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Floristic inventory of hydrophytes with special reference to their Ethnomedicinal uses in Khordha district of Odisha

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Abstract
An ethnobotanical exploration was carried out during 2018-2020 in different places of Khordha district to document the medicinal uses of aquatic plants. Knowledgeable old man and old women as well as traditional herbal healers of the area were interviewed to collect the information on the medicinal uses of the hydrophytes and their use as raw materials for the preparation of various herbal formulations. The present study revealed the distribution of 211 aquatic plant species belonging to 134 genera and 61 families. Out of the recorded 211 species, only 60 have been used by the local people for the treatment of 39 different diseases of human and 2 diseases of domestic animals. Among the different categories of aquatic plants, marshy hydrophytes were represented with the maximum diversity with 22 species followed by 20 species of amphibious hydrophytes, 9 species of submerged, 6 species of free-floating and 3 species of fixed floating hydrophytes. Some of the important aquatic medicinal plants documented during the course of present investigation are *Amannia baccifera* (against ringworm), *Bacopa monnieri* (stammering), *Caesulia axilaris* (fresh cut wound), *Centella asiatica* (hyperacidity & vomiting), *Ceratophyllum demersum* (glycosuria), *Crinum defixum* (dysuria), *Echinochloa stagnina* (diabetes), *Hydrilla verticillata* (lung's infection), *Hygroryza aristata* (urinary tract infection), *Limnophila heterophylla* (dyspepsia), *Lippia javanica* (burning sensation), *Marsilea minuta* (neurological disorder), *Neptunia oleracea* (ear-ache), *Nymphoides indica* (ulcer on scalp), *Ottelia alismoides* (diarrhoea in calf), *Pistia stratiotes* (diabetes), *Ranunculus scleratus* (bronchitis), *Scirpus articulates* (dysentery) and *Utricularia stellaris* used against eczema. It is important to note that some of the medicinal uses of aquatic plants are not reported earlier and they need both popularization among local people and their preservation which will helpful for future work.

Keywords: aquatic plants, diversity, ethnomedicine, Khordha, Odisha

Introduction

The intimate relationship between man and plant dates back to the origin of human on this earth. With the development of social sense in primitive men, their dependence on the plant resources increased, not only for food, but also for fuel and medicine. Although we are living in 21st century and modern civilization has gained its momentum but still there are several rural pockets, not only in India but also in other parts of the world, where the people are still practicing traditional knowledge and culture. These people practise herbal drugs for the treatment of different ailments, the knowledge of which they have acquired from their ancestors from the previous to next generation. Till date, traditional herbal healing practices play a crucial role in primary healthcare among indigenous communities in Indian subcontinent. Unfortunately, this traditional knowledge is declining day by day due to a change in lifestyles, dependency on the synthetic drugs and access to modern healthcare services.

A plant that grows in aquatic habitat for at least a part of its life cycle in water is called aquatic plant. Aquatic plants are remain in many forms like submerged, free floating, rooted floating, marshy and amphibious [1]. Some of the hydrophytes are not only useful in ecological processes but also utilized in the treatment of various diseases by the rural communities of India. Khordha district located in eastern Odisha harbours a diverse group of aquatic plants which are economically and medicinally important.

Living close to nature, rural communities of Khordha district are very much familiar with hundreds of plants and animals. By trial and error, they have screened and developed very specific knowledge on the local flora and fauna. Main objective of the present study was to document these invaluable knowledge systems before they are lost forever. Earlier reports indicate the use of several plant species by the rural community of Odisha to treat various human and animal diseases [2-35]. However, very little work has been done on ethnobotany of aquatic plants of India. The present paper focuses on the survey of aquatic flora and their use to treat various diseases by the locals in Khordha district of Odisha. The information related to the diversity of hydrophytic plants in the district with folklore claims will be useful for screening a newer source of ethnomedicinal knowledge which may serve as baseline data for future pharmacological investigation.

