Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; SP6: 482-488

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International Web-Conference
On
New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development
(21-22 June, 2020)

Traditionally used wild edible plants of Kuldiha wildlife sanctuary (KWLS), Odisha, India

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Abstract
India being a diverse country with varied ethnic groups and phytogeography the preference of wild edibles their occurrence also varied greatly in different regions. One of the major problems of today's world is food security. Therefore focus on wild edible plants would definitely be an important breakthrough at the same time it would also promote the economic upliftment of the tribal society. There has been no record of wild edible plants of KWLS. Study of wild edible uses of plants can further be explored in detail for sustainable utilization and development of alternate food source. A total of 85 plant species have been documented belonging to 42 families with edible values. In the present study, the UV ranged between 0.42 and 1.33. Out of 85 wild edibles studies 65 species showed Rfc value above 0.5 indicating the wide acceptance of plants as wild edibles. *Adenanthera pavonina* and *Glinus oppositifolius* as wild edible showed the lowest Rfc value indicating its low credibility as wild edible, whereas *Solena amplexicaulis*, *Passiflora edulis*, *Cordia dichotoma* and *Briedelia retusa* were highly sought after as food source. Keeping the idea of food security in mind these plants should be furthered be studied as low cost nutrients alternatives. Proper awareness and promotion is required for introduction of these vegetables in markets which would improve the livelihood of the locals.

Keywords: Kuldiha Wildlife Sanctuary (KWLS); wild edibles; Use Value; Relative frequency of citation (Rfc)

Introduction
Wild edible plants are those that are not domesticated or cultivated as food source but are wildly occurring as a part of the natural vegetation. India being a diverse country with varied ethnic groups and phytogeography the preference of wild edibles their occurrence also varied greatly in different regions. The study of ethnic uses of plants by aboriginal people is of immense importance in enhancing our knowledge about the plants and their varied usages as well as the different means of conservation of that plant to maintain diversity. Present day research emphasizes greatly on the traditional knowledge as it provides information on the alternative resources of food as well as medicine. One of the major problems of today's world is food security. Therefore focus on wild edible plants would definitely be an important breakthrough at the same time it would also promote the economic upliftment of the tribal society. The Garo and Khasi communities cultivate *Amaranthus polygamous* and *Fagopyrum esculentum*. Nutritional analysis of these pseudocereals confirmed their richness in protein with the essential amino acid 'lysine' which is usually deficient in most cereals and millets [1].
There are very stray records on ethnobotany of Kuldiha Wildlife Sanctuary. Though some ethnobotanical studies were done in Odisha earlier, but the medicinal plants available in this remote area have not been explored thoroughly. No previous records on ethnobotanical knowledge from within the study area are available. Inspite of a thick tribal population in the KWLS there has been a lacuna in documenting the traditional uses of plants therein. A single study was made by Pattanaik & Reddy (2008) [2] investigating plant materials used for medicinal purposes within communities located in the study area and documented 49 plant species used ethnomedicinally [2]. Much later Saravanan *et al.*, published the ethnomedicinally important plants of KWLS particularly used for gastrointestinal disorders and joint pains respectively [3, 4]. There has been no record of wild edible plants of KWLS.

Study of wild edible uses of plants can further be explored in detail for sustainable utilization and development of alternate food source. The present study was therefore undertaken to identify and form an inventory of traditional knowledge available regarding wild edible plants and to evaluate the use values of these plants that would help in the development of strategies for conservation of forests.

Material and Methods

Study site:

Kuldiha Wildlife Sanctuary (KWLS) designated on 04 January 1984; is situated in the southern part of the district of Balasore of Odisha State, lies between 21º 20' 31" to 21º 29' 08" N latitude and 86º 25' 23" to 86º 44' 50"E longitude (Plate 1). The sanctuary spreads across an area of 272.75 sq kms. The forests of the region cover the Nato hills and the Sukhupata hills merging with the Similipal National Park. It lies close to Nilagiri forest towards north and Mayurbhanj forest in northwest. Through Gadasahi forests on the south west, Kuldiha have a disjointed link with Baula RF. The vegetation of the sanctuary is mostly tropical moist deciduous type being dominated by Sal mixed dry deciduous forests. KWLS is a house of single village with 7 – 8 hamlets, 1018 population.

