



Ethnomedicinal Plants of Tripura: An Overview and Future Prospects

Koushik Majumdar¹, Bal Krishan Choudhary^{2*}, Badal Kumar Datta¹

¹Plant Taxonomy and Diversity Laboratory, Department of Botany, Tripura University, Suryamaninagar 799022, Agartala, Tripura, India.

²Department of Environmental Science, Ramthakur College, Agartala, Tripura- 799003,

*Email: bkmchoudhary@gmail.com

Keywords

Ethnomedicinal plants;
Traditional knowledge;
Medicinal plants;
Biodiversity Conservation;
Phytochemicals;
Herbal medicine

Abstract

Tripura, a northeastern state in India, is home to a rich diversity of ethnomedicinal plants, with a vast ethnobotanical heritage. The state's Ethnobotany is characterized by the traditional use of plants by indigenous communities, including the Tripuri, Reang, Jamatia, and Chakma, to treat various ailments. Tripura is endowed with Potential Medicinal Plants, such as *Centella asiatica*, *Andrographis paniculata*, and *Rauvolfia serpentina*, which have been used to treat diseases like malaria, diarrhea, and hypertension. Cultivation and marketing of these medicinal plants can provide livelihood opportunities for local communities, however, it requires systematic efforts to promote large-scale cultivation and standardization of agro-techniques. Unfortunately, many of these plants are Threatened due to deforestation, habitat loss, and over-exploitation, highlighting the need for Conservation and sustainable development of medicinal plants. To address this, recommendations include promoting cultivation of high-value medicinal plants, establishing nurseries and seed banks, and creating awareness about sustainable harvesting practices. The SCOPE for medicinal plant development in Tripura is vast, with opportunities for herbal-based industries, pharmaceuticals, and cosmetics, however, Challenges such as inadequate infrastructure, lack of market linkages, and climate change need to be addressed to realize this potential.

1. Introduction

In India, out of 17,000 species of higher plants, 7500 are known for medicinal uses. Ayurveda, followed by Siddha and Unani the oldest medical systems in Indian sub-continent have reported approximately 2000 plant species. The Charak Samhita, an age-old document on herbal therapy reports on the production of 340 herbal drugs and their indigenous uses. Currently, around 25% of drugs are derived from plants and many others are synthetic analogues built on prototype compounds isolated from plant species in modern pharmacopoeia (Shiva, 1998; Kala *et al.*, 2006). So far, about 8000 species of angiosperms, 44 species of gymnosperms and 600 species of pteridophytes have been reported from the India's Himalayan region and of these 1748 species are

known as medicinal plants (Sammant *et al.*, 1998). In India, for over 500 million people, traditional herbal medicines are the only alternative source, due to traditional knowledge, easy accessibility and lower price. This sector also provides employment to over one million traditional healers and vaidyas in the country (Shankar, 1997). The North East India in general has enormous diversity of life saving medicinal plants. Several ethnobotanical studies were carried out by Borthakur, 1976; 1981; Rao, 1981; Rao and Jamir, 1982; Rao and Haridasan, 1991, have brought out numerous information on the distribution and utilization of medicinal plants by indigenous tribes. It is mainly due to the inhabitants of various tribal groups having their own culture and rich indigenous traditional knowledge.

Tripura is a small hilly state is located in the North-Eastern part of the country, surrounded by Bangladesh on three sides and rich diversity of both flora and fauna. The physiography of the state is unique in the source that more than 60% of the state is hilly and there are five distinct hill ranges which run parallel to each other from north to south interposed with valleys in between through which run all the rivers of the state, west ward till they meet the river Brahmaputra in Bangladesh. The total area of the state is 10,497.69 sq km, located between 22° - 56' to 24° - 32' North latitude and between 90° - 09' to 92° - 20' East longitude. The climate of the state is characterized by moderate temperatures and a highly humid atmosphere. Forest covers an area of about 6292.681 sq km, with the annual rainfall of about 247.9 cm and the temperature varies between 10° C- 35° C. These suitable tropical climate support luxurious growth of various types of forests scattered all over the state from hilly tract to plain. The rich natural resources like dense forest with numerous varieties, traditional use of medicinal plant and about 19 ethnic groups with co-operating nature can encourage anyone to study the forest resources used by the tribal of Tripura and its potentiality. The 19 ethnic groups have been settled down with their different language, tradition, culture on the hilly tracts of Tripura. The Tripuri, Reang, Jamatia, Noatia, Chakma, Halam, Kuki, Lushai and Uchai are the main adibasi communities; among them some were immigrants in this state from adjoining Assam and Chittagong Hill tracts. The abundant forest resources and available Jhum land of Tripura had been the prime facts of migration of those adibasi. From the beginning they were dependent on their nearest forest not only for Jhum cultivation but also for different necessary forest products for their survival. So, consequently their both social and cultural life was typically associated with adjacent forests.

The food habit of primitive tribal communities of Tripura was different from the present time. They were totally depended on raw or boiled wild food from their adjacent dense forest which was rich in both flora and fauna. But with the change of civilization those old aboriginal community developed themselves and agricultural practice through Jhum (Shifting cultivation) by damaging the forest land for their food and economy. But the lack of appropriate agricultural knowledge results lower economic return bounded them again depend further on forest vegetable, wild fruits, tubers, leaves, roots, shoots, stems and flowers etc. They also collected those forest products for their own use and also brought by them to nearest village markets to sell. Those wild traditional forest products were used by tribal not only for food purpose but as those products possessed unique therapeutic medicinal properties, which was used directly or indirectly by them perhaps without any appropriate medicinal knowledge. Among them some plant parts proved as useful and some were harmful. Appropriate use of those plant parts resulted their body healthy, strong and disease free. Some tribal developed their own knowledge by personal experience about the use of those different plants for different disease. Some tribal earned this valuable information

about plants and procedure of traditional treatment from their old family person and from Guruji and this rich lore of medicinal plants preserve by them generation wise. Due to nonappearance of modern medical amenities in remote hilly areas of state logically bound them to depend on only those traditional treatments practiced by local medicine men. Those local tribal medicine men gradually developed themselves as a professional local doctor by using different plant parts in the form of juices, pills, pastes, raw or boiled for diverse simple to complex disease. They also locally called as – *Ochai*, *Kabiraj*, *Baddya*, *Ozai* and *Gunnin* etc. They have abundant ethnobotanical information about different medicinal plants and wild forest produce which are traditionally using by them and these are now appearing as the effective source of medicines and food for growing population and also providing us valuable information for searching new plants, medicine formulas and scientific researches. This is also a process of preservation of forest resources which is now disappearing due deforestation. It is also a way to conserve the identity and traditional heritage of the tribal communities, culture and art of livings. It undertake the study like present one in order to unfold, record and analysis the knowledge and wisdom the tribal of Tripura, living in hilly tract of forests and their ancient tradition, culture and heritage of using forest products for endurance. Such ethnobotanical approach not only suggests to studying the relationship between plant and man, but also their culture, tradition and art of living (Majumdar and Datta, 2007).

