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Original Research Article

Quantitative Assessment of Bioresource Utilization Patterns by the Ethnic Communities of Tripura, India

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Abstract: Bioresources are non-fossil biogenic resources which can be used by humans for multiple purposes. They are very important for sustenance of ethnic communities and contributing as food, medicine and livelihood security for the ethnic people of Tripura. The present research was conducted to document the plants usage by evaluating its ethnobotanical indices such as *Use value* "UV", *Family use value* "FUV", *Informant consensus factor* "ICF", *Fidelity Level* "FL" and *Relative Frequency of citation* "RFC". About 11 villages and 25 local markets in four districts of Tripura were surveyed; and a total number of 50 informants were selected for the study. Our result showed the relative usefulness of different species used by the ethnic people of Tripura. About 120 bioresource plant species have been encountered belonging to 102 genera under 49 families. Cucurbitaceae represents 8 species was found to be the most used family. *Chromolaena odorata* was most commonly prescribed species by the informants with a maximum RFC=1. Similarly, the mostly treated illness category were Urological (ICF=0.98) and 8 species namely *Chromolaena odorata*, *Sauropus androgynus, Phlogacanthus thyrsiflorus, Andrographis paniculata, Tabernaemontana divaricata, Curcuma longa, Helminthostachys zeylanica* and *Centella asiatica* has the highest FL%. Taxonomic inventories of bioresources and ethnobotanical indices will provide understanding for the long-term use of such plant and a key role in sustainable developments. As a result, it will lead to both conservation of bioresources in their natural habitats as well as develop a sustainable livelihood for the forest dwellers.

Key words- Bioresources, family use value index, livelihood, northeast India, quantitative analysis, sustainable utilization, Tripura, use value index.

Introduction

The northeastern (NE) region of India is considered one of the most bio-culturally diverse regions of India (Yumnam, 2008). India is counted in the countries with a growing market for aromatic and medicinal plants (Martinez, 2004). Diverse communities, traditional agriculture, indigenous resource management techniques, forest dependency, and the use of ethnic foods and medicines have resulted in a rich heritage of culturally embedded Traditional knowledge (Singh and Sureja, 2006). Bioresources are non-fossil biogenic resources which can be used by humans for multiple purposes: to produce food, substantial products, and/or energy carriers (Deipser and Körner, 2015). Bioresources of both cultivated and wild origin have played a vital role in the subsistence economy of the traditional communities living in the region (Maikhuri *et al.,* 2013). Interest in wild edibles plants has grown significantly with the increasing awareness in linking between biodiversity conservation with rural development. There are wide variety of plant products used as a source of food,

nutrition, fodder, fiber, medicine, condiment, and various other uses for meeting the basic household needs and also for commercial purposes that generate substantial income (Hamilton, 2004; *Sundriyal et al.,* 2004). Livelihood security of rural people depends greatly on the status and condition of the natural resources (Tewari and Campbell, 1997; Saxena, 2003). More recently edible wild bioresources are being viewed as untapped or underutilized resources that could play a significant role in rural development, poverty mitigation, sustained livelihood and nutritional security for the local communities through bioprospecting with the applications of science and technological interventions (Dhayani *et al.,* 2007). Although these wild plants for food and other valuable means are not consumed and utilized in large quantity but their role in local communities cannot be ignored not identical in the reference part (Maikhuri and Ramakrishnan, 1992; Maikhuri *et al.,* 1994). Majority of these wild plants could be utilized for various value-added edible products which have a high energy content and nutritional value with enormous medicinal properties (Singh and Arora, 1978). The biological, socio-cultural and economic factors predominant in the Northeast India have resulted in the evolution of diverse agriculture systems (Maikhuri *et al.,* 2013). Many traditional communities rely on these resources for social, cultural and religious functions.

Bioresources are important renewable natural resource and their sustained availability is essential to safeguard millions of dependent people. Natural resources have played a key role in the sustenance of human and still serving a large number of human populations throughout the world. Forest products constitute an important source of livelihood for millions of people from forest fringe communities across the world (Murphy, 2005; Mamo *et al.,* 2007; Blay *et al.,* 2007). But the markets remain a major challenge for bioresource products due to improper channels, existing low cost and unexplored value of the products. In Tripura, there are 19 ethnic groups which largely depend on the forest resource for their livelihood (Biswas *et al.,* 2018). Several documentations on the ethnobotanical studies, checklist on wild/semi wild edible plants and plant products utilization by the ethnic communities of Tripura has been done (Singh *et al.,* 1997; Das, 2008; Das and Choudhury, 2009, Deb *et al.,* 2012; Deb *et al.,* 2013; Majumdar and Datta, 2014; Guha, 2015; Biswas *et al.,* 2018); but, a comprehensive quantification study of the bioresources richness in different areas is still lacking. A quantitative approach of bioresources study in Tripura may reveal the people-plants relationships in a multidisciplinary manner. It also established the importance of bioresources in terms of ecology, economics, public policy, public health, and other disciplines. The present research was conducted to document in wide spectrums of plants usage which can be evaluated by using the ethnobotanical indices such as *Use values* and *family use values*. The technique of Use-Value and Family Use-Value is based on the number of uses and the number of people that cite the uses of a given plant. These have been widely used within the enthnobotanical studies to indicate the importance of a species in a given population of a specific region (Philips and Gentry, 1993; Hoffman and Gallaher, 2007; Saha and Sundriyal, 2012; Ojha *et al.,* 2020). The benefit of using such a quantitative approach is that it contributes in the production of informative data, which will aid in resource conservation and development (Hossain and Rahman, 2018). This documented information will facilitate for future investigation and discovery of several uses of a special plants, and to enlighten the local communities on sustainable forest management.

Materials and Methods

Study area

Tripura is the second smallest state of North-east India located between 23°302 to 23°442 North latitudes and between 91°152 to 91°282 East longitudes surrounding by Bangladesh in three sides assumes a special significance in the biogeography of the region due to its unique location and habitat heterogeneity. It is located at the confluence of Indo-Burma bio-geographical zone (Rao, 1994) and part of the 35 Biodiversity hotspots in the world (Myers *et al*., 2000). The undulating topography, high rainfall and varied altitudes are main factors that have

contributed to its rich hilly ecosystem and habitat diversity. The total geographic area of the state is 10,486 sq. km of which total recorded forest area is 6,294 sq km. "Reserved Forest" constitutes (RF) 66.33%, "Protected Forest" (PF) 0.03% and "Unclassified Forests" (UF) 33.64% of the total forest area (SFR, 2009). The State has eight districts: North, Dhalai, West, Sepahijala, Gomati, Khowai, Unakoti and South Tripura. The state consists of many villages surrounding the main capital city. So, most of the local traders and vendors can get quick access to the city market for the sale of their bioresources. The present study was carried out in four districts (Khowai, Sepahijala, South Tripura and West Tripura) of Tripura comprising local markets and ethnic villages (Fig. 1).

