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Indigenous knowledge in utilization of wetland plants of Bhadrak district, Odisha, India

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The objective of the study was to determine the utilization of wetland plant resources for livelihood in Bhadrak district of Odisha, India. Information was gathered from 73 informants of various ages in different villages of the district by using participant observation, open-ended conversations and semi-structured questionnaires. A total of 42 wetland plant species, belonging to 36 genera and 27 families were found to have been used traditionally for edible purposes. The dominant families were Araceae, Nymphyaceae and Poaceae. The most frequently used plant species were *Amorphophallus paeoniifolius* Dennst. (Nicolson), *Colocasia esculenta* (L.) Schott., *Ipomoea aquatica* Forssk., *Marsilea minuta* L. and *Trapa natans* L. Proper documentation of traditional knowledge related to these plants and identification of potential species for prioritization of conservation through sustainable management is essential for socioeconomic development of the rural people.

Keywords: Bhadrak district, Edible plants, Odisha, Traditional knowledge, Wetland.

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Introduction

Wetlands, often described as kidney of the landscape[1], are interesting landscapes of the world covering nearly 6 % of its area[2] and deliver 45 % of the world's natural productivity and ecosystem services[3]. They are ecotones between the terrestrial and aquatic ecosystems where the water table is usually at or near the surface or the land is covered by shallow water[1]. Such lands include bog, fen, marsh, peatland, moor, swamps, river and stream banks, bottomland or mangrove forest areas that may be wet round the year or during certain periods of time[4]. Wetlands have played a dominant role in shaping the culture, socio-economic needs and civilisation of a particular place. Their importance to the global carbon cycle, water balance, as bioindicators for eutrophication processes, wildlife, biodiversity, human food and medicine production is much greater than their proportional surface area on earth[5,6]. Increase in world population, urbanization and overexploitation has depleted many natural resources and threatened the existence of many wetlands and water bodies globally[7]. Around 50 % of the earth's wetlands are estimated to already have disappeared worldwide over the last hundred years[8]. Many of them are now transformed into other land forms, such as paddy fields, human settlements and sites for developmental projects.

Wetlands in India, though cover less than 5 % of the total geographical area are identified as the richest and most fascinating biomes that support around 800 plant species consumed as food[9]. Different workers have reported some information on wild edible plants of terrestrial ecosystems in our country[10,11]. However, importance of edible plants has not received due attention in Odisha although sporadic reports are available[12,13]. There is little recognition of wetland landscapes for their current and potential value[14], even though for people living in and around wetlands, wild wetland plants play pivotal roles in their daily lives particularly in supplying dietary food items. In addition, wetlands also provide livelihood to a substantial section of society living around them like in Bhadrak district where wetlands occupy about 19017 ha which is about 2.8 % of the total wetland

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area of the state. Many wetlands including small and large rivers systems, creeks, natural and manmade canals and ponds are scattered in the district and local inhabitants have traditional knowledge about the uses of wetland edible plants. Thus the present study documented the local knowledge about edible wetland plant resources used by the folk people of Bhadrak district, Odisha, India that may help in developing sustainable use and minimise loss of native wetland biodiversity.

Materials and Methods

Study site

Bhadrak district (20° 43′–21° 13′ N and 86° 6′–87° E) is located in Northeast Odisha and covers an area of 2505 km^2 with a population of 1.507 million (2011 Census). It is bordered by Balasore district in the North, Jajpur in the South, Bay of Bengal and Kendrapara district in the East and Koenjher in the West. The district accounts for 1.61 % of the state's territory and shares 3.59 % of the state's population. About 86.66 % of the population lives in villages and agriculture is their main occupation. The district is located in the deltaic region near the Bay of Bengal and has all the features of a costal climate, i.e. maritime weather influence, coastal winds and cyclones.