2. Ethnobotany of Tripura

So far as ethnobotanical study of Tripura state is concern, very little works is being done on this topic. However, there are some research article, related to this topic are - Deb (1968, 1971) provide information on medicinal plants of Tripura, Deb (1983) enumerated the economic plants of Tripura, Deb (1983) described the “Flora of Tripura State” in two volumes, mentioned various data on floristic resources of Tripura; Huidrom Das (1997) worked on ‘Wild Edible Plants of Tripura Tribes’; Majumdar (2004) conducted a ethno-medico-botanical survey of 55 plants in South and West Tripura; Majumdar *et al* (2006) enumerated 33 ethno-medicinal plants prescribed by tribal and non-tribal medicine men of Tripura; Majumdar and Datta (2007) illustrated 50 ethno-medicinal plants and their usage by Tripuri tribe in different ailments. Majumdar *et al.*, (2008, 2009) documented about 170 ethnomedicinal plants used by different tribes of Tripura and listed about 184 medicinal tresses with their local distribution status. Das *et al.*, (2009) reported the ethno-botanical uses of plants by Tripuri and Reang Tribe of the state. In another study, Deb *et al.*, (2012) worked out 39 medicinal plants used by Darlong tribes of Tripura, Majumdar and Datta (2013) have reported the various ethnobotanical formulation prescribed by the tribal people, Das (2014) have documents 5 traditional plants used for antifertility, Pandey and Marvinkurve (2014) have reported 19 angiosperm and one Pteridophyte plants used in local Chamka community of Tripura. The authors are engaged since 2004 for documentation of ethnobotanical knowledge among the tribes of Tripura. More recently a state level workshop on Traditional Medicine has been organized by the Department of Botany, Tripura University in collaboration with NEIFM, Pasighat and with the financial support of Department of AYUSH. In this workshop about 120 tribal traditional medical practitioners were identified and a state level committee was formed to promote their traditional practices. Recent some work had been started for conservation and propagation of some ethnomedicinal plants by tissue culture method by Tripura University Tissue Culture Laboratory. These are the little works related to ethnobotany of Tripura, whereas it requires comprehensive study and research. Therefore, several initiatives have already been undertaken by the authors (Taxonomy and Biodiversity Lab, Tripura University) on this aspect.

3. Potential Medicinal Plants of Tripura

About 50% of total higher plants species of India occur in the North-Eastern region with maximum number of endemic taxa and this region being the ‘Sanctuary of Primitive Angiosperms’ is considered as the cradle of flowering plants, where many groups of angiosperms have originated and diversified (Rao, 1998). The phyto-geographic and climatic conditions of the state are suitable to grow up enormous medicinal plants in natural forest areas throughout the state. The medicinal plant wealth of Tripura state was not explored preciously. Merely, Deb (1968, 1978) was given a preliminary idea on medicinal plants of the state. Very small number of literatures on the medicinal plants of Tripura is obtainable for comprehensive study. Although, any green plants in the world at least contain some chemical compounds which are advantageous to human being and other animals. Several useful important plants like cereals, pulses, fruits, timbers, vegetables, spices, garden and avenue plants are using in our everyday requirements rather than their medicinal value. While major part of those plants is also included in the list of medicinal plants. In that context the entire flora of an area might be included under the category of medicinal plants. Hence for that intention the clinically proved data on the efficacy of plants are to be recognized by means of bio-chemical and bio-medical investigations. It is practically difficult to assess the actual quantity of medicinal plants distributed in a state. Out of 129 species recognized as official drugs in Indian Pharmacopoeia (Chopra *et al.*, 1956, 1968), 61 species are found in Tripura, 26 growing wild and 35 under cultivation. Again of 350 items of plants materials used in Unani and Ayurvedic Systems of Medicine, 132 species are found in Tripura- 79 species as wild and 53 under cultivation as garden plants. Out of the 2535 taxa listed by Chopra *et al.* (1956) in “Glossary of Medicinal Plants”, 629 species (405 species are wild and 224 species are cultivated) are found in Tripura, of which 158 species are considered as medicinal plants and remaining species are more renowned for reasons other than Medicinal. Whereas Medicinal Plants Board of Tripura (MPBT) have been listed about 266 species of medicinal plants from the state. Among those 68 species of trees, 39 species of shrubs, 71 herbs and 88 species of climbers which are evenly distributed across the state forests. About 20 species of medicinal plant are given priority and important by the State Government. These are *Amoloki*, *Ulat-kambal*, *Agar*, *Amra*, *Arjuna*, *Ashoka*, *Ashwagandha*, *Aswatha*, *Tulsi*, *Babuitulsi*, *Bahea*, *Bel*, *Haritoki*, *Muktajhuri*, *Nageswar*, *Neem*, *Nishinda*, *Padma*, *Kanchan*, *Tentul*, *Vach* etc. It is very difficult to assess what is the actual quantity of medicinal plants and their local distributions throughout the forests of Tripura are still remaining after 35-40 years. Because that time span no such detailed floristic exploration was not conducted. Consequently, many plants are presently not occurring in their wild condition and many exotic species are introduced, which are now naturalized in different parts of state. It is estimated that there are approximately 350 medicinal plants are occurring in the state. Out of 350 only 184 tree species has been listed (Majumdar *et al.*, 2009) and the rest includes shrubs, herbs, climbers, grass and epiphytes. Priority has given to those plants which are still occurring in the forest throughout the state.

During reviewed of published papers by different authors in Tripura, found that about 288 plant species are used as medicinal plants, belongs to 231 Genera and 105 families (Figure 1). The analysis of parts used revealed that the whole plants are usable of 32 species. The five plants part viz. leaf, root, fruits, flower and twigs of one plant is used (Figure 2). Similarly, 3 and 2 plants part are used from 17 and 87 species respectively, whereas only one plant part was contributed from 152 species of the region. Different plants are used for the treatment of ailments by healers like

Jaundice, Dysentery, Fever, Cough and Cold, Gastritis, Anemia, Eczema and Ringworm, Bone fracture etc. Out of 288 plant species, 13, 25, 48, 78 and 123 plant species are used for the cure of 5, 4, 3, 2 and 1 ailment, respectively (**Figure 3**). Communities wise analysis showed that about 12, 93, 11, 61, 45, 39, 13, 15 and 91 species are being used by the Bengali, Chakma, Darlong, Halam, Jamatia, Mog, Lusai, Hrangkhwal and Riang community of Tripura, respectively (**Figure 4**). So, use of plants by remaining communities like Tripuri, Debbarma and Mizo needs to be explored for having complete information on the medicinal use of plants.

