

Status of Tree Diversity in Digha, West Bengal, India with Special Reference to their Phytochemical Constituents

Arnab Bera^{1,*}, Achintya Kumar Samanta¹, Sauris Panda²

¹Department of Botany, Ramnagar College (Vidyasagar University), Depal, Purba Medinipur, West Bengal, INDIA.

²Department of Botany, Charuchandra College (University of Calcutta), Lake Road, Kolkata, West Bengal, INDIA.

ABSTRACT

Background: Digha is a coastal area in the district of Purba Medinipur, West Bengal, India. The vegetation in this area is unstable, like many other coastal zones. Trees play an important role in this region to prevent soil erosion and act as a windbreak. Also, the local people here depend on trees for their livelihood. **Objectives:** The current study aims to enumerate the tree species growing along the Digha seashore with special reference to their IUCN status and phytochemical constituents. **Materials and Methods:** The study area was rigorously surveyed over a period of about 4 years to record the trees of the area. Standard literature and websites were followed to summarize IUCN status and chemical constituents of the documented trees. **Results:** A total of 65 tree species belonging to 59 genera, and under 28 families have been documented with Fabaceae contributing the most (14 species). *Tectona grandis* was the only endangered tree species among the plants recorded. **Conclusion:** Conservation strategies must be adopted by the Forest Department and other government organizations to protect the relevant tree species as well as this fragile biozone.

Keywords: Trees, Digha, Phytochemicals, IUCN Red List, Conservation.

Correspondence:

Mr. Arnab Bera

Department of Botany, Ramnagar College (Vidyasagar University), Depal, Purba Medinipur-721453, West Bengal, INDIA.
Email: arnabbera96@rediffmail.com

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INTRODUCTION

Digha is a seaside area,^[1] situated near the northern tip of the Bay of Bengal. It is a part of the Purba Medinipur district of West Bengal, India. It lies between the latitude of 21°32' N to 22°40'N and longitude of 88°05'E to 89°00'E. Even before India's independence, Digha gained recognition as a tourist destination, and its popularity has grown over time.^[2] Large number of tourists visit Digha mostly between January and December, also on other holidays.^[3] Digha have unique vegetation because of its climate, soil, water and sand dunes. There is a great deal of floral diversity in the freshwater- and saltwater-logging areas, both temporary and permanent. Due to fragile nature,^[4] trees in this area play a vital role in preventing soil erosion. Initiatives have long been in place to create a shelterbelt of *Casuarina equisetifolia* to prevent wind erosion of the surrounding terrain. Although some work has been done on the vegetation of this region, no work has been done so far on the diversity of tree species. The current survey gives a comprehensive account of the diversity of

trees in Digha and nearby areas with emphasis on their IUCN status, and phytochemical profiles.

MATERIALS AND METHODS

Digha, in Purba Medinipur district of West Bengal, India, was the area for this study (Figure 1). Survey of trees in Digha was carried out from February 2019 to October 2023 in three seasons: winter, pre-monsoon, and post-monsoon, in order to make a list of trees, and to assess their current IUCN status. The tree species were identified following standard literature.^[5-7] Correct nomenclature of the species/genera/families is given (www.powo.science.kew.org; downloaded in December 2023). Voucher specimens were preserved in the herbarium of Ramnagar College. IUCN status of the relevant trees was assessed following the website of IUCN (https://www.iucnredlist.org; downloaded in December 2023). Chemical profiles of each tree species were documented by thorough survey of literature (see references).

RESULTS

A total of 65 tree species belonging to 59 genera fewer than 28 families have been documented in this study. Highest number of trees was found under the family Fabaceae (14 species (22%), see Figure 2). List of the tree species along with their IUCN status, and phytochemical profiles is recorded in Table 1.



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Table 1: List of tree species in Digha along with their IUCN status and phytochemical profiles.

