Original Research Article

ETHNOBOTANICAL STUDY ON SAND-DUNE BASED MEDICINAL PLANTS AND TRADITIONAL THERAPIES IN COASTAL PURBA MEDINIPUR DISTRICT, WEST BENGAL, INDIA

ABSTRACT

Aims: To document, highlight and provide baseline data to preserving traditional uses of sand dune based medicinal plant species.

Place and Duration of Study: Different villages of coastal Purba Medinipur district under West Bengal state in India, between March 2016 to April 2018.

Methodology: The ethnobotanical information was collected through semi-structured interviews and key informant discussion. The data was recorded in a data sheet with the names of the plant species, families, vernacular names, voucher number of plant specimens, habits, life span, flowering and fruiting seasons, Raunkiaer's life form and sub type, IUCN status, plant part (s) used, mode of administration, uses(s), fidelity level (FL) and use value (UV). Data were analyzed using informant consensus factors (ICF), UV and FL for each medicinal plant species used to cure various ailments.

Results:

We documented 130 plant species showing "thero-chamaephytic" phytoclimate belonging to 49 families and 110 genera used for treating 21 human ailments, most of which were herbs. Most remedies were prepared in the form of decoction and used orally. The leaves were most frequently used plant parts. Dental ailments had the highest ICF 0.97, whereas analgesic uses had the lowest 0.5 ICF. *Ochthochloa compressa* had the highest FL (96.81%) being used for skin and wound healing and *Acanthus volubilis* had the lowest (3.33%) for the digestive and respiratory disorder.

Conclusions:

ICF values indicated that there was high agreement in the use of plants associated with dental problems. FL or UV values indicated the more preferred plant species used in study areas. This preferred plant species might be prioritized for conservation and subjected to further studies related to the potential for future. Most of the medicinal plants of the region were collected in the wild and were often harvested for trade. Sustainable harvesting methods and domestication of the highly traded species were thus needed in the study areas.

Keywords: Dune; Ethnobotany; Ethnomedicine; Fidelity level; Informant consensus factor; Purba Medinipur

Introduction

Coastal dunes are eolian landforms that develop in coastal situations where an ample supply of loose, sand-sized sediment is available to be transported inland by the ambient winds. Discharge, cliff and coastal erosion and input from sediment from the sea floor brought in by tides and washovers (Livingstone and Warren, 1996). They are part of unique ecosystems which are at the spatial transition between terrestrial and marine environments.

Coastal dunes are part of the sand- sharing system composed of the highly mobile sea-shore and more stable dune (Psuty and Rohr, 2000).

The micro-environmental conditions of different soil habitats are influenced by prevailing vegetation, soil texture, soil color and other variables. The variability is especially pronounced in sand dunes because of shifting substrate, burial by sand, bare areas among plants, porous nature of sand and minimum organic matter, especially during early stages of dune development (Maun, 2009). Even within a dune system there is disparity in radiative heating of different habitats that is manifested as variation in micro-environment factors such as relative humidity, light, temperature, soil moisture content and wind turbulence (Maun, 2009; Baer et al., 2012). The major factor affecting these changes is the establishment of vegetation that stabilizes the surface, develops sheds, adds humus, aids in the development of soil structure and reduces the severity of drought on the soil surface. The system changes from an open desert-like sandy substrate on the sea-shore to a mature well-developed soil system with luxuriant plant communities (Maun, 2009).

The plant present on coastal sand dunes is called psammophytic species. These species play a vital role in protecting the coast from erosion and flood (Muthukumar and Samuel, 2011). Disturbance of this coastal vegetation has caused growing concern in recent years. India has a 7500 km long coastline with several lagoons, estuaries and mangrove swamps which support rich biotic and abiotic resources (Chakraborty, 2018). With regards to geographical location, 98 km long stretch of Purba Medinipur coast in a significant segment on the east coast, is bestowed with the bounties of natural, biotic and marine resources.

A small coastal region is on the extreme south of the state. A part of the district of Purba Medinipur along the Bay of Bengal constitutes the coastal plane. The emergent costal plane is made up of sand and mud deposited by rivers and wind. Parallel to the coast there are colonies of sand dunes and marshy areas. In some areas dunes occur at a distance of 15-16 km from the coast and are 10-12 m high. West Bengal coastal landscape is valid due to difference in geology, climate, coastal process, geo-morphology, bio-geography, History of land use and actual human influence. Coastal habitats in West Bengal are therefore valued for their geological and geo-morphological, ecological, historical and scenic properties.

Coastal incipient dunes and fore-dunes provide required location for human recreation most of the sandy dunes are overcrowded in rainy season to winter season. A construction of tourist resorts, cottages and roads by the sea coast has virtually destroyed many fore-dunes. Other areas are also heavily used, where seedlings of annuals growing on the dunes are killed by trampling, vehicular traffic, enhanced erosion and burial. Trampling by people kills seedlings and adults plants, thus creating bare sand surface on paths that become susceptible to wind erosion and significant reduction in cover of vegetation.

Spinifex littoreus is a major dune building grass of tropical Bay of Bengal, has the greatest influence on coastal geo-morphology and development of vegetation (Fig. 1b). Another plants species on the fore-dunes, embryo-dunes and bures ridges, on coastal sand dunes along the coast of Purba Medinipur are *Ipomoea pes-caprae*, *Canavalia rosea*, *Hydrophylax maritima*, *Fimbristylis ferruginea*, *Euphorbia tithymaloides*. Fore-dune species in worm tropical and dry regions are stoloniferous hemi-cryptophytes e.g. *Ipomoea pes-caprae* (Fig. 1a) with buds barely embedded in the soil surface (Yeh and Kirschner, 2014; Table 2). Plants propagate towards disturbance-prone drift line by rhizomes or stolons. This is a convergent treat of high adaptive significance that promotes shoreline stabilization. The evolution of this growth from may have been stimulated by erosion of substrate, sand movement and accretion, and fragmentation of populations through wave action. In fact, regular disturbance may also be essential for the proliferation and continuity occupancy of this species.

Fragmentation of rhizome and stolons allows dispersal to new location and establish of new population. Fore dune species are characterized by the ability to occupy a bare area rapidly. Within one year a clamp of *Spinifex littoreus* expanded its area to approximately 15-20 times its original size. Seedling establishment in most cases is stochastic and related more to the amount and regular distribution of rainfall.

The Purba Medinipur district's coastal area is a region of rich floral diversity with diverse vegetation as well as high degree of valuable endemic medicinal plants. Therefore, it is assumed that a large number of medicinal plants in the region along with their indigenous knowledge are still waiting for proper documentation. In this study, we attempted to collect and document traditional ethnobotanical knowledge form the coastal areas of the district of India. Specifically, we aimed to answer the following question: i) What is diversity of medicinal plants of coastal sand dunes in the district? ii) What are the modes of preparation and administration of traditional herbal medicines? iii) What are the most important ailment categories and plant species used in the treatment of those categories in the study areas?

2. Materials and Methods

2.1. *Description of the study areas*

Purba Medinipur district (latitude 22º57′10′′- 21º36′35′′ N and longitude 88º 12′40′′-86º 33′50′′E, average altitude 7 m asl) is one of the 18 administrative districts of West Bengal with its headquarters located at Tamluk. The district was carved out of the erstwhile Medinipur district on January 1, 2002. It is bounded by the Bay of Bengal in the south, river Rupnarayana in the east and Subarnarekha in the west. The Rupnarayana is the joint flow of the river Dwarkeshwar and the river Shilai. The Bay of Bengal and these great rivers and their numerous branches have created a prosperous and easy water navigational system fostering commerce, culture and early contacts with the people outside the region. At the same time, these rivers help to develop the plant vegetation in this region. The surrounding districts are Paschim Medinipur, Howrah and South 24 Pargana in West Bengal and Balasore of Odisha (Fig. 2). The district is spread in an area of 4295 km^2 with a population of 5094238 persons (population density; 1076/km^2) as per 2011 census. Around 90% of the population lives in the rural areas of the district. The survey was conducted on sand dune areas in the coastal stretch of Purba Medinipur district with the assumption of vegetation type will vary with altitude variation which intern may have an impact on the type of ethnomedicinal plant availability.

2.2. *Participant selection, interviewing process and data collection*

The study was conducted from March 2016 to April 2018 across all seasons of the year. Participants were selected based on their ethnomedicinal knowledge. The interviews were carried out on plants used as ethnomedicine among the villagers. Individuals who were locally recognized as knowledgeable on plant use were identified with the assistance of the village elders. The selection in the questionnaire was described as systematic way and Participatory Rural Appraisal (PRA) method. A total of 198 informants were interviewed using a semi-structured questionnaire consisting of open and close-ended questions. There were 17 questions in the questionnaire which were conducted in the local dialect of Bengali language. Due to dynamic nature of ethnobotanical information, this study included plants mentioned by three or more informants to increase the reliability of the obtained data (Martin, 2004). The data was recorded in a data sheet with the names of the plant species, families, vernacular names, voucher number of plant specimens, habits, life span, flowering and fruiting seasons, Raunkiaer's life form and sub type, IUCN status, plant part(s) used, mode of administration, uses(s), fidelity level and use value. After knowing the specific use of the medicinal plants, informers were taken to the field to identify the plants on the basis of vernacular names. Photographs of the plant habit and reproductive structures

were taken and common plants were collected for herbarium preparation. Herbariums were deposited in the herbarium section, Department of Botany, Vidyasagar University. Rare or endangered plants were kept untouched. Collected plants were compared with the literature and identified with the help of standard keys to the specimens (Prain, 1903a, b; Pakrashi and Mukhopadhya, 2004; Paria, 2005; Anon, 2010). All plants scientific name were checked with www.theplantlist.org website and confirmed by only accepted name (The plant list, 2013).

