

PLANT SPECIES UTILIZATION IN WETLAND ECOSYSTEM OF THRISSUR DISTRICT– A PART OF VEMBANAD KOL, RAMSAR SITE OF KERALA

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ABSTRACT

Wetlands are fragile ecosystems and constitute a great potential for economic, cultural, scientific, and recreational value to human life. Different utilization patterns of wetland plants of Thrissur wetland system was discussed in this paper. The information was gathered through field investigation and unstructured interviews. Raw data were analysed using “informant consensus” method. The result unveils the conventional usage of 52 plant species of 38 genera belongs to 20 families, in which 35 plant species are Dicotyledons and 16 are Monocotyledons. One species belongs to Pteridophyte. Plants thrive in the wetlands can be used commercially as well as conventionally. Wetlands can be exploited for socio-economic welfare of the society in such a way that women empowerment through cottage industries using wetlands plants. These invaluable and silent services rendered by the wetlands should not be overlooked and efforts have to be taken to the sustainable development and conservation of this diverse habitat.

KEYWORDS: Wetland, Ramsar Site, Utilization Pattern, Use Value, Conventional Usage

Wetlands are considered to be one of the most productive ecosystems in the world and the most vital life-support system of man (Maltby; 1986). India, by virtue of its extensive geographical stretch and varied terrain and climate, supports a rich diversity of wetlands, mangroves and rivers. According to the new list of Ramsar convention, 26 sites of international importance were sited all over in India spread above 689,131 ha.

Humans often equate wetlands with wasteland; a place to be drained, filled in, burnt off and re-purposed. In fact, scientific studies show that 64% of the world’s wetlands have disappeared since 1900 owing to anthropogenic pressures in the form of habitat loss, industrialization, encroachments etc. In contrast with the terrestrial ecosystem, wetlands have been poorly studied indigenously even though peoples are living in and around the wetlands. The traditional use of terrestrial plants has been well known to the mankind but that of plants thrive in the wetland ecosystem is not so famous. Many of the local inhabitants especially the young generation are unaware of the ecological significance and livelihoods provided by the wetlands. Migration of rural populations to urban areas, and cultural changes in indigenous communities are threatening this knowledge (Signorini; 2009). Consequently there is an urgent need to document this knowledge before it vanishes. The study of such utilization patterns on the preference and use of plant resources may contribute to the sustainable development of societies and economics. In Kerala, medicinal properties of some wetland plants have been already reported (Jyothy and Suresh Kumar; 2014). However, the traditional usage other than the therapeutic is not studied

in detail and this work will expose the different utilization pattern of wetlands plants.

METHODOLOGY

Study Area

Kerala has the largest proportion of land area under wetlands about 1, 60, 590 ha. of which the study site Thrissur district carries 8. 27% alone. Out of the 14 district of Kerala state, Thrissur got the highest proportion of wetland area in relation with the geographic area (Sheeba Abraham; 2015).The study area lies in the central zone of Kerala state between 10^o 20’ to 10^o 40’ N and 75^o 58’ to 76^o 11’ E and is a part of Vembanad Kol which was declared as Ramsar site in 2002 by Ramsar Convention in 1971 and got international importance and regarded as the largest Ramsar site in India having an area of 151,250 ha.

Sampling Techniques

Mainly two methods have been adopted to gather the information regarding the different utilization patterns of wetland plants. One was on site floristic evaluation in which plant specimens were collected during the field trips in the company of at least one elderly people so that the errors can be minimum. Many of the local peoples were uninformed about the scientific names and familiar only with the vernacular ones. The other included unstructured interviews with open ended questions. Raw data were analysed using “informant consensus” method (Philips and Gentry; 1993). Appendix 1 point up the technique with a typical example of *Nelumbo nucifera* Gaertn. Use value for each plant species for each informant, UV_{is} was calculated. UV_{is} is defined as:

$$UV_{is} = \frac{\sum U_{is}}{n_{is}}$$

Where U_{is} number of uses mentioned for each plant species s by each informant i and n_{is} the number of events in which research participant i cites a use for species s .

Overall use value (UVs) for each species s is calculated by summing UV_{is} from all informants and divided by ns total number of informants for species s :

$$UV_s = \frac{\sum UV_{is}}{ns}$$

The study was performed during 2015 – 2016 and entire study area was stratified into eight clusters depending on the diversity and five informants had taken from each. Frequent field visits were conducted to assess the availability and use of plant resources. The collected specimens were identified using relevant literatures and made in to herbarium and deposited into Sree Narayana Mangalam Herbarium (SNMH!), Maliankara, Ernakulam, Kerala State.