Family	Scientific name; Voucher specimen	Vernacular name	IUCN status	Phytochemicals
<i>Acanthaceae</i>	<i>Avicennia alba</i> Blume; Digha 61	Sada bine	LC	Carbohydrates, combined reducing sugar, free reducing sugar, free anthraquinones, steroids, cardiac glycosides, flavonoids, terpenoids and alkaloids. ^[8]
<i>Acanthaceae</i>	<i>Avicennia marina</i> (Forssk.) Vierh.; Digha 76	Moricha bine	LC	Tannins, unsaturated sterols and terpenes, citric acid, oxalic acid, iridoid, carbohydrate and glycosides. ^[9]
<i>Acanthaceae</i>	<i>Avicennia officinalis</i> L.; Digha 68	Bine	LC	Protein, resin, tannins, steroids, glycosides, reducing sugars, terpenoids, cardio glycosides, catachol, phenols and oils. ^[10,11]
<i>Anacardiaceae</i>	<i>Anacardium occidentale</i> L.; Digha 90	Kaju	LC	Cyanidin, peonidin, anacardic acid, quercetin, ferulic acid, cardanol, caffeic acid, ethyl gallate, gallic acid, naringenin, cardolalicyclic acid and myricetin. ^[12,13]
<i>Anacardiaceae</i>	<i>Mangifera indica</i> L.; Digha 34	Aam	DD	Mangiferin and its derivatives, kaempferol, catechins and quercetin. ^[14,15]
<i>Annonaceae</i>	<i>Annona reticulata</i> L.; Digha 17	Nona	LC	Annonaretin A, kaurenoic acid and its derivatives, taraxerol, β -sitosterol and (2S)-di-O-methylquiritigenin. ^[16]
<i>Annonaceae</i>	<i>Monoon longifolium</i> (Sonn.) B. Xue & R.M.K. Saunders.; Digha 06	Debdaru	NE	O-methylbulbocapnine-N-oxide, polyfothine, N-methylnandigerine-N-oxide, oliveroline-N-oxide, pendulamine A, N-pendulamine B, 8-oxopolyalthiane, 16-oxo-5, 13-halimadien-15-oic acid, 16-Oxo-3, 13-clerodadien-15-oic acid, 16-hydroxycyleroda-3, 13-dien-16 and 15-olide, phenolic compounds. ^[17,18]
<i>Apocynaceae</i>	<i>Alstonia scholaris</i> (L.) R.Br.; Digha 28	Chatim	LC	Alkaloids, flavonoids, terpenoids phlobatanins, iridoids, coumarins simple phenolics, steroids, tannins and saponins. ^[19,20]
<i>Apocynaceae</i>	<i>Cascabela thevetia</i> (L.) Lippold.; Digha 93	Kolke	LC	Tannins, saponin, flavonoids, alkaloids, quinones, glycosides, terpenoids, triterpenoids, phenols, coumarins, phenolic acids, cyanins, cardiacglycosides, proteins and carbohydrates. ^[21]
<i>Arecaceae</i>	<i>Areca catechu</i> L.; Digha 23	Supari	DD	Polyphenols such as catechin, epicatechin, alkaloids (arecoline, arecaidine, guvacoline and guvacine), fats (lauric acid, myristic acid, palmitic acid, stearic acid, decanoic acid, oleic acid, dodecenoic acid, tetradecenoic acid and hexadecenoic acid), vitamins (B6 and C) and minerals (calcium, phosphorus and iron). ^[22]
<i>Arecaceae</i>	<i>Borassus flabellifer</i> L.; Digha 47	Tal	NE	Carbohydrates, protein, fats, iron, copper, manganese, zinc, aluminium, alkaloids, saponins, phenol and flavonoids. ^[23,24]
<i>Arecaceae</i>	<i>Cocos nucifera</i> L.; Digha 81	Narikel	NE	Phenols, tannins, leucoanthocyanidins, flavonoids, triterpenes, steroids, alkaloids, catechins, epicatechins, vitamin B, nicotinic acid (B3, 0.64 μ g/mL), pantothenic acid (B5, 0.52 μ g/mL), biotin (0.02 μ g/mL), riboflavin (B2, <0.01 ng/mL), folic acid (0.003 μ g/mL) vitamins B1, B6, and C, pyridoxine, thiamine, folic acid, amino acids and L-arginine. ^[25]