Methodology

An extensive investigation was conducted in Khordha district of Odisha during 2018-2020 to find out the medicinally important aquatic plants of the area. Field visits were organized in different seasons to the identified study sites of the district namely Balianta, Balipatana, Jatni, Bhubaneswar, Tangi, Khordha sadara, Banapur, Begunia,

Bolgarh and Chilika for two years (Fig. 1). As different species come to flowering and fruiting at different times, field surveys were conducted in such a way as to collect all relevant information in different stages of their life history. Some knowledgeable people as well as local medicine men were approached to know the name of the hydrophytes occurring in the area which they use to cure human and animal ailments. The detailed information about the plants, method of preparation, dosages and mode of uses etc. were documented. The supportive ethnomedicinal plant specimens were collected, processed, critically studied, identified and preserved. To get authentic data, the folklore claims were cross-checked by interacting with the different dwellers of the same community in the different study areas. The name of the locality where the noting was recorded and the accession number of the plant specimen given for future cross checking or collection. The identification of voucher specimens was authenticated by following the regional floras [36-38] and in consultation with standard literatures. All the identified specimens are deposited in the Herbarium of Centurion University of Technology and Management, Bhubaneswar, Odisha.

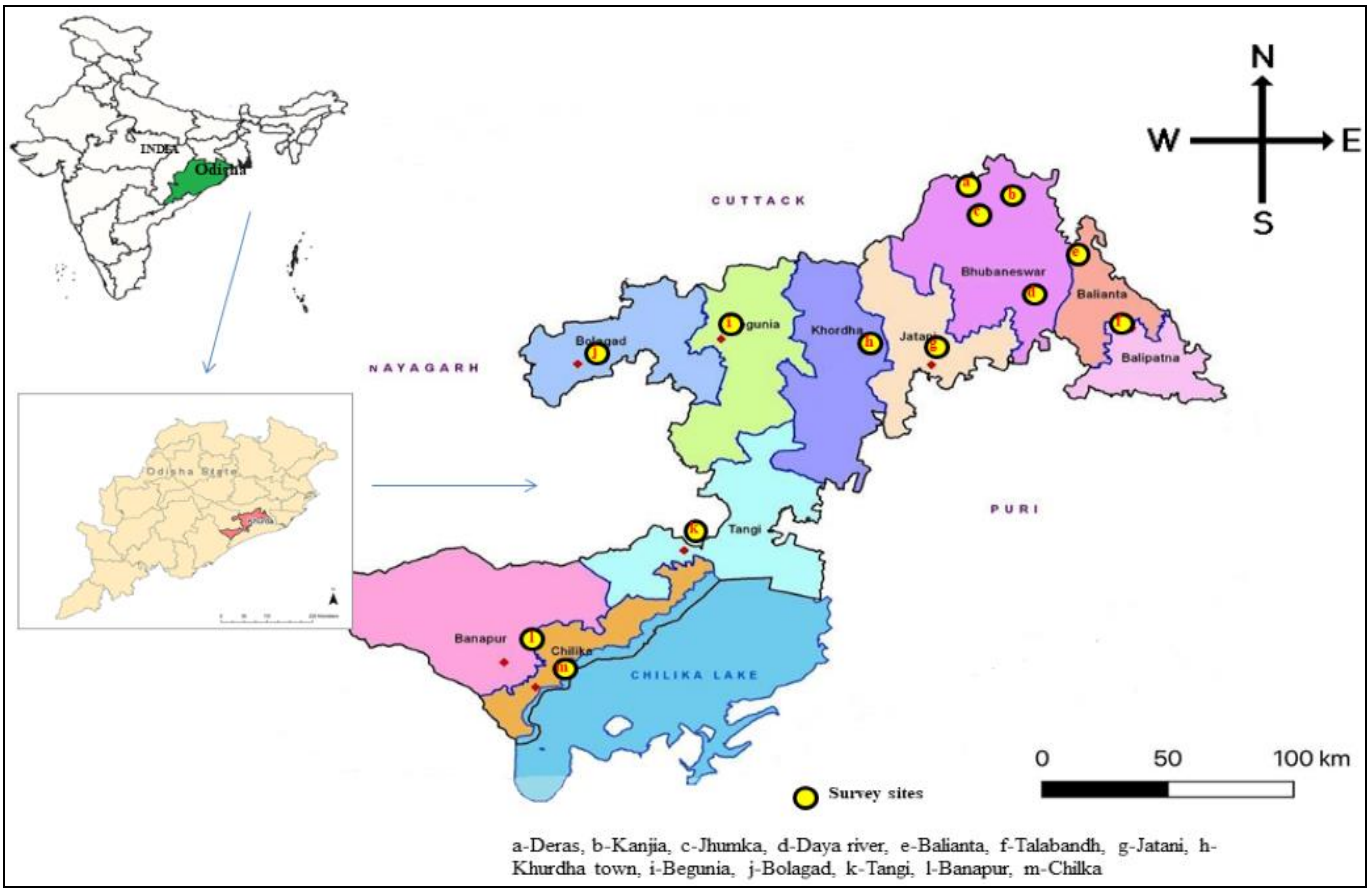

Fig 1: Map showing different locations of the study area

Result and Discussion

During the survey of aquatic ecosystems, located in the different study sites of Khordha district, 211 aquatic plant species belonging to 134 genera and 61 families have been collected, critically studied, identified and recorded. But ethnomedicinal data when analyzed it was observed to be from 60 species only included under 39 families (Table 1). This indicates that healthcare requirements are met from more than 28 % of total number species documented in the aquatic ecosystems of the district. Out of the 68 prescriptions, 66 were for human ailments and 2 for veterinary uses. The less number of species employed for animal diseases indicate that the cattle are by and large healthy and they encounter few health problems only.