Appendix 1: Calculating the Use values (UVs) using “informant consensus” method: *Nelumbo nucifera* Gaertn. as an example.

Appendix 1a: Informant 1: all the *N. Nucifera* uses mentioned in three separate events.

Specific Uses	Total	Edi	Med	Baf	Dom	Com	Oth
Event 1	1	1	0	0	0	0	0
Event 2	3	0	1	0	0	1	1
Event 3	1	0	1	0	0	0	0
Total uses	5	1	2	0	0	1	1
Mean	1.667	0.333	0.667	0	0	0.333	0.333

Appendix 1b: Use value of *N. Nucifera* for informants 1 to 7

Informant	Total	Edi	Med	Baf	Dom	Com	Oth
1	1.67	0.33	0.67	0	0	0.33	0.33
2	2.33	0.33	1	0	0	0.33	0.67
3	2	0.67	0.67	0	0	0.33	0.33
4	3	0.33	1	0	0	0.67	1
5	3	0.33	1	0	0	0.67	1
6	2.67	0.33	0.67	0	0	0.67	1
7	1.67	0	0	0	0	0.67	1
Use value	2.333						

Edi = Edible, Med = Medicine, Baf = Bird & animal feed, Dom = Domestic use, Com = Commercial, Oth = Other uses

RESULTS AND DISCUSSION

Aquatic vegetation is often considered as undervalued part of an ecosystem. However, they provide a mean of livelihood and a source of income. The

information collected regarding the conventional usage of wetland plant resources of Thrissur given away 52 individual plants under 38 genera belongs to 20 families of which 35 species of 7 families are Dicotyledons and 16 of

12 families are Monocotyledons. One species belongs to Pteridophyte (*Azolla pinnata* R. Br.).

It was monitored that 12 wetland species were considered as edible in the form of leafy vegetables (*Alternanthera* sp.), grains (*Oryza* sp., *Sacciolepis interrupta*), tubers (*Nymphaea* sp., *Nelumbo nucifera*, *Colocasia esculenta*), etc., 18 as medicinal, 22 as bird and animal feed and 10 as different domestic purposes. Beside these, 9 species of plants were commercially utilized by local inhabitants in such a way that core raw material for mat weaving and making handicrafts (*Eichhornia crassipes*, *Pandanus odorifer*) in cottage industries. 8 species were categorized under other uses which include ritual activities (*Nymphaea* sp., *Nelumbo nucifera*, *Vetiveria zizanioides*), bio fertilizer (*Azolla pinnata*, *Sesbania javanica*) etc. Based on their utilization patterns, out of the 20 families, Nelumbonaceae (2.33), Nymphaeaceae (1.56), Araceae (1.18), Pontederidaceae (1.03) and Poaceae (1.01) are the important families who scored highest use value and those have species of important socio – economic role in the study area (Table-1).

Human have utilized wetland plants as a source of staple food. The seeds of a number of aquatic grasses, including wild rice (*Oryza rufipogon*), are used by both poor and rich and the most important among them are *Sacciolepis interrupta*, *Echinochloa* sp. and *Coix lacryma – jobi*. Many plants thrive in the wetlands possess high nutritional content which is unknown to the local peoples of the study area. For example, the nutrient content of the seeds of *Coix lacryma – jobi* (fat – 6%, protein – 17.2%) is higher than in most of the other cereals while local inhabitants in the study area use seeds of *Coix* for preparing chains (Kondha) only (Gopalan *et al*; 1971). Starchy tubers (*Aponogeton appendiculatus*, *Colocasia esculenta*, *Nelumbo nucifera* and *Nymphaea nouchali*), leaves and tender shoots (*Alternanthera sessilis*, *A. philoxeroides* and *Glinus oppositifolius*) of aquatic plants provide the supplementary food. *Cyperus rotundus* and *Alternanthera sessilis* is widely used all over Kerala to increase the milk production in women soon after delivery.

These wetland plants not only acts as food but also as medicines. Kumar and Narayan reported the medicinal properties of several wetland macrophytes of India (Santosh Kumar and Satya Narayan; 2012). The local peoples especially the old age ones use many wetland plants to cure 21 ailments such as jaundice, urinary disorders, rheumatic fever, gonorrhoea, piles, impotency, etc. and this suggest that the communities

living around the wetlands still depend on the natural environment. *Nelumbo nucifera* is well known medicine for kidney stone in the study area. The rhizome of the plant is consumed with cow milk can lead to the dissolution of calcium oxalate (kidney stone).