Family	Scientific name; Voucher specimen	Vernacular name	IUCN status	Phytochemicals
<i>Arecaceae</i>	<i>Phoenix sylvestris</i> (L.) Roxb.; Digha 85	Khejur	NE	Carbohydrate, phenols, amino acids, flavonoids, tannins, alkaloids, terpenoids, dietary fibers, essential vitamins and minerals. ^[26,27]
<i>Bignoniaceae</i>	<i>Dolichandrone spathacea</i> (L.f.) K. Schum.; Digha 73	Gorsinga	LC	Caffeic acid derivatives, luteolin derivatives, p-hydroxybenzoic acid, vanillic acid, isoferulic acid and triterpenoids. ^[28]
<i>Calophyllaceae</i>	<i>Calophyllum inophyllum</i> L.; Digha 69	Punnag	LC	Chromanones, xanthonones, ketones, triterpenes and flavonoids. ^[29]
<i>Casuarinaceae</i>	<i>Casuarina equisetifolia</i> L.; Digha 86	Jhau	LC	Casuarine, Gallic acid, Ellagic acid, epicatechin, proanthocyanidins, procatechuic, p-coumaric, chlorogenic acid, catechin and terpenoids. ^[30,31]
<i>Combretaceae</i>	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.; Digha 94	Arjun	NE	Arjunolic acid, Arjunic acid, Arjunglucoside, Arjungenin, Castalagin, Ethylgallate, Gallic acid, Luteolin, Chebulinic acid, Terchebulin and Terminoic acid. ^[32-34]
<i>Dilleniaceae</i>	<i>Dillenia indica</i> L.; Digha 105	Chalta	LC	Tannin, Betulinic acid, myricetin, naringenin, quercetin, dillenetin and rhamnetin. ^[35]
<i>Dilleniaceae</i>	<i>Dillenia pentagyna</i> Roxb.; Digha 99	Bon chalta	NE	Naringenin and its derivatives, dihydroquercetin 5-galactoside along with rhamnetin-3-glucoside, diterpene, diploic acid, kaempferol, quercetin, isorhamnatin, lupeol, betunaldehyde, betulin, betulinic acid, mallic acid, β -sitosterol, stigmaterol and phenolics. ^[36]
<i>Fabaceae</i>	<i>Acacia auriculiformis</i> Benth.; Digha 59	Akashmoni	LC	Carbohydrates, flavonoids, saponins, anthocyanins and tannins. ^[37]
<i>Fabaceae</i>	<i>Albizia lebbek</i> (L.) Benth.; Digha 79	Siris	LC	Protein, fatty acids, saponins, triterpenoids, conjugated triterpenoid and saponins. ^[38]
<i>Fabaceae</i>	<i>Bauhinia acuminata</i> L.; Digha 43	Swet kanchan	LC	Carbohydrate, phenolic compounds, saponins, flavonoids, oils and fats, alkaloids, anthocyanoside, steroids, anthraquinone, terpenoids, resins, amino acid, sugars and cardiac glycosides. ^[39,40]
<i>Fabaceae</i>	<i>Caesalpinia pulcherrima</i> (L.) Sw.; Digha 54	Radhachura	LC	Free amino acids, phenols, tannins, stigmaterol, fatty acids and free sugars. ^[41]
<i>Fabaceae</i>	<i>Cassia fistula</i> L.; Digha 42	Shonalu	LC	Fistulic acid, rhein, rheinglucoside, galactomannan, alkaloids, terpenoids, reducing sugars, saponins, tannins, carbonyl, phlobatanin and steroids. ^[42]
<i>Fabaceae</i>	<i>Dalbergia sissoo</i> DC.; Digha 80	Sisu	LC	Flavonoids, tannic carbohydrate, reducing sugars, anthraquinones, steroids and phenols, saponins, glycosides, alkaloids, proteins, free amino acids, oils and lipids. ^[43]
<i>Fabaceae</i>	<i>Delonix regia</i> (Hook.) Raf.; Digha 88	Gulmohor	LC	Phenolic acids, carbohydrates, flavonoids, stigmaterol, steroids, isolupeol, tannins and glycosides. ^[44]
<i>Fabaceae</i>	<i>Erythrina variegata</i> L.; Digha 78	Parijat	LC	Alkaloids, flavonoids, protein and free amino acids. ^[45,46]