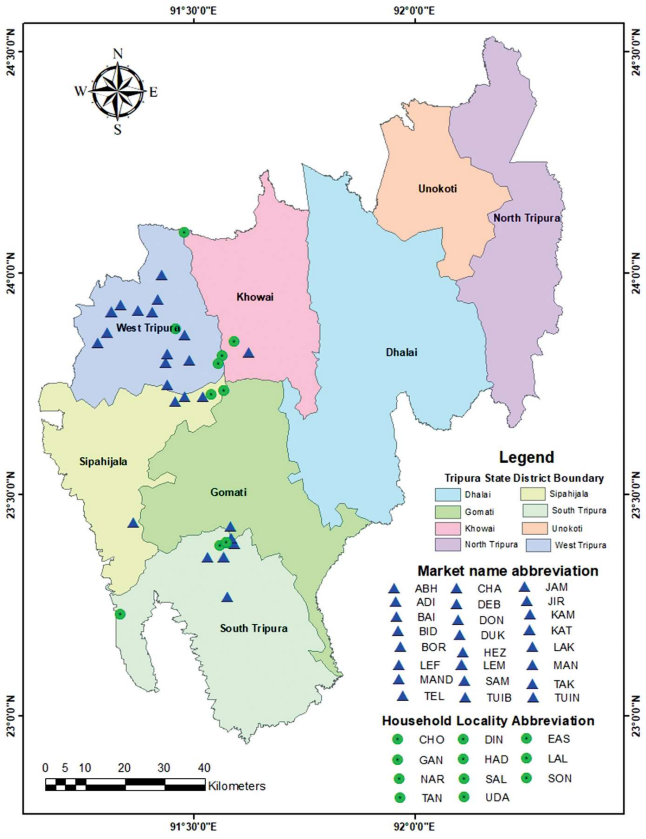

Fig. 1. Map of the study area showing different districts (Khowai, Sepahijala, South Tripura and West Tripura) in which present study was carried out. (Abbreviations on map (legend): Household locality-HAD- Hadupara, SAL- Salka para, SON- Sonarai para, TAN- Tangpui Village, DIN- Dingarai Para, GAN- Gangarai Para, EAS- East manu, CHO- chong pring, LAL- Lal Tilla Kami, NAR- Nareng Bari, UDA- Udaikwpra; Market name: TEL- Teliamura, TAK- Takarjala, JAM- Jampuijala, TUIB- Tuibandal, SAM- Sambar bazar, BID- Biddhi bazar, TAN- Tangpui, KAT- Kathalia bazar, MAN- Manu Bazar, BAI- Baikhora, TUIN- Tuinani bazar, DEB- Debipur Bazar, ADI- Adipur, DUK- Dukmali bazaar, JIR- Jirania bazaar, HEZ- Hezamara, BOR- Borokathal, ABH- Abhicharan, MAND- Mandai, LEM- Lembucherra, LEF- Lefunga, CHA- Champaknagar, LAK- Lake chowmani, DON- Donbosco school, KAM- Kamalghat).

Data collection

The information related to bioresources and wild edible plants are mainly obtained through market surveys using semi-structured questionnaires and informal discussions with the village market vendors and elderly people from the local community. Basic information is collected such as the vernacular names, parts used, and areas of extraction and market trades with little modification (Martin and Gardens, 1995; Jain and Mudgal, 1999). The work involved field surveys, interactions with the knowledgeable ethnic people, recording of data, analyses, and interpretation of the collated information. In the investigation about 11 (eleven) villages and 25 (twenty five) local markets distributed in four districts namely Khowai, Sepahijala, South Tripura and West Tripura were surveyed (Fig. 1).

In-depth interviews were also carried out with the semi-structured interviews and a total number of 50 knowledgeable informants/interviewees were conducted. From the investigations it is revealed that both man and women both participates in the collection of bioresources for food and raw materials. The Jamatia, Hrangkhwl, Kaipeng, Reang, Chakma, Tripuri and Rupini were the ethnic communities that took part in the interviews. Distribution of informants across the districts, communities and ages is shown in Table 1. Homegardens, Jhums (shifting cultivation site) and forest beds were visited during the interviews for tracking the source of extractions. Plant specimens were collected and photographs were taken for digitization and documentation. Some of the important collected plant specimens were submitted to Herbarium in Department of Botany, Tripura University (TUH).

Data analysis

The following ethnobotanical indices were evaluated such as *Use value* "UV" (Phillips and Gentry, 1993a & 1993b; Gomez-Beloz, 2002; Albuquerque *et al.*, 2006; Masoodi and Sundriyal,

Table. 1. Distribution of informants who answered the semi-structured interviews in the following district, with their respective native communities, total interviewees and the age classes.

District	Community		Age class		
		Total informants	20-40	41-60	>60
Khowai	Jamatia	10	2	5	3
Sepahijala	Hrangkhwl, Kaipeng	11	1	4	6
South Tripura	Reang, Chakma	17	3	5	9
West Tripura	Tripuri, Rupini	12	1	7	5

2020; Borah *et al.*, 2020), ***Family use value*** **"FUV"** (Hoffman and Gallaher, 2007; Cadena-González *et al.*, 2013; Ojha *et al.*, 2020; Masoodi and Sundriyal, 2020), ***Informant consensus factor*** **"ICF"** (Trotter and Logan, 1986; Uddin and Hassan, 2014; Ouedraogo *et al.*, 2020), ***Fidelity Level*** **"FL"** (Alexiades and Sheldon 1996; Friedman *et al.*, 1986; Andrade-Cetto and Heinrich 2011; Khan *et al.*, 2014) and ***Relative Frequency of citation*** **"RFC"** (Tardío and Pardo-De-Santayana, 2008; Hoffman and Gallaher, 2007; Chaachouay *et al.*, 2021).

Use value (UV)

It determines the relative importance on uses of plant species. The Use-Value was calculated using the formula:

$$UV = \frac{\Sigma Ui}{n}$$

Where, "UV" indicates use value of individual species, "*Ui*" is the number of uses recoded for that species and "*n*" represents the number of informants who reported that species. The informant's use values for a specific species are sum and then divided by the total number of informants.

Family use value (FUV)

It determines the importance of plant families that have more uses. A different family has different contributions to different use categories. FUV provides a measure of the relative usefulness of plant families. FUV for a particular family is calculated using the formula:

$$FUV = \frac{\Sigma UV}{n}$$

Where "UV" is the total use value of particular species and "n" is total number of species within a given family. The use values *UV* for all the species within a given family are sum and then divided by *n*.

Informant consensus factor (ICF)

It is used to test homogeneity of knowledge; the informant consensus factor was used.

$$ICF = \frac{Nur - Nt}{(Nur - 1)}$$

where "*Nur*" refers to the number of use-reports for a particular use category and "*Nt*" refers to the number of taxa used for a particular use category by all informants. "ICF" values can range from 0 (lowest level) to 1 (highest level) (Gazzaneo *et al.*, 2005). ICF values are low (near 0) when plants are randomly selected or if there is no consensus among informants on their use for the treatment of a certain disease category or if there is no exchange among informants. Values are high (close to 1) if a large proportion of informers prefer certain species for a specific disease category or if information is exchanged between informants. The medicinal plants with high FIC are believed to be effective in treating a certain disease category (Ouedraogo *et al.*, 2020).

Fidelity Level (FL)

It is used to determine the most frequently used plant species for treating a particular ailment category by the informants of the study area, we calculated the fidelity level (FL).

$$FL\% = \frac{Ip}{Iu} \times 100$$

Where, ***'Ip'*** is the number of informants who cited the use a plant species for treating a particular disease and ***"Iu"*** is the total number of informants that cited the species to treat any given disease.

Relative Frequency of Citation (RFC)

The RFC index was used as a measure of consensus between the information provided by different informants using the specified medicinally important plants. The RFC value describes the local importance of each recorded species. RFC for a species is calculated as,

$$RFC = \frac{FC}{N}$$

The RFC index was evaluated by dividing the number of informants who mentioned the use of the species (FC) by the total number of informants participating in the survey (N). The RFC index ranges from *zero to one*; **"0"** (when nobody referred to a plant as useful) and **"1"** (when all informants referred to a plant as useful).

Results

Plant bioresources and their family characteristics

Intense interviews and questionnaires have provided a list of a total of 120 bioresource plant species within the four studied districts used by the 7 communities/tribes of Tripura. Of these 120 species, it belongs to 102 genera under 49 families. The

Table. 2. List of Bioresources along with their respective family, vernacular names, habits, part used, mode of used and Use value (UV) & Family Use Value (FUV) index.