Among the different types of aquatic plants with folklore claims occurring in the study area, marshy hydrophytes were represented with the maximum diversity with 22 species followed by 20 species of amphibious hydrophytes, 9 species of submerged, 6 species of free-floating and 3 species of fixed floating hydrophytes (Fig. 2). Among the families Poaceae is rated as the largest represented by 7 species, followed by Asteraceae with 6 and Hydrocharitaceae with 4 species (Fig. 3). It was, however, reported by the local people that now-a-days they use these aquatic plants to treat diseases such as common cold, skin diseases, indigestion, flatulence or some other common temporary disorders only but do not use them to cure serious or chronic diseases.

Though 114 ethnobotanical notings were made from the selected study sites of the district during field work, only 68 were found to be frequently used, less known or interesting on comparison with the available literature sources [2-35, 39-41] and are presented here. The other recorded prescriptions were deleted due to various reasons including wrong identification, misinterpretation, non-confirmation in the cris-cross checking or mounted on baseless faiths etc.

Over the past few years overexploitation of the plants with proven medicinal properties by the pharmaceutical industries coupled with lack of adequate cultivation practices for their regeneration has resulted in a serious depletion of this much valued natural resources. Hence, it is the need of the hour to explore, identify and utilize new

medicinal plants in general and aquatic medicinal plants in particular on one hand and, on the other, to conserve the existing threatened species of rare medicinal plants. Besides, to avoid the use of costly synthetic medicines with probable side effects on the body, these herbal medicines, already in use, require to be scientifically utilized by identifying the bioactive principles responsible for curing the diseases. It is noteworthy that the present study on proper documentation of traditional uses of aquatic plants will be a significant footstep not only for future reference and clinical validation but also for floristic conservation which will ensure their long-term availability for exploitation in healthcare of human and livestock. It can be suggested that with the help of biotechnological intervention these aquatic plants can be commercialized for its use in wider scale (Fig.4)

Table 1: Ethnomedicinal uses of native aquatic plants of Khordha district of Odisha.