Survey and documentation:

Extensive surveys were done carried out during the period 2014 - 2017 and documented the ethnobotanical uses of the plants of the area by the local communities. Collected plant specimens were identified with the help of published regional Floras [5, 6]. Voucher specimens of the collected medicinal plants with accession number have been deposited in the herbarium of the Central Botanical Laboratory, Botanical Survey of India, Howrah.

Data Collection:

Collected plants were brought to their settlements in front of a group of elder medical practitioners. Semi-structured interviews were conducted with individuals and groups, such as herbal practitioners and the elderly persons, known to possess knowledge about medicinal plants [7]. The interviews were a relatively open framework that allowed and encouraged focused, conservational, two-way communication about medicinal plants and medicinal plant use among those being interviewed. All interviews were performed in the local Oriya language. Leading questions, technical terms and jargons were avoided when asking the questions. The gathered information was cross-checked with other informants. Information on the local names of the plants, and their uses as foods, etc. were documented. Other uses of the plants were similarly recorded.

Statistical Analysis

To compare the uses and cultural importance of different plant species, standard quantitative ethnobotanical techniques were applied [8, 9]. The local importance of each species was measured by a use-value (UV). This technique measures how many uses (medicinal or others) for a given species an informant knows relative to the average knowledge among all informants [8, 10]. A high use-value indicates a relatively important species.

$$UV = \frac{\Sigma \text{ Number of uses mentioned by each informant for a given species}}{\text{Total number of informants}}$$

The relative frequency of citation (Rfc) for each use, is the ratio of the frequency of citation by informants to the total no. of informants study [11]. Frequency of citation is the number of informants mentioning the particular use of that species. The high agreement for a particular use indicates its genuineness for that cultural group. Rfc values range from 0 to 1

$$Rfc = \frac{\text{Frequency of citation}}{\text{Total number of informants interviewed}}$$

Results and Discussion

The present study shows that the tribal people of Kuldiha wildlife sanctuary (Plate 1) have substantial knowledge regarding the wild edible plants. A total of 85 plant (Plate 2 & 3) species have been documented belonging to 42 families with edible values (Table 1) of which 14% (12) constitutes herbs, 13% (11) climbers, 21 % (18) shrubs and 52% (44) trees (Fig 1). The preference of using trees over other life forms may be attributed to the relative abundace of trees naturally occurring in the area [12].

Use value helps to identify the relative importance of the species to the local community. In the present study, the UV (Table 1) ranged between 0.42 and 1.33. Based on UV data, 35 plants were identified that had UV ranging between 1 and 1.33. These species were used for diverse purposes, as medicine, food, fodder or as fuel and timber. These findings indicate the extensive use of above mentioned species in the treatment of various ailments by local inhabitants/healers. The least used species is *Polyalthia cerasoides*, with the lowest UV and is solely used as wild edible. The results from this study correlates with previous work of Singh *et al*. from Nepal [13].