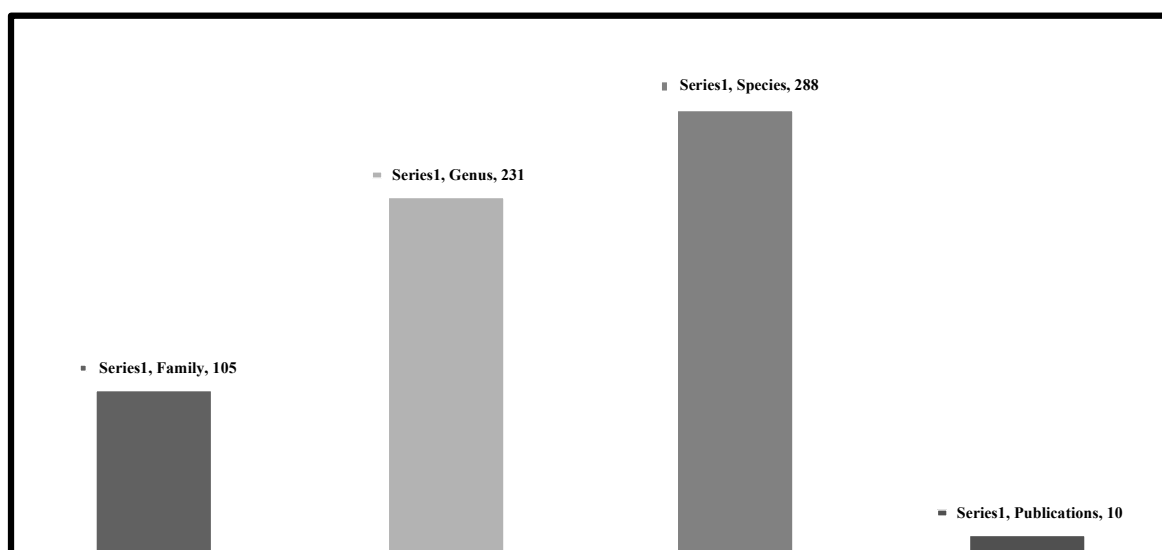
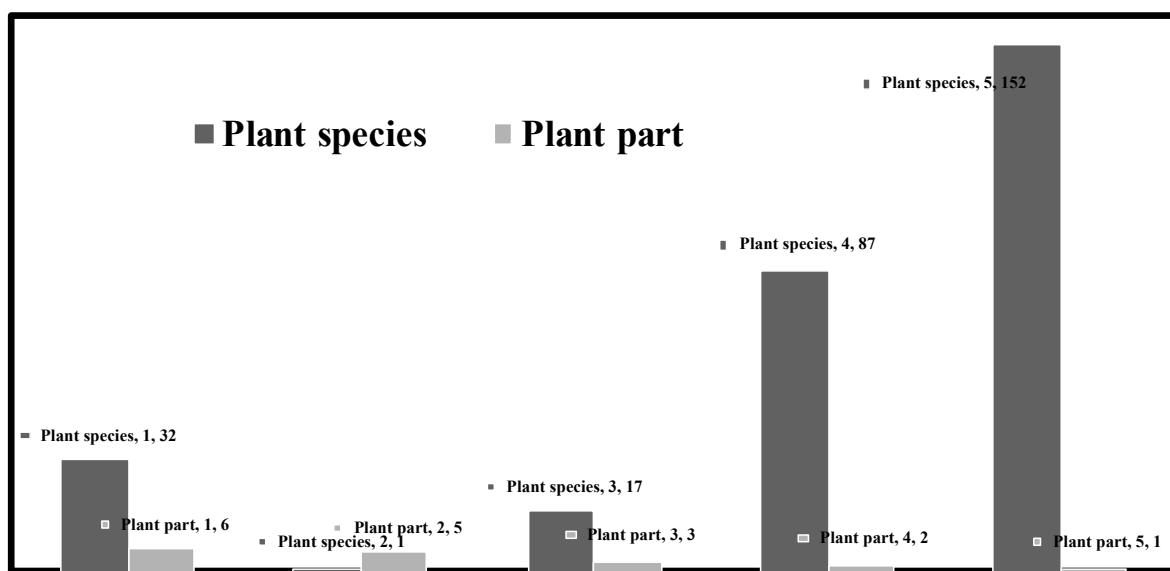


Figure 1: Number of families, general and species reported from Tripura.



1= Leaf, 2= leaf & root, 3= leaf, flower/bark & root, 4= Leaf, stem, root, flower & Fruit and 6= whole plant

Figure 2: Plants part viz. leaf, root, fruits, flower and twigs of one plant is used.

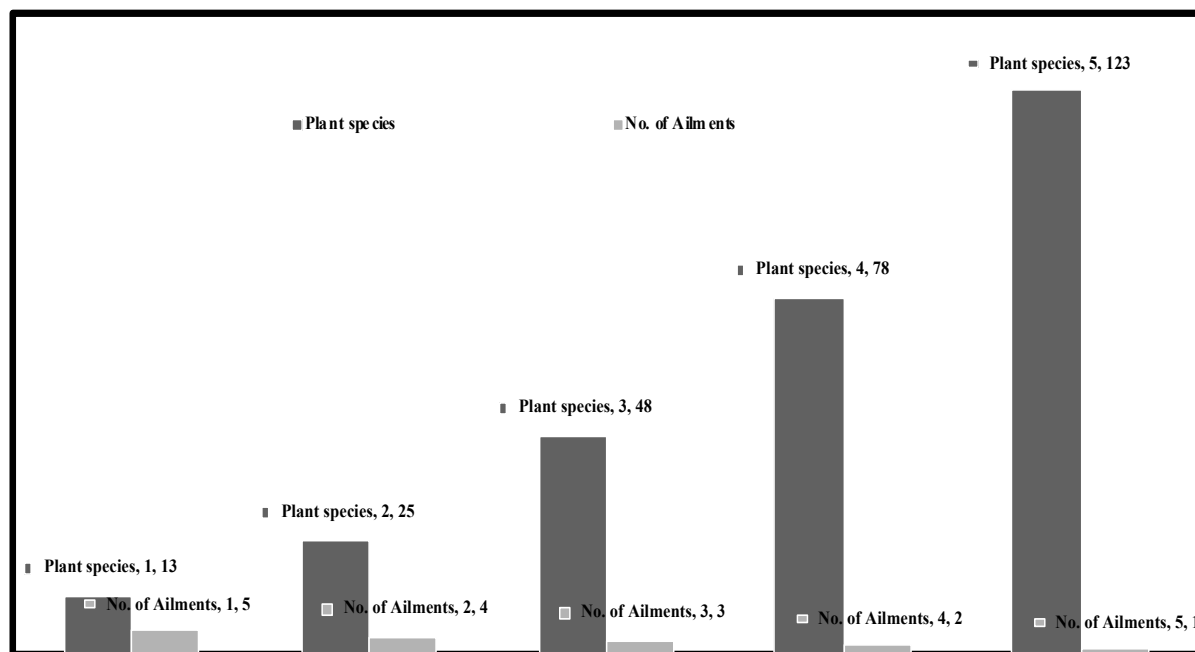


Figure 3: Showing number of plant species used for the treatment of number of ailments.