Sl. No.	Botanical name with Family	Local name(s)	Habitat	Ethnomedicinal use(s)
1.	*Aeschynomene aspera* L. [Fabaceae]	Sola	Amphibious	Roots along with the root of 'chitraka' (*Plumbago zeylanica*) are made into a paste and applied topically to treat leucoderma. Tangi, BB-208.
2.	*Alternanthera philoxeroides* (Mart.) Griseb. [Amaranthaceae]	Bada-madaranga	Amphibious	A paste made of the leaves mixed with equal amounts of the rhizome paste of ginger is used against intermittent fever. Balianta, BB-309
3.	*Alternanthera sessilis* (L.) R.Br. ex DC. [Amaranthaceae]	Madaranga Saga	Marshy	Decoction (100 ml) of the whole plant, with one cup of milk is prescribed to feeding mother for 15 days against galactorrhoea. Khandagiri, BB-206
4.	*Ammania baccifera* L. [Lythraceae]	Mula-kurandica	Marshy	Leaves bruised and applied externally against ringworm. Tangi, BB-216
5.	*Ampelopteris prolifera* (Retz.) Copel. [Thelypteridaceae]	Latapakshi	Amphibious	The leaf paste mixed with equal amount of castor oil is applied to the forehead against hemicarnia. Balipatana, BB-217
6.	*Aponogeton natans* (L.) Engl. & Krause [Aponogetonaceae]	Teebragandhi	Submerged	The fresh tuber (3-4) is made into paste and mixed with coconut oil (2-3 ml) and applied on the scalp to prevent hair fall. Kuakhai, BB-295
7.	*Azolla pinnata* R.Br. [Azollaceae]	Batakadala	Free-floating	Whole plant is feed to cattle daily for at least for 1 month to induce lactation. Ramachandrapur, BB-309
8.	*Bacopa monnieri* (L.) Pennell. [Scrophulariaceae]	Brahmi saga	Marshy	Plant juice (10 ml) along with 5 ml leaf juice of 'pasanavedi' (*Polycarpaea aurea*) is given on empty stomach once a day for 30 days against stammering in children. Saraswati Vihar, BB-299
9.	*Bergia ammannioides* Roxb. [Elatinaceae]	Rakta Biprusa	Marshy	Leaves are bruised and applied on the body against fungal infections. Banapur, BB-234
10.	*Blyxa echinosperma* (C.B.Cl) Hook.f. [Hydrocharitaceae]	Jalankura	Submerged	The juice of the leaf is used as an ear-drop to cure earache. Itipur, BB-244
11.	*Caesulia axillaris* Roxb. [Asteraceae]	Pishangika	Marshy	Plant paste is applied to cure fresh cut wounds. Jatni, BB-319
12.	*Centella asiatica* (L.) Urban [Apiaceae]	Thalkuri	Herb	Seven fresh leaves are taken every morning for three months to cure chronic hyperacidity. The leaf-juice is also given with sugar to check excessive vomiting. Begunia, BB-345
13.	*Ceratophyllum demersum* L. [Ceratophyllaceae]	Shrunjaparnee Dala	Submerged	The juice of the flowers (20g) mixed with a tea-spoon of lime-juice and a pinch of common salt is given every morning for a month for the treatment of glycosuria. Jhumka, BB-359
14.	*Ceratopteris thalictroides* (L.) Brongn. [Parkeriaceae]	Shrunga pakshi	Marshy	The fronds are applied as a poultice against skin diseases**.** Bolgarh, BB-353
15.	*Coix lacryma-jobi* L. [Poaceae]	Garagada	Marshy	The seed paste (20 g) mixed with sugar candy (10 g) is prescribed once in a day for 7 days against jaundice. Kalanga, BB-360
16.	*Commelina paludosa* Bl. [Commelinaceae]	Kaniseera	Marshy	Sap of leaf sheath is applied on the affected areas for curing eye-sores. Kantabada, BB-207
17.	*Crinum defixum* Ker-Gawl [Amaryllidaceae]	Panikenduli	Amphibious	The seed (10 g) powder is taken with water twice a day for 3 days for free flow of urine and dysuria. Tangi, BB-215
18.	*Cyperus rotundus* L. subsp. *tuberosus* (Rottb.) Kuek. [Cyperaceae]	Mutha	Marshy	Rhizome (50 g) is ground with dried ginger (50 g) and 'cumin' seeds (10 g) to powder. This powder is given (10 g) once in a day for one month against irregular menstruation. Begunia, BB-283
19.	*Echinochloa stagnina* (Retz.) P.Beauv. [Poaceae]	Suan	Amphibious	Decoction of the root (10 ml) is used once in a day for a month against diabetes. Garhhaldia BB-273
20.	*Eclipta prostrata* (L.) L. [Asteraceae]	Kesadura	Marshy	A preparation of warm sesame oil with plant paste (2:1) is applied to enhance luster and growth of hair. Patia, BB-272
21.	*Emilia sonchifolia* (L.) DC [Asteraceae]	Sarkara	Marshy	Whole plant juice in warm water is given against diabetes, asthma and joint pain Tomando, BB-303
22.	*Enydra fluctuans* Lour [Asteraceae]	Hidimicha-saga	Amphibious	Leaf juice mixed with coconut oil is applied gently on scalp daily for 1 month against alopecia and graying of hair. Pubusahi, BB-305
23.	*Eriocaulon quinquangulare* L. [Eriocaulaceae]	Nakachana	Amphibious	The plant paste (10 g) mixed with butter is massaged all over the body against body ache due to severe cold or fever. Kanapur, BB-328
24.	*Gnaphalium polycaulon* Pers.	Bahusmrutika	Marshy	Leaf juice mixed with sesame oil is applied gently on scalp daily for