Family	Scientific name; Voucher specimen	Vernacular name	IUCN status	Phytochemicals
Fabaceae	<i>Gliricidia sepium</i> (Jacq.) Kunth; Digha 107	Saranga	LC	Saponins, flavonoids, volatile oils and cinnamic acids. ^[47]
Fabaceae	<i>Peltophorum pterocarpum</i> (DC.) K.Heyne; Digha 33	Kanakchura	-	Peltopterin, free amino acids, phenols, flavonoids and fatty acids. ^[48]
Fabaceae	<i>Pithecellobium dulce</i> (Roxb.) Benth.; Digha 20	Khoi-babla	LC	Phenol, flavonoids and its derivatives, steroids and fatty acids. ^[49]
Fabaceae	<i>Senna siamea</i> (Lam.) Irwin & Barneby; Digha 15	Minjiri	LC	Chromone alkaloids, triterpenoids, steroids, carotenoids, saponins, glycosides, vitamins and minerals. ^[50]
Fabaceae	<i>Tamarindus indica</i> L.; Digha 91	Tentul	LC	Tartaric acid, phenolic acid, apigenin, luteolin, mucilage, pectin, cardiac glycosides, fatty acids and essential minerals. ^[51-53]
Fabaceae	<i>Vachellia nilotica</i> (L.) Hurter & Mabb.; Digha 83	Babla	LC	Proteins, polysaccharides, minerals, polyphenols and its derivatives. ^[54]
Lamiaceae	<i>Tectona grandis</i> L.f.; Digha 31	Segun	EN	Steroid, tannin, saponin, coumarin, protein, carbohydrate, phytosterol, alkaloid, diterpenes and Phlobatannins. ^[55]
Lamiaceae	<i>Vitex negundo</i> L.; Digha 13	Nisinda	LC	Alkaloid, flavonoid, carbohydrates, glycosides, proteins and amino acids, steroids, vitamin C, fat and fixed oil. ^[56]
Lauraceae	<i>Cinnamomum tamala</i> (Buch.-Ham.) T. Nees & C.H. Eberm.; Digha 08	Tejpata	LC	Oxygenated terpenoid, carryophyllene, curcumenol, germacrene D, furanosesquiterpenoids, cinnamyl acetate and terpene hydrocarbons. ^[57]
Lecythidaceae	<i>Barringtonia racemosa</i> (L.) Spreng.; Digha 36	Somudra-phal	LC	Protein, carbohydrate, ascorbic acid, phenol, tannins, alkaloids, steroids and flavonoids. ^[58-60]
Lythraceae	<i>Sonneratia alba</i> Sm.; Digha 95	Sadachak-keora	LC	Alkaloids, phenolic acids, flavonoids, steroids, tannins and saponin. ^[61]
Lythraceae	<i>Sonneratia apetala</i> Banks.; Digha 51	Keora	LC	Carbohydrate, lipid, protein, phenols, calcium, potassium, Magnesium, sodium, phosphorus, copper, iron and zinc. ^[62]
Magnoliaceae	<i>Magnolia pterocarpa</i> Roxb.; Digha 40	-	DD	Polyphenols, free amino acids and sesquiterpenoids. ^[63]
Malvaceae	<i>Heritiera fomes</i> Banks; Digha 103	Sundori		Carbohydrates, alkaloids, glycosides, flavonoids, saponins, sterols, tannins, fixed oil, resins and phenols. ^[64]
Malvaceae	<i>Sterculia foetida</i> L.; Digha 11	Janglibadam	NE	Steroids, saponin, phenol, flavonoid, alkaloid and carbohydrate. ^[65]
Meliaceae	<i>Azadirachta indica</i> A. Juss.; Digha 45	Neem	LC	Azadirachtin, nimbin, nimbidin, nimbolinin, quercetin, sitosterol, gedunin and Salannin. ^[66]
Meliaceae	<i>Swietenia mahagoni</i> (L.) Jacq.; Digha 27	Mehogini	NT	Limonoid, fatty acids, polyphenols and steroids. ^[67]