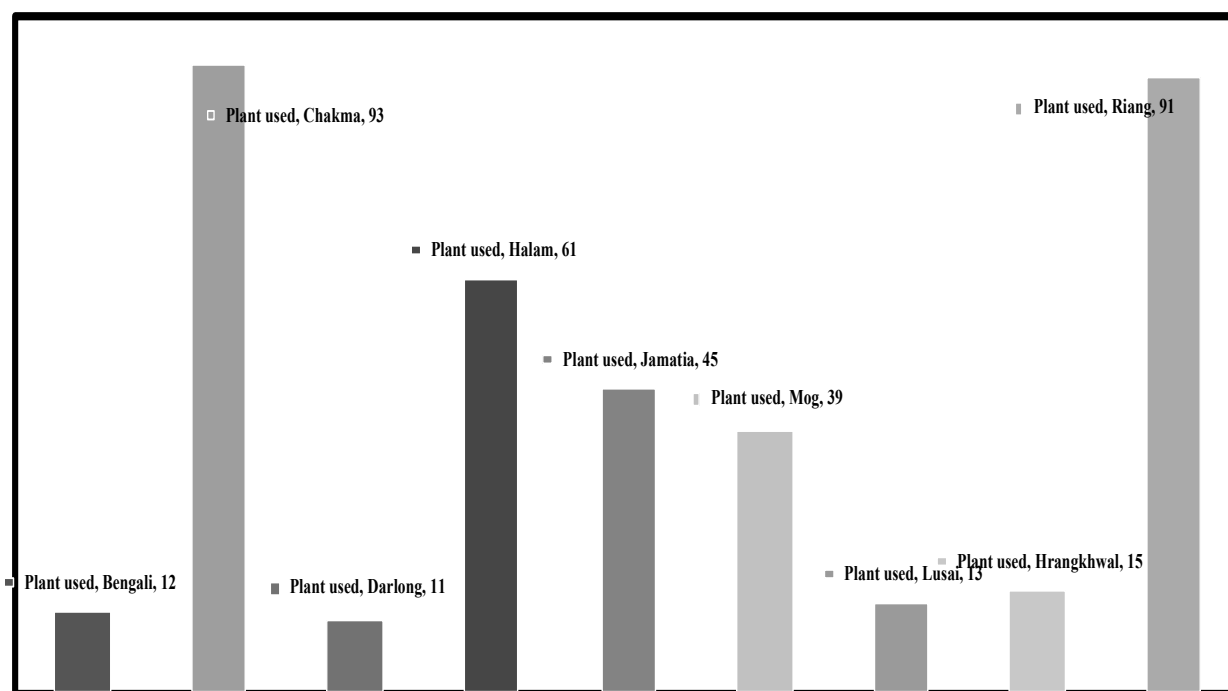


Figure 4: Showing number of plant species used for the treatment of number of ailments.

4. Cultivation and marketing of medicinal plants in Tripura

The physiographical features of Tripura itself encompass variety of climatic stipulation shelters enough suitable agro climatic condition such as land forms, soil, rainfall, temperature etc. for cultivation of several indigenous and exotic medicinal plants species. As Tripura is mainly an agriculture-oriented area, its local skilled cultivators and growers can execute for extensive cultivation of medicinal plants, can be grown in a variety of lands and conditions like kitchen gardens, field margins, existing tree plantations, wastelands, and jhum fallows. The fallows areas of jhum land can be lucrative for its cultivation and rehabilitation for jhum cultivators. More recently, the Forest Right Act (2006) or The Tribal Land Act (2006) has provided sufficient space for growing such economic plants. Taking the advantages of the divergent habits of medicinal plants, multi-tier cropping and inter-cropping are possible. Such cultivation will not only add to the productivity but also provide sustainable sources of income in a perennial manner to the farmers. Most of the herbaceous species have short conception period and yield economic return quickly. About 100 medicinal plants are said to be cultivated or commercially extracted in small quantities in the state. Among them *Amloki*, *Satamuli*, *Ashok*, *Berela*, *Neem*, *Brahmi*, *Pipul*, *Vashak*, *Tulsi*, *Bel*, *Chita*, *Haritoki*, *Bahera*, *Arjun* etc. are cultivating in large scale for meet the local demands. There is also some small-scale private cultivation particularly by the traditional Ayurvedic practitioners.

Those villages based specialized practitioners or local medicine men have plenty traditional knowledge of herbal home remedies of ailments and nutrition. Among *Arjun*, *Brahmi*, *Bel*, *Bringaraj*, *Bashak*, *Tulsi*, *Paddakuruj*, *Kalamegh*, *Kurchi*, *Hatvangha*, *Satamuli* etc. are importantly used and these are also locally traded. There is not sufficient information to filling the gaps between producers and the consumers or large processor and value addition agencies. While the marketing channel can be determined, other information concerning the amount of the product, local prices, and destination are more difficult to obtain. However, when interviewing the wholesalers, processors, vendors it was found that maximum medicinal plant parts (about 75%) are imported from Kolkata and Bangladesh, the rest are locally available. There are 15 medicinal plants have good market value, 8 plants moderate and 5 have poor market value. The forest department of Tripura state has developed agro-technologies for 30 species of medicinal plants. The National Medicinal Plants Board (NMPB) has identified 31 species of medicinal plant for commercial cultivation on their high demand, of which 15 species are found in Tripura. The significant contribution from medicinal plants and Non-Timber Forest Products (NTFPs) towards royalty collection through their special provision permitting hill men *Jhumias* to collect minor forest products and sell them at near village markets after paying royalty to the Forest Department (FD). The cultivation and conservation of medicinal plants is one of the thrust areas which support the urgent need for participation of local communities.

Cultivation of medicinal plants through community involvement program need to look as only probable solution to meet the demand of raw material for local markets and diluting the pressure on wild stocks. Joint Forest Management Committee (JFMC) has been practiced since late 1990s to different extent by State Forest Department of the state. Initially the concept was designed for rehabilitation of degraded forests by people's participation in planning process and management of such forest. More than 390 JFMCs with the involvement of about 35,000 families are covered about 1 lakh ha. of the forest land. Earlier cultivation and conservation of medicinal

plants has not been a priority on the forestry agenda. But, recently the Forest Department have started working with several JFMCs, Forest Development Agencies (FDAs), Self Help Groups (SHGs) and Non-Government Organizations (NGOs) to promote and development of medicinal plants in the state. Different medicinal plants garden needs to setup at community level and people's active participation in plantation and resources management to assemble sustainable livelihood opportunities. Local people involvement in medicinal plant habitat conservation would also help to fill the shortage of resources. However, achievement of the goals for sustainable ecosystem management and socio-economic development will not be possible without expansion of medicinal plant sectors in Tripura.