Aquatic plants provide spawning ground and shelter for fishes and they were also rich in nutrients and can directly eat by the fishes. Studies on the efficiency of duckweed (*Lemna* sp.) as low cost supplementary feed in monoculture of Nile Tilapia showed increase in the specific growth rate (Chowdhury *et al*; 2008). According to Petre, *Azolla*, an floating pteridophyte, play a vital role in the life cycle of fishes (Petre; 1993). *Azolla* sp. is also used as a bio fertilizer and cattle feed in all over India especially in the study area. Many of the local people practice *Azolla* cultivation in their home commercially. Farmers exploit wetland as a grazing ground for their cattle. Many grass members such as *Echinochloa* sp., *Ischaemum* sp., and *Cyperus* sp. (Cyperaceae) are extensively given to eat. Seeds of *Echinochloa* sp. and *Oryza rufipogon* used in poultry to feed the birds.

Wetland macrophytes are cornerstones of an aquatic environment and have the physiological ability of removing mineral nutrients and heavy metals. It has been demonstrated that wetland plants such as *Eichhornia crassipes*, *Phragmites* sp. and *Typha* sp. has been utilized as a mean of reducing the nutrient level of the polluted water, while *Phragmites karka* has low heavy metal sequestering ability (Uka *et al*; 2010). *Pandanus* and dried parts of *Eichhornia* is very good at barricade erosion.

Many local folks exploit wetlands commercially. The most important wetland plants used as source of income are *Eichhornia crassipes* and *Pandanus odorifer* that are used for making mats, baskets and other domestic objects. Even though *Eichhornia* is regarded as the worst aquatic pest plant in almost all tropical nations, some cottage industries localized in the study area concentrated in the making of handicrafts from this through which many women got employment. It is very interesting that eco-friendly products can be made from most notorious weed plant like *Eichhornia*. Now a day, dried plant parts of *Eichhornia* is used as a substratum for mushroom cultivation that was already practiced in Philippines year ago (Ratchance ; 1972). The stem of *Arundo donax* and *Phragmites karka* used for making flutes, toys and fishing rods. Even though *Arundo* is extensively used in pulp industries in other states of India, it is unfamiliar to the local peoples of the study area. Inflorescence stalk of

many Cyperaceae members such as *Actino scirpus grossus*, *Cyperus corymbosus* and *C. platystylis* are very long and used for broom making, mat weaving, etc. Many farmers cultivated *Nymphaea* and *Nelumbo*, in their home for marketing though these were used for various ritual activities, medicines and ornamental purposes. In many of the Indian states lotus seeds are available in the market as a vegetable other than the southern region of India.

The forgoing account revealed that the ecosystems investigated showed best with the traditional knowledge and there is an urgent need to protect these water bodies, and thus biological diversity can be preserved. Most of them not only affect local biodiversity and ecosystem functioning but also human use and employment generation. From now it is very important to safeguard this knowledge for the benefit of the society and mankind.