Family	Scientific name; Voucher specimen	Vernacular name	IUCN status	Phytochemicals
Meliaceae	<i>Xylocarpus granatum</i> J. Koenig; Digha 66	Dhundal	LC	Alkaloids, tannins, sundarbanxylogranins, krishnagranatins, thaixylogranins, granaxylocarpins, xylocarpoids, xylomexicanins, xylocensins, hainangranatamins, xylogranatins, thaigranatins, xylocartin, andhraxylocarpins, protoxylogranatin and protoxylocarpins. ^[68,69]
Moraceae	<i>Artocarpus heterophyllus</i> Lam.;; Digha 09	Kanthal	NE	Carotenoids, flavanoids, volatile acids sterols, anthocyanins and tannin. ^[70,71]
Moraceae	<i>Ficus benghalensis</i> L.;; Digha 22	Bot	NE	Phenols, flavonoids, sterols, alkaloids, tannins, saponin, terpenoids, quinine, rhein, psoralen and bergapten. ^[72]
Moraceae	<i>Ficus hispida</i> L.;; Digha 64	Dumur	LC	Sesquiterpenoids, triterpenoids, flavonoids, coumarins, phenylpropionic acids, benzoic acid derivatives, alkaloids, steroids and other glycosides alkanes. ^[73]
Moraceae	<i>Ficus religiosa</i> L.;; Digha 92	Aswaththa	LC	Phenols, flavonoids, alkaloids and terpenoids. ^[72,74]
Moraceae	<i>Streblus asper</i> Lour.;; Digha 30	Sheora	LC	Lignan, triterpenoids, sterols, cardiac glycosides and fatty acids. ^[75]
Moringaceae	<i>Moringa oleifera</i> Lam.;; Digha 52	Sajina	-	Tannins, saponins, alkaloids, flavonoids, terpenoids, glycoside, steroids and phenols. ^[76]
Myrtaceae	<i>Corymbia citriodora</i> (Hook.) Hill & Johnson; Digha 89	Eucalypt	LC	Alkaloid, flavonoid, phenols, reducing sugar and steroids. ^[77]
Myrtaceae	<i>Eucalyptus globulus</i> Labill.;; Digha 68	Eucalypt	LC	Tannins, saponins, terpenoids, glycosides, alkaloids, phenolic compounds, steroids, cardiac glycosides, terpenes, reducing sugars, carbohydrates, resins, acidic compounds and flavonoids. ^[78]
Myrtaceae	<i>Melaleuca leucadendra</i> L.;; Digha 62	Bhurja-patra	DD	Triterpenoids, phytosterols, flavonoids, phenolics and tannins. ^[79]
Myrtaceae	<i>Psidium guajava</i> L.;; Digha 98	Peyara	LC	Polyphenol, flavonoids, vitamins A, C, iron, phosphorus, calcium and minerals. ^[80]
Nyctanthaceae	<i>Nyctanthes arbor-tristis</i> L.;; Digha 97	Shiuli	LC	Flavanol glycoside, oleanic acid, essential oils, tannic acid, carotene, friedeline, lupeol, glucose and benzoic acid. ^[81]
Pandanaceae	<i>Pandanus odorifer</i> (Forssk.) Kuntze; Digha 29	Keya	NE	Alkaloids, carbohydrates, proteins, steroids, sterols, phenols, tannins, terpenes, flavonoids, gums and mucilage, saponins and glycosides. ^[82]
Primulaceae	<i>Aegiceras corniculatum</i> (L.) Blanco; Digha 49	Khalsi	LC	Alkaloids, phenols, flavonoids, tannins, anthraquinones, glycosides, lignins and sterols. ^[83]
Rhizophoraceae	<i>Bruguiera gymnorrhiza</i> (L.) Lam.;;Digha 10	Kakra phul	LC	Phenol, flavonoids, triterpenoids and tannins. ^[84]
Rhizophoraceae	<i>Ceriops decandra</i> (Griff.) W. Theob.;; Digha 44	Jhanti-garan	NT	Ceriopsin, catechin, procyanidin, ursolic acid, oleanolic acid and lupeol. ^[85]