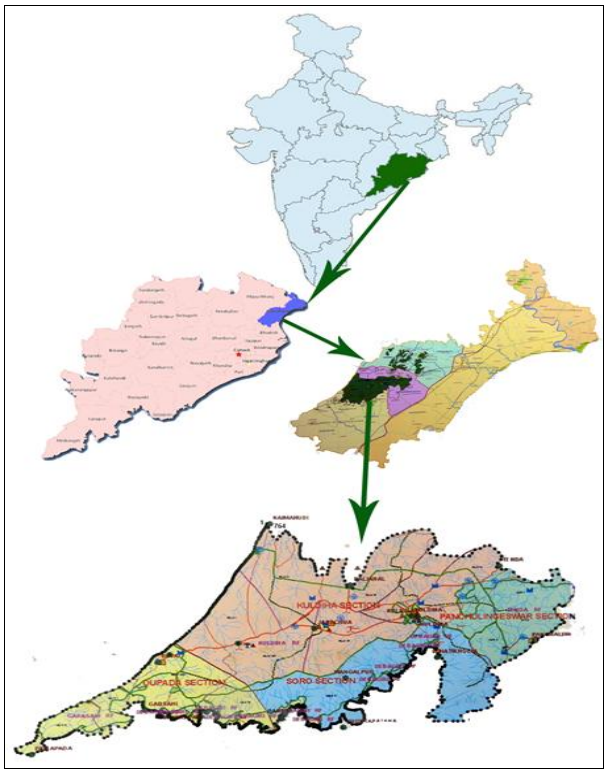

Plate 1: Study Area kuldiha wildlife sanctuary

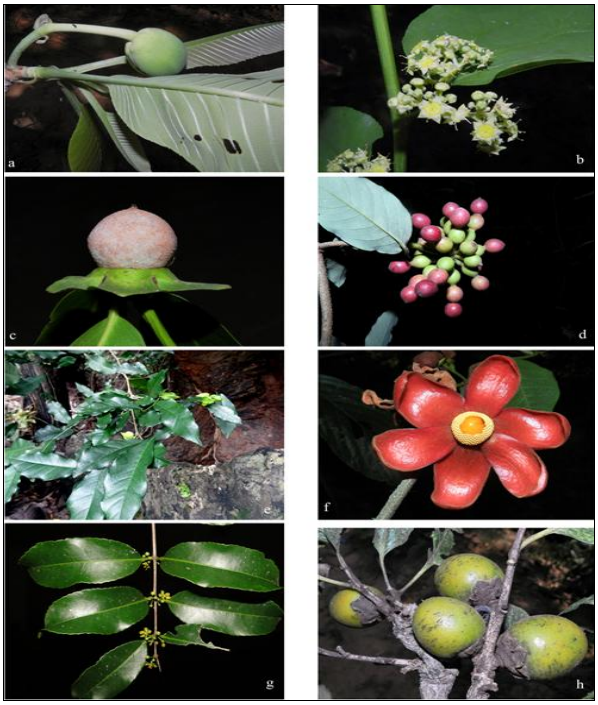

Plate 2: Wild edible plants of KWLS a: Dillenia aurea Sm.; b: Ziziphus funiculosa Buch.-Ham. ex Wall; c: Diospyros malabarica (Desr.) Kostel.; d: Desmos chinensis Lour.; e: Streblus taxoides (Roth) Kurz; f Uvaria hamiltonii Hook!. & Thomson; g: Salacia chinensis L.; h: Diospyros melanoxylon Roxb

Plate 3: Wild edible plants of KWLS a: Gardenia gummifera L. f.; b: Canthium coromandeliann (Burm. 1) Alston; c: Bidens pilosa L.; d: Ardisia solanacea (Poir.) Roxb.; e: Antidestna ghaesembilla Gaertn.; f: Aporosa octandra (Buch.-Ham. ex D. Don) Vickery; g: Dioscorea bulbffera L.; h: Amorphophallus naeonufolius (Dennst.) Nicolson: is Zizinhus nennnlia (LA Mill.

The plant parts used were fruits, leaves and shoots, tuber, flowers, seeds gums and calyx (Fig 2). Some of the plant species have been reported as edible by different workers from various parts of the country [14, 15, 16]. Out of 85 wild edibles studies 65 species showed Rfc value above 0.5 indicating the wide acceptance of plants as wild edibles. *Adenanthera pavonina* and *Glinus oppositifolius* as wild edible showed the lowest Rfc value indicating its low credibility as wild edible, whereas *Solena amplexicaulis, Passiflora edulis, Cordia dichotoma* and *Briedelia retusa* were highly sought after as food source. The total no. of wild edibles reported in this study is higher than that reported by Kumar *et al.* who reported the use of 21 species from locals of Balasore, Bhadrak, Jajpur, Keonjhar and Cuttack districts of