	[Asteraceae]			a month against hair fall and to delay graying of hair. Deuli, BB-346
25.	*Hydrilla verticillata* (L.f.) Royle [Hydrocharitaceae]	Chingudia-dala	Submerged	A dried powder of the plant is applied to cuts or wounds for speedy healing. Leaf paste (5-10 g) is given for 10 days against chronic stomach disorder and chronic lung infection. Hirapur, BB-341
26.	*Hydrolea zeylanica* (L.) Vahl [Hydroleaceae]	Nayana-tara	Amphibious	About 4-5 fresh leaves are taken and applied as a poultice on the affected part of the skin caused due to burn injury. Gopalpur, BB-351
27.	*Hygrophila auriculata* (Schum.) Heine [Acanthaceae]	Koilikhia	Amphibious	Leaf juice mixed with equal amount of lemon juice is taken every day in the evening for expelling intestinal worms. Banapur, BB-297
28.	*Hygroryza aristata* (Retz.)Nees ex Wt. & Arn. [Poaceae]	Jalamuli	Free floating	Decoction of the whole plant is taken orally with honey against urinary tract infection. Balianta, BB-298
29.	*Ipomoea aquatica* Forssk. [Convolvulaceae]	Kalama saga	Amphibious	Leaves and young shoots are cooked and eaten as vegetable to restore the broken health of women especially due to post-partom complications. Jatni, BB-304
30.	*Lemna perpusilla* Torrey [Lemnaceae]	Bataka dala	Free-floating	Whole plant along with crushed leaves of *Ludwigia octovalvis* is applied as a poultice against body ache. Khorda sadara, BB-243
31.	*Limnophila heterophylla* (Roxb.) Benth. [Scrophulariaceae]	Ambakasia	Amphibious	Leaf-paste (10 g) along with the seed paste (5 g) of 'jeera' (*Cyminum cuminum*) is given once in a day for 3 days against dyspepsia. Bolgarh, BB-233
32.	*Limnophyton obtusifolium* (L.) Miq. [Alismataceae]	Sukhma dhanupatri	Marshy	Juice (10 ml) of the whole plant along with ginger and cumin powder is taken for 5 days orally to cure dysentery. Balipatana, BB-238
33.	*Lippia javanica* (Burm.f.) Spreng. [Verbenaceae]	Gandhapatali	Amphibious	The leaf paste is massaged on the hands and feet of the pregnant lady against the burning sensation. Ankula, BB-224
34.	*Ludwigia octovalvis* (Jacq.) Raven [Onagraceae]	Bia-lavanga	Amphibious	10 g of flowers are ground in 10-15 ml of lemon juice and a pinch of common salt and the paste thus obtained is applied externally to treat eczema and ringworm. Biribadi, BB-214
35.	*Marsilea minuta* L. [Marsileaceae]	Chhota sunusunia	Amphibious	Leaf juice (10 ml) with 20 ml of curd given once daily for 7 days in epilepsy or anorexia. The patient is also advised to take leaves as vegetable for 1 month to cure epilepsy. Jaripada, BB-201
36.	*Marsilea quadrifolia* L. [Marsileaceae]	sunsunia	Marshy	Leave paste is used against high blood pressure. Lingipur, BB-213
37.	*Monochoria vaginalis* (Burm.f.) Presl [Pontederiaceae]	Kajalapati	Amphibious	Decoction of the roots (10 ml) is used for 15 days to cure bronchitis or asthma. Chandeswar, BB-220