2.3. *Quantitative ethnobotany*

2.3.1. *Fidelity level*

Because many plant species might be used in the same use-category, we needed to determine the most preferred species used for the treatment of a particular ailment, and we did so by calculating fidelity levels(FL) (Friedman et al.,1986):

$$FL=Np/N,$$

Where Np was the number of use-reports cited for a given species for a particular ailment, and N was the total number of use-reports cited for any given species. High FL values (near 100%) were obtained for plants for which almost all use-reports refer to the same method of use, where as low FLs were obtained for plants that were used for many different purposes.

2.3.2. *Informant consensus factor (ICF)*

Informant Consensus Factor (Logan, 1986; Heinrich et al., 1998) was calculated using the following formula:

$$FIC = Nur - Nt/(Nur - 1)$$

Where, "Nur" referred to the total number of use reports for each disease cluster and "Nt" referred to the total number of species used for that cluster. This formula was used to find out the homogeneity in the ethnomedicinal information documented from the traditional informants.

2.3.3. *Use value (UV)*

According to Phillips et al. (1994), the UV was calculated using the following formula:

$$UV = X/N$$

Where, "U" referred to the number of uses mentioned by the informants for a given species and "N" referred to the total number of informants interviewed. If a plant secured a high UV score that indicated there were many use reports for that plant, while a low score indicated fewer use reports cited by the informants.

3. Results and Discussion

3.1. *Demographic characteristics of informants*

The present survey was done among 198 informants who cited different use (s) of the plants especially for the preparation of traditional remedies. Among the informants, 93(46.97%) respondents were men and 105(53.03%) were women. This repartition was not unusual in ethnobotanical investigations in India, as a consequence of the importance of women in the domestic context, where most plant resources, especially alimentary and medicinal plants were managed. This also meant that, in the current investigation, women proved to be main upholders of traditions linked to domestic life. Most of them (81, i.e. 40.91% of all the informants) were professional herbalist; 41(20.71%) were unemployed; 32(16.16%) were housewives; 27(13.64%) were farmers; 11(5.56%) worked as a teacher and only 6(3.03%) employed in government sectors. Age of the informants was from 20 to 80 years. On depending on the age group, 86(43.43%) informants (age ≥61 years) were much higher than 43(21.72%, 51-60 years), 37(18.69%, 41-50 years), 23(11.62%, 31-40 years) and

9(4.55%, ≤ 30 years) respectively. As for educational qualifications, only 2(1.01%) illiterate; 57(28.79%) had only primary school education; 92(46.46%) secondary school education; 29(14.65%) higher secondary school education and only 18(9.09%), had university degree (Table 1, Fig. 3).

3.2. *Different plant taxa*

In the present study, a total of 130 species belonging to 110 genera distributed in 49 families were recorded from the coastal area of Purba Medinipur. The seven well represented dicotyledonous families in species (≥4 species) quantity were: Fabaceae 21(16.15%), Amaranthaceae 7(5.38%), Apocynaceae 5(3.85%), Euphorbiaceae 5(3.85%), Malvaceae 5(3.85%), Rhizophoraceae 5(3.85%), Acanthaceae 4(3.08%) and dominant three monocotyledonous families were Poaceae 11(8.46%), Arecaceae 4(3.08%), Cyperaceae 4(3.08%). Only two pteridophytic families namely Blechnaceae and Pteridaceae contained only single species (Table 2 and 3, Fig. 4).

The seven dominant plant families which encompassed more than 45% genera with descending numbers (≥4 species) were Fabaceae 15(13.64%), Poaceae 10(9.09%), Amaranthaceae 6(5.45%), Apocynaceae 5(4.55%), Euphorbiaceae 5(4.55%), Malvaceae 5(4.55%) and Rhizophoraceae 4(3.64%) (Table 2 and 3).

The one well represented genera containing 3 species were *Opuntia*. Another two well represented genera containing 2 species each were *Acacia*, *Acanthus*, *Avicennia*, *Calligonum*, *Crotalaria*, *Derris*, *Eragrostis*, *Pandanus*, *Phoenix*, *Prosopis*, *Rhizophora*, *Salvadora*, *Senna*, *Suaeda*, *Tamarix* and *Ziziphus*. Another 95 species contained single genus respectively (Table 2).

3.3. *Species diversity in different growth form*

The present floristic study of the sacred grove showed that it harbored a total of 130 plant species [dicots 104(80%), monocots 24(18.46%) and pteridophytes 2(1.54%)] belonging to genera 110[dicots 88(80%), monocots 20(18.18%) and pteridophytes 02(1.82%)] of 49 families [dicots 40(81.63%), monocots 7(14.29%) and pteridophytes 2(4.08%)]. Among these, 50(38.46%) of the reported species were herbs. Other reported species were shrubs 23(17.69%), trees 38(29.23%) and climbers 19(14.62%) respectively. Amongst the total dicots 104(80%), monocots 24(18.46%) and pteridophytes 2(1.54%); herbs, shrubs, trees and climbers represented 32, 20, 35, 17; 16, 3, 3, 2 and 2, 0, 0, 0 species respectively, representing 24.62%, 15.38%, 26.92%, 13.08%; 12.31%, 2.31%, 2.31%, 1.54% and 1.54%, 0%, 0%, 0% of the total species (Table 4, Fig. 5).

Major six herbaceous families (≥3 species) were Poaceae 11(22%), Amaranthaceae 7(14%), Cyperaceae 4(8%), Fabaceae 4(8%), Asteraceae 3(6%) and Rubiaceae 3(6%) held above 64% of the total herb population. The five major less-woody shrub families (≥2 species) were Fabaceae 6(26.1%), Cactaceae 3(13%), Euphorbiaceae 2(8.7%), Malvaceae 2(8.7%) and Pandanaceae 2(8.7%) held above 65% of the total shrub population. The nine most speciose families (≥ 2 species) in descending manner included Fabaceae 6(15.8%), Rhizophoraceae 5(13.2%), Arecaceae 3(7.9%), Acanthaceae 2(5.3%), Lythraceae 2(5.3%), Malvaceae 2(5.3%), Meliaceae 2(5.3%), Salvadoraceae 2(5.3%) and Tamaricaceae 2(5.3%), which contained above 68.7% of the total tree population. Another 12 families contained single tree species. Fabaceae 5(26.3%) and Apocynaceae 4(21.1%) were only two families contained more than one species and clasp above 47.4% of the total liana population (Table 2 and 3).

Most of the documented plant species were herbs (38.46%), followed by trees (29.23%), shrubs (17.69%), and climbers (14.62%). Similar results were reported with analogous studies conducted elsewhere (Purer, 1936; Olff et al., 1993; Castillo and Moreno-Casasola, 1996; Maun, 1998; Arun et al., 1999; Feagin et al., 2005; Sridhar and Bhagya, 2007; Pattanaik et al., 2008). The reason for a dominance of herbaceous plant in use was due

to the study areas being located in the sand dunes in coastal area and herbs being abundantly distributed throughout the study area. The traditional healers preferred to use herbs than other sources, due to comparative ease of collection from sand dunes, more facile preparation of ethnomedicines and were also enable conservation of the required plant species.

3.4. *Life span*

In the sand dune, 32(24.6%) annual plants would go through their life cycle in one growing season. There were 98(75.4%) perennial plants that could survive most unfavorable conditions and would stay alive more than two years (Table 2).

3.5. *Raunkiaer's life form and its distribution*

Phanerophyte was one of the Raunkiaer's life-form categories, whose perennating buds or shoots apices were born on aerial segment. The five most speciose families in descending manner included Fabaceae 13(21.67%), Rhizophoraceae 5(8.33%), Apocynaceae 4(6.67%), Arecaceae 4(6.67%) and Acanthaceae (5%) which contained above 38% of the total phanerophytes. Two major chamaephytic families in descending manner were Fabaceae 4(22.2%), Cactaceae 3(16.7%) total contained 38.9% population. Two leading hemicryptophytic families explicitly Poaceae 7(58.3%) and Cyperaceae 4(33.3%) total contained 91.6% population. Single cryptophytic family is Aponogetonaceae. The five major therophytic families were Amaranthaceae 7(17.95%), Fabaceae 4(10.26%), Poaceae 4(10.26%), Asteraceae 3(7.69%) and Rubiaceae 3(7.69%) and total contained 53.85% population (Table 2).

3.6. *Life form and biological spectrum*

The biological spectrum shows that phanerophytes 60(46.15%) was the dominant, followed by therophytes 39(30%), chamaephytes 18(13.85%), hemicryptophytes 12(9.23%) and cryptophytes 1(0.77%). Of the phanerophytes, nanophanerophytes 36(27.69%) was the dominant than mesophanerophytes 17(13.08%) and megaphanerophytes 7(5.38%) (Table 2 and 5).

It reveals that therophytes, chamaephytes and phanerophytes constitute the higher percentage +17%, +4.85% and +0.15% respectively than the normal spectrum exhibiting "thero-chamaephytic" phytoclimate (phanerophytes was negligible, because its value <1%). Further, the number of hemicryptophytes (-16.77%) and cryptophyte (-5.23%) was comparatively smaller in percentage than the normal spectrum. Of the phanerophytes, nanophanerophytes (+12.69) and megaphanerophytes (+2.38) were somewhat larger and mesophanerophyte (-14.92) comparatively smaller value than the normal spectrum (Table 5, Fig. 6).

3.7. *IUCN categories*

Among these 130 plants, 84 plants have not been evaluated still now. There were 44 Least Concerned (LC), 1 Endangered (EN) and 1 Near Threatened (NT) species. *Heritiera fomes* and *Phoenix paludosa* were the endangered trees and near threatened shrub species according to the IUCN (2018) (Table 2).