Family & Species	Vernacular Name	Habits	Parts used	Mode of Use	UV	FUV
Acanthaceae						**0.02**
Andrographis paniculata (Burm.f.) Nees	Chirota (R, Ko, J)	Herb	L	TM	0.02	
Phlogacanthus thyrsiflorus Nees.	Bashak ksom (R, Ko, J), Khala basok (C),	Shrub	L	TM	0.02	
Amaranthaceae						**0.02**
Amaranthus spinosus L.	Kanta maira (R, Ko, J), Khada mairi gaid (C), Kenda maira (M)	Herb	St	Veg	0.02	
Amaranthus viridis L.	Danta maira (R, Ko, J); Suichha mairi sak (C)	Herb	L & Sh	Veg	0.02	
Chenopodium album L.	Kuskuria (K)	Herb	L & Sh	Veg	0.02	
Anacardiaceae						**0.033**
Anacardium occidentale L.	kachu badam (R, Ko, J & Ru), Khasu badam (C)	Tree	Fr, N	F, N	0.04	
Mangifera indica L.	Thaichu (R, Ko, J), Am (C),	Tree	Fr	F, PrF	0.03	
Annonaceae						**0.02**
Annona reticulata L.	Ataphol (R, Ko, J & Ru), Odasi gula (C),	Tree	Fr	F	0.02	
Apiaceae						**0.022**
Centella asiatica (L.) Urb	Samzuta (M), Samsota (R, Ko, J & Ru), Maimoni sak (C),	Herb	L & Sh	Veg, TM	0.03	
Coriandrum sativum L.	Danya bakhor (R, Ko, J, M & Ru), Danya pada (C)	Herb	L & Sh	Co	0.02	
Eryngium foetidum L.	Bakhor (R, Ko, J), Borbaur sak (C),	Herb	L	Co	0.02	
Trachyspermum roxburghianum (DC.) H. Wolff	Khundrupui (R, J, Ko & Ru), Kor Chongrui (M),	Herb	L & Sh	Co	0.02	
Apocynaceae						**0.02**
Catharanthus roseus (L.) G.Don	Khum boiragi (R, Ko, J), lukhima phool (C),	Shrub	In, L	TM	0.02	
Rauvolfia serpentina (L.) Benth. ex Kurz	Chanduama (R),	Shrub	L & Sh	TM	0.02	
Tabernaemontana divaricata (L.) R.Br. ex Roem. &Schult.	Khum tautoi (R),	Shrub	In	TM	0.02	
Araceae						**0.025**
Aglaonema hookerianum Schott	kerang muithape (R, Ko, J)	Herb	Rh	Co, Veg	0.02	
Alocasia macrorrhizos (L.) G.Don	Tha ktorma (R, Ko, J), Mal kochu (C), Bal kong char(M),	Herb	St, Tu	Veg, PrF	0.02	
Amorphophallus bulbifer (Roxb.) Blume	Batema (R, Ko, J & Ru), ul kochu mura (C), Batet char (M), Tal kon (Ka)	Herb	L & Sh, Tu	Veg, PrF	0.04	
Colocasia esculenta (L.) Schott	Muiktu (R), jaruwa khochu (C), Muitul (Ko, J), Badol lon (M), Dalpot rizik (Ka)	Herb	St, L, Ro, Co	Veg, PrF	0.03	

Homalomena aromatica (spreng .) Schott	Kamaitru (R), Gandri (Ko, J & Ru), Mantiri (M), Gondui (C), Komantri (Ka)	Herb	St	TM	0.02	
Lasia spinosa (L.) Thwaites	Kantha (R), Gantha (Ko, J), khatuicha mura (C), Kantha bal (M), Kanthapachol (M),	Herb	St, Rh, In	TM	0.02	
Xanthosoma sagittifolium (L.) Schott	Manai (R, Ko, J), Ara kochu (C)	Herb	St, Co	Veg	0.02	
Araliaceae						**0.02**
Brassaiopsis griffithii C.B.Clarke	Chapok (R, Ko, J), Romuke (K)	Shrub	Fr	Co	0.02	
Arecaceae						**0.033**
Areca catechu L.	Kuwai (R, Ko, J, M & Ru), Subari (C)	Tree	N	N	0.02	
Borassus flabellifer L.	Tal mthai (R, Ko, J), Tal gula (C)	Tree	Fr, N	F	0.02	
Cocos nucifera L.	Naningra (R, Ko, J & Ru), Nari khul (C),	Tree	N, L	F, PrF, Co, Oil	0.05	
Phoenix sylvestris (L.) Roxb.	Khagli (R), Khejur (Ko, J & Ru), Khasur gaid (C)	Tree	Fr, Sa	F, S/J	0.04	
Athyriaceae						**0.02**
Diplazium esculentum (Retz.) Sw.	Muikhondo msou (R), Muikhumchok (Ko), Khokochor (M), Di sak (C), Kokadon (Ka)	Herb	L & Sh	Veg	0.02	
Basellaceae						**0.02**
Basella alba L.	Moifrai (R, Ko, J), Phui sak (C)	Climber	L & Sh, Fr	Veg	0.02	
Bignoniaceae						**0.02**
Oroxylum indicum (L.) Kurz	Taukharung (R, Ko, J & Ru), Khonsa (C), Vaak molong (M)	Tree	Fr	Veg	0.02	
Bromeliaceae						**0.028**
Ananas comosus (L.) Merr.	Omtoi (R), Anaroso (Ko, J), Anaid (C), Mortwi (M)	Herb	Fr	F, PrF	0.03	
Burseraceae						**0.02**
Canarium strictum Roxb.	Satrai (R, Ko, J), Dhoopra gaid (C),	Tree	Re	In	0.02	
Caricaceae						**0.02**
Carica papaya L.	Kinkya (R), Kowai phol (Ko), Kokiya (J), Birisu gula (C)	Shrub	Fr	F	0.02	
Compositae						**0.022**
Acmella paniculata (Wall. ex DC.)	Ushnoi (R), Usundui (Ko & Ru), Jhumo	Herb	L & Sh	Veg, TM	0.03	
R.K.Jansen	osuin sak (C), Uswnwi (M), Uisanei (Ka)	Herb	L & Sh	Veg	0.02	
Acmella radicans (Jacq.) R.K.Jansen	Usnoi brou (R), Jarua osuin sak (C),	Shrub	L	TM	0.02	
Chromolaena odorata (L.) R.M. King & H. Rob.	Maisnoi (R, Ko, J), Muja gaid (C),	Herb	L & Sh	Veg	0.02	
Enhydra fluctuans Lour	Hankhne (R, Ko, J), Akoin sak (C),	Herb	In	TM	0.02	
Tagetes erecta L.	Khumtu (R),					
Cucurbitaceae						**0.025**
Cucumis sativus L.	Sosa (R, Ko, J, C & Ru), Changma (M)	Climber	Fr, L & Sh	F	0.02	
Cucurbita pepo L.	Chakma (R), Sumuri gula (C); Chakumra (Ko, J)	Climber	Fr, L & Sh	Veg	0.02	
Hodgsonia macrocarpa (Blume) Cogn.	Thaibai (R, Ko, J), Pela gula (C),	Climber	N	N	0.02	
Lagenaria siceraria (Molina) Standl.	Muilao (R, Ko, J, M & Ru), Khudu gula (C), Tuium (M)	Climber	Fr, L & Sh	Veg, Con	0.02	
Luffa acutangula (L.) Roxb.	Jenga (R, Ko, J & Ru), Jinya (C), Phoi (M)	Climber	Fr	Veg, Sp	0.04	
Luffa cylindrica (L.) M.Roem.	Fro (R, Ko, J & Ru), Furul (C), Porol (M),	Climber	Fr, L & Sh	Veg, Sp	0.04	
Momordica charantia L.	Kangla (R, Ko, J & Ru), Tita gula (C),	Climber	Fr	Veg	0.02	
Momordica dioica Roxb. ex Willd.	Rajkangla (R) Kangro (Ko, J), Khara gula (C)	Climber	Fr	Veg	0.02	
Dilleniaceae						**0.034**
Dillenia indica L.	Thaiflo (R, Ko, J & Ru), Ulu gula (C),	Tree	Fr	F, PrF	0.03	