Data collection

Base line information on the use of wetland edible plant were collected through literature survey and field visits to the seven blocks of the district namely Basudevpur, Bhadrak, Bhandaripokhari, Bonth, Chandbali, Dhamnagar and Tihidi from June 2012 to October 2014 in Bhadrak district. The field study was carried out monthly following established and standard procedures[15,16]. The information on the use of wetland plants as food was obtained through a combination of tools and techniques of structured questionnaires, complemented by free interviews and informal conversations[16,17]. Prior informed consent was obtained from the informants during the field survey. Elderly persons were considered key informants and the selection process was based on the knowledge base, experience and current practices in ethno-edible plant species. Personal interviews and group discussions carried out in the local language revealed specific information about the plants, which were further compared and authenticated by crosschecking[18]. Information about local names of plants, plant parts used and mode of preparation were obtained. The plants were classified as wild, semi-cultivated or cultivated. Semi-cultivated plants were those that some informants harvested wild while others tried to preserve them in their ponds. Seventy three (44 women and 29 men) persons were interviewed, of which 10 % were 21–40 years, 50 % were 41–60 years and 40 % were older than 60 years. The collected specimens were processed, dried and herbarium specimens were prepared. Voucher specimens of the collected plant species were deposited in the herbarium of the Department of Botany, Chandbali College, Chandbali. The literatures consulted during field visit for identification of species were Haines[19] and Saxena and Brahmam[20].

Results and Discussion

Traditional knowledge of plants has played pivotal role in people's lives historically and has the potential to continuously contribute much in the future for the sustainable development of societies and economies[21]. Traditional foods are those which indigenous peoples have access to locally, without having to purchase them and within traditional knowledge and the natural environment from farming or wild harvesting[22]. Wild food plants occupy an important place in the rural dietary habits and their consumption particularly during periods of food scarcity and famine is practiced in various regions of the world. Some studies have shown that these plants often provide better nutrition and may be responsible for good health[23,24]. In India, more than 3000 wild plant species are used as subsidiary food and vegetable by indigenous people and at least 250 plants can be developed as a new source of food[25]. The ethno-edible plants collected during the study are given in Table 1. A total of 42 plant species belonging to 36 genera and 27 families being used as food by the local people of Bhadrak district were collected and recorded. Plate 1a-u shows some of the plant species collected.

About 59.5 % of the documented plant species belonged to dicotyledons followed by monocotyledons (38.1 %) and Pteridophytes (2.4 %). Family Nymphyaceae was most frequently represented with a total of 4 species, followed by Araceae and Poaceae with 3 species each. Rests of the families were represented by one or two species each. The distribution of edible wetland species by plant family has also been found elsewhere in the world [26-28], for instance in Manipur state of India. In a previous study Jain *et al*[26] observed that Araceae, Cyperaceae