Different utilization patterns of wetland plants are mentioned below:-

1. *Acorus calamus* L., Poaceae
Consumption of powdered rhizome with egg white used to cure whooping cough.
Stem and leaves used in cool drinks for getting pleasant odour.
2. *Actino scirpus grossus* (L. f.) Goetgh. & D. A. Simpson, Poaceae
Inflorescence axis is used for broom making and mat weaving.
3. *Alternanthera philoxeroides* (Mart.) Griseb., Amaranthaceae
Leaves and tender shoots are used as leafy vegetable and fodder.
4. *Alternanthera sessilis* (L.) R. Br. ex DC., Amaranthaceae
Leaves and tender shoots are given to women to increase milk production soon after delivery, leafy vegetable and fodder.
5. *Ammania baccifera* L., Lythraceae
Daily consumption of plant juice can control arthritis.
6. *Aponogeton appendiculatus* Van Bruggen, Aponogetonaceae
The starchy tuber is used as food.
7. *Arundo donax* L., Poaceae
Stem used for fencing, making walking sticks, flutes, toys, fishing rods.
8. *Azolla pinnata* R. Br., Azollaceae
Extensively cultivated in the study area and as biofertilizer and cattle feed.
9. *Bacopa monnieri* (L.) Pennell, Scrophulariaceae
Used against constipation, epilepsy. Daily consumption of plant juice with butter can increase mental ability and memory in children.
10. *Brachiaria mutica* (Forssk.) Stapf, Poaceae
Widely used as cattle feed in the study area.
11. *Coix lacryma – jobi* L., Poaceae
Chains (kondha) are prepared using seeds.
12. *Coldenia procumbense* L., Boraginaceae
External use against swellings and allergy.
13. *Colocasia esculenta* (L.) Scott, Araceae
Starchy tubers are edible and available in the market in the form of vegetables.
14. *Cyperus corymbosus* Rottb., Cyperaceae
Inflorescence axis is used for broom making and mat weaving.
15. *Cyperus difformis* L, Cyperaceae
Used as cattle feed.
16. *Cyperus haspan* L., Cyperaceae
Used as cattle feed.
17. *Cyperus platystylis* R. Br., Cyperaceae
Inflorescence axis is used for broom making and mat weaving.
18. *Cyperus rotundus* L., Cyperaceae
Root tuber is given to women to increase milk production soon after delivery and used as baby food by mixture with cow milk. Consumption of root tuber with honey can control diarrhoea in children.
19. *Echinochloa colona* (L.) Link., Poaceae
Used as bird and cattle feed.
20. *Echinochloa crus-galli* (L.) P. Beauv, Poaceae
Grains are edible for human.
Used as bird and cattle feed.
21. *Echinochloa stagnina* (Retz.) P. Beauv, Poaceae
Used as bird and cattle feed
22. *Eclipta prostrata* (L.) L., Asteraceae
Widely used for making hair oil and shampoo.
23. *Eichhornia crassipes* (Mart.) Solms-Laub, Pontederiaceae
Used for making different kinds of handicrafts such as baskets, mat, etc.
Used as a substratum for mushroom cultivation.
Local peoples cover up the shorelines with dried parts of plant to control soil erosion.
Widely used in the cottage industry as a raw material.
24. *Glinus oppositifolius* (L.) A. DC., Molluginaceae
Leafy vegetable, used against several skin diseases
25. *Hydrilla verticillata* (L. f) Royle., Hydrocharitaceae
Source of food for aquatic organisms

26. *Hygrophila schulli* (Buch. - Ham.) M. R & S. M., Acanthaceae
Widely used to prepare 'Kashayam' to cure jaundice and a well known medicine for impotency, rheumatic fever and gonorrhoea.
Leaves are edible often used in house as vegetable.
27. *Ipomoea aquatica* Forssk., Convolvulaceae
Leaves are used as blood purifier.
Used as cattle feed.
28. *Ipomoea carnea* Jack., Convolvulaceae
Many of the locals used the stout stem in the form of fire wood.
29. *Ischaemum mangluricum* (Hack.) Stapf ex C. E. C. Fisch., Poaceae
Used as cattle feed.
30. *Ischaemum molle* Hook. f., Poaceae
Used as cattle feed.
31. *Ischaemum nilgiricum* Hack., Poaceae
Used as cattle feed.
32. *Ischaemum rugosum* Salisb., Poaceae
Used as cattle feed.
33. *Lemna perpusilla* Torrey., Araceae
Source of food for aquatic organisms and birds.
34. *Monochoria vaginalis* (Burm .f.) Presl., Pontederiaceae
Daily consumption of plant juice can control Epilepsy.
External usage of paste of leaves and flowers can heal burns and scars.
35. *Nelumbo nucifera* Gaertn., Nelumbonaceae
Very good at many ailments such as kidney stone, diarrhoea, cholera, jaundice, influenza, night blindness
To eradicate the effect of snake venom, consume the water with grinded lotus flower
Grow in home garden as ornamental plant.
Utilize for ritual activities in temples, poojas, etc.
Tubers possess high nutritional quality and medicinal property. Consumption of tuber with cow milk can dissolve kidney stones.
Tubers used as food.
36. *Nymphaea nouchali* Burm. f., Nymphaeaceae
Daily consumption of plant juice with cow milk is a best cure for osteoporosis.
Grow in home garden as ornamental plant.
Utilize for ritual activities in temples, poojas, etc.
Seed is edible
37. *Oryza rufipogon* Griff., Poaceae
Grains used as food for humans, animal and bird feed.
38. *Oryza sativa* L., Poaceae
Rice (grains) is one of the important foods of south Indians in their daily menu and it is widely cultivated all over India. Paddy straw is a widely used cattle feed.
39. *Pandanus odorifer* (Forssk.) Kuntze., Pandanaceae
Used for making different kinds of handicrafts such as baskets, mat, etc.
Local peoples cover up the shorelines with dried parts of plant to control soil erosion.
Widely used in the cottage industry as a raw material.
40. *Panicum auritum* Presl ex Nees., Poaceae
Used as cattle feed.
41. *Panicum repens* L., Poaceae
Used as cattle feed.
42. *Paspalum scorbiculatum* L., Poaceae
Used as cattle feed.
43. *Persicaria pulchra* (Blume) Sojak, Polygonaceae
Root can be used against snake venom.
Used as cattle feed.
44. *Phragmites karka* (Retz.) Trin. ex Steud., Poaceae
Stem used for making walking sticks, flutes, fishing rods, etc.
45. *Pistia stratiotes* L., Araceae
External application can cure swellings.
46. *Saccharum spontaneum* L., Poaceae
Consumption of water boiled with root used to cure urinary infections.
47. *Sacciolepis interrupta* (Willd.) Stapf., Poaceae
Grains used as food for human.
Used as cattle feed.
48. *Sesbania javanica* Miq., Fabaceae
Utilize in the form of biofertilizer in the home gardens of the study area.
49. *Sphaeranthus indicus* L., Asteraceae
Daily consumption of root with curd is well known for the treatment of piles
50. *Spilanthes ciliata* HBK., Asteraceae
Leaves and flowers used against tooth ache
51. *Typha angustifolia* L., Poaceae
Consumption of water boiled with root used to cure urinary infections.
52. *Vetiveria zizanioides* (L.) Nash, Poaceae
Used in cosmetic industries for making soaps, perfumes, etc.
Used as a fumigants for Mosquito, ritual activities