3.8. *Plant part(s) used*

All part (s) of various plant species were used against different diseases. The most utilized plant parts were leaves 50 (38.46%) followed by whole plant 42(32.31%), root 35(26.92%), fruit 26(20%), stem bark 22(16.92%), seed 18(13.85), stem 13(10%), bark 9(6.92%), flower 9(6.92%), root bark 6(4.62%), latex 4(3.08), gum 2(1.54%), rhizome 2(1.54%), inflorescence 1(0.77) and tuber 1(0.77) respectively (Table 2, Fig. 7). In some cases, more than one organ of the same species, especially a combination of leaves and stems, were used in the preparation of different remedies. The fact that leaves were the most frequently used part corresponds to similar results were reported in many other ethnomedicinal studies in Asia (Subramanian et al., 2008; Pattanaik et al., 2008; Langenberger et al., 2009; Srithi et al., 2009; Ugulu et al., 2009; Chowdhury and Koike,

2010; Rokaya et al., 2010; Upadhyay et al., 2011; Abe and Ohtani, 2013; Faruque et al., 2018) and in other regions of the world (Giday et al., 2003; Gazzaneo et al., 2005; Teklehaymanot and Giday, 2007; Jeruto et al., 2008; Giday et al., 2009; Ragunathan and Solomon, 2009; Teklehaymanot, 2009; Kimondo et al., 2015; Asefa and Bahiru, 2018). Leaves were commonly used for the preparation of herbal medicines due to likely presence of active compounds and comparative ease of phytochemical and pharmacological studies compared to other parts (Singh and Lal, 2008). It was also observed that residents had been using leaves to identify medicinal plants. Additionally, leaves were the main photosynthetic organs in plants, and photosynthates were translocated to other parts, such as the roots, bark, fruits and seeds. These might act as toxins for protection against predators and some were of medicinal value to humans. Ghorbani (2005) noted that leaves were active in food and metabolite production. The utilization of the underground organs, both roots and rhizomes, was less widespread, whereas aerial organs were highly used. On the other hand, roots were the second frequently used plant part by healers, likely due to their higher concentration of bioactive compounds than other plant parts (Giday et al., 2003; Ragunathan and Solomon, 2009; Ugulu et al., 2009; Allabi et al., 2010; Rokaya et al., 2010; Upadhyay et al., 2011; Sivasankari et al., 2014; Malik et al., 2018). Inhabitants of dry coastal sand regions tend to focus their attention on plant parts that were continuously available, such as bark or roots because plants in such areas might be regularly exposed to long periods of drought and thus lose their leaves. However, the use of roots was more damaging to the health of the individual plant compared to the use of its leaves of branches.

Dominant families utilized were the Fabaceae 21(16.15%), Poaceae 11(8.46%), Amaranthaceae 7(5.38%), Apocynaceae 5(3.85%), Euphorbiaceae 5(3.85%), Malvaceae 5(3.85%), Rhizophoraceae 5(3.85%), Acanthaceae 4(3.08%) Arecaceae 4(3.08%) and Cyperaceae 4(3.08%). Similar results were reported by other ethnobotanists (Moreno-Casasola and Espejel, 1986; Arun et al., 1999; Sridhar and Bhagya, 2007; Pattanaik et al., 2008; Sen, 2018).

3.9. *Preparation and administration*

The main method of preparation was use of the intact plants decoction 51(39.23%), followed by juice 34 (26.15%), paste 17(13.08%) infusion 11(8.46%) raw 9(6.92%) powder 3(2.30%) and pulp 3(2.30%), while oil and vegetable represented the least used (0.78%) (Table 2). In other words, above 66% of the plants were used fresh and 34% were heated somehow. Both internal and external methods of administration were used to cure ailments (Giday et al., 2003; Muthu et al., 2006; Ragunathan and Solomon, 2009; Upadhyay et al., 2011, Soukand et al., 2017). The advantage of external application is safe because external application results in indirect yet immediate local effects on the area and allows for easier regulation of dosages depending on the concentrations of beneficial or toxic compounds.

3.10. *Fidelity level (FL)*

FLs for plant species for a specific disease varied widely, ranging between 1% and 100% for plants in the study area. The maximum FL of 80% to 100% was found for 7 species, including which were, *Ochthochloa compressa* (98.81%), *Prosopis juliflora* (95.38%), *Merope angulata* (89.13%), *Opuntia stricta* (86.15%), *Mimosa pudica* (82.76%), *Spermacoce articularis* (82.67%) and *Ipomoea pes-caprae* (81.25%) respectively, which were used to treat skin and wound healing, child birth and dental problem, skin disease, skin and wound healing, child birth and sexual disease, liver disorder, sexual disease (Table 2). Most of the plants with high FL values had pharmacological effects that had been proven scientifically. On the other hand, the lowest FL (*Acanthus volubilis*), 3.33%, indicated less-preferred species for treating specific ailments. In contrast, these plants had been widely used against several diseases. However, there were 48 plants used against two or more diseases, and 82 plants were used to cure a single ailment. High ICFs and FLs for specific species suggest that the plant

might contain valuable physiochemical compounds. These traditional or local medicines, handed down despite their traditional background had high ICFs and FLs because of their efficacy and safety.

3.11. *Use value (UV)*

In the present study, the UVs, representing the relative importance of plants were such: The six (UVs ≥0.75) most commonly used ethnomedicinal plant species were *Rothia indica* (0.85), *Aegiceras corniculatum* **(**0.80), *Borassus flabellifer* (0.80), *Senna occidentalis* (0.80), *Sarcolobus globosus* (0.79) and *Bruguiera gymnorhiza* (0.75). The five (UVs=0.11) least used species were Cissus *quadrangularis*, *Derris scandens*, *Leucas aspera*, *Ochthochloa compressa* and *Saccharum spontaneum* (Table 2). These species were used for diverse purpose including treating analgesic, antitumor, diabetes, digestive, respiratory and restorative disorder, while the five species with the lowest UV were used to treat metabolic disorder, sexual disease, and skin disease and wound healing. All plants showed a high UV when used for endogenous diseases, such as digestive and respiratory disorders. Our study shows that plants with higher UVs had become more widely used for a variety of diseases in modern times. This was a remarkable consequence and showed the importance of medicinal plants in the region.

3.12. *Informant consensus factor (ICF)*

The documented ethnomedicinal plants were used to treat different ailments which were grouped into 21 different categories. The ICF values ranged from 0.97 to 0.50. The five higher ICF value (≥0.95) in descending order were dental problem (0.97), child birth (0.95), liver disorder (0.95), snake bite (0.95) and wound healing (0.95), while the lowest ICF value was 0.50 for analgesic (Table 6, Fig. 8). This low ICF suggested a lesser level of agreement among informants on the use of plant species to treat this particular disease category. In addition, a low ICF was associated with many plants with almost equally high usage reports. This low ICF might also be explained by availability of easily accessible pharmaceutical that provided alternatives to traditional medicine. These pharmaceuticals might reduce the use of some traditional remedies (Abe and Ohtani, 2013).

The ailments with the highest ICF values (0.97) were dental problems which were treated with specific plant species. *Barringtonia acutangula*, known as "hijal" to the locals. The young shoot of *Prosopis juliflora* and *Prosopis cineraria*, when soaked in water overnight and decocted, could be used for dental remedies. *Prosopis juliflora* (Hebbar et al, 2004; Hari Prasad et al., 2011; Thakur et al., 2014) and *Prosopis cineraria* (Manikandar et al., 2009; Bithu et al., 2012; Patel et al., 2013) was reported to have an antimicrobial effect.

The second highest ICF (0.95) were for child birth, liver disorder, snake bite and wound healing. Child birth was treated by drinking a decoction (42.86%); e.g., *Prosopis cineraria* (Sharma et al., 1992; Jain et al., 2004), *Prosopis juliflora* (Sharma et al., 1992; Wakie et al., 2012) and *Sericostoma pauciflorum* (Dakshini, 1985), followed by juice (42.86%); e.g., *Ceriops decandra* (Abideen, 2007; Iftekhar and Takama, 2008), *Mimosa pudica* (Azmi et al., 2011; Joseph et al., 2013), and *Phyla nodiflora* (Behera, 2006; Sharma et al., 2010) and paste (14.28%); e.g., *Pluchea lanceolata* (Koppikar, 2008; Sanjay et al., 2009). Next same ICF (0.95) value for liver disorder, which was treated by juice (80%); e.g., *Achyranthes aspera* (Samy et al., 1999; Tahiliani and Kar, 2000; Manjunatha et al., 2017), *Spermacoce articularis* (Parameshwar et al., 2010; Conserva and Jesu Costa Ferreira, 2012), *Tamarix indica* (Rahman et al., 2011; Naz et al., 2013) and *Toddalia asiatica* (Hao et al., 2004; Orwa et al., 2008) or drinking decoction (20%); e.g., *Oldenlandia tenelliflora* (Lajis and Ahmad, 2006; Joseph et al., 2010). The third same ICF (0.95) value, was for snake bite, was treated by juice (50%; e.g., *Tylophora flexuosa* (Khanduri, 2016; Kamble et al., 2018) or paste (50%; e.g., *Acanthus ilicifolius* (Bandaranayake, 1998; Singh et al., 2009; Singh and Aeri, 2013).

The incidence of wound healing, ICF (0.95) value were treated by appling paste (50%; e.g., *Aeluropus lagopoides* (Khan and Qaiser, 2006; Qasim et al., 2014), *Balanites roxburghii* (Annan and Dickson, 2008; Chothani and Vaghasiya, 2011), *Ochthochloa compressa* (Hameed et al., 2011), *Suaeda monoica* (Agoramoorthy et al., 2008; Suganthy et al., 2009), drinking decoction (25%; e.g., *Croton bonplandianus* (Divya et al., 2011; Pattanayak et al., 2012), *Sonneratia alba* (Tiwari, 2008)), pulp (12.5%; *Opuntia stricta* (Stintzing and Carle, 2005; Feugang et al., 2006) and juice (12.5%; *Phyla nodiflora* (Biswas and Mukherjee, 2003; Muthu et al., 2006)). It was interesting that not only general disease but also specific ailment such as dental problem was high in the top five ailments. The current studies of ICF results support the finding that dental problem, child birth, liver disorder, snake bite and wound healing and other disorders, was a risk factor for the major cause of death in the coastal Purba Medinipur district of West Bengal in India.