Table 1—Ethnoedible wetland plants of Bhadrak district

S. No.	Scientific name, Voucher* deposition date	Family name	Vernacular name (in Odia)	Parts used	Mode of use
1	*Alocasia macrorrhizos* (L.) G.Don., 16.05.2014	Araceae	*Sankhasaru*	Petiole, tuber	Petiole along with stalk is cut into pieces, boiled in water and consumed in curry. Tubers are boiled in water and consumed in either in curry or in mashed form.
2	*Alternanthera sessilis* (L.) R. Br., 22.02.2014	Amaranthaceae	*Madaranga*	Shoot, leaf	Tender shoots along with leaves are used as vegetable.
3.	*Amorphophallus paeoniifolius* (Dennst.)Nicolson, 15.07.2014	Araceae	*Olua*	Rhizome	Rhizome is cut into pieces, stir-fried in oil after eliminating their bitter taste by boiling them long time in water, and are eaten with other food.
4.	*Aponogeton natans* (L.) Engl. & K. Krause, 04.09.2013	Aponogetonaceae	*Jhechu*	Bulbil	The bulbils are eaten as raw and vegetable.
5.	*Aponogeton undulatus* Roxb., 15.09.2013	Aponogetonaceae	*Kesarkanda*	Bulbil	The bulbils are consumed as raw and also after cooking.
6.	*Bacopa monnieri* (L.) Pennell, 06.10.2013	Scrophulariaceae	*Brahmi*	Shoot	Tender shoots are fried in oil or cooked in water as vegetable.
7.	*Centella asiatica* (L.) Urb., 02.08.2014	Apiaceae	*Thalkudi*	Leaf, petiole	Young leaves and petiole are eaten fresh as vegetables.
8.	*Colocasia esculenta* (L.) Schott., 31.05.2014	Araceae	*Saru*	Leaf, tuber	Tender leaves along with stalk are cooked with other vegetables. Tubers cut into pieces are boiled in water and consumed in either in curry or in mashed form mostly during the month of *Kartik*.
9.	*Commelina benghalensis* L., 05.09.2014	Commelinaceae	*Kansiri*	Leaf, shoot	Tender leaves and shoots are eaten cooked as vegetable.
10.	*Corchorus capsularis* L., 06.08.2013	Tiliaceae	*Nalita*	Leaf	Young leaves are eaten fresh as vegetables.
11.	*Crinum asiaticum* L., 17.03.2013	Amaryllidaceae	*Arsa*	Rhizome	Bulb is eaten as vegetable.
12.	*Echinochloa crusgalli* (L.) P.Beauv., 08.11.2013	Poaceae	*Dhera*	Grain	Grains are consumed by the rural poor people during times of food scarcity.
13.	*Echinochloa stagnina* (Retz) P. Beauv., 25.06.2013	Poaceae	*Jhipa*	Grain	Grains are consumed by the rural poor people during times of food scarcity.
14.	*Eclipta alba* (L.) Hassk., 05.06.2014	Asteraceae	*Bhrungaraj*	Shoot	Freshly collected shoot are cooked and consumed occasionally by the poor people.
15.	*Enydra fluctuans* Lour., 07.07.2014	Asteraceae	*Hidimicha*	Leaf, shoot	Freshly collected tender shoots and leaves are eaten fried or cooked with other vegetables.
16.	*Euryale ferox* Salisb., 13.10.2013	Nymphaeaceae	*Kanta Padma*	Fruit, seed	The fruits are edible and seeds are roasted and eaten.
17.	*Glinus oppositifolius* (L.) A. DC., 14.02.2014	Molluginaceae	*Pitasaga*	Leaf, shoot	Leaves along with tender shoots are consumed as vegetable.
18.	*Hydrolea zeylanica* (L.)Vahl., 25.01.2013	Hydrophyllaceae	*Langulia*	Whole plant	The plant is consumed as food occasionally by the poor people.
19.	*Hygrophila auriculata* Schum. (Heine), 10.07.2014	Acanthaceae	*Koelikhia*	Leaf	Tender leaves are eaten as vegetable.
20.	*Ipomoea aquatica* Forssk., 10.06.2013	Convolvulaceae	*Kalamasaga*	Leaf, shoot	Tender leafy shoots are eaten fried or cooked.
21.	*Limnophila indica* (L.) Druce., 15.12.2014	Scrophulariaceae	*Keralata*	leaf	Tender leaves are eaten fried or cooked.

Contd.

Table 1—Ethnoedible wetland plants of Bhadrak district (Contd.)

