ISSN: 2457-0761

JBC-APRF-4(1): 298-298, 2020

JOURNAL OF BIODIVERSITY AND CONSERVATION

Mangrove plants of Odisha: an ecological indicators & sources of bioactive compounds

Akash Das, R. S. Devi and S. Kumar*

Biodiversity and Conservation Lab, Ambika Prasad Research Foundation, Odisha
*Email-Id: sanjeet.biotech@gmail.com

ARTICLE INFO

Article History

Received: 05 December 2019

Received in revised form:18 March 2020

Accepted: 20 March 2020

Keywords: Mangroves, Bioactive compounds, Pharmacology, Ethnobotany, Bioactivity

ABSTRACT

Mangroves are known to its unique adaptation and tolerance to salt. They have unique plant defence mechanisms which lead to synthesize diverse secondary metabolites. Proper address in this regard is urgently needed to isolate novel bioactive compounds from mangroves to fight against lethal diseases. Keeping this in view, an attempt has made to document the mangroves of Odisha as a source of bioactive compounds through literature & field survey. The results revealed that about 90 plant species found in mangroves of Odisha having future source of potent bioactive compounds. The present study highlights the importance of mangroves of Odisha in ethno-pharmacological research and formulation of new drugs against microbial resistance.

INTRODUCTION

Mangroves are the characteristic intertidal plants group that grows on the tropical and subtropical coastlines (Saenger 2002). They are considered as one of the most specialized ecological assemblages (Figure 2) of halophytes acting as a transition zone between the land and ocean (Neethu and Harilal 2018). They are the botanical amphibians occupy a desiccating heat chocking mud and salt levels that would kill an ordinary plant within hours (Srivastava 2015). Bandaranayake (2002) classified the mangrove plants into True mangrove and Mangal associates, the true mangroves are those which are restricted to the intertidal area where as mangal associates are halophytes and may occur in transitional vegetation and they do not interact with true mangroves. The common mangroves plants are *Rhizophora mucronata* Lam., *Sonneratia alba* Sm., *Acanthus ilicifolius* L. (Plate 1F), *Avicennia officinalis* L.,

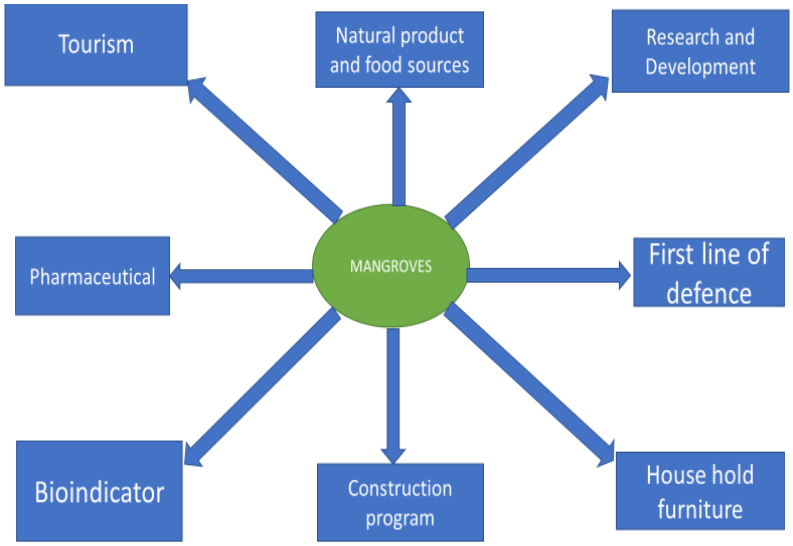

Figure 1: Importance of Mangrove plants in Odisha, India

Excoecaria agallocha L., *Bruguiera gymnorrhiza* (L.) Savigny., *Aegiceras corniculatum* (L) Blanko, *Acrostichum aureum* L., *Aeluropus lagopoides* L., *Clerodendrum inerme* (L) Gaertn., *Caesalpinia crista*, *Dalbergia spinosa* Roxb., *Ipomoea pes carpae* (L.) R.Br., *Drynaria quercifolia* (Linn.) J. Sm. (Plate 1E), *Xylocarpus granatum* K. D. Koenig. (Plate 1D), *Thespesia populnea* (L.) Sol. ex Correa. (Plate 1A), *Sonneratia caseolaris* (L.). Engl. **(**Plate 1B**),** *Cerbera odollam* Gaertn. (Plate 1C) and *Fimbristylis ferruginea* (L.) Vahl (Kumar and Kumara 2012). These are the group of plants (Plate 1) that have different types of morphological and physiological adaptation by which the they can stand in the saline condition (Srivastava 2015). Mangrove plants contain a high source of plant secondary metabolites which have various activities in the field of medicine and pharmacy (Kumar and Dahibhate 2018). The secondary metabolites produced in the mangrove plants may help the plants to with stand in such unfavourable conditions. These secondary metabolites plays important role in different types of defence and survival mechanism (Figure 1). The bioactive compounds in mangroves belong to structural classes such as Nitrogen containing (alkaloids and amines), terpenoids and phenolics such as phenolic acid, tannins, flavonoids and quinines (Kumar and Dahibhate 2018). The bioactive compounds and secondary metabolites from mangroves are with toxicological, pharmacological and ecological importance. Different species of mangroves are being used in traditional medicine. It also has insecticides and pesticides property. The bioactive compounds from mangroves have significance property as antioxidant and antimicrobial (Patra et al. 2011). The secondary metabolites from mangroves are used for the treatment of various diseases like dyspepsia, hepatitis, asthma, diabetes, leukemia, stomach problems, antibacterial, and antihelmintic (Kumar and Dahibhate 2018). The mangrove diversity in the Indo-West pacific (IWP) region is higher than the Atlantic-Caribbean-East pacific (ACEP) regions (Chapman1976). The mangroves diversity in India is about 6.749km² along with 7516.6 km long coastline including island. These mangroves are present in east coast about 4700 km², west coast about 850 km² and 1190 km² in Andaman and Nicobar islands (Mandal and Nashkar 2008). Indian mangroves are primarily present in the tropical and subtropical coastal region. The