Dioscoreaceae						**0.02**
Dioscorea alata L.	Tha mtai (R, Ko, J), Borjad alu (C),	Climber	Tu	TM	0.02	
Dioscorea bulbilfera L.	Tha brou (R, Ko, J & Ru), Jumo alu (C),	Climber	Tu	Veg	0.02	
Dioscorea hamiltonii Hook.f.	Tha koin (R, Ko, J), khuyang alu (C), Rambal (Ka)	Climber	Tu	Veg	0.02	
Dioscorea oppositifolia L.	Tha bolong (Ko), Tha sher (R), Rambal (Ka)	Climber	Tu	Veg	0.02	
Dioscorea pubera Blume	Tha Borok (Ko) , Tha rmo (R)	Climber	Tu	Veg	0.02	
Dioscorea wallichii Hook. f.,	Tha gonga (Ko), Tha naroih (R)	Climber	Tu	Veg	0.02	
Elaeocarpaceae						**0.029**
Elaeocarpus floribundus Blume	Jolpai (R, Ko, J, M & Ru), Jolpui (C),	Tree	Fr	F, PrF	0.03	
Euphorbiaceae						**0.025**
Euphorbia neriifolia L.	Buraha latha (R), Thichou (M)	Herb	L	TM	0.02	
Mallotus tetracoccus (Roxb.) Kurz	Lai chau (R, Ko, J), Mura gaid (C), Kharduk (M)	Tree	L	Pa	0.02	
Manihot esculenta Crantz	Thabuchu (R, Ko, J & Ru), Khabla alu (C), Kangbal hog char (M),	Shrub	L & Sh, Tu	Veg, Fe	0.04	
Ricinus communis L.	Letau (R), Dugh Bidul gaid (C),	Shrub	Se	TM	0.02	
Fabaceae						**0.023**
Neptunia oleracea Lour.	Thorai ha (Ko), Tui zongcha (M), Zawngcha (Ka)	Herb	L & Sh	Co	0.02	
Parkia javanica (Lam.) Merr.	Waikre (R, Ko, J, C), Zong cha (M),	Tree	Fr	Veg	0.02	
Tamarindus indica L.	Tentoi (R), Thentroi (Ko, J & Ru),	Tree	Fr	F, PrF	0.03	
Hypoxidaceae						**0.02**
Molineria latifolia (Dryand. ex W.T.Aiton) Herb. ex Kurz	Lai dom (R), Toroin pada (C)	Herb	L	Pa	0.02	
Lamiaceae						**0.02**
Leucas aspera (Willd.) Link	Dongclasa (K), Sumundru Kelek chwk (M),	Herb	L & Sh	Veg	0.02	
Ocimum americanum L.	Manda (R & Ru), Banta (J, Ko), Sabreng (C), Bana (M)	Shrub	L & Sh	Co	0.02	
Ocimum tenuiflorum L.	Tulasi (R), Tulsi gaid (C), Tulsi (J, Ko & Ru)	Shrub	L	TM	0.02	
Premna esculenta Roxb.	Orai (R, Ko, J, M, Ka & Ru), Melong pada (C)	Shrub	L	Co	0.02	
Lauraceae						**0.02**
Cinnamomum tamala (Buch.-Ham.) T. Nees & Eberm.	Dalchini (R, Ko, J, C)	Tree	L	Co	0.02	
Cinnamomum verum J.Persl	Tej pata (R, C, Ko, J, M, K & Ru)	Tree	B	Co	0.02	
Leguminosae						**0.023**
Cajanus cajan (L.) Millsp.	Khokleing (R, J), Mui masing (Ko), Jhuma sumoi (C), Bethwng (M)	Shrub	Fr, L	Veg, TM	0.02	
Canavalia gladiata (Jacq.) DC.	Baikang (R, Ko, J & Ru), Mamak (C)	Climber	Fr	Veg, PrF	0.03	
Lablab purpureus (L.) Sweet	Kosoi (R, Ko, J & Ru), Fudisumoi (C), Be kwimwtin (M)	Climber	Fr	Veg	0.02	
Malvaceae						**0.024**
Abelmoschus esculentus (L.) Moench	Murma (R), Deroso (Ko, J & Ru), Deroid (C)	Shrub	Fr	Veg	0.02	
Bombax ceiba L.	Borchuk (R, Ko, J & Ru), Tula gaid (C)	Tree	In, C	Veg, TM	0.03	
Ceiba pentandra (L.) Gaertn.	Tula (R, Ko, J & Ru), Sorgari tula (C),	Tree	C	Cot	0.02	
Hibiscus rosa sinensis L.	Khum chau (R), Joba (J, Ko), leb joba phool (C),	Shrub	In	TM	0.02	
Hibiscus sabdariffa L.	Mukhui kchau (R, J, Ko), Amila gula (C)	Shrub	L, Fr	Veg, PrF	0.04	
Sida rhombifolia L.	Nosi brou (R, Ko, J), Jaru gaid (C),	Shrub	St	Br	0.02	

Sterculia villosa Roxb.	Phati Lang bau (R), Lang bak (Ko, J & Ru)	Tree	B	Rope	0.02	
Marantaceae						**0.02**
Phrynium pubinerve Blume	Lai ru (R, Ko, J), Nathwl (M), khechho pada (C), Nathial bo (Ka)	Herb	L	Pa	0.02	
Meliaceae						**0.025**
Azadirachta indica A.Juss.	Neem (R, Ko, J, C, Neem, Ka & Ru)	Tree	L	TM	0.02	
Moraceae						**0.026**
Artocarpus chama Buch. Ham	Jram (R, Ko, J), Jara khatol gaid (C),	Tree	Fr, Se	F, N	0.03	
Artocarpus heterophyllus Lam.	Thaiplong (R), Thai pong (Ko, J & Ru), Khatol gaid (C), La uii (Ka)	Tree	Fr, Se	F, Veg, N	0.04	
Artocarpus lacucha Buch. Ham.	Dua (R), Botta gula gaid (C)	Tree	Fr	TM	0.02	
Ficus semicordata Buch. Ham. Ex Sam.	Khuichang (R, Ko, J & Ru), Suroi gula (C), Thwichang (M)	Tree	Fr	F	0.02	
Morus australis Poir.	Mukhui yongphau (R, Ko, J), Prijam gula (C), Zongphak mwkhwi (M)	Shrub	Fr	TM	0.02	
Moringaceae						**0.02**
Moringa oleifera Lam.	Sejana (R, Ko, J, C, M)	Tree	Fr	TM	0.02	
Musaceae						**0.045**
Musa acuminata Colla	Thaili (R, Ko, J), Khola (C), Laiphang (M), Changvui (M, Ka), Leiphang (Ka)	Herb	Fr, In, Pi, L	Veg, F, Pa	0.05	
Musa paradisiaca Roxb.	Thaili songrong (R), Anaji thalik (Ko, J), khiyang khola (C), Mot anhel (M)	Herb	Fr, In, Pi, L	Veg, Pa	0.04	
Myrtaceae						**0.02**
Psidium guajava L.	Goyam (R, Ko, J & Ru), Gongsu gula (C),	Tree	Fr	F	0.02	
Syzygium cumini (L.) Skeels	Chambu (R), Jambu (Ko, J & Ru), Jam gula (C)	Tree	Fr	F	0.02	
Nyctaginaceae						**0.02**
Bougainvillea glabra Choisy	Khunglekha (R, Ko, J), khawaid phool (C)	Shrub	In	TM	0.02	
Oleaceae						**0.02**
Jasminum sambac (L.) Aiton	Khumali ste (R), Khumali (Ko, J), Suinno malati phool (C)	Shrub	Fr	TM	0.02	
Nyctanthes arbor tristis L.	Shephali (Ko, J), Khum soti (R), Sephali phool (C),	Shrub	In	TM	0.02	
Ophioglossaceae						**0.02**
Helminthostachys zeylanica (L.) Hook.	Soi machya (R, J, C)	Herb	L	TM	0.02	
Oxalidaceae						**0.02**
Averrhoa carambola L.	Kamranga (R, Ko, J, M), khangra gula (C)	Tree	Fr	TM	0.02	
Pandanaceae						**0.02**
Pandanus amaryllifolius Roxb.	Muimtom maimtom (R), Binni pada (C),	Herb	L	Co	0.02	
Phyllanthaceae						**0.03**
Phyllanthus emblica L.	Amlai (R, Ko, J, M & Ru), Khadamala gula (C),	Tree	Fr	F, TM	0.04	
Sauropus androgynus (L.) Merr.	Pressure bithi (R, Ko, J),	Shrub	L & Sh	TM	0.02	
Piperaceae						**0.022**
Piper betle L.	Phathoi (R, Ko, J, M & Ru), phan (C),	Climber	L	Ch, TM	0.03	
Piper nigram L.	Gol moris (R, Ko, J, M & Ru), Gol moroid (C)	Climber	Fr	Veg	0.02	
Poaceae						**0.028**
Bambusa tulda Roxb.	Warna (R), Wandal muya (Ko, J & Ru), Mirya basuri (C), Toi pui (M),	Bamboo	Sh	Veg, PrF	0.03	