Commercialization of local medicinal plants in Tripura is not well developed, but whatever exist only in the informal sector. Network exists, but very weak towards storage and trade at both regional and national level. Many people un-authorized harvests large volumes of plants from wild populations throughout the reserve forests of the state and supply them illegally to the traders mostly from Assam, Mizorum and Bangladesh. The trade network includes forest dwellers, NTFP collectors, transporters, wholesalers, street retailers, traditional healers and exporters. In Tripura, several weekly village markets exist where street sellers trade herbal medicine mainly prepared by local traditional healers.

5. Threatened medicinal plants of Tripura:

The Demand of medicinal plants are increasing, their survival in their natural environment is under severe threat. This is due to rapid degradation and loss of natural habitats and in certain instances due to over-harvesting of species. It is estimated that today around a 1000 species of medicinal plants are facing threat to their existence in the wild, and some of them like have already become extinct in the wild. Trade studies indicate that there are around 880 species of medicinal plants in all India trade, out of which 100 species are from cultivated sources, 14 are imported and exotic to India and the remaining are collected from the wild from both forest and other landscapes. Thus 90% of the medicinal plants used by the Indian industry today are collected from the wild. Over 70% of the plant collections involve destructive harvesting because of the use of parts like roots, bark, wood, stem and the whole plant. This pattern of use poses a definite threat to the genetic stocks and to the diversity of medicinal plants. Threat assessment exercises as per latest IUCN guidelines, for southern and northern India have already listed around 200 species of medicinal plants that are rare, endangered and threatened (Biswas *et al.*, 2000).

Extensive harvest of medicinal plants from their natural habitat over the last century has eroded these resources severely. A number of economic plant species are included in the Conservation on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for export restriction and strict control of Trade (Anon, 2001). In India, a number of plant species are threatened of extinction due to commercial exploitation of root, rhizome, tuber and whole plant (Nayar and Sastry, 1987). The major risk occurring in the state for the plants to turn into RED list are over-exploitation of a species, over-harvesting from wild condition, expansion of Jhum cultivation and frequently tends to change the site of Jhum land, change in habit condition due to human interference, illegal forest felling, illegal trade of some species, reduction and poor stock of some species in wild, introduction of several exotic species such as *Cleom*, *Cassia*, *Acacia*, *Lantana*, *Eupatorium*, *Mikania* etc., extension of township, construction and drilling work by

ONGC, CPW construction, PWD road construction, N F Railways track construction, NBCC or NPCC boarder fencings etc. It is also due to mention that the State Forest Department recently developing many recreational parks or eco-parks by destroying natural forest patches and corridors and replace the local forest with some exotic species (eg. *Cassia*, *Acasia*, *Albizia*, *Polyalthia*, *Eucalyptus* etc.). The tendency of monoculture of some species such as Rubber, Sal, Teak, Gmelina, Bamboo, are also causing serious threat to the natural vegetation of the region. The extremely degraded forest lands prevent the natural regeneration of species in wild condition resulting them to merge slowly in to the threatened categories in near future. Species with over-harvesting from wild reserve for their economic purposes rather than their medicinal potentials are also categorized in this list. Large quantity of threatened medicinal plants is being illegally traded. Being a three side boarded by Bangladesh it is very easy to export them otherwise illegally. Thus the real stakeholders are not getting the actual price and also the forest department is not getting the actual revenue as per the Forest Policies. A list of locally threatened medicinal plants is given in Table-1.

6. Conservation and sustainable development of medicinal plants

India is one of the major sources of medicinal plant as raw material for the global market. Most of the medicinal plants are present in the forests of India. Post –independence reduction in forest area has eroded the availability base of medicinal plants, some having been pushed out of existence and others are on the verge of extinction. A clear picture of the threatened status of medicinal plants indicates that about 10% species are endangered, indicating widespread degradation of forests in India (Anon, 1997, 2000). Medicinal plants which have acquired endangered and threatened status, require urgent damage control measures. These are the only sources to provide understanding of reproductive biology, genetic architecture, relationships with the environmental factors, with their growth and natural distribution. Basic approaches for conservation are (a) ex-situ preservation which requires maintenance of germplasm outside their original habitat and (b) in-situ conservation by protective maintenance of a natural plant population, especially habitat.

7. Recommendations for cultivation and promotion of medicinal plants in Tripura

There several hundred hectares of fallow land laying throughout the state and developing strategies for cultivation of medicinal plants will be proven as effective initiatives to bring livelihood opportunities for income generation among rural hilly people. Commercial cultivation of medicinal herbs can be promoted by establishing a linkage with several Govt. agencies and private firms. Identification of prioritized plant species with high commercial value and establishment of nurseries/ garden to propagate and supply sufficient raw materials. Selection of superior germplasm for large scale commercial production. Promote and transfer latest agro technology for standardization of propagation and cultivation practices among the interested farmers. Extend scope for research to find suitable techniques for bulk production, processing, storage and marketing. Understand the gaps between the farmers, funding agencies, traders and industries for effective management of market and production chains. Establishment of laboratories for validation of the traditional usages of various medicinal plants in curing different disease. Initiate suitable schemes and grant to assist the traditional healers and to protect their Intellectual Property Rights (IPRs). Modifications in the Govt. schemes and policies to support

research and development on herbal medicines and to curb over-exploitation of medicinal herbs in natural forests.