mangrove occurs in estuary as well as along open coastlines (Somanta 2017). India has already lost 40% of its mangrove area during the last century (Sahu et al. 2015). Among all mangrove forest in India Sundarbans and Bhitarkanika occupy a large area and other mangrove forests are comparatively smaller. The Sunderbans of West Bengal is largest mangrove region of world followed by Bhitarkanika of Odisha. The Godavari-Krishna mangrove presents in the delta of two rivers Godavari and Krishna in Andhra Pradesh. Pichavaram mangroves in Tamil Nadu are the home of many species of aquatic birds. In Odisha state, mangroves are located within the latitude 19º N and 22º N and longitude 85º E and 87º E. They are distributed in the 3 major zones such as mangroves of the Mahanadi delta, mangroves of the Brahmani and the Baitarani delta (Bhitarkanika) and mangroves of Balasore-Bhadrak coast (Srivastava 2015). The details about mangrove plants are listed in Table-1.

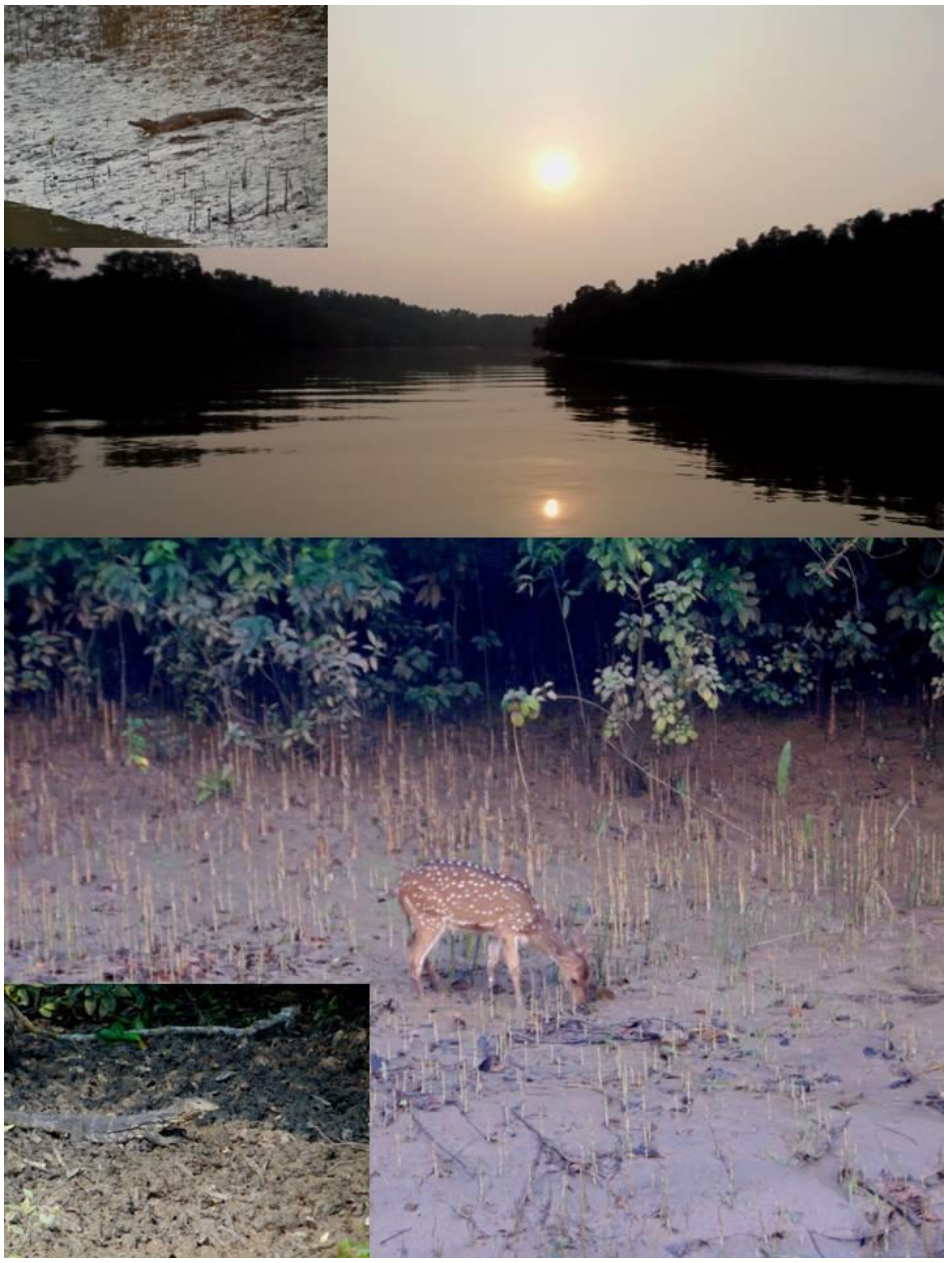

Figure 2: Panoramic view of mangroves of Odisha and their taxa

TRADITIONAL USES OF MANGROVES

The biowealth of mangroves always attract to human beings for their multi-utility potentials. The plant parts are used for various aspects (Bandarnayake 1998). The mangroves plants and its products have been used from the ancient times. In world, the mangroves were initially used in the manufacture of dwellings, furniture, boats and fishing gear, tannins for dyeing. In India traditionally these plants have been exploited for firewood and charcoal. It has also been found that the timber and wood of these plants are used in the construction of roofs and windows. In Odisha, these plants were used as fuel for cooking as well as for making furniture. The details of traditional uses listed in Table 2.

BIOACTIVE COMPOUNDS IN MANGROVES

The mangrove plants contain high amount of bioactive compounds such alkaloid, Flavonoids, amides, tannins, saponins, glycosides, terpenoides, and phenolics. These compounds may contain aromatic rings with hydroxyl or sulfur group (Mondal et al. 2016). These bioactive substances have wide pharmaceutical applications (Wu et al. 2008). Details are listed in Table 3.

PHARMACOLOGICAL VALUES OF MANGROVES