38.	*Myriophyllum tetrandrum* Roxb. [Haloragaceae]	Shahashra - patri	Submerged	Whole plant is made as a poultice and applied on the affected part of the skin to cure boils. Kulei, BB-264
39.	*Najas graminea* Del. [Hydrocharitaceae]	Shesanaga dala	Submerged	Juice (10 ml) of the whole plant along with equal amount of sap of ginger is taken for 5 days orally to cure dysentery. Bhabanipur, BB-266
40.	*Neptunia oleracea* Lour. [Mimosaceae]	Pani-lajakuli	Fixed Floating	Leaf juice is dropped into the ear to stop earache. Jatni, BB-277
41.	*Nymphaea pubescens* Willd. [Nymphaeaceae]	Dhalakain	Fixed floating	Stamen powder (2 g) is taken with warm water (20 ml), 3 times a day for two days against flatulence. Nandapur, BB-278
42.	*Nymphoides indica* (L.) Kuntze [Menyanthaceae]	Chandramala	Fixed floating	Flower paste in date palm juice is applied to treat the scalp with chronic ulcers (locally known as 'Bada gha') in children. Kantia, BB-282
43.	*Oryza rufipogon* Griff. [Poaceae]	Balunga	Marshy	The fermented water rice of the cooked grains is given to the patients to expel toxic substances of the stomach. Bentapur, BB-287
44.	*Ottelia alismoides* (L.) Pers. [Hydrocharitaceae]	Pani-kundri	Submerged	Paste of the whole plant is given orally to cure diarrhoea in calves. Guapur, BB-290
45.	*Oxalis corniculata* L. [Oxalidaceae]	Ambiliti	Marshy	Leaf juice mixed with juice of 'onion' (*Allium cepa*) in the proportion of 1:1 applied on warts. Kantabada, BB-293
46.	*Paspalum scrobiculatum* L. [Poaceae]	Kodua	Marshy	Mature grains (10 g) are made into a paste with the latex (1ml) of banyan prop roots and administered once daily for 7 days to lessen the excessive appetite during diabetes. Balipatna, BB-325
47.	*Pistia stratiotes* L. [Araceae]	Borajhanji	Free floating	The juice (10 ml) of whole plant along with equal amount of green coconut milk is given to reduce sugar content in blood. Kalarang, BB-324
48.	*Polygonum barbatum* L. var. *barbatum* Wight [Polygonaceae]	Bahukoni	Amphibious	Seed powder (10 g) mixed with 'turmeric' powder (10 g) is given to remove poisonous substance from the stomach. Nariso, BB-331
49.	*Potamogeton nodosus* Poir. [Potamogetonaceae]	Ugragandha	Submerged	The ash of the whole plant is held up in the mouth for 1-2 minutes against toothache. Kurunjipur, BB-364
50.	*Ranunculus scleratus* L. [Ranunculaceae]	Pani-dhania	Amphibious	The juice (10 ml) of the whole plant mixed with 5 ml sap of ginger and given once in a day for 7 days to treat bronchitis. Kalyanpur, BB-372
51.	*Rotala indica (Willd.)Koehne [Lythraceae]*	Badbadi	Marshy	Young twigs are prescribed as vegetable to the mother of a new born baby suffering from anaemia. Jatni, BB-375
52.	*Sagittaria trifolia* L. [Alismataceae]	Dhanushira	Marshy/Swamps	Decoction of the whole plant is used externally against skin infections. Basuaghai, BB-386