Odisha but comparable to that obtained in a survey of Kendrapara district reporting 86 plants [17, 18]. 137 species of wild edibles was reported from Dhenkanal district [19] and Sinha & Lakra reported 50 leaves, 46 fruits, 14 tubers to be the part of tribal diet in parts of Keonjhar, Mayurbhanj and Dhenkanal districts [20]. These reports are higher than that reported in our study. Local tradition and customs of using plants could be the possible reason of the variation of usage difference of plants. It is worthy of mention that about 18 plants out the reported wild edibles have been used for its medicinal value which again indicates proper conservation needs of these plants. *Leucas ciliata, Monochoria vaginalis, Alternanthera sessilis and Flemingia macrophylla* are consumed as medicine. This overlap indicates the close relationship between health and food. Overlapping between foods and medicines is quite well known in traditional societies [21]. Recent studies revealed that wild edible are much rich in nutritive potential and calorific value as compared to the cultivated crops that accumulate high chemical inputs such as fertilizers, plant growth regulator, herbicides, etc., and hence has lost their natural taste, and nutritive values on the contrary it has also led to onset of several diseases in mankind [22]. It is to be noted that the use of these wild edibles are now practiced rarely and are gradually being lost. For wild edible fruits it is still being used by children. Keeping the idea of food security in mind these plants should be furthered be studied as low cost nutrients alternatives. Proper awareness and promotion is required for introduction of these vegetables in markets which would improve the livelihood of the locals. Among them 1 species (*Flacourtia indica*) is endemic, 2 species (*Uvaria hamiltonii* and *Garcinia cowa*) are rare. The ethnobotanical use of rare endangered plants would result in large scale extraction and hence conservation of these species becomes essential. The local population using these plants were very conscious in their mode of extraction of these plants. They specifically spread the seed in deep jungles from their last harvest which is almost a part of the ritual. Similarly while extracting tubers they voluntarily maintain a ratio of extraction and un-extracted plants. The age of the plants are also considered while using, locals prefer old plants over young as source of food especially in case of tubers and seeds.

Table 1: Plants used as wild edible sources in KWLS

Sl. No.	Name of the plant (Family)	Uses	Rfc	UseValue
1	*Adenanthera pavonina* L. (Leguminosae) Manda Kaincha	Seed kernels are eaten occasionally.	0.33	0.58
2	*Aegle marmelos* (L.) Correa (Rutaceae) Belo	Ripen fruits are eaten and made into sharbat (Belpana).	0.58	1.25
3	*Alangium salviifolium* (L. f.) Wang. (Cornaceae) Dhalaankol	Fruits are edible.	0.67	1.0
4	*Alternanthera sessilis* (L.) R. Br. ex. DC. (Amaranthaceae) Kolamsago	Leaves used as leafy vegetable	0.83	1.25
5	*Amorphophallus paeoniifolius* var. *paeoniifolius* Sivad. (Araceae) Goda garia	Tubers are edible.	0.50	1.0
6	*Anacardium occidentale* L. (Anacardiaceae) Lanka Amba	Roasted and raw kernels are eaten as a dessert, employed in confectionery and are highly nutritious	0.67	1.17
7	*Antidesma bunius* (L.) Spreng. Euphorbiaceae) Anepu	Ripen fruits are eaten. Leaves used as vegetables.	0.75	0.83
8	*Antidesma ghaesembilla* Gaertn. (Euphorbiaceae) Kath Marmuri	Ripen fruits are eaten.	0.50	0.83
9	*Aporosa octandra* (Buch.-Ham. ex D. Don) Vickery (Euphorbiaceae) Dumbojoda	Ripen fruits are eaten.	0.75	0.67
10	*Ardisia solanacea* Roxb. (Primulaceae) Hadokonkali	Flowers are edible.	0.83	0.75
11	*Atalantia monophylla* (L.) DC. (Rutaceae) Narangi	Fruits are edible, also used for making sharbat and pickles.	0.58	0.75
12	*Bauhinia vahlii* Wight & Arn. (Leguminosae) Sialpatra	Seeds are edible.	0.67	1.25
13	*Bidens pilosa* L. var. *minor* (Blume) Sherff (Asteraceae) Magha Latenga	Leaves used as vegetable.	0.83	0.58
14	*Boerhavia diffusa* L. (Nyctaginaceae) Kharkharia	Plant used as vegetable.	0.83	0.92
15	*Bombax ceiba* L. (Malvaceae) Semulo	Young capsules are also cooked for preparing curry.	0.83	1.17
16	*Briedelia retusa* (L.) A. Juss. (Euphorbiaceae) Kasi	Ripen fruits are eaten.	1.00	1.33
17	*Buchanania cochinchinensis* (Lour.) M.R.Almeida (Anacardiaceae) Char	Fruits are edible.	0.58	0.58
18	*Callicarpa tomentosa* (L.) L. (Lamiaceae) Badopatri	Leaves are used as vegetable.	0.67	0.67
19	*Canthium coromandelicum* (Burm. f.) Alston (Rubiaceae) Kantaphal	Fruit is edible.	0.67	1.0
20	*Capparis zeylanica* L. (Capparaceae) Asadua	Ripen fruits are eaten.	0.50	0.83
21	*Careya arborea* Roxb. (Lecythidaceae) Kumbhi	Fruits are edible.	0.42	0.75
22	*Carissa spinarum* L. (Apocynaceae)	Fruits are edible.	0.75	0.5
23	*Catunaregam spinosa* (Thunb.) Tirveng. (Rubiaceae) Kalai kanta	The ripe fruits are edible	0.67	1.17
24	*Chlorophytum arundinaceum* Baker (Asparagaceae) Jhinka	Leaves are used as vegetable.	0.83	0.67
25	*Cordia dichotoma* G.Forst. Saxena & Brahmam (Boraginaceae) Ambota	Ripen fruits are eaten.	1.00	0.83
26	*Cordia monoica* Roxb. (Boraginaceae) Ambota	Ripen fruits are eaten.	0.92	0.83
27	*Cyathula prostrata* (L.) Blume (Amaranthaceae)	The plant is used as a green vegetable.	0.50	0.5