The mangroves plants have high potential because the type of habitat in which it grows is very harsh under this condition the production of some secondary metabolites occurs for their survival (Mishra et al. 2015). The extract from the mangrove plants being used from recent past and it has proven that extracts have inhibitory activity against pathogens. The bioactive compounds from mangrove species have a significance role against microbial growth (Miki et al. 1994). The extract of Mangroves is also a good source of mosquito larvicides, antifungal, antiviral, anticancer anti-diabetic compounds (Wu et al. 1997). Details are listed in Table 4.

MANGROVES AS ECOLOGICAL INDICATORS

The mangroves have some peculiar characteristics so it can be used as indicators of characteristics change or pollution in coast or rise in sea level (Saenger 1996). In the recent time interest have been shown about the response of mangrove shorelines to the sea –level or climate change (Woodroffe 1990). Mangrove plant is used as bio-indicator for different types of environmental pollutions such as heavy metal pollution, organic pollution, hydrocarbon pollution and detection of ozone layer depletion (Sadooni and Ibrahim 1999). The leaves of *Avicennia marina* accumulate high concentration of fluoride and shows reduced seedling growth (Murray 1985). The mangrove plant *K. candel* grows on high copper and zinc polluted area (Chew and Hsiu 1995). *Rhizophora mangle* is a bio-indicator against the pollution of nickel (Gonzalez and Ramirez 1995). Arsenic concentration in young leaves is more than that of mature leaves of mangrove (Kasssava et al. 1991). *Rhizophora mangle* shows viviparity in the presence of high K and Cl. *A. marina* develops highly branched pneumatophores in the oil polluted coast (Grant et al. 1993). It was concluded that a greater number of pneumatophores developed due to high oil pollution (Dasilva et al. 1997).

CONCLUSION

Considering the multiuse of mangroves, is a right choice to screen the bioactive compounds from them to isolate new secondary metabolites to fight against new diseases and disorders. They are ecologically very important for a

landscape. Hence, need to do value addition for making conservation plan at community level. The literature indicates, there is ample scope using mangrove in ethnopharmacology. Hence, need a proper design for sustainable use and conservation activities