53.	*Scirpus articulatus* L. [Cyperaceae]	Gaichira	Amphibious	Root-paste (10 g) mixed with black pepper powder (1 g) is given against dysentery. Benupur, BB-380
54.	*Sphaeranthus indicus* L. [Asteraceae]	Bhuin-kadamba	Marshy	Flower paste (15 g) is prescribed with little old jaggery two times a day for 7 days to check the excessive urination. Balianta, BB-385
55.	*Sphenoclea zeylanica* Gaertn. [Campanulaceae]	Manginee	Marshy	Decoction of its leaves along with fruit paste of *Physalis minima* taken for 7 days to cure jaundice. Deogaon, BB-390
56.	*Spirodela polyrhiza* (L.) Schleiden [Lemnaceae]	Kundalidala	Free floating	Whole plant is used for reducing body swelling**.** Tangi, BB-399
57.	*Tonningia axillaris* (L.) Kuntze [Commelinaceae]	Godhuli	Amphibious	Leaf paste, mixed with equal amounts of ginger is used to treat poisonous insect bites. Balipatna, BB-405
58.	*Trapa natans* L. var. *bispinosa* (Roxb.) Makino [Trapaceae]	Pani-singada	Free floating	Seed (5 nos) paste is given once daily for 30 days against general debility and menorrhagia. Kulei, BB-409
59.	*Utricularia stellaris* L.f. [Utriculariaceae]	Bhatudia-dala	Submerged	Plant paste mixed with common salt applied externally to cure eczema or ring worm. Bheteswar, BB-404
60.	*Vetiveria zizanioides* (L.) Nash [Poaceae]	Bena	Damp & Swampy place	Roots (100g) boiled in water (500 ml) for 30 minutes and the filtrate (10 ml) is given with little honey to cure dysuria. Ratanpur, BB-406