Family	Scientific name; Voucher specimen	Vernacular name	IUCN status	Phytochemicals
Rhizophoraceae	<i>Rhizophora mucronata</i> Lam.; Digha 37	Vara	LC	Alkaloids, flavonoids, tannins, saponins and sterols. ^[86]
Rubiaceae	<i>Morinda citrifolia</i> L.; Digha 57	Hurdi	-	Protein, lipid, fats, alkaloids, phenols, flavonoids, tannins, saponins and sterols. ^[87]
Rubiaceae	<i>Neolamarckia cadamba</i> (Roxb.) Bossler; Digha 19	Kadam	LC	Indole alkaloids, terpenoids, sapogenins, saponins, tannic acids, tannins, terpenes, steroids, fats and reducing sugars. ^[88]
Rutaceae	<i>Aegle mermelos</i> (L.) Correa; Digha 24	Bael	NT	Citral, limonene, marmelin, rutin, lupeol and 1,8-cineole. ^[89]
Sapindaceae	<i>Spondias pinnata</i> (L.f.) Kurz; Digha 03	Amra	-	Phenol, flavonoids, saponins, anthraquinones, steroid and alkaloids. ^[90]

IUCN status: LC-Least Concerned, VU-Vulnerable, EN-Endangered, DD-Data Deficient, NT-Not Threatened, NE-Not Evaluated.