28	*Dendrocalamus strictus* (Roxb.) Nees (Poaceae) Salia Banso	Young shoot is eaten.	0.75	1.17
29	*Desmos chinensis* Lour. (Annonaceae)	Ripen fruits are eaten.	0.75	0.67
30	*Dillenia aurea* Sm.(Dilleniaceae) Korkotta	Ripen fruits are eaten by tribal people.	0.67	1.08
31	*Dillenia pentagyna* Roxb. (Dilleniaceae) Kirmilla	The flower buds and young fruits are eaten raw or cooked and these are pleasantly acidic.	0.50	1.25
32	*Dioscorea alata* L. (Dioscoreaceae) Khambo-alu	Tubers are edible.	0.50	1.0
33	*Dioscorea bulbifera* L. (Dioscoreaceae) Pita-alu	Tubers are edible.	0.58	1.0
34	*Dioscorea hamiltonii* Hook.f. (Dioscoreaceae) Suta-alu	Tubers are edible.	0.67	1.0
35	*Dioscorea hispida* Dennst. (Dioscoreaceae) Bainya-alu	Tubers are edible.	0.75	1.0
36	*Dioscorea pentaphylla* L. (Dioscoreaceae) Pittalo Kanda	Tubers are edible.	0.67	1.0
37	*Dioscorea pubera* Blume (Dioscoreaceae) Dang-alu	Tubers are edible.	0.58	1.0
38	*Diospyros malabarica* (Desr.) Kostel. (Ebenaceae) Kola Kendu	Ripe fruits are edible by tribal communities	0.67	1.33
39	*Diospyros melanoxylon* Roxb. (Ebenaceae) Kendu	The ripen fruits are edible	0.50	1.33
40	*Erycibe paniculata* Roxb. (Convolvulaceae) Chain Katho	Ripen fruits are eaten.	0.83	0.58
41	*Ficus semicordata* Buch.-Ham.ex J.E.Sm. (Moraceae) Bhuidumri	Ripen fruits are edible.	0.67	1.0
42	*Flacourtia indica* (Burm. f.) Merr. (Salicaceae) *Endemic Kontaikuli	Fruits and flower buds are edible.	0.75	0.92
43	*Flacourtia montana* Graham (Salicaceae) Kontaikuli	Ripen fruits are eaten.	0.92	1.0
44	*Flemingia macrophylla* (Willd.) Prain ex Merr.(Leguminosae) Thlikur	Pods are eaten.	0.83	0.67
45	*Flueggea leucopyrus* Willd. (Euphorbiaceae) : Bhoji Bhaji	Ripen fruits are eaten.	0.42	0.83
46	*Flueggea virosa* (Roxb. Ex Willd.) Voigt. (Euphorbiaceae) Bhoji Bhaji	Ripe fruits are eaten by tribal people	0.50	0.75
47	*Garcinia cowa* Roxb.ex DC. (Clusiaceae) *Rare Rajkusuma	Ripen fruits are eaten.	0.42	0.92
48	*Gardenia gummifera* L. f. (Rubiaceae) Gurudu	Fruits are edible.	0.58	0.75
49	*Gardenia latifolia* Ait. (Rubiaceae) Dimaru	Fruits are eaten	0.50	1.0
50	*Glinus oppositifolius* (L.) Aug.DC. (Molluginaceae) Pitasag	Plant is used as leafy vegetable.	0.33	0.75
51	*Glycosmis pentaphylla* (Retz.) DC. (Rutaceae) Chauli	Fruits are edible	0.58	0.67
52	*Gmelina arborea* Roxb. ex Sm. (Lamiaceae) Bhodropornni	Fruits edible.	0.67	1.08
53	*Ixora pavetta* Andr. (Rubiaceae) Telkurma	Ripen fruits are eaten by tribal people.	0.83	0.67
54	*Lagerstroemia parviflora* Roxb. (Lythraceae) Sidha	Plants yield an edible gum.	0.50	0.75
55	*Leucas ciliata* Benth.ex Wall. (Lamiaceae)	Leaves are used as vegetable helping in reducing the diabetes.	0.67	0.75
56	*Limonia acidissima* L. (Rutaceae) Kaitho	Fruits are edible.	0.75	0.67
57	*Mangifera indica* L. (Anacardiaceae) Ambo	Ripe and unripe fruits are edible	0.50	1.33
58	*Manilkara zapota* (L.) P.Royen (Sapotaceae) Sapota	Fruits are edible.	0.75	0.67
59	*Melastoma malabathricum* L. (Melastomataceae) Korali	Calyx is edible.	0.83	0.5
60	*Memecylon ovatum* Roxb. (Melastomataceae) Bonohorono	Fruits are edible.	0.58	0.5
61	*Miliusa tomentosa* (Roxb.) Finet & Gagnep. (Annonaceae) Gandha palasa	Ripen fruits are tasty and eaten by tribal people.	0.67	0.75
62	*Miliusa velutina* (Dunal) Hook. f. & Thoms. (Annonaceae) Gandha Palasa	The fruit is eaten by local tribal people.	0.83	0.67
63	*Monochoria vaginalis* (Burm. f.) Presl (Pontederiaceae) Mirmira	Leaves consumed as vegetables.	0.83	0.58
64	*Olax scandens* Roxb. (Olacaceae)	Pulp of the fruits is edible.	0.83	1.0