4. Conclusion

This study reveals that plants are still a major source of medicine for local people living in coastal area of Purba Medinipur district. The sand dunes species of the region are extremely important resources, which play a vital role in the economic and social life of nearby people. Modern health care systems in this area are not adequate, and some parts of the population have limited means to by modern medicine. Thus, traditional medicine remains the popular solution for health issues. The dominant parts of most of the medicinal plants, collected from wild sources used to prepare remedies by healers are leaves, whole plants and roots. Our results also reveal the urgency of collecting ethno-pharmacological data because due to modernization, knowledge of ethnomedicinal plants is vanishing.

As described earlier, conservation and judicious utilization of this coastal plant wealth is important because they have been threatened by over-exploitation, clearing of forest, rapid urbanization, human settlements, etc. the vegetation cover of old dunes should be protected, as their base sand surfaces are always washed away by sea water.

The traditional medicine used in the region lacks phyto-therapeutic evidence. It is too necessary to perform photochemical or pharmacological studies to explore the potentiality of plants used for medicinal purpose. The unsustainable harvesting of such medicinal plants that are obtained from wild sources may cause a serious decline in plants population. It is thus recommended that cultivation techniques should be formulated, especially for the most important plants species that may be used widely and traded outside the region. Because the knowledge of the uses of the medicinal plants reported here belongs to the indigenous people of the study area, the benefits obtained from this knowledge should equally be shared with them.

Conflicts of interest

None

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Table 1: Demographic characteristics of informants.

Factors	Categories	Number of the informants	Percentage (%)
Sex	Male	93	46.97
	Female	105	53.03
Profession	Government employee	6	3.03
	Teacher	11	5.56
	Farmer	27	13.64
	Housewife	32	16.16
	Unemployed	41	20.71
	Professional herbalist	81	40.91
Age	≤30	9	4.55
	31-40	23	11.62
	41-50	37	18.69
	51-60	43	21.72
	≥61	86	43.43
Education	Illiterate	2	1.01
	Primary	57	28.79
	Secondary	92	46.46
	Higher Secondary	29	14.65
	University/Technical degree	18	9.09

Table 2: Sand dune based ethnomedicinal plants of Purba Medinipur district in West Bengal, India.

Sl. No.	Name of Species	Family	Vernacular name	Voucher no.	Habitat	Life-span	Fl. and Fr. time	Raunkiaer's life-form	*Sub-type*	IUCN red list status	Plant part(s) used	Mode of administration	Use(s)	Fidelity level (FL)	Use value (UV)
1.	*Acacia jacquemontii* Benth.	Fabaceae	Khayer	USFD-1	S	P	May-Sep.	Ph	*N*	NE	Ba,Gu,St	Infusion	Skin disorder	20.00	2.80
2.	*Acacia senegal* (L.) Willd.	Fabaceae	Khayer	USFD-2	T	P	May-Nov.	Ph	*N*	NE	Fr,Sb	Infusion	Skin disorder	27.66	2.40
3.	*Acanthus ilicifolius* L.	Acanthaceae	Hargoza	USAD-1	S	P	Apr.-Jul.	Ch		LC	Wp	Paste	Snake bite	31.48	3.00
4.	*Acanthus volubilis* Wall.	Acanthaceae	Hargoza	USAD-2	C	P	Mar.-Jul.	Ph	*N*	LC	Se	Raw	Digestive and respiratory disorder	3.33	1.60
5.	*Achyranthes aspera* L.	Amaranthaceae	Apang	USAD-3	H	A	Sep.-Feb.	Th		NE	Wp	Juice	Urinary and liver disorder	50.60	4.27
6.	*Acrostichum aureum* L.	Pteridaceae	Golpata	USPP-1	H	A	Apr.-Jul.	Th		LC	Le,Rh,Ro	Juice	Digestive and urinary disorder	12.50	1.75
7.	*Aegiceras corniculatum* (L.) Blanco	Primulaceae	Khalsi	USPD-1	T	P	Mar.-Aug.	Ph	*N*	LC	Sb	Decoction	Analgesic	3.57	1.25
8.	*Aeluropus lagopoides* (L.) Thwaites	Poaceae	Nona Durba	USPM-1	H	P	All	Th		NE	Wp	Paste	Wound healing	35.19	3.00
9.	*Aerva javanica* (Burm.f.) Juss. ex Schult.	Amaranthaceae	Ulatkambal	USAD-4	H	P	Jul.-Jan.	Th		NE	In,Le	Paste	Rheumatism	45.00	3.25
10.	*Ageratum conyzoides* (L.) L.	Asteraceae	Dochunti	USAD-5	H	A	Nov.-Mar.	Th		NE	Le,Ro	Paste	Skin disease	22.92	2.80
11.	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	Sincheshak	USAD-6	H	A	Jul.-Feb.	Th		LC	Wp	Juice	Digestive and nervous disorder	6.25	1.40
12.	*Anacardium occidentale* L.	Anacardiaceae	Kajubadam	USAD-7	T	P	Mar.-Jun.	Ph	*N*	NE	Fr,Le,Rb, Sb,St	Decoction	Antitumor	60.00	8.14
13.	*Aponogeton natans* (L.) Engl. and K.Krause	Aponogetonacea e	Ghechu	USAM-2	H	P	Aug.-Nov.	Cr		LC	Le	Raw	Febrifuge	26.42	4.00
14.	*Argemone mexicana* L.	Papaveraceae	Sialkanta	USPD-2	H	A	Dec.-Apr.	Th		NE	Fr,Se	Juice	Skin disease	18.75	3.67
15.	*Asparagus dumosus* Baker	Asparagaceae	Satomuli	USAM-1	C	P	Sep.-May	Ph	*N*	NE	Rh,St	Paste	Digestive and urinary disorder	11.11	1.40
16.	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Kalaban	USAD-8	T	P	Apr.-Jul.	Ph	*N*	LC	Wp	Juice	Astringent	20.34	2.83
17.	*Avicennia officinalis* L.	Acanthaceae	Jatban	USAD-9	T	P	Apr.-Jul.	Ph	*N*	LC	Ba,Fr,Ro, Se	Paste	Astringent, sexual and skin disease	16.28	3.67
18.	*Azadirachta indica* A.Juss.	Meliaceae	Neem	USLD-1	T	P	Mar.-Jul.	Ph	*M*	NE	Ba,Le	Decoction	Skin disease	29.58	5.75
19.	*Bacopa monnieri* (L.) Wettst.	Plantaginceae	Brahmi	USPD-3	H	A	Apr.-Jan.	Th		LC	Wp	Infusion	Nervous disorder	16.28	2.20
20.	*Balanites roxburghii* Planch.	Zygophyllaceae	Hingol	USZD-1	T	P	Dec.-Jul.	Ph	*N*	NE	Ba,Fr,Le, Ro,	Paste	Worm and wound healing	10.00	1.80
21.	*Barringtonia acutangula* (L.) Gaertn.	Lecythidaceae	Hijal	USLD-2	T	P	Jan.-Apr.	Ph	*M*	NE	Fr,Le,Sb, Se,St	Juice	Dental problem and digestive disorder	32.84	4.17
22.	*Borassus flabellifer* L.	Arecaceae	Tal	USAM-3	T	P	Feb.-Aug.	Ph	*M M*	NE	Fr,Le,St	Juice	Digestive and respiratory disorder	6.67	1.25
23.	*Bruguiera gymnorhiza* (L.) Lam.	Rhizophoraceae	Kankra	USRD-1	T	P	Apr.-Jul.	Ph	*N*	LC	Ba	Juice	Digestive and restorative disorder	5.00	1.33
24.	*Bulbostylis barbata* (Rottb.) C.B.Clarke	Cyperaceae	Masa	USCM-1	H	P	Jul.-Oct.	He		NE	Le	Decoction	Digestive disorder	24.49	2.83
25.	*Caesalpinia bonduc* (L.) Roxb.	Fabaceae	Natakaranj	USFD-3	C	P	Aug.-Apr.	Ph	*N*	NE	Le,Ro,Se	Infusion	Digestive disorder	7.14	1.50
26.	*Calligonum polygonoides* L.	Polygonaceae	Chimtee Sag	USPD-4	S	P	Aug.-Jan.	Ch		NE	Wp	Decoction	Urinary disorder	31.15	5.00
27.	*Calophyllum inophyllum* L.	Clusiaceae	Sultan	USCD-1	T	P	Jan.-Apr.	Ph	*M*	LC	Se	Oil	Nervous and skin	5.00	1.86