Cymbopogon citratus (DC.) Stapf	Suimanda (R, Ko, J), Kheng sagoreng (C), Sonbana (M)	Herb	L	TM	0.02	
Imperata cylindrica (L.) Raeusch.	Soing (R), son (C, Ko, J, M, Ka)	Herb	L	T/R	0.02	
Melocanna baccifera (Roxb.) Kurz	Warthoi muya (R, Ko, J & Ru), Ejja basuri (C), Toi char (M),	Bamboo	Sh	Veg, PrF, Cr	0.05	
Thysanolaena latifolia (Roxb. ex Hornem.) Honda	Nouksi (R, Ko, J & Ru), Suinda gaid (C), Lomphi (M), Nomphi (ka)	Herb	In	Br	0.02	
Pontederiaceae						**0.02**
Monochoria hastata (L.) Solms	Chichiri (R, Ko, J, M, Ka & Ru)	Herb	L & Sh	Veg	0.02	
Rhamnaceae						**0.02**
Ziziphus jujuba Mill.	Boroi (R, J, Ko, M & Ru), Boroi gula (C), Morai ra (Ka)	Tree	Fr	F, PrF	0.03	
Rubiaceae						**0.02**
Oldenlandia corymbosa L.	Bakhate (R, J, Ko), Mida dima sak (C),	Herb	L & Sh	Veg	0.02	
Rutaceae						**0.027**
Aegle marmelos (L.) Corrêa	Bel (R, Ko, J, M, K), Bel gula (C),	Tree	Fr	F, TM	0.04	
Citrus hystrix DC.	Satokra (R, Ko, J), Samara hausi (C), Mwserhok (M)	Shrub	Fr	F, TM	0.03	
Citrus limon (L.) Osbeck	Slong (R), Jambi (Ko, J), Khausey gaid (C), Mwserkung (M)	Shrub	Fr	F, PrF	0.03	
Citrus maxima (Burm.) Merr.	Jamra (R, Ko, J & Ru), khandal Jamur (C),	Shrub	Fr	F	0.02	
Zanthoxylum limonella (Dennst.) Alston	Muiching (R, Ko, J & Ru), Sing itt (M)	Tree	L	Co	0.02	
Sapindaceae						**0.02**
Litchi chinensis Sonn.	Lechu (R, Ko, J), Lichu gula (C),	Tree	Fr	F	0.02	
Solanaceae						**0.02**
Solanum torvum Sw.	Skam Khanka (R), Khamkha (Ko, J & Ru), Tita gula (C),	Shrub	Fr	Veg	0.02	
Xanthorrhoeaceae						**0.02**
Aloe vera (L.) Burm.f.	Alovera	Herb	L	TM	0.02	
Zingiberaceae						**0.039**
Alpinia nigra (Gaertn.) Burtt	Thrai (R), Therai (Ko, J), Thara sem (C), Thwrai (M),	Herb	Pi	Co	0.02	
Amomum dealbatum Roxb.	Bring (R), Biring (J, Ko),	Herb	In	Co	0.02	
Curcuma longa L.	Kormo (R, Ko, J), Oloit (C),	Herb	Rh, L	Co, TM, PrF	0.05	
Zingiber officinale Roscoe	Haiching (R, J, Ko & Ru), Ada (C),	Herb	L, In, Ro	Co, TM, PrF	0.06	

Vernacular names: R- Reang, Ko- Kokborok, J- Jamatia, Ru- Rupini, M- Molsom, Ka- Kaipeng; **Plant Parts**: B- Bark, C- Cotton, Fr- Fruit, In- Inflorescence, Pi- Pith, L- Leaf, Sh- Shoot, Sa- Sap, Se- Seed, Tu- Tuber, Ro- Root, N- Nut, Re- Resin, Rh- Rhizome, St- Stem, Co- Corm; **Mode of Use:** Traditional medicinal- TM, Vegetable- Veg, Fruit-F, Nut- N, Preserved Food- PrF, Condiment- Co, Sap/juice- S/J, Incent- In, Container- Con, Spong- Sp, Packing- Pa, Fenching- Fe, Cotton- Cot, Broom- Br, Chewing- Ch, Thatch/Roof- T/R, Crafting- Cr

families with the highest numbers of species reported as useful bioresources are Cucurbitaceae (8 species), Araceae (7 species), Malvaceae (7 species), Dioscoreaceae (6 species), Compositae (5 species), Moraceae (5 species), Poaceae (5 species), Rutaceae (5 species) and Apiaceae (4 species) (Table 2). The herbaceous were the most dominant life form (33.33 % of all species) followed by trees (27.50 %) and shrubs (21.67%) (Fig. 2) while the most dominant parts of plant used are observed in Fruit (30.72 %), Leaf (18.30 %), Leaf & Shoot (15.03 %), Inflorescence (8.50 %) and Tuber (5.88 %). (Fig. 3)

Quantitative indices of plant bioresources and their *Use Value* & *Family Use Value*

According to informants' reports all these species particularly have different use categories such as rope-making, thatching,

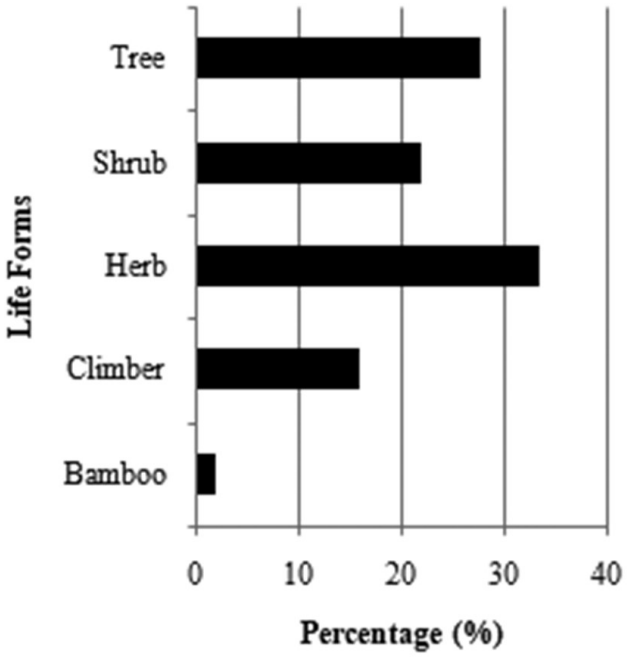

Fig.2. Life forms % of plant species used.

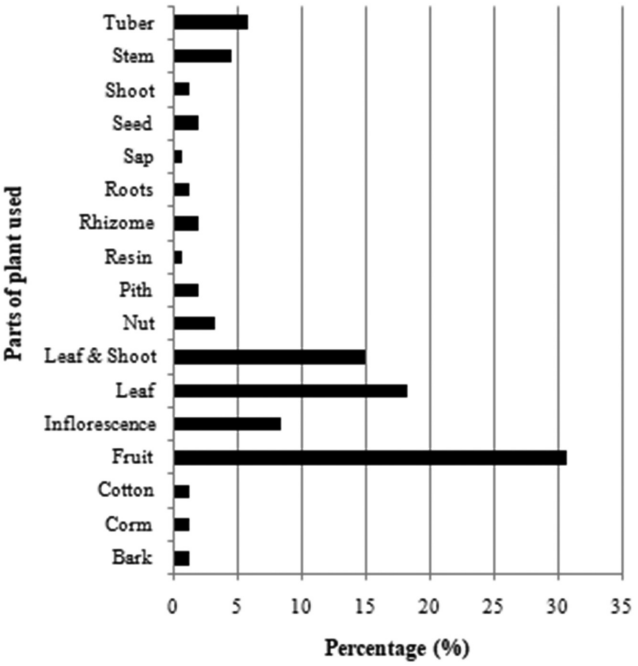

Fig. 3. Percentage % of plant part used.

cleaning, cotton, nut, packing, traditional medicine, condiments, and fruit, vegetable, incent and oil yields. Two important quantitative indices were applied to analyze the collected bioresource data which include Use value (UV) and Family use value (FUV) for all the 120 reported species. The UV ranges from 0.02 to 0.06. The use value (UV) of plants indicates the importance of specific plants for the communities. The species like *Zingiber officinale*, *Curcuma longa*, *Melocanna baccifera*, *Musa acuminata*, *Cocos nucifera*, *Aegle marmelos*, *Amorphophallus bulbifer*, *Anacardium occidentale*, *Hibiscus sabdariffa* and *Luffa cylindrical* have high UV indicating that these species are most important for the studied population (Table 2). This shows that they are using the same species for many different purposes, which may be an indicator of the intensity of plants used. Further FUV analysis of plant families was conducted which ranges from 0.02 to 0.0452. The highest FUV reported for the specific plant family indicates that it is responsible for multiple uses. The most important plant families with the highest FUV belongs to Musaceae, Zingiberaceae, Dilleniaceae, Anacardiaceae, Arecaceae, Phyllanthaceae, Elaeocarpaceae, Poaceae, Bromeliaceae and Rutaceae (Table 2).

