indica* is edible and tribals used it as cooking oil. It is widely used for skin and hair care by tribal women. It has industrial use for manufacturing soap, beauty products and as fuel. The left-over oil cake obtained after oil extraction has economic value as organic fertilizer. It is imperative to popularize the usefulness of *M. indica* plant to modern society and conservation of the species for food and economy (Kumar *et al.* 2017).

Tamarindus indica (Tamarind) is one of the commonly available multipurpose plants of India. Commercial cultivation of *T. indica* is done in Tamil Nadu, Madhya Pradesh, Karnataka, Andhra Pradesh and Maharashtra. It is a valuable plant species of commercial use and rural livelihood, due to their edible pod like fruit with sweet and tangy pulp used for cooking, beverages and traditional medicine (Chitra *et al.* 2024). Besides, nutritional value of *T. indica* seed kernel is equivalent to other leguminous pulses. It is also exploited as binding agent in food industry (Hemalatha & Parameshwari 2021). Thus, market base should be developed to facilitates optimal market value *T. indica*. *Diospyros melanoxylon* (Kendu) is endemic to India and one of economically valuable plant because of its edible fruit, medicinal bark, and leaves. The kendu leaves are used as raw material for 'Bidi' making and is regarded as economic lifeline of tribals (Sagar *et al.* 2021). Besides their traditional use, the leaves can be used to maximize their economic benefits through alternate methods like using in biodegradable packaging and making some artisan crafts (Tamrakar & Dixit 2025). The ethnomedicinal value of *Diospyros melanoxylon* in Gandhamardan hill of Odisha shows the RFC 0.03 and UV 0.12 (Pandey *et al.* 2024), whereas in the present study it has RFC 1 and UV 2.42, which is much higher due to its multiple useful parts. *Semecarpus anacardium* is one of the important medicinal plants, where the nuts possess phytochemicals that have potential to fight against several diseases. In ancient time these are used in marking of cloth and hair dye (Jain & Sharma 2013). *S. anacardium* has higher ethnobotanical significance due to its therapeutic value and edible fruits, still there is decline in plant population due to over harvesting (Vijay *et al.* 2014). Thus, sustainable harvest and suitable market base should be developed for commercialization of NTFP.

Under-utilized plants potential for agri-business

The present study recognized *Phyllanthus emblica*, *Ricinus communis*, *Syzygium cumini* and *Thysanolaena latifolia* with high RFC and UV as potential plant for tribal livelihood through cultivation and agri-business. *Ricinus communis* (Castor) plant is easy to grow, tolerant to all kind of soil and can yield oil of 350-900kg/ha. In African countries, farmers are sensitized to adopt castor cultivation as an agri-business for the upliftment of their economy (Salihi *et al.* 2014). Rajasthan, Andhra Pradesh, and Gujarat are the top states in terms of castor production in India. In Salem district of Tamil Nadu, the suitable environment for castor cultivation and availability resulted returns Rs. 31725 to 43105/ ha. (Senthilkumar *et al.* 2019). *Phyllanthus emblica* and *Syzygium cumini* are the potential species due to pharmacological significance of their fruits. *P.*

emblica fruits possess various secondary metabolites such as flavonoids, tannins and ascorbic acid. *Syzygium cumini* fruits are rich in phenolics, flavonoids, anthocyanins, carotenoids, tanins etc. imparting antimicrobial and antioxidant properties. Seeds of *S. cumini* contain alkaloids, glycosides, phenols, flavonoids etc. (Qamar *et al.* 2022). In Ayurveda these are highly used for the management of diabetes, cardiac wellness and many other health issues (Prananda *et al.* 2023, Ramakrishna & Suzaine 2024). Due to increased demands and commercial use, it is essential to cultivate *P. emblica* varieties which can give higher yields in a short time period (Khedikar & Chaudhari 2024).

The tall grass *Thysanolaena latifolia* was recorded to have a single use for making soft broom from panicle bloom. In North East India, *T. latifolia* is cultivated in the degraded land following 'Jhum' a traditional cultivation method. The hilly slop and degraded mountains are suitable for the plant growth and contribute income generation. It has been considered to be the best choice to transform waste and degraded lands into commercial farms of *T. latifolia* (Bora *et al.* 2023). A study in Nagaland, India has reported that cultivation of 1500 plants/acre can give an income of Rs.74124/ in a year (Jamir & Yanyak 2022). The *T. latifolia* broom is an emerging argo-product gradually transforming the rural economy and can be a means of livelihood for forest dwellers.

The study indicated *Asparagus racemosus* (UV 0.05, RFC 0.05) and *Eulaliopsis binata* (UV 0.63, RFC 0.63) growing in wild as the underutilized plant species of BWS. *A. racemosus* is one of the important medicinal plants used in therapeutic products and healthy tonics. The root extract has properties of antioxidant, antistress, antitumor, rejuvenator etc. (Rafiq *et al.* 2023). The cultivation of the medicinal plant *A. racemosus* can ensure very good return (Saran *et al.* 2020). Another under-utilised species is *Eulaliopsis binata* (Sabai grass). It is resilient to adverse climatic conditions and infertile soil. The roots prevent soil erosion and leaves are potential for production of high-quality paper and fibre. *E. binata* is a suitable material in handicraft industry for making doormats, flower vases, tray, bags, table mats, brooms and screens etc. (Sahu & Das, 2024). Cultivation of *E. binata* and its commercialization is potential for creating self-employment in rural areas (Adhikari *et al.* 2025). A study conducted in an artisan village Guhaldihi of Mayurbhanj district, Odisha, India reported Sabai producer women group turned entrepreneurs. The women group enhanced their income, which improved their food security and well-being. The group entrepreneurship is helpful in making quality handicraft products and avail government support through SHG (Self-Help Group), which leads them to live a satisfied prosperous life (Mohapatra & Saha 2021). Similar initiative can be taken for the women inhabitant of BWS for alternate livelihood.

Conclusions

Tribal communities of BWS are well aware about the use of plant resources available around and highly depend on wild plants for their livelihood maintenance. The multipurpose species *Shorea robusta*, *Madhuca longifolia*, *Phoenix sylvestris*, *Mangifera indica*, *Semecarpus anacardium*, *Diospyros melanoxylon*, *Aegle marmelos*, *Phoenix acaulis*, *Ziziphus oenoplia* and *Phanera vahlii* have high chances of over exploitation. Thus, awareness must be created among the local communities for sustainable harvest of the useful plant parts. Further, alternative livelihood opportunities may be developed by cultivation under-utilized species *Phyllanthus emblica*, *Ricinus communis*, *Syzygium cumini*, *Thysanolaena latifolia*, *Asparagus racemosus* and *Eulaliopsis binata*, along with commercialization of their valuable parts through agri-business. Such approaches can certainly improve livelihood opportunities of forest dwellers along with sustainable management of BWS flora. Future study should be focused on population status of useful plant species to ensure their effective utilization and conservation, as well as preservation of traditional culture and heritage of local tribal communities.

Declarations

List of abbreviations: BWS- Baisipalli Wildlife Sanctuary, UV-Use value, RFC-Relative frequency citation, PPV-Plant part value, UVk-Category use value, GPT-Global population trend, IUCN-International union for conservation of nature

Ethics approval and consent to participate: The participation of informants was subject to the acceptance of the Free and Informed Consent Form. Photographs of the informants were captured with their due consent.

Consent for publication: Not applicable

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