Table -1 Threatened Medicinal Plants of Tripura

Name of the species	Local name	Parts Used	Status	Threat Due to
<i>Acorus calamus</i>	Boch	Rhizome	R	Illegal trade, habitat destruction
<i>Alpinia galanga</i>	Gondoki	Whole	V	Extension of Jhum land
<i>Aegle marmelos</i>	Bel	Fruit	NT	Over-exploitation
<i>Aquilaria malaccensis</i>	Agar	Wood	EN	Illegal trade
<i>Ardisia solanacea</i>	Saua	Leaves, Flower	R	Habitat destruction
<i>Asparagus racemosus</i>	Satamuli	Root	NT	Over-exploitation
<i>Butea monospermum</i>	Palash	Flower seed	NT	Habitat destruction
<i>Cinnamomum obtusifolium</i>	Ban Tejpata	Bark, leaves	R	Habitat destruction
<i>Cycas pectenata</i>	Rishok	Young Shoot	CE	Habitat destruction, exploitation for vegetable
<i>Diospyros montana</i>	Bon Gab	Fruit	R	Over-exploitation for fruits
<i>Drosera burmani</i>	Surjasisir	Whole plant	EN	Habitat destruction
<i>Entada phaseoloides</i>	Ghat gila	Fruit	EN	Habitat destruction, Over-exploitation
<i>Gynocordia odorata</i>	Gatha	Fruit, Bark	EN	Habitat destruction
<i>Hydnocarpus kurzii</i>	Chalmorga	Fruit	EN	Habitat destruction, Illegal trade
<i>Homalomena aromatic</i>	Gandhuri	Rhizome	R	Illegal trade, Habitat destruction
<i>Homonia riparia</i>		Fruit, leaves	EN	Habitat destruction
<i>Hymenodictylon excelsum</i>	Bon Kadam	Flower, bark	NT	Habitat destruction
<i>Ipomoea hederacea</i>	Dudh Kalmi	Flower, root	R	Habitat destruction
<i>Kaempferia galanga</i>	Akangi	Rhizome	R	Over-exploitation, Jhum cultivation
<i>Lasia spinosa</i>	Kattush	Stem	NT	Over-exploitation, Habitat destruction
<i>Litsea glutinosa</i>	Menda	Bark	NT	Over-exploitation, Habitat destruction
<i>Oroxylum indicum</i>	Kanai dinga	Fruit, bark	NT	Over-exploitation, Habitat destruction
<i>Piper longum</i>	Pipul	Fruit	NT	Illegal trade
<i>Pueraria tubarosa</i>	Bhui kumra	Tuber	NT	Illegal trade , Habitat destruction
<i>Rauvolfia serpentina</i>	Sarpagandha	Root	CE	Illegal trade , Habitat destruction
<i>Saraca asoka</i>	Ashok	Bark, flower	EN	Illegal trade , Habitat destruction
<i>Semecarpus anacardium</i>	Bhela	Seed, bark	EN	Habitat destruction
<i>Smilax glabra</i>	Shuk chini	Root, leaves	CR	Illegal trade, Over-exploitation
<i>Strychnos wallichii</i>	Bish Lata	Stem	R	Habitat destruction
<i>Terminalia arjuna</i>	Arjun	Bark	R	Habitat destruction
<i>Terminalia chebula</i>	Haritoki	Fruit	R	Over-exploitation , Habitat destruction
<i>Vallis solanacea</i>	-	Whole plant	R	Habitat destruction

(* Threat assessment is based on regional and national status)

8. Scope

Medicinal herbs or plants have been known to be an important potential source of therapeutics or curative aids. The use of medicinal plants has attained a commanding role in health system all over the world. This involves the use of medicinal plants not only for the treatment of diseases but also as potential material for maintaining good health and conditions. Through recent research, plant-derived drugs are discovered from the study of curative, therapeutic, traditional

cures and most especially the folk knowledge of indigenous people. Some of these claims and believe of people are irreplaceable despite the recent advancement in science and technology (Oladeji, 2016). Medicinal plants have provided mankind a large variety of potent drugs to alleviate or eradicate infections and suffering from diseases in spite of advancement in synthetic drugs, some of the plant-derived drugs still retained their importance and relevance. The use of plant-based drugs all over world is increasing (Bhat, 1995). Some of the drugs believed to be obtained from plants are aspirin, atropine, artimesinin, colchicine, digoxin, ephedrine, morphine, physostigmine, pilocarpine, quinine, quinidine, reserpine, taxol, tubocurarine, vincristine and vinblastine (Oladeji, 2016). These plants are either “wild plant species” those growing spontaneously in self-maintaining populations in natural or semi-natural ecosystems and could exist independently of direct human actions or the contrasting “Domesticated plants species” or “cultivated plants in home garden or in protected lands”, that have arisen through human actions such as selection or breeding and depend on management for their existence (Calixto, 2000).

Information about medicinal plants has long been transmitted gradually and from generation to generation, a human knowledge has gradually become complete with the formation of civilizations and the provision of more facilities. The use of plants for treating diseases is as old as the human species. Popular observations on the use and efficacy of medicinal plants significantly contribute to the disclosure of their therapeutic properties, so that they are frequently prescribed, even if their chemical constituents are not always completely known. For example, *Musa paradisiaca* L. is used traditionally in Tripura to treat diabetes by the local communities viz. Bengalee, Lusai and Mog (Tarafdar *et al.*, 2014). They also showed varying degrees of hypoglycemic effect of methanolic extract of green fruits of (Ojewole and Adewunmi, 2003, Parmar and Kar, 2008) without knowing the specific active molecules. Nowadays, the rate of bioassay-guided fractionation has been significantly enhanced by the development of precision instruments such as high-performance liquid chromatography-mass spectrometry (HPLC/MS), liquid chromatography mass spectrometry (LC/MS), magnetic field and nuclear magnetic resonance (NMR) (NMR) is a recent major breakthrough technique for the categorization of compounds that are extremely limited in quantity in their organisms of origin (Schroeder and Gronquist, 2006).

This raises curiosity regarding their further scientific characterization to endorse their traditional use in modern healthcare system and identification of new bioactive molecules. Further pharmacological validations of these plants will help in the development of effective herbal drugs in near future. Awareness regarding application of plants to prepare food and medicine has been realized over period of time through trial and error method, and gradually human became able to meet his different needs from his natural surroundings. Ensuring the safety, quality and effectiveness of medicinal plants and herbal drugs very recently became a key issue in industrialized and developing countries. By standardizing and evaluating the health of active plant-derived compounds, herbal drugs can help the emergence of a new era of the healthcare system to treat human diseases in the future. Today, according to the WHO, more than 80% of the world's population relies more often on traditional drugs, mainly plants, serving as the main source of health care (Farnsworth *et al.*, 1985). This figure includes not only a large population of China, India and all the developing countries of the world but also many advanced countries (Ganesan, 2008).

Although diseases are currently being treated more often through medicines of synthetic origin and specifically developed in laboratories, and their definite effects in the treatment of diseases have contributed to the development of their use, the use of some medications leads to certain damages to the body. Therefore, the importance of medicinal plants and their products are increasingly recognized and the public confidence in their use is constantly strengthened (Zargari, 1992). Awareness of traditional knowledge and medicinal plants can play a key role in the exploitation and discovery of natural plant resources. In order to maintain this knowledge, comprehensive approach and collaboration are needed to maintain historical records on medicinal plants and use these resources in favor of human beings, before they are destroyed forever.