	Badalia			
65	*Passiflora edulis* Sims in Curtis (Passifloraceae)	Fruits are edible.	1.00	0.67
66	*Phoenix sylvestris* (L.) Roxb. (Arecaceae) Khajuri	Fruits are eaten after ripening.	0.58	1.0
67	*Phyllanthus emblica* L. (Phyllanthaceae) Amla	Fruits are edible and used in preparation of pickles.	0.67	1.25
68	*Physalis minima* L. (Solanaceae) Tipai	Ripen fruits are eaten.	0.67	0.83
69	Pithecellobium dulce (Roxb.) Benth. (Leguminosae) Simakoina	Fruits are edible.	0.50	0.83
70	*Pogostemon benghalensis* (Burm. f.) O. Ktze. (Lamiaceae) Gonda Dulia	Plant is used as vegetable.	0.42	0.75
71	*Polyalthia cerasoides* (Roxb.) Bedd. (Annonaceae) Potmossu	Ripen fruits are eaten by local tribal people.	0.75	0.42
72	*Salacia chinensis* L. (Celastraceae) Batra	Fruits are edible.	0.67	0.75
73	*Schleichera oleosa* (Lour.) Oken (Sapindaceae) Kusum	Fruits are edible.	0.83	1.33
74	*Solena amplexicaulis* (Lam.) Gandhi in Saldanha& Nicolson (Cucurbitaceae) Ban Kundri	The young (unripe fruit) is used as vegetable.	1.00	0.83
75	*Streblus asper* Lour. (Moraceae) Sahada	Ripen fruits are edible.	0.92	0.83
76	*Streblus taxoides* (Heyne ex Roth) Kurz (Moraceae) Phutkuli	Leaves and fruits are edible.	0.50	0.67
77	*Suregada multiflora* (A. Juss.) Baill. (Euphorbiaceae) Ganari	Ripen fruits are eaten by tribal people	0.75	0.67
78	*Syzygium nervosum* A. Cunn. Ex DC. Saxena & Brahmam (Myrtaceae) Chota Jamun	Fruits are edible.	0.75	1.0
79	*Tamilnadia uliginosa* (Retz.) Tirveng. & Sastre (Rubiaceae) Telkur	The unripe fruits are boiled or roasted as a vegetable for curry.	0.67	0.83
80	*Uvaria hamiltonii* Hook.f & Thoms. (Annonaceae) *Rare Lakankuli	Ripen fruits are eaten.	0.50	0.67
81	*Zehneria maysorensis* (Wight &Arn.) Arn. (Cucurbitaceae)	Leaves and young fruits are used as vegetable.	0.50	0.58
82	*Ziziphus funiculosa* Buch.-Ham. ex Lawson (Rhamnaceae) Chunkoli	Fruits are edible.	0.58	1.0
83	*Ziziphus mauritiana* Lam. (Rhamnaceae) Koli	Fruits are edible. Ripen fruits are dried and then used for making chutney.	0.67	1.17
84	*Ziziphus nummularia* (Burm.f.) Wight & Arn. (Rhamnaceae) Jangulikoli	Fruits are edible.	0.75	1.0
85	*Ziziphus oenoplia* (L.) Mill. (Rhamnaceae) Koli	Fruits are edible.	0.67	1.0