Diversity of Ethnomedicinal plants, its utilization patterns and their Relative Frequency of Citation, Informant Consensus Factors & Fidelity Level

From the Table 3, all the important plants having the medicinal properties have been selected separately for their quantitative analysis. A total of 37 medicinal species from 23 families were reported. Out of which, 17 species were sold in the market and the rest 20 species was observed during the household surveys. Our result also included the important traditional utilization methods or remedies for treating the common ailments which was frequently cited by the informants. The relative frequency of citation (RFC) had been analyzed for each species with medicinal values which was claimed by the informers to be effective for specified disease (Table 4). In our present study, RFC values ranged from 0.12 to 1. The highest RFC was recorded for *Chromolaena odorata* (1), *Phlogacanthus thyrsiflorus* (1), *Sauropus androgynus* (1), *Zingiber officinale* (1) and *Ocimum tenuiflorum* (0.72) as shown in table 4. The ethnomedicinal plants species having high RFC index indicated their abundant uses and holding extensive knowledge among the local communities. Most of the species were grown in home gardens and easily accessible within the

Table 3. Important plant families along with their traditional practiced or utilization pattern indulge by the local communities.

Family	Vegetable	Traditional medicinal	Condiments	Preserved Food	Craft	Edible Fruits	Packing
Musaceae	✓	-	-	-	-	✓	✓
Zingiberaceae	✓	✓	✓	-	-	-	-
Dilleniaceae	-	-	-	✓	-	✓	-
Anacardiaceae	-	-	-	✓	-	✓	-
Arecaceae	-	-	-	✓	-	✓	-
Phyllanthaceae	-	✓	-	✓	-	✓	-
Elaeocarpaceae	-	-	-	✓	-	✓	-
Poaceae	-	✓	✓	✓	✓	-	-
Bromeliaceae	-	-	-	✓	-	✓	-
Rutaceae	-	✓	✓	✓	-	✓	-
Moraceae	✓	✓	-	✓	-	✓	-
Cucurbitaceae	✓	-	-	-	-	✓	-
Araceae	✓	✓	✓	✓	-	-	-
Meliaceae	-	✓	-	-	-	-	-
Euphorbiaceae	✓	✓	-	-	-	-	✓

Table 4. Important Traditional medicinal plants along with ethno-medicinal uses and Relative frequency of citation (RFC):

Sl. No.	Species	Family	Part used	Medicinal uses as mentioned by informers	RFC
1	*Aegle marmelos*	Rutaceae	Fruits (both green and ripe) and leaves	Decoction is made of the fruit and taken on an empty stomach everyday for gastric problems, dysentery and other stomach problems; Leaf paste is used for high malarial fever.	0.21
2.	*Aloe vera*	Xanthorrhoeaceae	Leaves	Jelly extract of leaf is applied on burn skin, pimples; This jelly is also eaten at empty stomach for treating gastric problems.	0.39
3.	*Andrographis paniculata*	Acanthaceae	Whole plant	Whole plant is used as decoction for treating malarial fever.	0.66
4.	*Artocarpus lacucha*	Moraceae	Bark	Bark powder/paste is applied to Abscess/ carbuncle to draw out purulent discharge; it can also be used for treating pimple.	0.12
5.	*Averrhoa carambola*	Averahoaceae	fruit	Fresh fruit are eaten to treat jaundice and piles; also acts as anti-scorbutic for mouth problem/diseases.	0.2
6.	*Azadirachta indica*	Meliaceae	Leaves and Bark	Leaves and Bark are boiled and warm neem water is bathe to treat pox and skin problems.	0.68
7.	*Bombax ceiba*	Bombaceae	Root, fruit and flower	Root as stimulant & tonic and used as homeostatic astringent and also for curing diarrhoea & dysentery; fruit and flower are used for treating snake bite.	0.15
8.	*Cajanus cajan*	Fabaceae	Leaves	The leaf is chew for toothache; leaf extract is taken for jaundice.	0.29
9.	*Catharanthus roseus*	Apocynaceae	Leaves	Raw leaves paste is used for wound healing and roots used for curing high blood pressure.	0.22
10.	*Centella asiatica*	Apiaceae	Leaves	Raw/ cooked leaves are taken against dysentery and diarrhea.	0.67
11.	*Chromolaena odorata*	Asteraceae	Leaves	Leaves paste are applied on wounds to stop bleeding.	1
12.	*Cinnamomum tamala*	Lauraceae	Leaves	Decoction of leaf is taken to treat cough, headache and dizziness, rheumatism, diarrhea and dysentery.	0.28
13.	*Citrus hystrix*	Rutaceae	Fruit, Root	Fruits juice is taken for treating gall bladder stone; root decoction is used to treat hepatitis; fruits are also eaten to treat inflammation of tongue/mouth.	0.45

14.	*Curcuma longa*	Zingiberaceae	Rhizome	Rhizome paste is used for the treatment of skin inflammation.	0.36
15.	*Cymbopogon citratus*	Poaceae	Leaves	Decoction is prepared to treat cold & cough and sore throat; Leaf boiled along with tea to treat headache.	0.54
16.	*Dioscorea alata*	Dioscoreaceae	Tuber	Cooked tuber is used in leprosy and piles.	0.18
17.	*Diplazium esculentum*	Athyriaceae	Young frond	Young and fresh frond is boiled with salt is taken to treat piles, gastric and stomach problems.	0.38
18.	*Enhydra fluctuans*	Asteraceae	Whole plant	*Enhydra fluctuans* mixed with *Centella asiatica* are good combination for treating hypertension and control blood sugar.	0.6
19.	*Euphorbia neriifolia*	Euphorbiaceae	Leaves	Leaves heated on fire and placed on chest to control cough; heated leaves are squeeze to extract juice then drank to treat cold & cough and sore throat.	0.62
20.	*Helminthostachys zeylanica*	Ophioglossaceae	Leaves	Used as tonic to treat cough and fever.	0.36
21.	*Hibiscus rosa sinensis*	Malvaceae	Leaves, flower/ bud and root.	Raw flower is taken for curing jaundice; Root is used for mouth wash; leaf juice used by women to treat infertility; Bud and root paste along with rice water is prescribed for irregular menstruation.	0.44
22.	*Homalomena aromatica*	Araceae	Stem and rhizome	Fresh rhizomes and stem are crushed to prepare decoction for treating cough and breathing problems.	0.2
23.	*Jasminum sambac*	Oleaceae	Leaves and flower	Leaves and flower paste are used for treating wound; Fresh flowers are kept under pillow (beneath the head) to treat insomnia.	0.35
24.	*Lasia spinosa*	Araceae	Tender leaves and rhizome	Paste from tender leaves and rhizome are used for preparing decoction which are very useful for chronic rheumatism.	0.44
25.	*Moringa oleifera*	Moringaceae	Bark	Bark decoction is used to treat cold & cough and also fever.	0.33
26.	*Morus australis*	Moraceae	Leaves and root	Leaves decoction are used as mouth wash to treat sore throat; roots extracts are used as astringent.	0.27
27.	*Nyctanthes arbor tristis*	Oleaceae	Leaves	Juice of young leaves with honey/sugar is given to children to treat bronchitis, asthma and whooping cough, stomach disorder.	0.41
28.	*Ocimum americanum*	Lamiaceae	Young shoot and inflorescence	Roasted leaf given to treat cold and cough.	0.62
29.	*Ocimum tenuiflorum*	Lamiaceae	Leaves	Leaf juice/decoction is used to treat bronchitis, asthma, inflammation, worm infection.	0.72
30.	*Phlogacanthus thyrsiflorus*	Acanthaceae	Leaves	Leaf juice used as an expectorant.	1
31.	*Phyllanthus emblica*	Euphorbiaceae	fruit	Fruit paste/juice is used to prevent hair fall; regular taking of fresh fruit can treat diabetes and urinary problems.	0.36
32.	*Rauvolfia serpentina*	Euphorbiaceae	Root, leaf	Leaf juice is used for hypertension, anxiety and bitter tonic; root paste is used to treat snake bite.	0.44
33.	*Ricinus communis*	Euphorbiaceae	Leaves	Leaf heated for 5 minutes and used on swellings and rheumatism.	0.35
34.	*Sauropus androgynus*	Phyllanthaceae	Leaves	Leaf boiled or cooked and taken to control hypertension or blood sugar.	1
35.	*Tabernaemontana divaricata*	Apocynaceae	Root bark	Root bark Extract is used on toothache.	0.28
36.	*Tagetes erecta*	Asteraceae	Leaves	Leaves paste is used on wound to stop bleeding and also used on other skin problems.	0.26
37.	*Zingiber officinale*	Zingiberaceae	Rhizome	Rhizome extracted juice with honey is used rhizome Rhizome extracted juice with honey is used for treating cold and cough and other respiratory problems.	1

studied area while some species existed in the adjacent forest but frequently utilized by the local people.