9. Challenges

Despite the success of research to produce medicinal plants to introduce new bioactive molecules over the past few decades, future efforts face many challenges. The quality of the herbal product has been studied. Standardization of raw materials is an important issue for the plant industry (Yadav *et al.*, 2014). Herbaceous plants can be easily infected during growth, processing and collection. Contamination and pollution with heavy metals are two main problems with the quality of herbal drugs. It is therefore necessary to improve the quality and quantity of bioactive compounds for the production of herbal drugs while making effort to discover more new herbal drugs (Clark, 1996). Due to expanding the use of natural substances around the world, the quality and safety of plant-derived medicines should be comprehensively and accurately studied issues. The traditional and the millennial beliefs about these issues cannot be surely trusted. Therefore, scientific and enlightening studies are essential to obtain reliable information for the use of medicinal plants in health care (Firenzuoli and Gori, 2007). On the other hand, one of the challenges facing medicinal plants is the loss of medicinal plant species due to the non-principled use of these resources. According to the International Union for Conservation of Nature and Natural Resources (IUCN), there are between 50 000 and 80 000 flowering plant species, are used for pharmaceutical purposes around the world. Among these numbers, about 15 000 species are exposed to a risk of extinction due to over exploitation and destruction of habitats (Bentley, 2010). About 20% of their wildlife resources are decreasing due to growing human populations and excessive consumption of plants (Ross, 2005). Therefore, the environmental code of ethics that preserves biodiversity in the processes of exploiting natural resources to discover natural drugs should be considered (Pan *et al.*, 2013). Good agricultural practice (GAP) for medicinal plants are planned to regulate production and ensure quality and facilitate the standardization of herbal drugs (Chan *et al.*, 2012). GAP is an approach that uses high-quality, safe and non-contaminated (raw drugs) herbal medicines to help solve various problems (Muchugi *et al.*, 2008). GAP includes comprehensive items such as environmental ecology, production locations, germplasm, cultivation, collection and quality aspects of pesticide detection, macroscopic or microscopic validation, chemical identification of active compounds, and checking of metal elements (Makunga *et al.*, 2008). Many countries seriously implement and promote the GAP. For example, in China, GAP has promoted the growth of conventional medicinal plants in areas where these plants are traditionally cultivated (Ma *et al.*, 2012; Jamshidi-Kia *et al.*, 2018).

Author's Contribution: Koushik Majumdar (KM) contributed to the design of the research problem, data compilation, analysis, interpretation, and drafting the research article. Bal Krishan Choudhary (BKM) was involved in conceptualization, critical revision, and final approval of the manuscript, and is the corresponding author. Badal Kumar Datta (BKD) designed the methodology, executed data processing, and analyzed the results.

Author's Agreement: All the authors have seen and approved the final version of the manuscript being submitted. Further, we warrant that the article is the authors' original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

Declaration of interests: The authors declare no competing interests, whether financial or personal relationships with other people or organizations that could inappropriately influence or bias our work.

Reference

- Anonymous, 2001. Appendix I, II and III to Convention on International Trade in Endangered Species of Wild Fauna and Flora. US Fish and Wildlife Service, USA, 32.
- Anonymous, 1997. Report of the National Consultation on Medicinal Plants. Ministry of Environment and Forest, Govt. of India, New Delhi.
- Anonymous, 2000. Report of the Task Force on Conservation and Sustainable Use of Medicinal Plants. Planning Commission, Govt. of India, New Delhi.
- Bentley, R.E., 2010. Medicinal Plants. London: Domville-Fife Press, 23-46.
- Bhat, K.K.P., 1995. Medicinal plant information databases. In: Non-Wood Forest Products. Medicinal Plants for Conservation and Health Care, Rome: Food and Agriculture Organization.
- Biswas, S., Jain, S.S., Chandra, S., 2000. Some Rare and Threatened Medicinal Plants of Himalaya and North Eastern Regions of India and Strategies for their Conservation. *Journal of Non-Timber Forest Products*, 7, 101-111.
- Borthakur, S.K., 1981. Certain Plants in Folklore and Folklife of Karbis (Mikirs) of Assam-in SK Jain (ed.), Glimpses of Indian Ethnobotany. Oxford & IBH Publication, New Delhi, 170-181.
- Borthakur, S.K., 1976. Less known Medicinal Uses of Plants among the Tribals of Mikir Hills. *Bulletin of the Botanical Survey of India*, 18,166-171.
- Calixto, J.B., 2000. Efficacy, safety, quality control, marketing and regulatory guidelines for herbal medicines (phytotherapeutic agents). *The Brazilian Journal of Medical and Biological Research*, 33(2), 179-189. <https://doi.org/10.1590/s0100-879x2000000200004>
- Chan, K., Shaw, D., Simmonds, M.S., Leon, C.J., Xu, Q., Lu, A., Sutherland, I., Ignatova, S., Zhu, Y.P., Verpoorte, R., Williamson, E.M., 2012. Good practice in reviewing and publishing studies on herbal medicine, with special emphasis on traditional Chinese medicine and Chinese materia medica. *Journal of Ethnopharmacology*, 140(3), 469-475. <https://doi.org/10.1016/j.jep.2012.01.038>.
- Chopra, R.N., Chopra, I.C., Varma, V.S., 1968. Supplement to Glossary of Indian Medicinal Plants. CSIR. New Delhi
- Chopra, R.N., Nayar, S.L., Chopra, I.C., 1956. Glossary of Indian Medicinal Plants. CSIR. New Delhi.
- Clark, A.M., 1996. Natural Products as a Resource for New Drugs. *Pharmaceutical Research*. 13(8),1133-41. <https://doi.org/10.1023/a:1016091631721>.
- Das, B., Talukdar, A.D., Choudhury, M.D., 2014. A few traditional medicinal plants used as antifertility agents by ethnic people of Tripura, India, *International Journal of Pharmacy and Pharmaceutical Sciences*, Vol. 6, (3).
- Das, H.B., Majumdar, K., Datta, B.K., Roy, D., 2009. Ethnobotanical uses of some plants by Tripuri and Reang tribes of Tripura, *Natural Product Radiance*, 8(2), 172-180
- Deb, D., Darlong, L., Sarkar, A., Roy, M., Datta, B.K., 2012. Traditional Ethno-Medicinal Plants Use By The Darlong Tribes In Tripura, Northeast India, *International Journal of Aurvedic and Herbal Medicine*, 2(6), 954-966.
- Deb, D.B., 1978. Cultivation of Medicinal Plants in Tripura State, *Indian Drugs*, 15(6), 93-106.
- Deb, D.B., 1968. Medicinal Plants of Tripura, *Indian For*, 1968, 94(10), 753-765.
- Deb, D.B., 1983. The Flora of Tripura State, Vols I & II, Today and Tomorrows' Printers and Publishers, New Delhi.
- Farnsworth, N.R., Akerele, O., Bingel, A.S., Soejarto, D.D., Guo, Z., 1985. Medicinal plants in therapy. *Bull World Health Organ*. 63(6), 965-81.
- Firenzuoli F, Gori L. 2007. Herbal medicine today: clinical and research issues. *Evidence-Based Complementary and Alternative Medicine*, 4, 594728. <https://doi.org/10.1093/ecam/nem096>
- Ganesan, A., 2008. The impact of natural products upon modern drug discovery. *Current opinion in chemical biology*, 12(3), 306-317. <https://doi.org/10.1016/j.cbpa.2008.03.016>.
- Kala, C.P., Dhyani, P.P., Sajwan, B.S., 2006. Developing the Medicinal Plants Sector in Northern India: Challenges and Opportunities. *Journal of Ethnobiology and Ethnomedicine*. 2, 32. <https://doi.org/10.1186/1746-4269-2-32>
- Jamshidi-Kia, F., Lorigooini, Z. and Amini-Khoei, H., 2018. Medicinal plants: Past history and future perspective. *Journal of Herbmed Pharmacology*, 7(1), 1-7. <https://doi.org/10.15171/jhp.2018.01>