S. No.	Scientific name, Voucher* deposition date	Family name	Vernacular name (in Odia)	Parts used	Mode of use
22.	*Ludwigia adscendens* (L.) Hara., 22.03.2014	Onagraceae	*Jagal*	Shoot, leaf	Tender leafy shoots are eaten fried or cooked with other vegetables.
23.	*Ludwigia prostrata* Roxb., 25.12.2013	Onagraceae	*Jalajali*	Shoot, leaf	Tender leafy shoots are eaten fried or cooked with other vegetables.
24.	*Marsilea minuta* L., 18.02.2014	Marsileaceae	*Sunsunia*	Leaf, petiole	Leaf and petiole are cooked in mustard oil.
25.	*Monochoria hastata* Solms-Laub., 17.08.2013	Pontederiaceae	*Demdem*	Inflorescence	The young inflorescences are cooked as vegetable.
26.	*Nelumbo nucifera* Gaertn., 18.10.14	Nymphaeaceae	*Padma*	Seed, rhizome	Seeds are used as raw. Rhizomes are eaten as vegetable.
27.	*Neptunia oleracea*, Lour., 14.03.2013	Mimosaceae	*Panilajkuli*	Leaf	Tender leaves are eaten as vegetable.
28.	*Nymphaea nouchali* Burm.f., 06.10.2013	Nymphaeaceae	*Nilakain*	Fruit	Ripen fruits are eaten raw.
29.	*Nymphaea pubescens* Willd., 05.10.2014	Nympaeaceae	*Rangakain*	Rhizome, petiole, seed	Rhizome, petioles and seeds are eaten.
30.	*Nymphoides indica* (L.) Kuntze, 12.11.2013	Menyanthaceae	*Panchuli*	Fruit	Ripen fruits are taken raw especially by the children.
31.	*Oryza rufipogon* Griff., 10.09.2013	Poaceae	*Balunga*	Grain	The grains are eaten in times of scarcity.
32.	*Ottelia alismoides* (L.) Pers., 18.06.2014	Hydrocharitaceae	*Panikundri*	Shoot, flower	Tender shoots and flower buds are used as vegetables.
33.	*Oxalis corniculata* L., 28.08.2014	Oxalidaceae	*Ambiliti saga*	Leaf	Leaves are cooked as vegetable.
34.	*Phoenix paludosa* Roxb., 06.04.2013	Arecaceae	*Hental*	Fruit	Fruits are used as vegetable.
35.	*Polygonum barbatum* L., 20.02.2013	Polygonaceae	*Nara*	Leaf	Leaves are eaten as vegetable.
36.	*Polygonum glabrum* Willd., 11.11.2013	Polygonaceae	*Bihongi*	Leaf, shoot	Tender leafy shoots are eaten as vegetable.
37.	*Sagittaria sagitifolia* L., 19.09.2013	Alismataceae	*Muya*	Root	Cooked roots are eaten.
38.	*Sonneratia apetala* Buch.-Ham., 20.06.2014	Sonneratiaceae	*Keruan*	Fruit	Fruits are eaten raw.
39.	*Sonneratia caseolaris* (L.) Engl., 25.05.2014	Sonneratiaceae	*Orua*	Fruit	Fruits are used as vegetable and also consumed as raw.
40.	*Trapa natans* L., 12.11.2013	Trapaceae	*Pani Singada*	Fruit	The fruits are consumed as raw and also used as vegetable.
41.	*Vallisneria natans* (Lour.) H. Hara., 12.01.2014	Hydrocharitaceae	*Panchaduba*	Leaf	Young leaves are used as vegetables.
42.	*Wolffia globosa* (Roxb.) Hatog & Plas, 18.09.2013	Lemnaceae	*Panidala*	Leaf	Leaves are cooked as vegetable.

*Specimens are stored alphabetically in herbarium.

and Poaceae contributed disproportionately to the list of useful species in the state of Manipur, India whereas Zhang *et al.*[27] reported dominance of Poaceae for a wide range of traditional uses in China.

The plants were collected from natural environments, particularly from ponds surrounding villages, field crops, river bank and canals. Majority (88.1 %) of the edible plants mentioned are the wild. Some of the edible plants like *Amorphophallus paeoniifolius* Dennst. (Nicolson), *Ipomoea aquatica* Forssk. and *Trapa natans* L. are domesticated by local people in their individual land/pond but are also available in the wild. Herbs were the primary source of edible plants (88.1 %) followed by trees (7.1 %) and climbers and shrubs (2.4 %) each. Within the edible parts of the plant, leaves (32.2 %), shoot (18.6 %), fruit (11.9 %) and rhizome (6.8 %) were most widely consumed and the remaining constituted tuber, petiole, bulbil, whole plant, root etc. Fresh plucking of the vegetables just before cooking is the most preferred mode of using the plant. In the local system, a dish made from wetland plant is