			Champa						*M*				disease		
28.	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Akanda	USAD-10	S	P	Mar.-Feb.	Ch		NE	Ba,Fl,La, Le,Rb,Ro, Se,	Decoction	Digestive disorder	37.50	5.00
29.	*Canavalia rosea* (Sw.) DC.	Fabaceae	Beach Bean	USFD-4	C	A	All	Ph	*N*	NE	Fl,Fr,Se	Infusion	Digestive disorder and rheumatism	25.00	3.60
30.	*Capparis decidua* (Forssk.) Edgew.	Capparaceae	Kair	USCD-2	C	P	Nov.-Mar.	Ph	*N*	LC	Le,Ro,St	Paste	Respiratory disorder	32.31	6.25
31.	*Carissa spinarum* L.	Apocynaceae	Ban-Karamcha	USAD-11	C	P	Mar.-Oct.	Ph	*N*	NE	Fr	Raw	Digestive disorder	32.00	4.50
32.	*Casuarina equisetifolia* L.	Casuarinaceae	Jhau	USCD-3	T	P	Apr.-Oct.	Ph	*M* *M*	NE	St	Decoction	Digestive and respiratory disorder	36.54	3.83
33.	*Ceriops decandra* (Griff.) W.Theob.	Rhizophoraceae	Jhamtigoran	USRD-2	T	P	Apr.-Oct.	Ph	*M* *M*	NE	Ba	Juice	Child birth	35.00	5.00
34.	*Cissus quadrangularis* L.	Vitaceae	Harbhanga	USVD-2	C	P	May-Jun.	Ph	*N*	LC	Wp	Decoction	Metabolic disorder	44.44	9.00
35.	*Cocos nucifera* L.	Arecaceae	Narikel	USAM-4	T	P	Apr.-Mar.	Ph	*M* *M*	NE	Fr,St	Raw	Digestive and Immune system buster	41.03	5.00
36.	*Crotalaria burhia* Benth.	Fabaceae	Shon	USFD-5	S	A	All	Ch		NE	Le,St	Powder	Digestive disorder	52.50	3.29
37.	*Crotalaria retusa* L.	Fabaceae	Atasi	USFD-6	S	A	Jul.-Jan.	Ch		NE	Wp	Decoction	metabolic disorder and restorative	54.00	4.67
38.	*Croton bonplandianus* Baill.	Euphorbiaceae	Churchuri	USED-1	H	P	Mar.-Dec.	Th		NE	La,Le	Decoction	Wound healing	65.57	5.25
39.	*Cynodon dactylon* (L.) Pers.	Poaceae	Durbaghas	USPM-2	H	P	All	He		NE	Wp	Decoction	Digestive disorder	40.00	3.60
40.	*Cyperus arenarius* Retz.	Cyperaceae	Mutha	USCM-2	H	P	Jul.-Jan.	He		LC	Wp	Decoction	Digestive and urinary disorder	33.33	6.33
41.	*Cyperus rotundus* L.	Cyperaceae	Mutha	USCM-3	H	P	Sep.-Dec.	He		LC	Wp	Decoction	Digestive and immune system buster	41.18	6.33
42.	*Delonix elata* (L.) Gamble	Fabaceae	Krishnachura	USFD-7	T	P	Mar.-Jul.	Ph	*N*	LC	Le,Sb	Decoction	Rheumatism	54.24	4.40
43.	*Derris scandens* (Roxb.) Benth.	Fabaceae	Panlata	USFD-8	C	P	Jul.-Jan.	Ph	*N*	LC	Wp	Raw	Skin disease	33.33	9.50
44.	*Derris trifoliata* Lour.	Fabaceae	Panlata	USFD-9	C	P	Mar.-Aug.	Ph	*N*	NE	Wp	Infusion	Analgesic	12.50	2.40
45.	*Enicostema axillare* (Poir. ex Lam.) A.Raynal	Gentianaceae	Madhuka	USGD-1	H	P	All	Th		NE	Wp	Juice	Diabetes and worm infection	34.67	4.67
46.	*Eragrostis gangetica* (Roxb.) Steud.	Poaceae	Chirakoni	USPM-3	H	P	Aug.-Feb.	Th		NE	Wp	Decoction	Skin disease	53.33	7.43
47.	*Eragrostis unioloides* (Retz.) Nees *ex* Steud.	Poaceae	Chira ghas	USPM-4	H	P	Aug.-Feb.	Th		LC	Wp	Decoction	Skin disease	27.78	5.75
48.	*Eucalyptus globulus* Labill.	Myrtaceae	Eucalyptus	USMD-1	T	P	Apr.-Mar.	Ph	*M* *M*	NE	Le	Decoction	Digestive and respiratory disorder	25.00	2.50
49.	*Euphorbia tithymaloides* L.	Euphorbiaceae	Rangchita	USED-2	H	P	Mar.-Apr.	Th		NE	Wp	Decoction	Metabolic disorder	33.33	6.67
50.	*Evolvulus alsinoides* (L.) L.	Convolvulaceae	Shankhapushpi	USCD-4	H	A	Jul.-Feb.	Th		NE	Wp	Decoction	Respiratory and sexual disease	47.37	7.83
51.	*Excoecaria agallocha* L.	Euphorbiaceae	Gewa	USED-3	T	P	Nov.-Feb.	Ph	*N*	LC	La	Juice	Skin disease	75.76	8.44
52.	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Golpati	USCM-4	H	P	Jul.-Oct.	He		LC	Wp	Juice	Digestive disorder	10.71	3.00
53.	*Gisekia pharnaceoides* L.	Gisekiaceae	Lalsag	USGD-2	C	P	Jul.-Aug.	Ph	*N*	NE	Wp	Juice	Metabolic and sexual disease	19.57	3.67
54.	*Gloriosa superba* L.	Colchicaceae	Bislanguli	USCM-	C	P	Jul.-Sep.	Ph	*N*	LC	Le,Tu	Paste	Skin disease	53.61	5.83
55.	*Halopyrum mucronatum* (L.) Stapf	Poaceae		USPM-5	H	P	Sep.-Feb.	He		NE	Ro	Decoction	Skin disease	21.62	6.33
56.	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Nanajhaw	USAD-12	H	A	Oct.-Mar.	Th		NE	Wp	Powder	Skin disease	55.13	6.43
57.	*Heliotropium curassavicum* L.	Boraginaceae	Hatishura	USBD-1	H	P	Mar.-Nov.	Th		LC	Le,Ro	Decoction	Sexual disease	42.86	8.00
58.	*Hemidesmus indicus* (L.) R. Br. ex Schult.	Apocynaceae	Anantamul	USAD-13	C	P	Aug.-Jan.	Ph	*N*	NE	Ro	Powder	Digestive and sexual disorder	52.17	3.50
59.	*Heritiera fomes* Buch.-Ham.	Malvaceae	Sundri	USLD-3	T	P	Apr.-Jul.	Ph	*M*	EN	Gu,Le,Se	Decoction	Digestive disorder	34.78	3.67
60.	*Hibiscus tilliaceus* L.	Malvaceae	Bala	USLD-4	S	P	All	Ch		NE	Le,Ro	Juice	Digestive disorder and rheumatism	39.62	4.83
61.	*Hydrophylax maritima* L.f.	Rubiaceae	Mudu Getakola	USRD-3	H	A	Mar.-Jun.	Th		NE	Wp	Decoction	Skin disease	32.20	6.25
62.	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Chhagalkhuri	USCD-5	H	A	Oct.-Jul.	He		NE	Le,Ro	Decoction	Sexual disease	81.25	6.11
63.	*Jatropha gossypiifolia* L.	Euphorbiaceae	Lalbharenda	USED-4	S	P	Apr.-Aug.	Ch		NE	La,Le,Se	Decoction	Respiratory disorder	49.12	5.80
64.	*Kandelia candel* (L.) Druce	Rhizophoraceae	Guria	USRD-4	T	P	Mar.-Jul.	Ph	*N*	LC	Le,Sb	Decoction	Diabetes	5.26	1.71
65.	*Launaea sarmentosa* (Willd.) Sch.Bip. ex Kuntze	Asteraceae	Chakma	USAD-14	H	A	Apr.-Sep.	Th		NE	Wp	Juice	Rheumatism	78.65	7.75
66.	*Leucas aspera* (Willd.) Link	Lamiaceae	Dronapuspi	USLD-5	H	A	Sep.-Jan.	Th		LC	Wp	Juice	Skin disease	74.23	9.00
67.	*Merope angulata* Swingle	Rutaceae	Guria	USRD-5	S	P	Apr.- Jul.	Ch		LC	Ro	Decoction	Skin disease	89.13	4.33
68.	*Mimosa pudica* L.	Fabaceae	Lajjabati	USFD-10	H	P	Jul.-Nov.	Th		LC	Le,Ro	Juice	Child birth and sexual disease	82.76	3.50
69.	*Nicotiana plumbaginifolia* Viv.	Solanaceae	Bantamak	USSD-1	H	A	May-Sep.	Th		NE	Le	Juice	Skin disease	43.06	7.25
70.	*Ochthochloa compressa* (Forssk.) Hilu	Poaceae	Karankusa	USPM-6	H	A	Jul.-Feb.	He		NE	Wp	Paste	Skin and wound healing	96.81	9.00
71.	*Oldenlandia tenelliflora* (Blume) Kuntze	Rubiaceae	Paripat	USRD-6	H	A	Apr.-Nov.	Th		NE	Wp	Decoction	Liver disorder	48.94	3.67
72.	*Opuntia dillenii* (Ker Gawl.) Haw.	Cactaceae	Phanimansa	USCD-6	S	P	Aug.-Nov.	Ch		LC	Wp	Pulp	Digestive disorder and rheumatism	50.00	4.50
73.	*Opuntia monacantha* (Willd.) Haw.	Cactaceae	Nagphana	USCD-7	S	P	Apr.-Aug.	Ch		LC	Wp	Pulp	Digestive disorder and rheumatism	58.49	4.38
74.	*Opuntia stricta* (Haw.) Haw.	Cactaceae	Phani-Mansa	USCD-8	S	P	Apr.-Aug.	Ch		LC	Wp	Pulp	Skin and wound healing	86.15	5.75
75.	*Pandanus odorifer* (Forssk.) Kuntze	Pandanaceae	Keya	USPM-7	S	P	Jul.-May	Ph	*N*	LC	Fl,Le,Ro	Juice	Urinary disorder	31.82	4.17
76.	*Pandanus tectorius* Parkinson ex Du Roi	Pandanaceae	Keora	USPM-8	S	P	Jul.-Oct.	Ch		NE	Fl,Le,Ro	Juice	Urinary disorder	47.25	8.60
77.	*Panicum turgidum* Forssk.	Poaceae	Kana	USPM-9	H	P	Jul.-Feb.	He		NE	Wp	Raw	Digestive disorder	31.65	6.67
78.	*Pedalium murex* L.	Pedaliaceae	Bara Ghokru	USPD-5	H	A	Jul.-Oct.	Th		NE	Fr,Le	Juice	Restorative and skin disease	40.00	7.20
79.	*Phoenix paludosa* Roxb.	Arecaceae	Hental	USAM-5	S	P	Apr.-May	Ph	*N*	NT	Fr	Raw	Nervous disorder	26.92	2.00
80.	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	Khejur	USAM-6	T	P	Feb.-Jun.	Ph	*M*	NE	Fr	Raw	Restorative	25.61	7.67
81.	*Phragmites karka* (Retz.) Trin. ex Steud.	Poaceae	Nal	USPM-10	H	P	Jul.-Oct.	He		LC	Ro	Juice	Urinary disorder	52.22	8.67
82.	*Phyla nodiflora* (L.) Greene	Verbenaceae	Bhuiokra	USVD-1	H	P	Sep.-Mar.	Th		LC	Wp	Juice	Child birth and wound healing	54.17	3.50
83.	*Pluchea lanceolata* (DC.) C.B.Clarke	Asteraceae	Kukronda	USAD-15	H	A	Aug.-Oct.	Th		NE	Le,Ro	Paste	Child birth	72.97	7.43
84.	*Pongamia pinnata* (L.) Pierre	Fabaceae	Karonj	USFD-11	T	P	Apr.-Feb.	Ph	*M*	LC	Ba,Fl,Le, Ro,Se	Juice	Skin disease	37.50	5.75
85.	*Porteresia coarctata* (Roxb.) Tateoka	Poaceae	Golpati	USPM-11	H	A	Oct.-Dec.	Th		NE	Wp	Juice	Digestive disorder	42.59	5.40
86.	*Prosopis cineraria* (L.) Druce	Fabaceae	Khejri	USFD-12	T	P	Apr.-Feb.	Ph	*M*	NE	Fr,Le,Rb, Sb,St	Decoction	Child birth and dental problem	75.64	6.67
87.	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Khejri	USFD-13	T	P	Apr.-Feb.	Ph	*M*	LC	Fr,Le,Rb, Sb,St	Decoction	Child birth and dental problem	95.38	5.78
88.	*Rhizophora apiculata* Blume	Rhizophoraceae	Amla	USRD-7	T	P	Apr.-Jul.	Ph	*M*	LC	Sb	Infusion	Astringent and restorative	45.45	4.67