In the studied areas (both markets & households), we have uncovered some traditional medicines to treat common ailments. There are about 35 common ailments which have been categorized into 14 illness categories (Table 5). To further investigates the authenticity of the medicinal plants against the ailments, the quantitative indices comprising *Informant consensus factor* (ICF) and *Fidelity Level* (FL) was conducted. Traditional medicines made of plant products were important cultures for all these communities in the past as well as present scenario. The Informant Consensus Factor (ICF) reflects the homogeneity of information that is claimed by different informants on the plant species used to treat specific diseases (Ouedraogo *et al.*, 2020). Our studies revealed the value of ICF index range from 0.92 to 0.98 (Table 5); the highest ICF was observed in urological (0.98) followed by bleeding (0.97), hypertension (0.97) and maternal ailment (0.97). The high ICF value indicates agreement among the informants for the claimed of certain plants to treat a particular disease. To test the rate of informant's choice for each ailment and the potential species related to the disease, analysis of Fidelity level was conducted. FL values in our studies range from 22.73% to 100% (Table 6). Our result showed 8 ethnomedicnal species of plants with an high FL index (100%), which is considered to be widely used by the local people; these species are *Chromolaena odorata*, *Sauropus androgynus*, *Phlogacanthus thyrsiflorus*, *Andrographis paniculata*, *Tabernaemontana divaricata*, *Curcuma longa*,

Table 5. ICF values by illness categories for treating human ailments

Illness Categories	Common Ailments	Nur	Nt	ICF
Bleeding	Wounds, Bleeding	79	3	0.97
Dermatological	Pimple, Skin Problem, Swelling, Abscess, Carbuncle, Pox, Leprosy	140	8	0.95
Fever	Malaria/ Fever/Vomiting	84	4	0.96
Gastrointestinal	Constipation, Indigestion, Stomache, Gastric, Dysentry, Diarrhoea	122	6	0.96
Hypertension	Hypertension, Blood Pressure	152	6	0.97
Insomnia/Headache	Insomnia, Headache	27	2	0.96
Maternal ailments	Menstruation Problem	27	1	0.97
Metabolic	Jaundice,Hepatitis	73	4	0.96
Musculoskeletal	Rheumatism,Arthritis	50	3	0.96
Oral problem	Mouth, Tongue Problems, Toothache, decay	110	7	0.94
Pile	Pile	37	4	0.92
Respiratory diseases	Cold & Cough/Sore Throat	351	13	0.97
Snake Bites	Snake Bites	31	2	0.97
Urological	Gall Bladder Stone/Urinary Problem	64	2	0.98

Nur- Number of use-reports for a particular use category.

Nt- Number of taxa used for a particular use category by all informants.

ICF- Informants consensus factor.

Table 6. Fidelity level value of medicinal plants commonly reported against a given ailment

Species	Specific ailments	Ip	Iu	FL%
Chromolaena odorata	Bleeding	20	20	100
Sauropus androgynus	Hypertension	20	20	100
Phlogacanthus thyrsiflorus	Expectorant	15	15	100
Andrographis paniculata	Malaria	12	12	100
Tabernaemontana divaricata	Toothache	10	10	100
Curcuma longa	Skin problem	6	6	100
Helminthostachys zeylanica	Cold & cough	6	6	100
Centella asiatica	Diarrhoea & Dysentry	5	5	100
Homalomena aromatica	Cough	12	15	80
Cajanus cajan	jaundice	17	22	77.27
Rauvolfia serpentina	Snake bite	19	25	76
Azadirachta indica	pox	17	23	73.91
Ricinus communis	Swelling	19	28	67.86
Jasminum sambac	Wounds	12	18	66.67
Euphorbia neriifolia	Cold & cough	20	32	62.50
Morus australis	Astringent	10	16	62.50
Catharanthus roseus	Wounds	14	23	60.87
Citrus hystrix	Gall bladder stone	20	34	58.82
Aloe vera	pimple	16	30	53.33
Zingiber officinale	Cold & cough	20	38	52.63
Averrhoa carambola	mouth problem	12	23	52.17
Cymbopogon citratus	Cold & cough	19	37	51.35
Bombax ceiba	Snake bite	10	20	50
Hibiscus rosa sinensis	Menstruation problem	10	20	50
Zingiber officinale	Respiratory problems	18	38	47.37

Ip- Number of informants who cited the use a plant species for treating a particular disease.

Iu- Total number of informants that cited the species to treat any given disease.

FL%- Fidelity Level (%)

Helminthostachys zeylanica and *Centella asiatica.* While, low FL values obtained (i.e. below 50%) are considered to serve several diseases but those maybe not utilized by all the informants throughout the studied communities.

Discussion

The northeastern region of India falls under a major part of the Indo-Burma biodiversity hotspots and state Tripura is being part of it. With variety of uses of bioresources in traditional delicacies were very common among the tribal communities in the Himalayan Mountains (Sundriyal *et al.*, 2004) which explains their role in diversifying diet and fulfilling the nutritional requirement of the local system (Konsam *et al.*, 2016). The role of bioresources is particularly important in the north eastern region where a large proportion of the rural population depends on them as a source of wild fruits, vegetables, fodder, medicinal plants, food, fibre, dye, and other useful materials for daily needs and trade (Rana *et al.*, 2021). Our findings showed that a plant's value is determined not only by the amount of uses it has, but also by how well established it is. In some cases, the influence of the number of informants maximizes the Use-Value of a given species when they attribute many uses to a plant (Albuquerque *et al.*, 2006).

According to the local informants, there are selectively few species that have additional values like Traditional medicinal, condiments, preserved food, cleaning, fruits, packing and vegetables. Species use has been highly dependent on the local socio-economic conditions and distribution pattern may vary from place to place (Bhattarai and Ghimire, 2006; Kala, 2000, Masoodi and Sundriyal, 2020). Based on the quantitative indexing, the most valued plant families with the highest FUV with multiple uses were Musaceae, Zingiberaceae, Dilleniaceae, Anacardiaceae, Arecaceae, Phyllanthaceae, Elaeocarpaceae, Poaceae, Bromeliaceae and Rutaceae (Table 3). Different families made very different contributions to different use categories. Use of bioresources with different used categories showed that these species are very important for the sustenance of the inhabitants. Studies in Himalayan communities had revealed high dependence on and a wide variety of NTFPs for the medicinal purpose (739 species), followed by edible (141 species) and fodder (109 species) purposes (Masoodi and Sundriyal, 2020).

Usually there are home-made foods item used for long term consumption and these people have mastered with the right ingredients to make the food fresh for many days. But these products fail to reach its commercialization due to less production and limited resources. In order to provide market reached for these, numerous supports are required such as funding for domestication and commercialization. The wild bioresource based income generating activities have significantly improved the livelihood of the people and contributed to biodiversity conservation by reducing pressures on other locally valuable species (Maikhuri *et al.*, 2013).

Traditional knowledge and bioresources conservation management by the ethnic people

The state is endowed with a wide range of bioresources, and the ethnic people who live there have a wealth of traditional knowledge about how to efficiently use the resource. Many researchers had studied on various wild vegetables of northeast India in relation to the people and their dependency on the bioresources for economical, raw material, social and ritual sustenance (Bora and Pandey, 1996; Borthakur, 1996; Chakraborty, 2002; Kar and Borthakur, 2007; Borah and Sarkar, 2008).

The present study reveals that the ethnic communities use their old age indigenous knowledge to utilize the bioresources in various used categories. The results were obtained with the assessment in both local market and household survey (Fig. 4 & Fig. 5). Generally, these tribes practice jhum/shifting cultivation to meet their food requirements, and when food is scarce, they gather various edible plant parts from the forest to supplement their diet. The age group ranging from 20-40 years (both man and women) play significant role in collection of such edible fruits, roots and tubers, leaves, etc. The majority of herbaceous plant was the most dominant life form used followed by trees and shrubs (Masoodi and Sundriyal, 2020). Most of the wild

Fig. 4. Bioresources sold in the market- (a) Typical market trades with bioresources (b) Old man with his bamboo craft vendor (c) Leaves of *Zanthoxylum limonella* (b) Tuber of *Dioscorea bulbilfera* (e) *Neptunia oleracea* (f) Tuber of *Dioscorea hamiltonii*, rhizome & inflorescence of *Lasia spinosa* (g) *Cajanus cajan* (h) dried stem of *Alocasia macrorrhizos* (i) *Thysanolaena latifolia* (j) *Brassaiopsis griffithii* (k) *Trachyspermum roxburghianum* (l) Young shoot of *Lasia spinosa*.