Table 1: Species inventoried with respective use value.

Taxa	Vernacular Name	Uses	Use value
<i>Acorus calamus</i> L.	Vayambu	Med, Dom, Com	1.47
<i>Actino scirpus grossuss</i> (L. f.) Goetgh. & D. A. Simpson	-	Baf, Dom	0.83
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Kozhuppa cheera	Edi, Baf	0.56
<i>Alternanthera sessilis</i> (L.) R. Br. ex DC.	Kozhuppa, Meenangani	Edi, Med, Baf	0.67
<i>Ammania baccifera</i> L.	Neer mel narippu	Med	0.33
<i>Aponogeton appendiculatus</i> Van Bruggen	-	Edi	0.33
<i>Arundo donax</i> L.	-	Dom, Com	2.00
<i>Azolla pinnata</i> R. Br.	-	Baf, Oth	1.67
<i>Bacopa monnieri</i> (L.) Pennell	Brahmi	Med	0.87
<i>Brachiaria mutica</i> (Forssk.) Stapf	Theetta pullu	Baf	0.67
<i>Coix lacryma – jobi</i> L.	Poocha kallu	Oth	0.33
<i>Coldenia procumbense</i> L.	Thekkada	Med	0.33
<i>Colocasia esculenta</i> (L.) Scott	Kaattu chembu	Edi	2.22
<i>Cyperus corymbosus</i> Rottb.	Paya pullu	Dom	0.50
<i>Cyperus difformis</i> L.	-	Baf	0.50
<i>Cyperus haspan</i> L.	-	Baf	0.33
<i>Cyperus platystylis</i> R. Br.	Chool pullu	Dom	0.56
<i>Cyperus rotundus</i> L.	Muthanga	Edi, Med	1.01
<i>Echinochloa colona</i> (L.) Link.	-	Baf	1.33
<i>Echinochloa cruss-galli</i> (L.) P. Beauv	-	Baf	1.42
<i>Echinochloa stagnina</i> (Retz.) P. Beauv	-	Baf	1.10
<i>Eclipta prostrata</i> (L.) L.	Kanjunni	Med, Dom, Com	1.13
<i>Eichhornia crassipes</i> (Mart.) Solms-Laub	Kula vazha	Dom, Com, Oth	1.56
<i>Glinus oppositifolius</i> (L.) A. DC.	Seetha priya	Edi, Med	0.56
<i>Hydrilla verticillata</i> (L. f.) Royle.	-	Baf	1.00
<i>Hygrophila schulli</i> (Buch. - Ham.) M. R & S. M.	Vayal chulli	Med	1.10
<i>Ipomoea aquatica</i> Forssk.	-	Med, Baf	0.50
<i>Ipomoea carnea</i> Jack.	-	Dom	0.33
<i>Ischaemum mangluricum</i> (Hack.) Stapf ex C. E. C. Fisch.	-	Baf	0.50
<i>Ischaemum molle</i> Hook. f.	-	Baf	0.67
<i>Ischaemum nilgiricum</i> Hack.	-	Baf	0.50
<i>Ischaemum rugosum</i> Salisb.	-	Baf	0.33
<i>Lemna perpusilla</i> Torrey.	-	Baf	1.00
<i>Monochoria vaginalis</i> (Burm. f.) Presl.	Karingoovalam	Med	0.50
<i>Nelumbo nucifera</i> Gaertn.	Thaamara	Edi, Med, Com, Oth	2.33
<i>Nymphaea nouchali</i> Burm. f.	Aambal	Edi, Med, Com, Oth	1.56
<i>Oryza rufipogon</i> Griff.	Vari nellu	Edi, Baf	1.25
<i>Oryza sativa</i> L.	Nellu	Edi, Baf, Dom, Com	3.9
<i>Pandanus odorifer</i> (Forssk.) Kuntze.	Kaitha	Com, Oth	1.42
<i>Panicum auritum</i> Presl ex Nees.	-	Baf	0.67
<i>Panicum repens</i> L.	-	Baf	0.60
<i>Paspalum scorbiculatum</i> L.	-	Baf	0.56
<i>Persicaria pulchra</i> (Blume) Sojak	Peraratha	Med	0.56
<i>Phragmites karka</i> (Retz.) Trin. ex Steud.	-	Oth	0.78