- Koushik, M., Datta, B.K., 2013. Practice pattern of traditional pharmaceutical formulations by the tribes of Tripura, Northeast India, *Global Journal of Pharmacology* 7 (4), 442-447. <https://doi.org/10.5829/idosi.gjp.2013.7.4.7652>
- Ma, J., Rong, K., Cheng, K., 2012. Research and practice on biodiversity in situ conservation in China: progress and prospect. *Biodiversity Science*. 20(5), 551-8. <https://doi.org/10.3724/sp.j.1003.2012.08118>.
- Majumdar, K., Datta, B.K., Roy, D., 2009 Inventory and Status of Medicinal Trees of Tripura. Trivedi PC (ed.) Indian Medicinal Plants. Aviskar Publisher, Jaipur. 93-123.
- Majumdar, K., Datta, B.K., 2007. A study on ethnomedicinal usage of plants among the folklore herbalists and Tripuri medical practitioners: Part-II. *Natural Product Radiance*, 6(1), 66-73.
- Majumdar, K., Datta, B.K., 2007. Ethno-botanical Observation on the Traditional Usage of Medicinal Plants among the Tribes of Tripura, (PC Trivedi Ed.), "Ethno medicinal Plants of India". Aviskar Publisher, Jaipur. 2007. 136-161.
- Majumdar, K., Saha, R., Datta, B.K. and Bhakta, T., 2006. Medicinal plants prescribed by different tribal and non-tribal medicine men of Tripura state. *Indian Journal of Traditional Knowledge*, 5(4), 559-562.
- Makunga, N.P., Philander, L.E., Smith, M., 2008. Current perspectives on an emerging formal natural products sector in South Africa. *Journal of Ethnopharmacology*, 119(3), 365-375. <https://doi.org/10.1016/j.jep.2008.07.020>.
- Muchugi, A., Muluvi, G.M., Kindt, R., Kadu, C.A., Simons, A.J., Jamnadass, R.H., 2008. Genetic structuring of important medicinal species of genus Warburgia as revealed by AFLP analysis. *Tree Genetics & Genomes*, 4(4), 787-795. <https://doi.org/10.1007/s11295-008-0151-3>
- Nayar, M.P., Sastry, A.R.K., 1987. Red Data Book of Indian Plants. Vol.I-III, Botanical Survey of India, Kolkata.
- Ojewole, J.A., Adewunmi, C.O., 2003. Hypoglycemic effect of methanolic extract of Musa paradisiaca (Musaceae) green fruits in normal and diabetic mice. *Methods and Findings in Experimental and Clinical Pharmacology*. 25, 453-456.
- Oladeji, O., 2016. The characteristics and roles of medicinal plants: Some important medicinal plants in Nigeria. *Natural Products: An Indian Journal*, 12(3), 102.
- Pan, S.Y., Zhou, S.F., Gao, S.H., Yu, Z.L., Zhang, S.F., Tang, M.K., Sun, J.N., Ma, D.L., Han, Y.F., Fong, W.F., Ko, K.M., 2013. New perspectives on how to discover drugs from herbal medicines: CAM'S outstanding contribution to modern therapeutics. *Evidence-Based Complementary and Alternative Medicine*, (1), 627375. <https://doi.org/10.1155/2013/627375>.
- Pandey, A., Mavinkurve, R.G., 2014. Ethno-Botanical usage of plants by the Chakma community of Tripura, Northeast India. *Bulletin of Environment, Pharmacology and Life Sciences*, 3(6), 11-14.
- Parmar, H.S. and Kar, A., 2008. Medicinal values of fruit peels from Citrus sinensis, Punica granatum, and Musa paradisiaca with respect to alterations in tissue lipid peroxidation and serum concentration of glucose, insulin, and thyroid hormones. *Journal of Medicinal Food*, 11(2), 376-381.
- Rao, R.R., Haridasan, K., 1991. An ethnobotanical survey of Medicinal and other useful plants of North-East India. *Journal of Economic and Taxonomic Botany*, 15(2), 423-435.
- Rao, R.R., Jamir, N.S., 1982. Ethnobotanical studies in Nagaland. I. Medicinal plants. *Economic Botany*, 36(2), 176-181.
- Rao, R.R. 1998. Biodiversity Conservation in North East India: Priorities and Prescriptions. Sundriyal RC, Shankar U, Upreti TC (eds.). Prescriptions for Planning and Development in North East India. GBPIHED, Almora, 91-99.
- Rao, R.R., 1981. Ethnobotany of Meghalaya: medicinal plants used by Khasi and Garo tribes. *Economic Botany*, 35(1), 4-9.
- Ross, I.A., 2005. *Medicinal plants of the world, volume 3: Chemical constituents, traditional and modern medicinal uses*. Totowa, NJ: Humana press.
- Samant, S.S., Dhar, U., Palni, L.M.S., 1998. *Medicinal plants of Indian Himalaya: diversity, distribution, potential values* (No. 13). Gyanodaya Prakashan.
- Schroeder, F.C. and Gronquist, M., 2006. Extending the scope of NMR spectroscopy with microcoil probes. *Angewandte Chemie International Edition*, 45(43), 7122-7131. <https://doi.org/10.1002/anie.200601789>.
- Shiva, M.P., 1998. *Inventory of forest resources for sustainable management & biodiversity conservation with lists of multipurpose tree species yielding both timber & non-timber forest products (NTFPs), and shrub & herb species of NTFP importance*. Indus Publishing.

- Tarafdar, R.G., Nath, S., Talukdar, A.D. and Choudhury, M.D., 2015. Antidiabetic plants used among the ethnic communities of Unakoti district of Tripura, India. *Journal of Ethnopharmacology*, 160, pp.219-226. <https://doi.org/10.1016/j.jep.2014.11.019>
- Yadav, M., Chatterji, S., Gupta, S.K. and Watal, G., 2014. Preliminary phytochemical screening of six medicinal plants used in traditional medicine. *International Journal of Pharmacy and Pharmaceutical Sciences*, 6(5), 539-542.
- Zargari A., 1992. Medicinal Plants. Tehran University Press, Tehran 889.

Received: 30 October 2023

Accepted: 15 November 2023