Fig. 5. Showing Household and procured bioresources (a) Old man in his traditional bamboo hut (b) Interview with traditional healer (c) Ethnic women pounding *batema* (d) Processed food of *Amorphophallus bulbifer* (Batema) (e) Dried preserved fruits of *Canavalia gladiata* (f) Wet preserved shoot of *Melocanna baccifera* (g) Dried preserved shoot of *Bambusa tulda* (h) Dried preserved peel of *Manihot esculenta* (i) Tracking source of edible bioresources in wild (j) Harvested *Jhum* based vegetables (k) Cotton of *Ceiba pentandra* used in household (l) Resin of *Canarium strictum.*

vegetable procurers were the women of a family, implying that women are more knowledgeable when it comes to resource collection (Phillips and Gentry, 1993; Medhi and Borthakur, 2013; Shah *et al*., 2020). While the man also practice hunting and fishing for a supplementary source of livelihood. An aged-man has knowledge on traditional herbal medicine to cure and prevent common ailments (Dutta and Dutta, 2005; Islam, 2006; Das *et al*., 2016; Faruque *et al*., 2018). In Tripura, the traditional healing practices sometimes include rituals which consist of mainly plants and animal materials. Even though, they are thoughts to have specialized knowledge in traditional and ethnomedicines; however in recent years, there are only a few such practitioners left who indulge in such activities. Such investigations in the rural areas are necessary to understand the utilization patterns of bioresources and the conservation management by ethnic people. Interestingly most of the commonly used bioresources in terms of materials, foods, medicines and socio-religious purposes etc. are now being conserved in their natural habitat through forest management system as well as cultivating certain rare medicinal species of plants at home gardens or private forest. Forest products always have been an important article for trades and social livelihoods of the ethnic people therefore they are compelled to participate in bioresource extraction and sale in the local market. Hence, such report is significant to assess the extent of bioresource utilization which could be useful to frame strategies by the policy makers.

Use of Ethonomedicinal plants by the ethnic people

The present study provides information on 37 medicinal plants used by local people. The study revealed that the ethnic communities of this region have been using plant resources for treating various ailments. According to the relative frequency of citation (RFC) index, each medicinal plant species highlights about the informant's agreement towards healing categories of diseases (Table 4). The local people know the useful plants and mode of preparation through ancestral prescription and personal practice (Debbarma *et al*., 2017; Reang *et al*., 2016; Majumdar and Datta, 2007). Dosages of these medicinal plants are most commonly used as decoction and are administered orally (Shil *et al*, 2014; Mussarat *et al*., 2014) except for some ailments (eg. skin problem) which are used externally. Certain similar results were reported for the medicinal plant studies conducted in India. *Chromolaena odorata* has a good wound healing property (Sirinthipaporn and Jiraungkoorskul, 2017), *Morus australis* are used as astringent (Saha *et al*., 2013), *Euphorbia neriifolia* are often used for treating cold & cough (Mali and Panchal, 2017), *Centella asiatica* have a cure against diarrhoea & dysentry (Pattanayak *et al*., 2015), *Phlogacanthus thyrsiflorus* is used as Expectorant to treat cough (Perme *et al*., 2015), *Andrographis paniculata* decoction treats malaria and fever (Mishra *et al*., 2007) and *Hibiscus rosa sinensis* are often used in maternal health or menstruation problem (Rajith *et al*., 2012). Our survey on ethnomedicinal plants also revealed treatments for some ailments like gall bladder stone, hypertension/blood pressure and snake bite using traditional medicine (Table 5). The factor of informant consensus (ICF) is particularly useful to focus on the diseases that were treated by the local communities. By using this analysis, researchers can identify the medicinal plant that is successfully treating the diseases. In addition, Fl % is used to ensure the percentage of accuracy of using the medicinal plants against the specific ailments (Table 6). Therefore, these analytical tools will lead to the selection of one or more species which can be used against the main disease categories. Our findings showed that traditional treatment using ethnomedicinal plants has still existed in the studied area. Documentation of new ethnomedicinal species along with their therapeutic uses will encourage further phytochemical and pharmacological investigations that will ultimately leads to discovery of new drugs.

Policies Implications and management of the bioresources

Most of the *forest based policies* (*viz*., National Forest Policy, 2018) in the country focused on sustainable utilization of forest produce and maximizing the wood timber for revenue generation. The *Ministry of Environment, Forest and Climate Change* (MoEFCC) is implementing the afforestation schemes in the forest areas with participatory approach in most of the

states. The plantation of a species under the schemes is selected by the implementing agencies or the members of *Joint Forest Management Committees* (JFMC) on the basis of their needs, ecological conditions and other local factors in agreements with the Forest Department. With this regards, the provided information on UV & FUV data **(Table 2)** would establish most excellent criterion to select the plant species for plantation. Moreover it is also prudential to choose the native species for plantation in the forest areas giving importance to trees with multiple uses. *Compensatory Afforestation Fund Management and Planning Authority* (CAMPA) are responsible for the compensatory levies from states inter-alia which is being used in plantation activity including compensatory afforestation by States/UTs. Much of the schemes are functional with special reference to the tree species whereas NTFPs or bioresources are also equally importance when it comes for securing livelihoods. So far, *Tripura Biodiversity Board* (TBB) took an initiation for the cultivation of 30 (thirty) medicinal plants. Certain works such as conservation, cultivation, processing and marketing of medicinal plants and their products for sustainable developmental process had been implemented. But many others prioritized bioresources plant species are in the stage of deprivation. As a result, mass plantation of bioresource plant species, as well as afforestation, should be established in the near future. Management of Non-Timber Forest Produce (NTFP) such as medicinal and aromatic plants, oil seeds, resins, wild edibles, fibre, bamboo, grass etc. can provide sustenance to the forest reliance communities by supplying food and livelihood security. The contribution of these daily net resources to livelihoods typically ranges from 10-60% of the total household income (Pandey *et al*., 2016).

Role in Scientific research and educations

In the revised National Forest Policy (2018), the government bodies in India have emphasized scientific research in forestry and wildlife for the forest management which would contributes to understand the forest dynamics and can guide towards pragmatic conservation planning. Some of the main research priorities undertaken are- integrated and multidisciplinary research on forest products for increasing livelihood support & economic growth; and research on forest inventories including growth yield assessment of forest products. With scope for researches and educational purpose, it is recommendable to adopt statisti-cal validation for prioritization of the plant species in a specific sampled area. A promising statistical analysis i.e. quantitative ethnobotanical indices can create a complete imitating forest data which can be recorded in spreadsheet or statistical software and allows to routinely check the data of a given sample size. Measuring the "importance" of plants and vegetation to people is a primary concern in quantitative ethnobotany (Hoffman and Gallaher, 2007). A common tool to quantify a qualitative data in the biological and social sciences is an index. The indices such as the "use values" which was developed by Prance *et al*. (1987) and Phillips and Gentry (1993a, 1993b) are applied in ethnobotany to calculate a value per interviewee or biological plant taxon. These approaches in research can provide data which are applicable for hypothesis-testing, statisti-cal validation, and comparative analysis of the plant bioresources.

Conclusion

The diverse use of bioresources for food, medicine, income and socio-cultural purposes by the ethnic communities of Tripura revealed its high dependency. The present study has documented 120 species comprising 37 ethnomedicnal plants that are claimed to heal upto 35 common ailments. Documentation of ethnomedicinal species along with their therapeutic uses will encourage further phytochemical and pharmacological investigations. The quantitative assessments of bioresources and medicinal plants may serve as baseline data for future research and development activities by policy makers or government intervention. The evaluation of important information such as diversity, its consumption pattern, contribution to rural income, and forest revenue may enable planners or policy maker to accurately plan sustainable management of resources and community development in the near future. Taxonomic inventories of bioresources and evaluation of ethnobotanical indices will provide understanding for the long-term use of such plant wealth, which can play a

key role in a variety of regional sustainable developments. In such a way large scale cultivation of these bioresources may be initiated. As a result, it will lead to conservation of bioresources in their natural habitats and develop a sustainable livelihood for the forest dwellers.

Competing interests

The authors declare no competing interests.

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