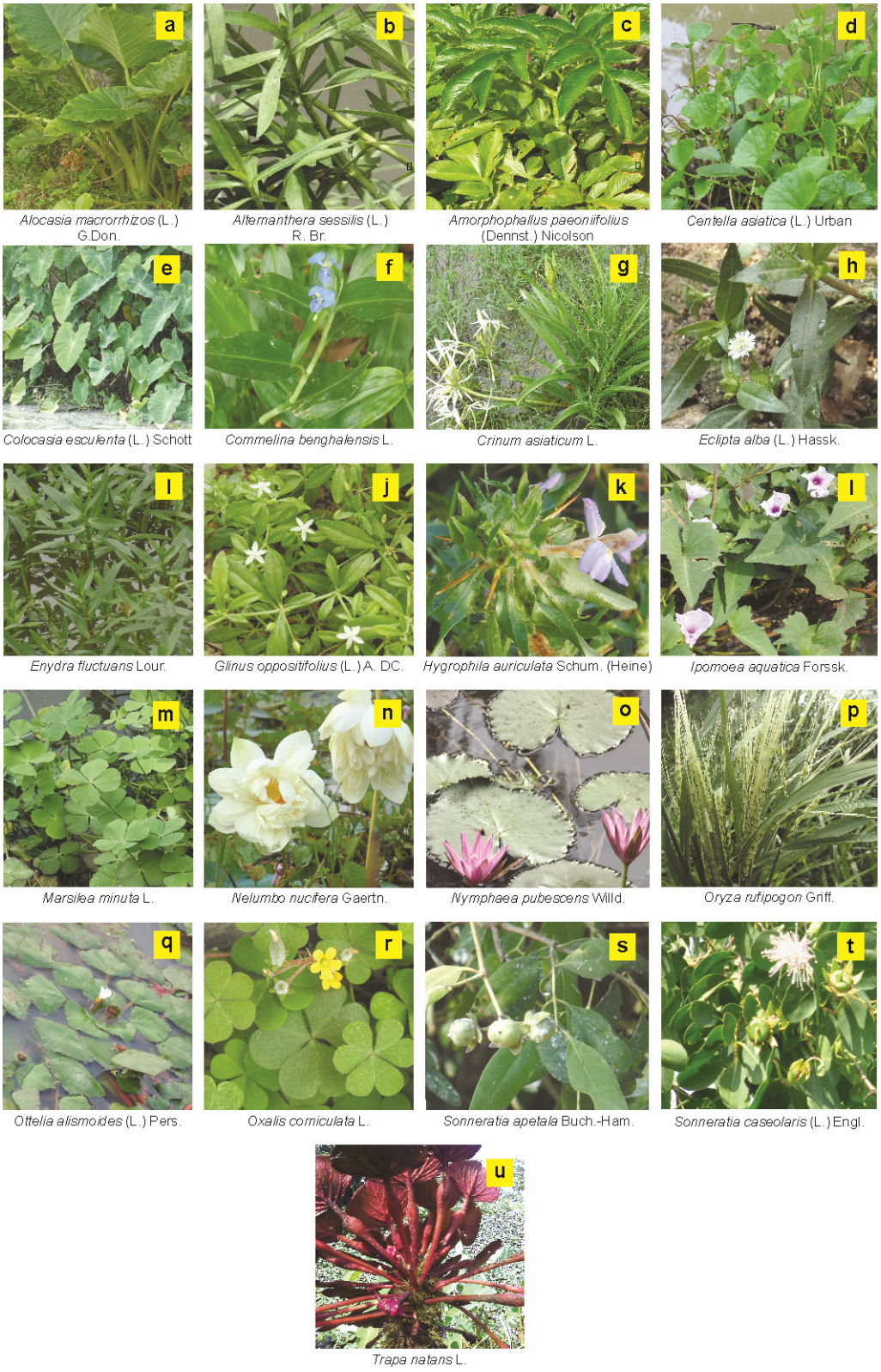

Plate 1a-u—Some plant species observed during the study

one of the items in everyday meal. Most commonly used species were *A. paeoniifolius* Dennst.(Nicolson), *Colocasia esculenta* (L.) Schott., *I. aquatica* Forssk. and *Marsilea minuta* L. Wild plants are consumed as vegetables (fresh or dry) and eaten as boiled, stir-fried in oil with other vegetables. Informants reported that some plants needed a purification process before being consumed like petiole of *Alocasia macrorrhizos* (L.) G.Don. and rhizomes of *A. paeoniifolius* Dennst.(Nicolson) are boiled for a long time in water (for removal of unpleasant taste) and are eaten with other food. Some plant species reported in the present study such as *C. esculenta* (L.) Schott., *Enydra fluctuans* Lour., *I. aquatica* Forssk., *M. minuta* L., *T. natans* L. and *Nymphaea pubescens* Willd. are also reported from other places[14,29-31].