[BB - Name of the first author in abbreviated form]

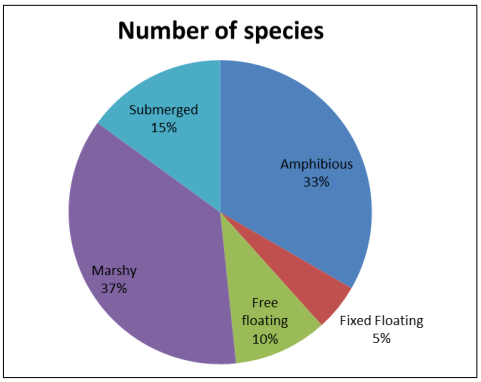

Fig 2: Habitat-wise distribution of aquatic plants (in %) in the study area

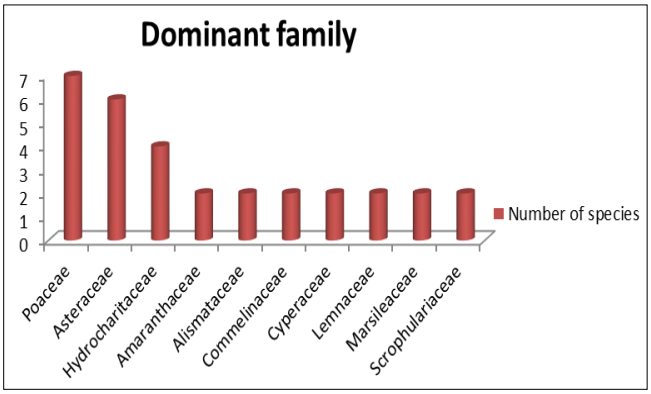

Fig 3: Family-wise distribution aquatic plant species in the study area

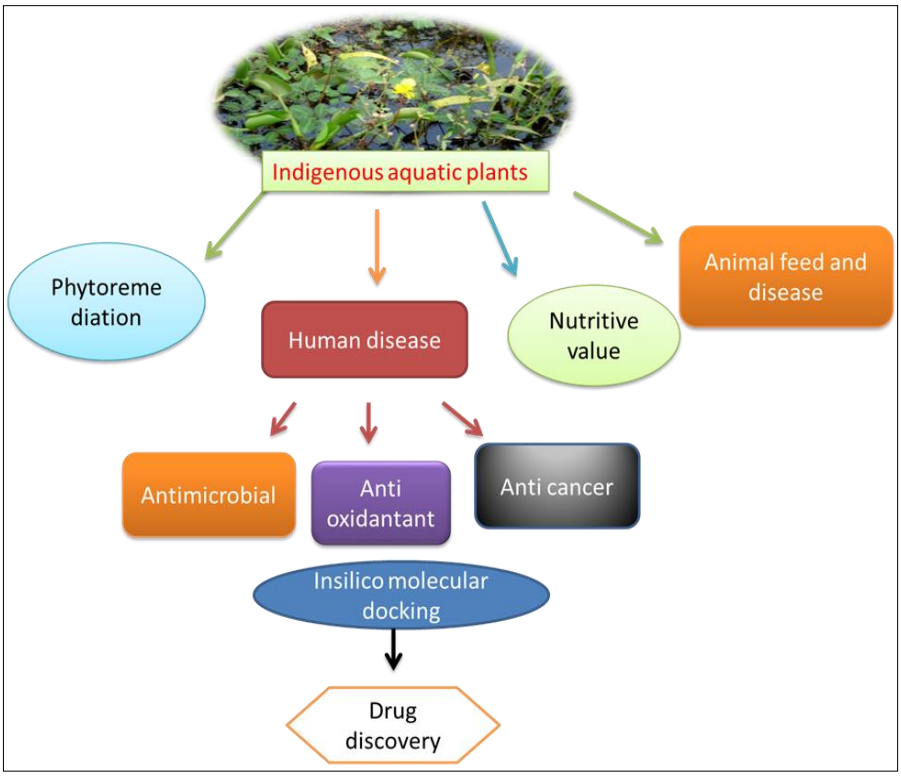

Fig 4: An integrated innovative approach for exploring the use of aquatic plants

Conclusion

It is evident from the present study that the traditional herbal cure practice in the rural areas is losing its importance because of the easy accessibility to modern medicines and ignorance about the medicinal plants occurring in their surroundings. Our investigation emphasizes upon the popularization of age old knowledge on household remedies of rural communities for ensuring local values to be

translated into rational use of the folklores as source of medicine. Further scientific study of these native ethnomedicinally important aquatic plants may lead to the discovery of new phytomolecules for the development of drugs. On the other hand, the findings of the present study will be of immense help to the locals of the remote rural areas to get additional livelihood for organized collection, processing and trading of these therapeutically important marshy, floating or submerged aquatic plants depending on the requirements of the pharmaceutical houses.

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