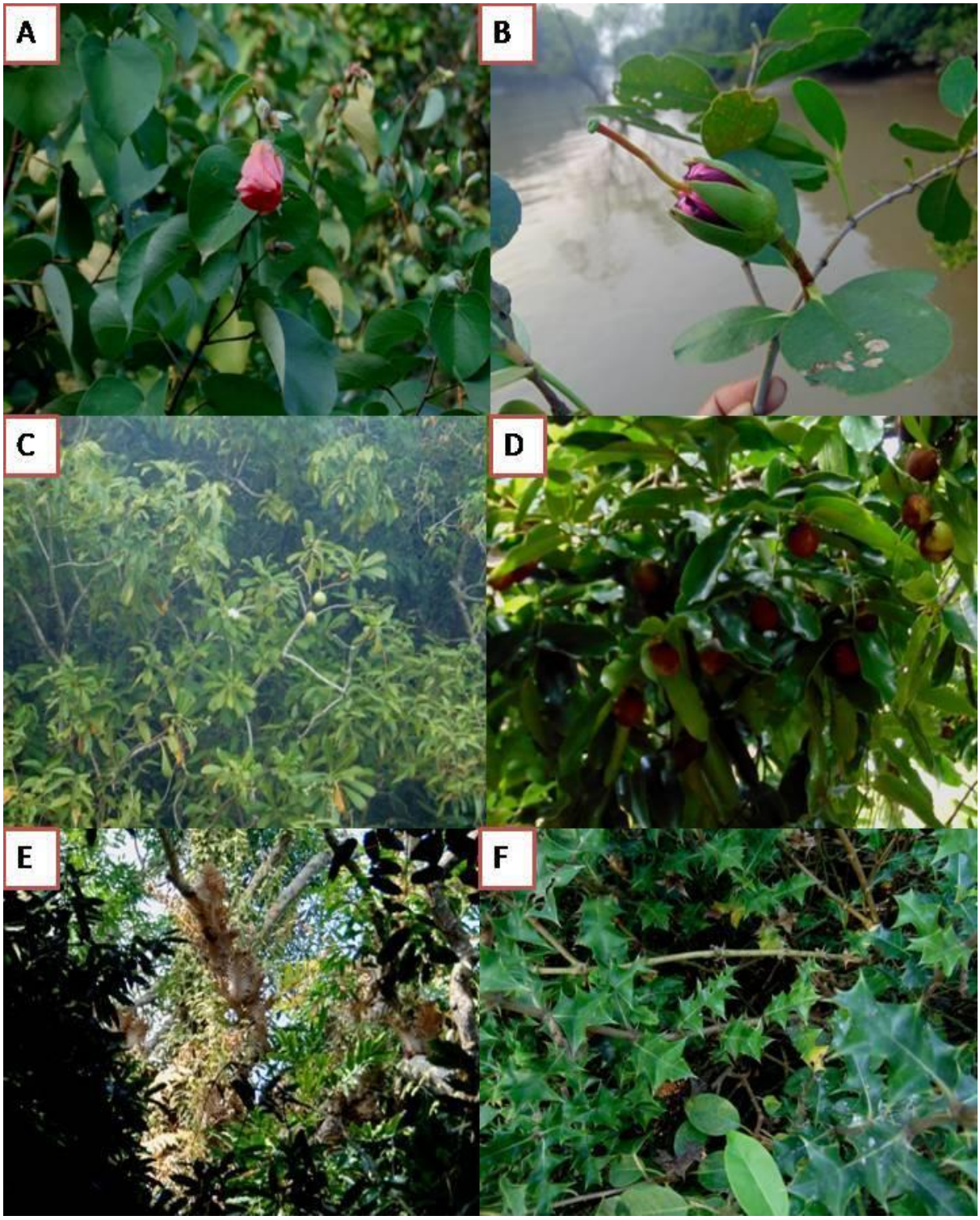

Plate 1: Some common mangrove plants of Odisha; A) *Thespesia populnea;* B) *Sonneratia caseolaris* ; C) *Cerbera odallam;* D) *Xylocarpus granatum*; E) *Drynaria quercifolia*; F) *Acanthus ilicifolius*

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Table 1: Common mangrove plants of Odisha