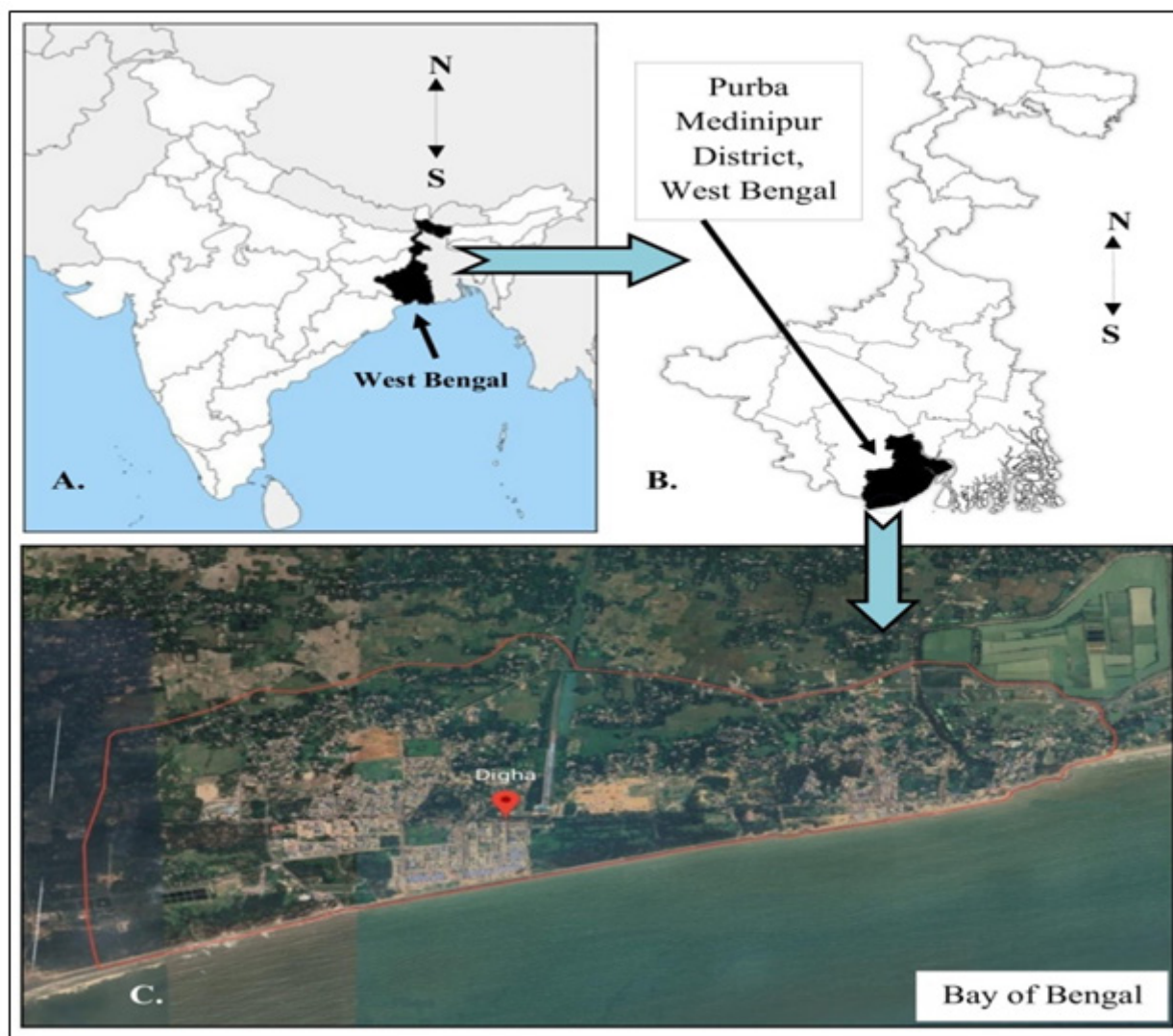


Figure 1: A. Map of India showing West Bengal, B. Map of West Bengal showing Purba Medinipur district, C. Study area showing Digha and its adjoining areas (Source: Google Earth).