The nutritional value of some edible wetland plants reported in this study has been reported earlier like edible tuber of *A. macrorrhizos* (L.) G.Don., which is rich in carbohydrates, protein, fat, fiber, thiamin, vitamin C, riboflavin, iron, phosphorus, niacin and calcium[32]. It is also a good source of zinc, potassium, copper and manganese and is used as staple food in many parts of the tropics and sub-tropics[33]. Its high fiber content may be helpful in treating constipation[34]. Dietary fiber has gained attention as it is said to reduce the incidences of colon cancer, diabetes, heart disease and some other digestive diseases[35]. Nutritional value of *Centella asiatica* (L.) Urb. is also promising as it is rich in carbohydrates, protein, calcium, iron, fiber, vitamin C, phosphorus and β-carotene[36]. As a vegetable and for therapeutic use, whole plant including leaves, stem and root are consumed[37]. In Malaysia and Indonesia, it is commonly eaten fresh as vegetable (ulam and salad) especially among the local Malay and Javanese populations[38]. In Sri Lanka the plant is used as porridge for feeding pre-school children in order to combat nutritional deficiency[39]. In Thailand, it is consumed as vegetable and tonic and drunk as a tea or juice[40]. Tribals of Wayanand district (Western ghats) use it for preparing a dish *Muthil* (cooked with crab or fish)[41]. *C. asiatica* is also widely available in the market as tea and soft drinks[42]. *C. esculenta* is an important staple food of developing countries in Asia, Africa, West Indies and Pacific region and is considered a good source of carbohydrates, fat, protein, oxalate, phytate, zinc, calcium and iron[43]. It also contains greater amounts of vitamin B-complex than whole milk[33]. *Commelina benghalensis* L. leaves are good source of nitrogen, sodium, phosphorous, potassium, calcium, iron, zinc and manganese[44]. *I. aquatica* Forssk. is eaten by all social groups throughout tropical Asia. The leaves of the plant are rich in fiber, carbohydrates, lipid, protein, sodium, phosphorous, calcium, iron, zinc and magnesium[45]. The plant also contains several vitamins including A, B, C, E and U (S-methyl-methionine), aliphatic pyrrolidine amides, carotenoids, hentriacontane, β-sitosterol and its glycosides, prostaglandin, leukotrine, N-trans- and N-cis feruloyltyramines and is used to treat gastric and intestinal disorders[46]. The shoot of *M. minuta* L. is good source of carbohydrates, fat, protein, sodium, phosphorous, potassium and nitrogen[47]. *Oxalis corniculata* L. leaves are good source of carbohydrates, lipid, protein, sodium, potassium, nitrogen, calcium and magnesium and can be used as supplementary food source particularly during scarcity of food production[48]. *T. natans* L. Roxb. is one of the most popular vegetables used in Asia and is commercially cultivated in many parts of India, particularly in Uttar Pradesh, Madhya Pradesh, Bihar and Odisha[49]. It contains carbohydrates, minerals, calcium, phosphate, iron, copper, manganese, magnesium, sodium and potassium and the kernels contain vitamins like thiamine, riboflavin, nicotinic acid, vitamin C, vitamin A, Damylase and considerable amount of phosphorylases[50]. These plants may help to ease stress from the costly conventional edible plants and can also be explored to alleviate malnutrition in developing countries.

Some of the reported wild edible plants such as *C. esculenta* (L.) Schott., *I. aquatica* Forssk., *M. minuta* L. and *T. natans* L. Roxb. are found to be sold in the local markets particularly by poor and economically marginalised families, thereby generating a supplementary income. The selling price varied with species, season and market location. It was observed that people collected wild plants notably during their growing season. It is worth noting that many young adults were not familiar with wild plants whereas most adults and old people could remember plant names and their use in local diet. The knowledge may be lost if not passed on to the new generations. The present investigation indicates that traditional knowledge is always associated with the natural area in which the users

live, as well as with the relative abundance of prospective edible species. A number of edible plants like *Alternanthera sessilis* (L.) R. Br., *Bacopa monnieri* (L.) Pennell, *C. asiatica* (L.) Urb., *C. benghalensis* L., *Eclipta alba* (L.) Hassk., *E. fluctuans* Lour., *Hygrophila auriculata* Schum.(Heine) are reported to have both therapeutic and dietary functions and hence are used as medicinal food remedy. This overlap between food and medicines is well known in traditional societies[14,30,31].

Conclusion

The present study indicates that Bhadrak district of Odisha is rich in both wetlands and traditional knowledge of wetland plants. The evidence shows that wetland plants provide substantial health and economic benefits to those who depend on them. Efforts to conserve biodiversity and preserve traditional food systems need to be combined and enhanced.

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