89.	*Rhizophora mucronata* Lam.	Rhizophoraceae	Kamo	USRD-8	T	P	Apr.-Jul.	Ph	*M*	LC	Sb	Infusion	Astringent and restorative	56.52	4.29
90.	*Rhynchosia minima* (L.) DC.	Fabaceae	Kulata	USFD-14	C	P	Sep.-Feb.	Ph	*N*	LC	Fr,Rb	Paste	Digestive disorder	33.33	3.00
91.	*Ricinus communis* L.	Euphorbiaceae	Rerhi	USED-5	S	P	Jan.-Apr.	Ph	*N*	NE	Fl,Le,Ro, Se	Paste	Digestive disorder and rheumatism	14.29	4.00
92.	*Rothia indica* (L.) Druce	Fabaceae	Nuchakura	USFD-15	S	A	Oct.-Apr.	Ph	*N*	NE	Wp	Vegetable	Restorative	58.33	1.18
93.	*Rumex dentatus* L.	Polygonaceae	PahariPalang	USPD-6	H	A	Feb.-Apr.	Th		NE	Wp	Decoction	Skin disease	73.85	7.43
94.	*Saccharum spontaneum* L.	Poaceae	Kash	USPM-12	H	P	Aug.-Nov.	He		LC	Le,Ro	Juice	Sexual disease	47.13	8.75
95.	*Salacia chinensis* L.	Celastraceae	Dimal Marati	USCD-9	C	P	Feb.-Apr.	Ph	*N*	NE	Ro	Decoction	Sexual disease	77.08	8.33
96.	*Salsola kali* L.	Amaranthaceae	Kali	USAD-16	H	A	Jul.-Aug.	Th		NE	Wp	Decoction	Digestive disorder	21.15	5.33
97.	*Salvadora oleoides* Decne.	Salvadoraceae	Kamber	USSD-2	T	P	Aug.-Dec.	Ph	*N*	NE	Fr	Decoction	Digestive disorder	13.85	3.17
98.	*Salvadora persica* L.	Salvadoraceae	Jhak	USSD-3	T	P	Aug.-Dec.	Ph	*N*	NE	Fr	Decoction	Digestive disorder	43.75	5.00
99.	*Sarcolobus globosus* Wall.	Apocynaceae	Baoali lata	USAD-17	C	P	Mar.-Aug.	Ph	*N*	NE	Se	Paste	Antitumor	10.53	1.27
100.	*Senna auriculata* (L.) Roxb.	Fabaceae	Jhunjuni	USFD-16	S	P	Mar.-Aug.	Ch		NE	Ro	Decoction	Sexual and urinary disorder	47.44	6.67
101.	*Senna occidentalis* (L.) Link	Fabaceae	Kalkasunda	USFD-17	S	P	Aug.-Dec.	Ch		NE	Le,Ro,Sb	Decoction	Diabetes and digestive disorder	8.33	1.25
102.	*Sericostoma pauciflorum* Stocks ex Wight	Boraginaceae	Karbash	USBD-2	S	P	All	Ch		NE	Ro,Sb	Decoction	Child birth and digestive disorder	32.31	4.80
103.	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Nonasak	USAD-18	H	P	Dec.-Aug.	Th		NE	Wp	Juice	Digestive disorder	55.26	7.50
104.	*Sida cordifolia* L.	Malvaceae	Berela	USLD-6	S	A	Aug.-Dec.	Th		NE	Le,Ro	Decoction	Digestive and sexual disorder	48.61	7.75
105.	*Sonneratia alba* Sm.	Lythraceae	Bina	USLD-7	T	P	May-Aug.	Ph	*M M*	LC	Fl,Fr,Sb	Decoction	Respiratory and wound healing	75.38	5.88
106.	*Sonneratia apetala* Buch.-Ham.	Lythraceae	Keora	USLD-8	T	P	Apr.-Jul.	Ph	*M*	LC	Sb	Decoction	Digestive disorder	48.00	2.08
107.	*Spermacoce articularis* L.f.	Rubiaceae	Madnabata	USRD-9	H	A	Jul.-Dec.	Th		NE	Ro	Juice	Liver disorder	82.67	6.43
108.	*Spinifex littoreus* (Burm.f.) Merr.	Poaceae	Kharkanta	USPM-13	H	P	Aug.-Jul.	He		NE	Ro	Juice	Digestive disorder	35.38	7.00
109.	*Stenochlaena palustris* (Burm. f.) Bedd.	Blechnaceae	Akar Paku	USBP-1	H	A		Th		NE	Wp	Raw	Digestive and skin disease	20.34	4.50
110.	*Stictocardia tiliifolia* (Desr.) Hallier f.	Convolvulaceae	Balilata	USCD-10	C	P	Oct.-Jan.	Ch		NE	Wp	Juice	Restorative	43.75	3.50
111.	*Suaeda maritima* (L.) Dumort.	Amaranthaceae	Girasak	USAD-19	H	A	Jul.-Oct.	Th		NE	Le	Decoction	Febrifuge	17.74	7.25
112.	*Suaeda monoica* Forssk. ex J.F.Gmel.	Amaranthaceae	Girasak	USAD-20	H	A	Apr.-Jul.	Th		NE	Wp	Paste	Wound healing	51.11	3.00
113.	*Tamarix aphylla* (L.) H.Karst.	Tamaricaceae	Raktajhav	USTD-1	T	P	Oct.-May	Ph	*M*	NE	Sb	Paste	Skin disease	42.86	3.17
114.	*Tamarix indica* Willd.	Tamaricaceae	Jaora	USTD-2	T	P	Mar.-Aug.	Ph	*N*	NE	Wp	Juice	Liver disorder	42.31	3.13
115.	*Tecomella undulata* (Sm.) Seem.	Bignoniaceae	Parul	USBD-3	T	P	Feb.-Apr.	Ph	*M*	NE	Sb	Decoction	Sexual disease	57.69	3.00
116.	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Bannil	USFD-18	H	P	Sep.-Dec.	Th		LC	Le,Ro,Se	Decoction	Digestive and urinary disorder	25.71	2.25
117.	*Tephrosia villosa* (L.) Pers.	Fabaceae	Swetbannil	USFD-19	H	P	Jul.-Oct.	Th		LC	Le,Ro,Se	Decoction	Digestive and urinary disorder	27.66	3.17
118.	*Terminalia catappa* L.	Combretaceae	Bakshabadam	USCD-11	T	P	Apr.-Feb.	Ph	*M*	NE	Fr,Le,Sb	Decoction	Digestive disorder	76.32	7.29
119.	*Thespesia populnea* (L.) Sol. ex Corrêa	Malvaceae	Parashpeepul	USLD-9	T	P	Aug.-Jan.	Ph	*M*	NE	Le,Ro	Paste	Rheumatism and skin diseases	50.00	3.50
120.	*Toddalia asiatica* (L.) Lam.	Rutaceae	Kullata	USRD-10	C	P	Sep.-Mar.	Ph	*N*	NE	Wp	Juice	Liver disorder and rheumatism	64.00	2.25
121.	*Tribulus terrestris* L.	Zygophyllaceae	Kantagokhru	USZD-2	C	A	Feb.-Sep.	Th		NE	Fr,Le	Juice	Restorative	52.31	6.00
122.	*Triumfetta rhomboidea* Jacq.	Malvaceae	Banokra	USLD-10	H	A	Sep.-Jan.	Th		NE	Fl,Le,Ro, Sb	Decoction	Digestive and sexual disorder	26.67	5.00
123.	*Tylophora flexuosa* R. Br.	Apocynaceae	Antamul	USAD-21	C	P	Apr.-Nov.	Ph	*N*	NE	Le	Juice	Urinary disorder and snake bite	30.77	2.00
124.	*Vachellia tortilis* (Forssk.) Galasso and Banfi	Fabaceae	Nonababla	USFD-20	T	P	Mar.-Apr.	Ph	*M*	NE	Fr,Sb	Infusion	Skin disease	50.00	5.80
125.	*Vitex negundo* L.	Lamiaceae	Nisinda	USLD-11	T	P	Mar.-Jun.	Ph	*N*	NE	Fl,Fr,Le, Rb,Ro,Sb, Se,St	Infusion	Respiratory disorder	71.43	3.00
126.	*Volkameria inermis* L.	Lamiaceae	Banajai	USLD-12	S	P	Aug.-Jan.	Ch		NE	Le	Infusion	Febrifuge	9.23	4.00
127.	*Xylocarpus granatum* J.Koenig	Meliaceae	Dhundal	USLD-13	T	P	Apr.-Jul.	Ph	*M*	LC	Ba,Fr,Se	Decoction	Digestive disorder	33.33	1.73
128.	*Ziziphus jujuba* Mill.	Rhamnaceae	Kul	USRD-11	T	P	Sep.-Mar.	Ph	*M*	LC	Fr,Le,Ro, Sb,Se,St	Decoction	Digestive disorder and immune system buster	39.39	4.83
129.	*Ziziphus nummularia* (Burm.f.) Wight and Arn.	Rhamnaceae	Bhui Kul	USRD-12	S	P	Feb.-Apr.	Ch		NE	Fr,Le,Ro, Sb	Decoction	Digestive disorder and immune system buster	10.71	5.67
130.	*Zornia diphylla* (L.) Pers.	Fabaceae	Samrapani	USFD-21	H	A	Aug.-Feb.	Th		NE	Le	Decoction	Skin disease	44.00	2.00