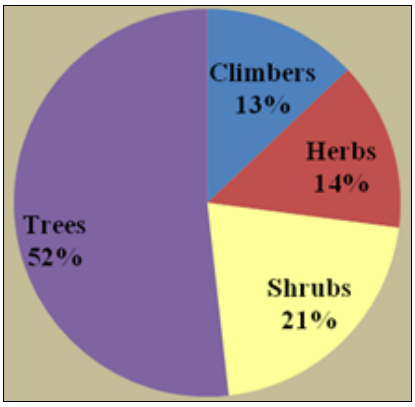

Fig 1: Habitat wise categorization of wild edible plants in KWLS

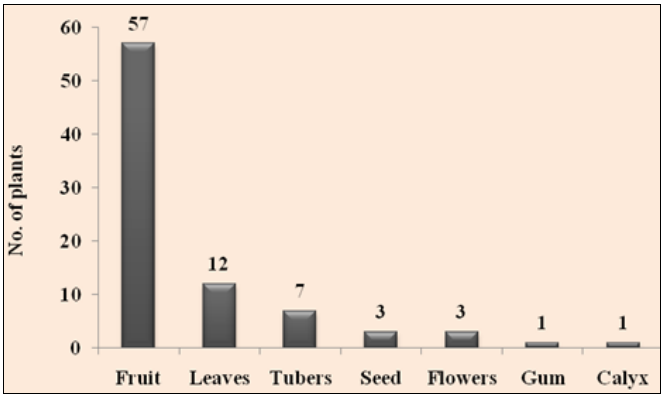

Fig 2: Plant parts used as wild edibles in KWLS

Conclusion

This research summarized ethnobotanical uses of plants distributed in KWLS. The present study provides an example of sustainable utilization of native plants for sustaining the traditional healthcare system based on ethnobotanical knowledge and needs scientific validation of available knowledge before its losses. There are several new ethnomedicinal claims identified which requires further phytochemical confirmation, so that new alternative plant based drugs can be prepared for these plants. The outcomes of the present study would be helpful in better understanding and appreciating the multiple values and potential of native plants and also to contribute narrowing the gap in the literature. This comprehensive information will help the local people, traditional healers, plant nursery owners, researchers, academicians, conservation professionals and restoration specialists to identify and use the appropriate native plant species for different developmental schemes.

Acknowledgement

We are grateful to The Director, Botanical Survey of India, Kolkata for all facilities. We are also thankful to PCCF (Wildlife), Odisha; DFO, Balasore Wildlife Division, Balasore and all other forest officials of Balasore Wildlife division for giving necessary entery permission and all other support during field works. We are duly acknowledge the help of Dr. Sujana K.A in the field survey and preparation of the manuscript. Thanks are also due to the local field mans and green watchers of Kuldiha Wildlife Sanctuary for their

excellent assistance in field. We are grateful to the tribal informers, medicine men who shared traditional knowledge and wisdom with us.

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