Odia name	Vernacular name(s)	Botanical name	Family	Distinguishing features
Ooanara	Chinese taro (E)	*Aglaia cucullata* (Roxb.) Pellegrin.	Meliaceae	Leaves compound, leaflets 2-4 pairs and petals longer.
Harakancha	Sea holly (E)	*Acanthus ilicifolius* L.	Acanthaceae	Gregarious shrub up to 2 m tall and bluish white flower.
Harakancha	Sea holly (E)	*Acanthus volubilis* Wall.	Acanthaceae	Bracteoles never present, bract longer than calyx and climber white flower.
Kharkhari	Mangrove fern (E)	*Acrostichum aureum* L.	Acrotichaceae	Fern like leaves and young leaves have crimson colour.
Banarua	Club mangrove (E)	*Aegialitis rotundifolia* Roxb.	Plumbaginaceae	Shrub, leaves shining above and flat stem.
Kharsi	River mangrove(E)	*Aegiceras corniculatum* (L.) Blanco.	Myrsinaceae	Sweet scented and white flowers.
Khandakoli	Toothed leaf allopylus (E)	*Allophylus serratus* (Roxb.) Kurz.	Sapindaceae	Leaves trifoliate, leaflet elliptic, serrate, central leaflet larger than lateral, flowers white, clustered.
DhalaBani	Baen (B)	*Avicennia alba* Blume.	Avicenniaceae	Leaves lanceolate or linear.
SingalaBani	White mangrove (E)	*Avicennia marina* (Forsk.) Vierh	Avicenniaceae	Leaves ovate.
BadaBani	Indian mangrove (E)	*Avicennia officinalis* L.	Avicenniaceae	Pneumatophores longer.
NIL	Mistle toe (E)	*Azima tetracantha* Lam.	Salvadoraceae	Straggling shrub, spines straight, paired in the leaf axils and Flowers yellowish berry white.
Latisundari	Durian laut (M)	*Brownlowia tersa* (L.) Kosterm.	Tiliaceae	Leaves alternate.
Kaliachua	Bakau putih (M)	*Bruguiera cylindrica* (L.) Blume.	Rhizophoraceae	3 flowers in each group
Bandari	Orange mangrove (E)	*Bruguiera gymnorrhiza* (L.) Lamk.	Rhizophoraceae	Leaves reddish beneath.
Dot	Small flower bruguiera	*Bruguiera parviflora* Wt. & Arn.	Rhizophoraceae	Calyx lobes slender.

	(E)			
Bandari	Oriental mangrove (E)	*Bruguiera sexangula* (Lour.) Poir.	Rhizophoraceae	Viviparous germination and hypocotyl up to10 cm long.
Gilo	Fever nut (E)	*Caesalpinia bonduc* (L.) Roxb.	Caesalpiniaceae	Spines on fruit, pods, inflorescence always axillary and flowers yellow.
Nentei	Crested fever nut (E)	*Caesalpinia crista* L.	Caesalpiniaceae	Yellow colour and flowers leaflets always opposite.
Luna samba	NIL	*Canavalia maritima* (Aubl.) Thouars	Fabaceae	Stems with white silky hairs and flowers pink.
Panamia	Suicide tree (E)	*Cerbera odollam* Gaertn.	Apocynaceae	Corolla with a yellow eye.
Garani (Yellow mangrove)	Chiru kandal (T)	*Ceriops decandra* (Griff.) Ding Hou.	Rhizophoraceae	Hypocotyl sharply ridge with blunt.
Garani (Yellow mangrove)	Spurred mangrove (E)	*Ceriops tagal* (Perr.) C. B. Rabinson.	Rhizophoraceae	Hypocotyl upto 25 cm.
Chiani	Glory bower (E)	*Clerodendrum inerme* (L.) Gaertn.	Verbenacea	Scaly under surface of leaves and white flowers with bright red filaments.
Panikenduli	Sukhadarsan (H)	*Crinum defixum* Ker Gawl.	Amaryllidaceae	5-10 white flowers on each peduncle,
Singada	Wrinkle pod mangrove (E)	*Cynometra iripa* Kostel.	Casalpiniaceae	Evergreen small tree and sepals curved distally.
Singada	Balitbitan(H)	*Cynometra ramiflora* L.	Casalpiniaceae	Sepals not curved.
LuniMutha	NIL	*Cyperus arenarius* Retz.	Cyperaceae	Leaves terete and fleshy, often recurved and trigonous.
Hanshi grass	Mali (H)	*Cyperus conglomeratus* Rottb.	Cyperaceae	
Keuti grass	Piripiri (E)	*Cyperus corymbosus Rottb.*	Cyperaceae	
Katha KatiraNai	NIL	*Dalbergia candenatensis* (Dennst.) Prain.	Fabaceae	Leaflet elliptic oblong and white flowers.
Gohirakanta	Chillanki (T)	*Dalbergia spinosa* Roxb.	Fabaceae	Flowers purple whitish and leaflets 9-11.
Mangala	Honey suckle mistle toe (E)	*Dendrophthoe falcata* (L. f.) Etting.	Loranthaceae	Flowers orange in racemes, subrended by a single sub orbicular bract and petals 5.
Dhalakatira	Gonj	*Derris scandens* (Roxb.)	Fabaceae	Leaflet elliptic