Abbreviation:

Habit: H-Herb, S-Shrub, T-Tree, C-Climber

***Life-Span*:** A-Annual, P-Perennial

Flowering (Fl.) and Fruiting (Fr.) time: Jan.- January, Feb.- February, Mar.- March, Apr.- April, Jun.- June, Jul.- July, Aug.- August, Sep.- September, Oct.- October, Nov.- November, Dec.- December

***Raunkiaer's Life-form and Sub-type*:** Ch- Chamaephytes, Cr- Cryptophytes, He- Hemicryptophytes, MM- Megaphanerophytes, M- Mesophanerophyte, N- Nanophanerophytes, Ph- Phanerophytes, Th-Therophytes

IUCN Red List Status: EN- Endangered, LC- Least Concern, NE- Not Evaluated, VU- Vulnerable, LR- Lower Risk, DD- Data Deficient, NT- Near Threatened

***In Importance (s) and Part (s) used*:** Ba- Bark, Fl- Flower, Fr- Fruit, Gu-Gum, In-Inflorescence, La- Latex, Le- Leaf, Rb- Root bark, Rh- Rhizome, Ro- Root, Sb- Stem bark, Se-Seed, St- Stem, Tu- Tuber, Wp- Whole plant

Table 3: Analysis of plant taxa.

I- DICOTS

Sl. No.	Family	Angiosperm type	Genus/Genera	Species				
				Herb(s)	Shrub(s)	Tree(s)	Climber(s)	Total
1.	Acanthaceae	D	2		1	2	1	4
2.	Aizoaceae	D	1	1				1
3.	Amaranthaceae	D	6	7				7
4.	Anacardiaceae	D	1			1		1
5.	Apocynaceae	D	5		1		4	5

6.	Asteraceae	D	3	3				3
7.	Bignoniaceae	D	1			1		1
8.	Boraginaceae	D	2	1	1			2
9.	Cactaceae	D	1		3			3
10.	Capparaceae	D	1				1	1
11.	Casuarinaceae	D	1			1		1
12.	Celastraceae	D	1				1	1
13.	Clusiaceae	D	1			1		1
14.	Combretaceae	D	1			1		1
15.	Convolvulaceae	D	3	2			1	3
16.	Euphorbiaceae	D	5	2	2	1		5
17.	Fabaceae	D	15	4	6	6	5	21
18.	Gentianaceae	D	1	1				1
19.	Gisekiaceae	D	1				1	1
20.	Lamiaceae	D	3	1	1	1		3
21.	Lecythidaceae	D	1			1		1
22.	Lythraceae	D	1			2		2
23.	Malvaceae	D	5	1	2	2		5
24.	Meliaceae	D	2			2		2
25.	Myrtaceae	D	1			1		1
26.	Papaveraceae	D	1	1				1
27.	Pedaliaceae	D	1	1				1
28.	Plantaginceae	D	1	1				1
29.	Polygonaceae	D	2	1	1			2
30.	Primulaceae	D	1			1		1
31.	Rhamnaceae	D	1		1	1		2
32.	Rhizophoraceae	D	4			5		5
33.	Rubiaceae	D	3	3				3
34.	Rutaceae	D	2		1		1	2
35.	Salvadoraceae	D	1			2		2
36.	Solanaceae	D	1	1				1
37.	Tamaricaceae	D	1			2		2
38.	Verbenaceae	D	1	1				1
39.	Vitaceae	D	1				1	1
40.	Zygophyllaceae	D	2			1	1	2
41.	Aponogetonaceae	M	1	1				1
42.	Arecaceae	M	3		1	3		4
43.	Asparagaceae	M	1				1	1
44.	Colchicaceae	M	1				1	1
45.	Cyperaceae	M	3	4				4
46.	Pandanaceae	M	1		2			2
47.	Poaceae	M	10	11				11
48.	Blechnaceae	P	1	1				1
49.	Pteridaceae	P	1	1				1
Total			**110**	**50**	**23**	**38**	**19**	**130**

***In Angiosperm Type*: D-** Dicotyledon, **M-** Monocotyledon

Table 4: Summary of different plant taxa.

Group	Families	Genera	Species				
			Herbs	Shrubs	Trees	Climbers	Total
Dicots	40	88	32	20	35	17	**104**
Monocots	7	20	16	3	3	2	**24**
Pteridophyte	2	2	2				**2**
Total	**49**	**110**	**50**	**23**	**38**	**19**	**130**

Table 5: Biological spectrum of the studied area and its comparison with Raunkiaer's normal spectrum.

Life forms	Total no. of species	Life form (%)	Raunkiaer's normal spectrum (%)	Deviation= (Raunkiaer's normal spectrum- Biological spectrum)
Phanerophytes (Ph)	**60**	46.15	46.00	0.15
Megaphanerophytes (MM)	*7*	5.38	*3.00*	2.38
Mesophanerophyte (M)	*17*	13.08	*28.00*	-14.92
Nanophanerophytes (N)	*36*	27.69	*15.00*	12.69
Chamaephytes (Ch)	**18**	13.85	9.00	4.85
Hemicryptophytes (He)	**12**	9.23	26.00	-16.77
Cryptophytes (Cr)	**1**	0.77	6.00	-5.23
Therophytes (Th)	**39**	30.00	13.00	17
Total	**130**	**100**	**100.00**	

Table 6: Category of various ailments and their informant consensus factor (ICF).

Sl. No.	Category/disorders	Plant species	Used reports	Informants consensus factor(ICF)

1.	Analgesic	2	3	0.500
2.	Antitumor	2	19	0.944
3.	Astringent	4	47	0.935
4.	Child birth	7	123	0.951
5.	Dental problem	3	58	0.965
6.	Diabetes	3	15	0.857
7.	Digestive disorder	46	411	0.890
8.	Febrifuge	3	13	0.833
9.	Immune system buster	4	43	0.929
10.	Liver disorder	5	82	0.951
11.	Metabolic disorder	4	46	0.933
12.	Nervous disorder	4	15	0.786
13.	Respiratory disorder	9	94	0.914
14.	Restorative	9	119	0.932
15.	Rheumatism	10	135	0.933
16.	Sexual disease	13	198	0.939
17.	Skin disease	28	382	0.929
18.	Snake bite	2	21	0.950
19.	Urinary disorder	12	139	0.920
20.	Worm infection	2	15	0.929
21.	Wound healing	8	131	0.946

Fig. 1a. *Ipomoea pes-caprae* (L.) R. Br.

Fig. 1b. *Spinifex littoreus* (Burm.f.) Merr.