<i>Pistia stratiotes</i> L.	Neer pola	Med	0.33
<i>Saccharum spontaneum</i> L.	Naaykarippu	Edi	1.00
<i>Sacciolepis interrupta</i> (Willd.) Stapf.	Chaama	Edi, Baf	0.89
<i>Sesbania javanica</i> Miq.	-	Oth	0.83
<i>Sphaeranthus indicus</i> L.	Adakkamaniyan	Med	0.50
<i>Spilanthus ciliata</i> HBK.	Pallu vedhana chedi	Med	0.56
<i>Typha angustifolia</i> L.	Eraka pullu	Med	0.33
<i>Vetiveria zizanioides</i> (L.) Nash	Ramacham	Dom, Com, Oth	1.00

Edi = Edible, Med = Medicine, Baf = Bird & animal feed, Dom = Domestic use, Com = Commercial, Oth = Other uses



Eichhornia crassipes



Dried petiole



Handicrafts



Pandanus odorifer



Dried leaf blade



Handicrafts



Plate 1: Making handicraft from *Eichhornia* and *Pandanus*

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REFERENCES

- Maltby E., 1986. Waterlogged Wealth. Why waste the world's wet places. Earth scan, London.
- Chowdhury M.M.R., Shahjahan M., Rahman M.S. and Islam M.S., 2008. Duckweed (*Lemna minor*) as supplementary feed in Monoculture of Nile Tilapia, *Oreochromis niloticus*, J. Fish. Aquatic Sci., pp.54-59.
- Gopalan C.S., Balasubramanian C., Ramasasthri B.V. and Rao K., 1971. Nutrition Atlas of Asia. National Institute of Nutrition, Hyderabad.
- Jyothy P.V. and Suresh Kumar S., 2014. Flora of medicinal significance in Kol wetlands of Ponnani, Kerala, J. Aq. Bio. and Fish., 2: 252-259.
- Petre T., 1993. Aquatic weeds and fisheries production in developing regions of the world, J. Aquat. Plant Manage., 31: 5-10.
- Philips O.L. and Gentry A.H., 1993. The useful plants of Tambopata, Peru: I. Statistical hypothesis test with a new quantitative technique. Econ. Botany, 47(1):15-32.
- Ratchance K., 1972. Water hyacinth, Abstract No. 12. Applied Scientific Research Cooperation, Thailand.
- Kumar S. and Narayan S., 2010. Growth form of macrophytes in salona tal and its adjoining wetlands of Uttar Pradesh. Int. J. Pharma and Bio Science, 6(2):1-12.
- Abraham S., 2015. The relevance of wetland conservation in Kerala, Int. J. Fauna and Biological Studies, 2(3):1-5.
- Signorini M.A., Piredda M. and Bruschi P., 2009. Plants and traditional knowledge: An ethnobotanical investigation on Monte Ortobene (Nuoro, Sardina), J. Ethnobiology and Ethnomedicine. 5.
- Uka U.N., Mohammed H.A. and Aina E., 2010. Preliminary studies on the phyto remedial potential of *Phragmites karka* in Asia river, Proc. Xth Annual Conference of the Fisheries Society of Nigeria, pp.181-184.