Nai	(E)	Benth.		oblong with acute tip 3-6 pairs.
Kala Katira Nai	Karanjvel (M)	*Derris trifoliata* Lour.	Fabaceae	Cilmber, glabrous, leaflets 3-5, alternate and rose coloured flowers.
Gosinga	Mangrove trumpet tree (E)	*Dolichandrone spathacea* (L. f) K. Schum,	Bignoniaceae	Long tubed flower, young leaves often reddish.
Guan	Binding mangrove (E)	*Excoecaria agallocha* L.	Euphorbiaceae	Exudes white latex on injury.
Luni grass	Common finger rush (E)	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	
KhasaiLata	Kalak kambing (E)	*Finlaysonia obovata* Wall.	Asclepiadaceae	Flowers white or purple and corolla densely white inside.
Bahumruga	Whip vine (E)	*Flagellaria indica* L.	Flagellariaceae	Tall herb, often climbing and drupe globose with a produced base turning pinkish red on maturity.
NIL	Salt heliotrope (H)	*Heliotropium curassavicum* L.	Boranginaceae	Leaves lanceolate, shallowly retuse, fleshy and silvery and flowers white in terminal.
Bdasundari	Sundari (B)	*Heritiera fomes* Buch. -Ham.	Sterculiaceae	Bark inner brown turn reddish.
Kanikasundari	Sundar (B)	*Heritiera Kanikensis* Majumdar& Banerjee.	Sterculiaceae	The species is similar to *H fomes*.
Dhalasundari	Water coconut (E)	*Heritiera littoralis* Dry and ex Ait.	Sterculiaceae	Fruit smooth with a rudder like.
Bania	Sea hibiscus (E)	*Hibiscus tiliaceus* L.	Malvaceae	Evergreen shrub, epicalyx present, petal light yellow.
Hoya	Wax plant (E)	*Hoya parasitica* (Roxb.) Wall	Asclepiadaceae	Leaves broadly elliptic-oblong, fleshy, glaborous, yellowish green.
NIL	East Indian water bluet (E)	*Hydrophylax maritima* L. f	Rubiaceae	Succulent herb leaves fleshy, ovate-elliptic, flowers lilac and fruit oblong-ovoid.
Maasitha	Pacific teak (E)	*Intsia bijuga* (colebr.) Kuntz.	Caesalpiniaceae	Compound leaf, whitish brown bark and petal solitary, at first white turning red.
NIL	Beach moon (E)	*Ipomea tuba* (Sch.) G. Don	Convolvulaceae	Large twiner and corolla white large

				with a long and narrow tube,.
Kansarilata	Goat foot vine (E)	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Leaf apex bifurcate, persistent large calyx and reddish at margin.
Sinduka	Gudia (B)	*Kandelia candel* (L.) Druce.	Rhizophoraceae	Hypocotyl upto 40 cm long.
Mahi	Indian Ash tree	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Leaves clustered at the end of thick branchlets, beneath. flowers small yellowish green.
NIL	Beach Launea (E)	*Launaea sarmentosa* (Wild.) Schultz-Bip.	Asteraceae	Perennial, prostrate, stoloniferous herb, rooting at each rosette and leaf margins denticulate.
Churunda	White flowered black mangrove(E)	*Lumnitzera racemosa* Wild.	Combretaceae	Flowers white and sessile.
Banalembu	Mangrove lime (E)	*Merope angulata* (Wild.) Swingle	Rutaceae	Flowers white, fruits triangular in section, 2 to 3 cm large.
Luna Baidanka	Sea bean	*Mucuna gigantea* (Wild.) DC.	Fabaceae	Leaflets ovate-elliptic, acuminate, glaborous, lateral leaflets in equilateral. Flowers in umbellium corymbs and corolla greenish-yellow.
Nailagrass	NIL	*Myriostachya wightiana* (Needs. ex Steud.) Hook. f.	Poaceae	Leaf blade broad, serrated, inflorescence panicles and whorled flowering.
Nypa palm	Nipa (E)	*Nypa fruticans* (Thunb.) Wurumb.	Arecaceae	Rhizomatous palm and looks like sunken coconut palm.
Ketakikia	Umbrella tree (E)	*Pandanus fascicularis* Lam.	Pandanaceae	Male inflorescence sweet-scented and fruiting carpels without an apical prickle.
Lunikia	Kattukaitha (Mal)	*Pandanus foetidus* Roxb.	Pandanaceae	Much branched, male inflorescence foetid and fruiting carpels with apical prickle.
Raigidi	Ambarvel (H)	*Pentatropis capensis* Bullock.	Asclepiadaceae	Twining herb with milky latex, leaves