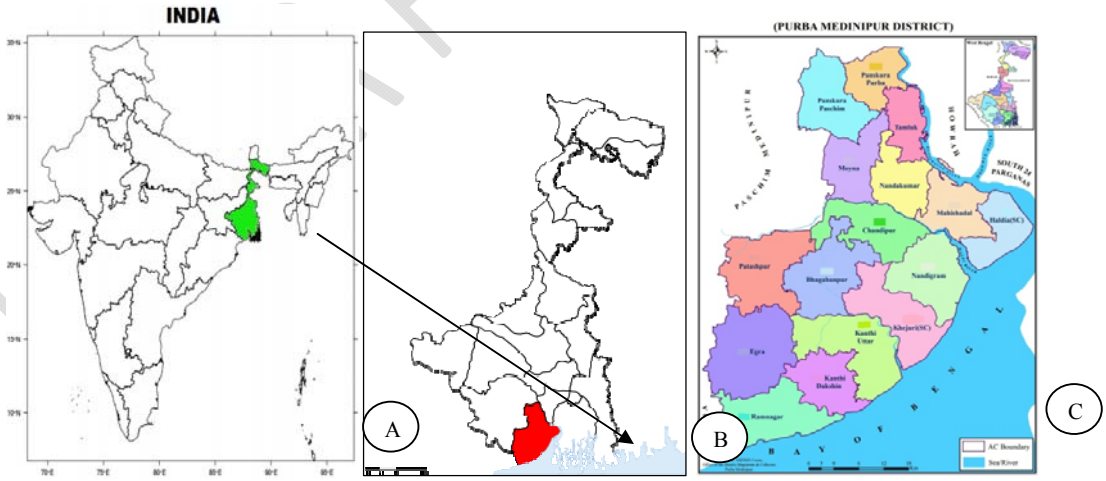
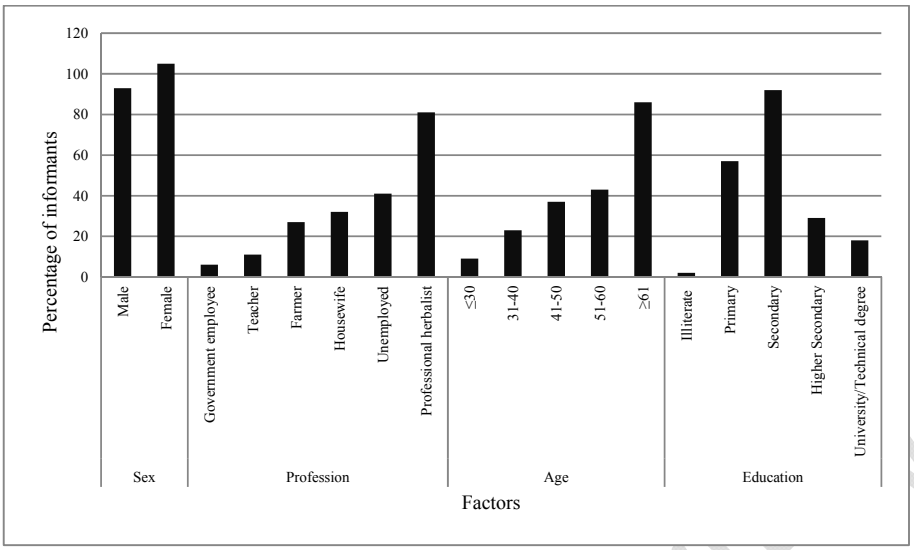
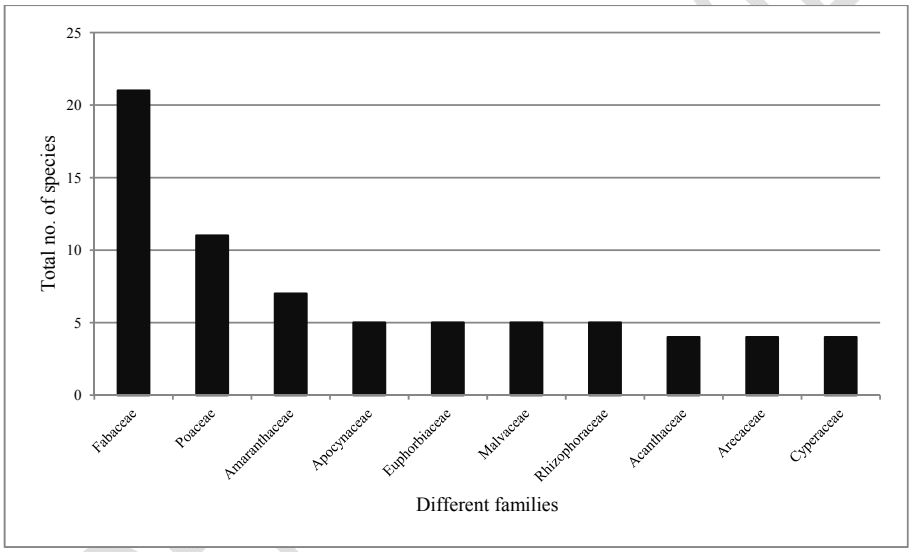


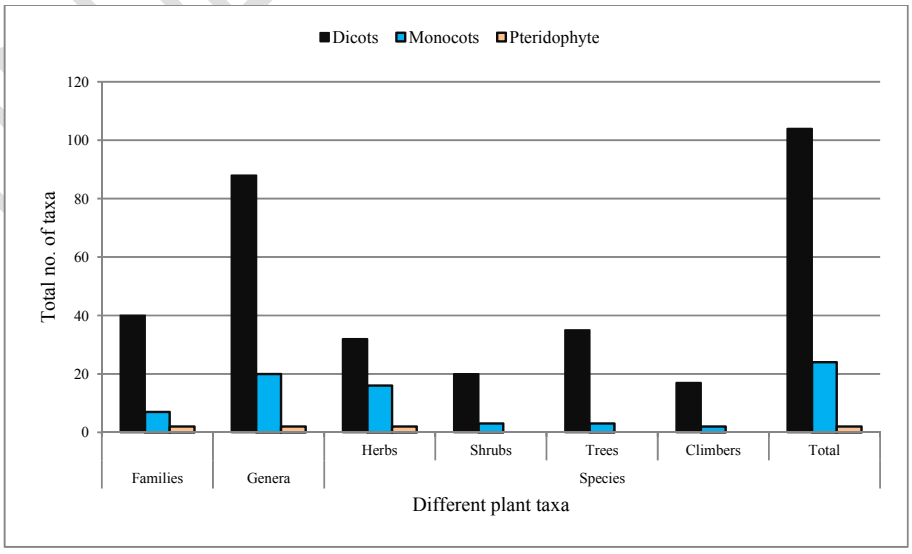
Fig. 2. Location of the study area: A. West Bengal in India, B. Purba Medinipur district in West Bengal, C. Different blocks in Purba Medinipur district.



716
717 **Fig. 3.** Percentage of different factors and categories of the informants.

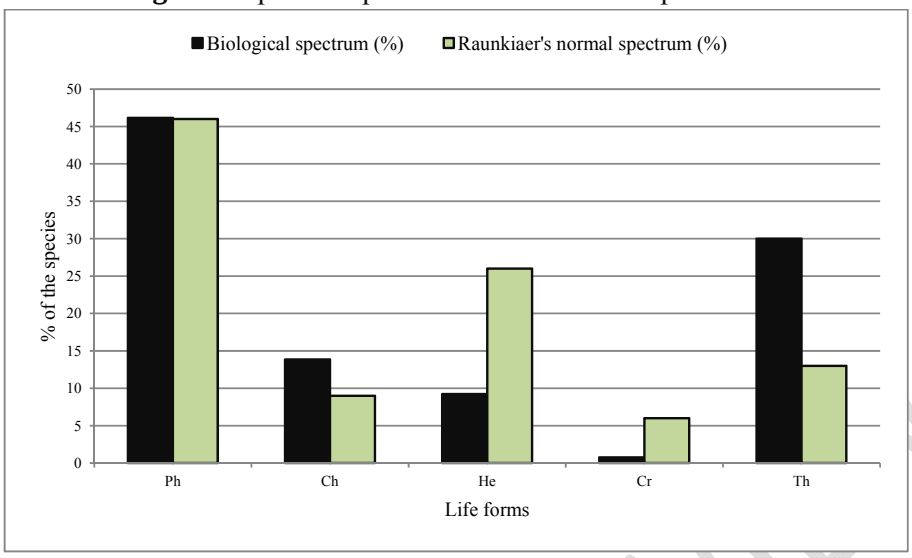


718
719 **Fig. 4.** Ten well represented families used for medicinal purposes.



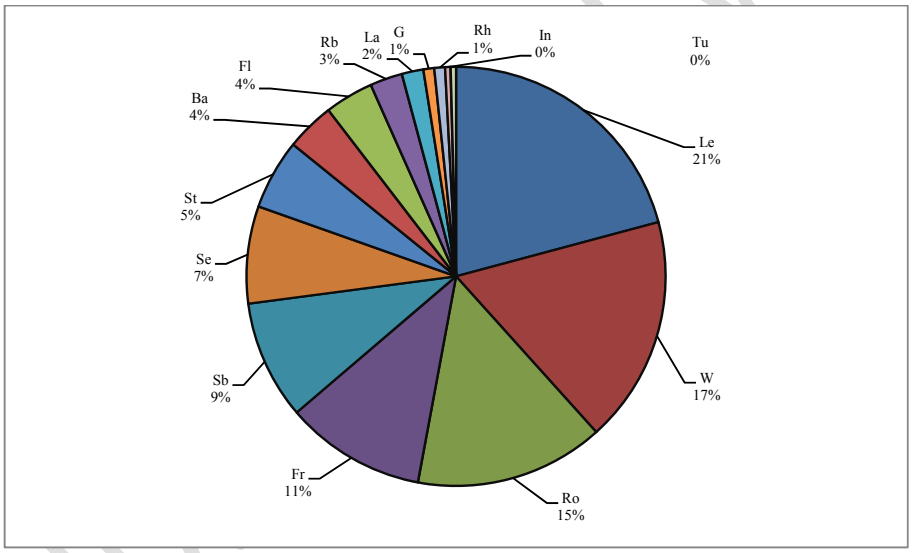
720

721 **Fig. 5.** Graphical representation of different plant taxa.



722

723 **Fig. 6.** Comparison of biological spectrum with Raunkiaer's normal spectra.



724

725 **Fig. 7.** Uses of the plant (s) part (s).

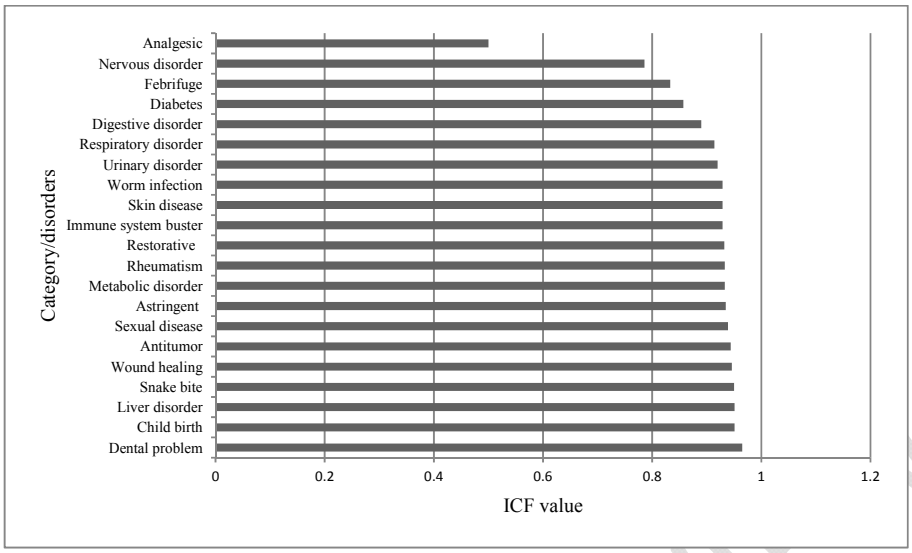


Fig. 8. Different category/disorders with their informant consensus factor (ICF).