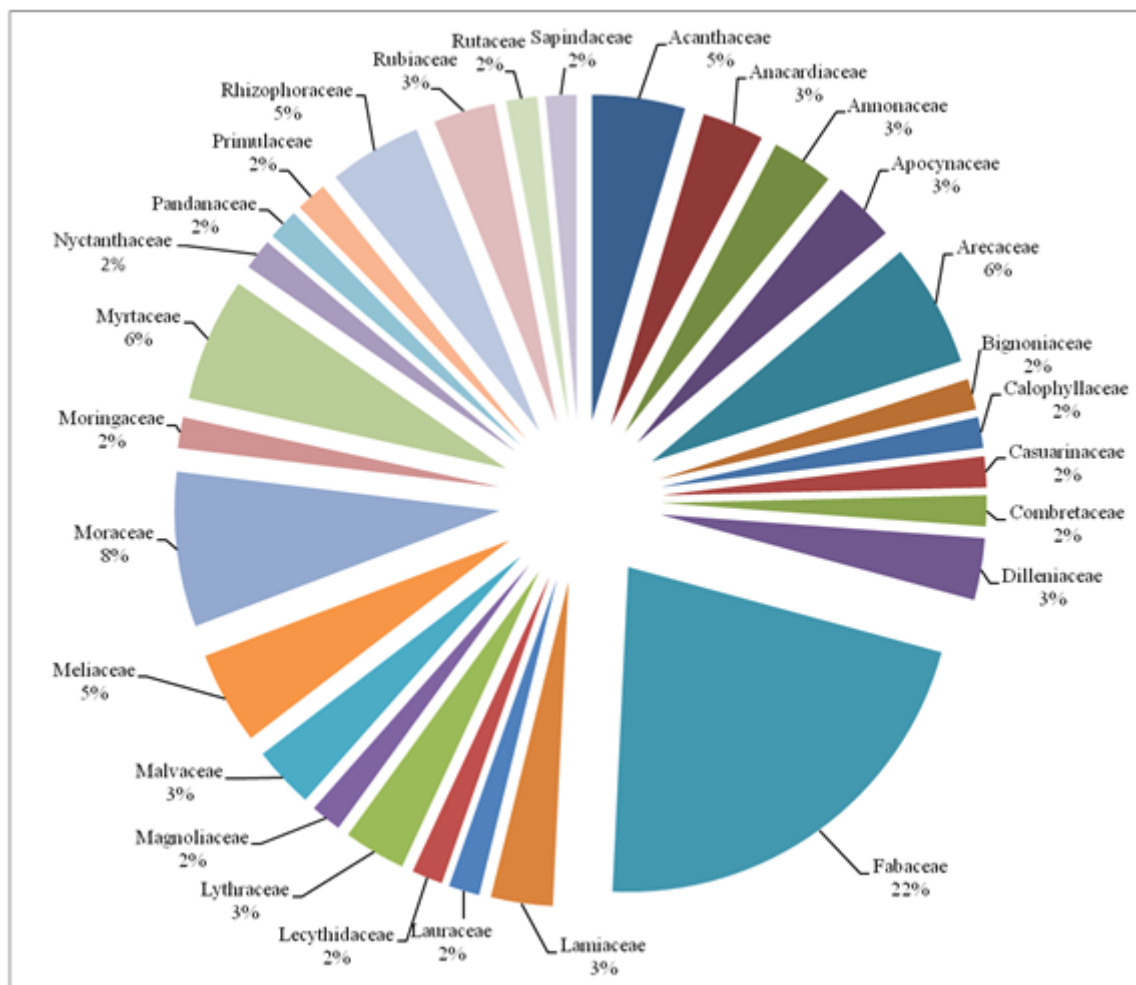


Figure 2: Percentage of tree distribution under different families.

DISCUSSION

The study addresses 65 tree species growing in Digha. *Terminalia arjuna*, *Alstonia scholaris*, *Azadirachta indica* are commonly known medicinal trees in that area. Phytochemical study revealed the presence of arjunolic acid in *Terminalia arjuna*. Arjunolic acid is a novel phytochemical with multiple medicinal properties like antioxidant, antimicrobial, hepatoprotective, cardioprotective activity.^[91,92] Nimbin from *Azadirachta indica* is reported to have antiviral, antifungal, antimicrobial and anti-inflammatory properties.^[93-95] Azadirachtin, another compound from neem plant, is reported to have insect repellent activity.^[96-98] Indole alkaloids of *Alstonia scholaris* exhibit multiple pharmacological properties.^[99,100] *Casuarina equisetifolia* is one of the dominant trees in this area to prevent soil erosion, also acts as a windbreak. In addition, various species of mangroves such as *Sonneratia alba*, *Sonneratia apetala*, *Rhizophora mucronata*, *Ceriops decandra* are found in this coastal belt, which stabilize the habitat. Timber yielding plants like *Tectona grandis* is placed on the endangered

category by IUCN. These ecologically, economically, and medicinally important trees require immediate conservation, both *in situ* and *ex situ*.

CONCLUSION

The study reveals 65 tree species in Digha, which are natural and/or planted. There are a few vulnerable and endangered tree species, that require due attention of the Forest department and other organizations for conservation. Further cultivation of trees in Digha and nearby areas is strongly recommended.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

IUCN: International Union for Conservation of Nature; LC: Least Concerned; VU: Vulnerable; EN: Endangered; DD: Data Deficient; NT: Not Threatened; NE: Not Evaluated; NA: Not Applicable.

SUMMARY

According to the current study, there are about 65 natural/planted trees found in Digha coastal region. The documented trees contain diverse chemical compounds which can be a major source of alternative system of medicine. They also play important roles to prevent soil erosion and function as wind break. Conservation strategies should be applied to protect these trees in fragile coastal region.

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