				small size and corolla lobes lanceolate.
Hental	Sea date (E)	*Phoenix paludosa* Roxb.	Arecaceae	Leaves are like date palm, trunk erect, stem annular and single spathe.
Nala	Tall reed (H)	*Phragmites karka* (Retz.) Trin.	Poaceae	Culms erect, stout, leaf blades flat, lanceolate and inflorescence panicles.
Karanja	Indian beach tree (E)	*Pongamia pinnata* (L.) Pierre	Fabaceae	Evergreen leaves broadly ovate with acute tip and fruit flattened but thick with blunt tip.
DhaniDhana	Dhani harakata (B)	*Porteresia coarctata* (Roxb.) Tateoka.	Poaceae	Leaves acicular, margin spinulose.
Rai	Tall stilt mangrove (E)	*Rhizophora apiculata* Blume.	Rhizophoraceae	Leaves without acute apex, short petiole petal yellowish.
Rai	Loop root mangrove (E)	*Rhizophora mucronata* Lamk.	Rhizophoraceae	Leaf with mucronate apex, longer petiole, petal whitish and hairy on margin, stamens 8.
Rai	Spotted mangrove (E)	*Rhizophora stylosa* Griff.	Rhizophoraceae	Stigmas on a slender style, hypocotyl smooth,
Batra	Chinese salacia (E)	*Salacia prinoides* DC.	Hippocrateaceae	Scandent shrub and flowers yellowish,.
Batula	Glasswort (E)	*Salicornia brachiata* Roxb.	Chenopodiaceae	Stem fleshy,leaves simple, fleshy, petals yellow and showy.
Miriga	Tooth brush tree (E)	*Salvadora persica* L.	Salvadoraceae	Flowers greenish-white and calyx lobes rounded.
Ghigidi	Kiri makulu (Mal)	*Sapium indicum* Wild.	Euphorbiaceae	Leaves alternate, lanceolate-oblong, exudes white latex, seeds ovoid and dark brown.
Lata Rai	Pala boddu teega (T)	*Sarcolobus carinatus* Wall.	Asclepediaceae	Climbing herb, bracteate and inflorescence unbranched corymb.
Raigadi	Baoli lata (B)	*Sarcolobus globosus* Wall.	Asclepiadaceae	Prostrate or climbing shrub, leaves elliptic and flower whitish green.
Sipal	Club rush	*Scirpus litoralis* Schr.	Cyperaceae	Leaves reduced to

	(E)			bladeless. Spikelet large, short pedicel and bracteates.
Goda Bani	Sea purslane (E)	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Creeping herb, red shining glaborous stems, sepal 5, persistant, margin white and pink corolla absent.
Nabhiankuri	Purple fruited pea egg plant (E)	*Solanum trilobatum* L.	Solanaceae	Leaves 3-lobed and hairy, Flower purple blue, berry globose turned red on maturity.
Orua	Apple mangrove (E)	*Sonneratia alba* J.Smith.	Sonneratiaceae	Calyx cup shaped, ribbed and white petals.
Keruan	Sonneratia mangrove (E)	*Sonneratia apetala* Buch. – Ham.	Sonneratiaceae	Calyx 4 lobed.
Orua	Crabapple mangrove (E)	*Sonneratia caseolaris* (L.) Engler.	Sonneratiaceae	Petiole short or absent petals red colour and veins inconspicuous.
Orua	NIL	*Sonneratia griffithii* Kurz.	Sonneratiaceae	Vein conspicuous and Petals absent.
Giria	Seepweed (E)	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Erect herb, leaf wide and acts as a soil binder.
Giria	South indian seepweed (E)	*Suaeda monoica* Forssk. ex Gmel.	Chenopodiaceae	Leaves linear, obtuse or sub-acute. Flowers polygamous, in slender and lax-spikes.
Giria	Muchole (E)	*Suaeda nudiflora* (Wild.) Moq.	Chenopodiaceae	Erect branches and leaves semi terete, green but reddish after maturation.
Jagula	Nona jhau (B)	*Tamarix dioica* Roxb.	Tamaricaceae	Leaves sheathing, , bracts triangular.
Jagula	Nona jhau (B)	*Tamarix troupii* Hole.	Tamaricaceae	Leaves not sheathing, flowers bisexual, pink-violet.
Pestabadam	Indian almond (E)	*Terminalia catappa* L.	Combretaceae	Female flowers at the base and male flowers distally, fruits of almond shaped develop in clusters at the base of spike.
Habali	Indian tulip tree (E)	*Thespesia populnea* (L.) Sol. ex Corr.	Malvaceae	Leaves deeply cordate, pedicles

				erect.
Puruni	Giant pigweed (E)	*Trianthema portulacastrum* L.	Aizoaceae	Leaves opposite, unequal Flowers solitary sunk in the forks and pinkish.
Swasmari	Antamul (H)	*Tylophora indica* (Burum. f.) Merr.	Asclepiadaceae	Stems twinning, more or less pubescent, follicles 2, lanceolate, smooth and produced into an angular beak.
Sisumar	Canonball mangrove (E)	*Xylocarpus granatum* Koeing.	Meliaceae	Large fruit up to 25 cm diameter and trunk surface smooth.
Pitamari	Passur (B)	*Xylocarpus mekongensis* Pierre.	Meliaceae	Fully deciduous during mid-February and fruit not exceeding diameter of 12cm.
Pitakorua	Canonball mangrove (E)	*Xylocarpus moluccensis* (Lamk.) Roem.	Meliaceae	Leaflets usually 4 0r 6, more less ovate.

(E:English; B:Bengali; H: Hindi; T:Telugu; Mal: Malayalam; O: Odia; M: Malay language)

Table 2: Traditional uses of mangroves

Plant Name(s)	Uses	Source(s)
Rhizophora spp.	Seedlings consumed as food.	Bandanayake (1999)
Rhizophora spp.	Bark consumed with milk against liver disease.	Bandanayake (1999)
Rhizophora mucornata *Bruguiera gymnorhiza* *Ceriop stagal*	Wood is used for construction of buildings.	Bandanayake (1999)
Bruguiera spp. *Rhizophora* spp.	Straight stem used for making roof and window.	Amarsinghe (1988)
Sonneratia spp. *Rhizophora* spp. *Bruguiera* spp.	Timbers are used for making rafters.	Amarsinghe (1988)
Entadapervillei spp. *Gluta tourtour* *Ceiba pentandura*	Stem used for making stilt house by traditional fisherman in Madagascar.	Rasolfo (1997)
Avecennia spp.	Timber used for making dugout timber.	Walsh (1977)
Bruguiera spp. *Ceriops* spp.	Used as fuel for cooking heating.	Sin (1990)
Nypa fructicans	Leaves are used for making shingles for roof thatching.	Mercier and Hamilton (1984)
Sonneratia spp. *Anona* spp.	Pneumatophores used for making corks and fishing boats	Walsh (1977)
Avecennia spp. *R. mangle*	From the ash of the plant soap is made.	Field (1995)

B gymmorhiza *B. sexagula* *C. tagal*	From the bark adhesive substances is made.	Field (1995)
H. fumes *E. agallocha*	Pulp, fibre, cellulose and cellophones are made.	Latif (1965)

Table 3: Bioactive compounds of some Mangrove plants

Botanical name	Bioactive compounds	Source(s)
E. agallocha	The stem extracts contain diterpenes secolabdanoid and *ent*-isopimarane.	Annam et al. (2015)
X. granatum	Alkaloids such as granatoine and xylocarpin .	Cui et al. (2008)
C. tagal	New diterpenes such as tagalenes, tagalsin and lupane type of triterpenes are present.	Wang et al. (2010)
R. mangle	The plant extract contain alkaloids, phenol, steroids, tannins and flavonoids.	Molyneux (2003)
A. marina *X. granatum* *B. sexangula*	The extract contain flavonoid such as rutin, quercetin, kaemapferol and catechin.	Kasim(2012)
A. illicifolius	The ethanol extract shows the presence of terpenoids, steroids and triterpenoids.	Bandaranayake(2002)
K. candel	High flavonoid.	Agoramoorthy(2008)

Table 4: Pharmacological values of some mangroves plants

Botanical name	Pharmacological uses	Source(s)
A. ebracteatus	The leaf stem and bark is used as antibiotics, against skin allergy, snake bites and for cure of common cold	Padmakumar and Ayyakkannu (1997)
A. ilicifolius	Theleaf , bark , fruit , and root is used for the treatment of asthma diabetes , leprosy , paralysis and stomach pain.	Barr et al. (1988)
A. aureum	The leaf and rhizome is used to treat the wound boils and rheumatism.	Balasooria et al. (1982)
A. marina	The leaves show antimicrobial activity.	Abeysinghe and Wasnigtunge (2006)
E. agallocha	The leaves and shot extract show antimicrobial.	Chandrasekan et al. (2009)
E. agallocha *B. gymnorriza*	The trunk extract shows antifungal activity.	Kazuhiko (2002)

S. caseolaris	Shows a significant inhibition activity against cell proliferation of SMMC-7721 human hepatoma cells in an *in vitro* cytotoxic assay.	Minqing et al. (2009)
A. officinalis *B. sexangula*	Antibacterial activity against Pseudomonas species.	Abeysinghe et al. (2006)
Andrographis paniculata	Antioxidant activity	Rafat et al. (2010)
Borreria hispida	Antimicrobial activity against certain microbes	
Euodia redlevi *Oenanthe javanica*	Antioxidant activity.	Rafat et al. (2010)
S.apetala	Antimicrobial activity against antibiotic resistance bacteria.	Varaprasad and Bobbarala et al. (2009)
A. corniculatum, L. Racemosa and *C. decandra.*	Antimicrobial activity against Methicillin resistant, clinical isolates of *Staphylococcus aureus.*	Chandrasekaran (2009)
R. mucronata	Shows the highest antioxidant potential activity as well as antimicrobial activity against pathogenic bacteria.	HaqImdadul et al. (2011).
C. tagal and *Pemphis acidula*	Leaves extract shows antimicrobial activity against Pseudomonas *aeruginosa, Klebsiella pneumoniae, Vibrio parahaemolyticus, S. aureus* and *Vibrio cholera.*	Natarajan et al. (2011)
C. tagal *E. agallocha* *R. stylosa,* *S. paracaseolaris* *Xylocarpus spp*	Extracts of twig and stem shows antitumor activity.	Vinn et al. (2017)
X. moluccensis	Seeds of plants shows inhibitory activity against nitric oxide production and anti-inflammatoryactivity	Palacios et al. (2011)
B. cylindrica, *C. decandra* *R. mucronata* *R. apiculata*	The leaf, bark, root, stilt root, hypocotyls, and flower extracts show insecticidal activity against the dengue vector *Aedes aegypti*.	Ali et al. (2014)