

Compendium of plants used for preparation of traditional alcoholic beverages by four major ethnic communities of Assam, northeast India

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Abstract. Borah D, Gogoi T, Sarma J, Borah PJ, Gohain B, Mili C, Upadhyaya A, Basumatary J, Neog K, Wangpan T, Tangjang S. 2021. *Compendium of plants used for preparation of traditional alcoholic beverages by different major ethnic communities of Assam, Northeast India. Biodiversitas* 22: 2019-2031. This paper deals with the ethnobotanical research on the preparation of traditional alcoholic beverages by *Ahom*, *Bodo*, *Karbi* and *Mishing* ethnic communities of Assam, India. Along with the information on preparation, the plant species associated with the preparation of alcoholic beverages are also recorded. Field investigations were conducted to cover 32 villages of six districts of Assam, India. The data was generated from 202 respondents using participatory rural appraisal tools including semi-structured questionnaires and personal interviews. The plant species were collected, identified and submitted in the Herbarium of Rajiv Gandhi University, Arunachal Pradesh, India. The study recorded 129 plants falling under 107 genera and 54 families which are exclusively used for the preparation of alcoholic beverages by the studied communities. The study confirmed that the association of traditional alcoholic beverages with their rich indigenous knowledge. The finding also revealed varied forms of protocol followed by these tribes to prepare traditional liquors and the starter cakes for brewing of alcohol were prepared locally. However, the *Mishing* tribe was known to prepare unique rice beer known as *Po:ro apong*, as the preparation technique and extraction process of this liquor was slightly different. Distillation of alcohol was also observed in all the communities except the *Ahom*. The rich traditional knowledge of brewing alcohol and the plant species used in the process were worth documenting considering the on-going alteration of traditional society with the modernization.

Keywords: Alcoholic beverage, ethnobotany, Northeast India, traditional knowledge, tribal society

INTRODUCTION

Fermentation and fermented beverages have always been an integral part to human cultures and traditions since ancient times (Alan 1997). The beer is supposed to have originated in Sumeria before 7000 B.C. (Demain et al. 1998). Traditionally prepared fermented beverages have always been associated with the values and survival of the tribes throughout the world since the dawn of civilization (Alan 1997). It is assumed that the preparation of traditional wine, beer and their varieties in consumption may have probably emerged due to the varied climatic conditions and was heavily dependent on the availability and utilization of locally available natural resources (Roy et al. 2004). The fermented rice beverages of the tribal people are prepared using various plants which are known to possess numerous medicinal properties. It has been reported that the phytochemical components present in these plant species proved to have remarkable therapeutic potential when used alone or in combinations (Prakash et al. 2004; Bhuyan and Baishya 2013). These forms of traditional alcoholic beverages have a considerable impact

on health care and provide health benefits of preventing and treating gastrointestinal diseases along with certain physiological disorders (Nath et al. 2019) such as insomnia, headache, diarrhea, body ache and inflammation of body parts, expelling worms along with the treatment of cholera and urinary problems (Samati et al. 2007; Deka and Sarma 2010; Nath et al. 2019). Several reports from different parts of Northeast India have also been claimed the presence of nutritional as well as antioxidant properties in rice beer samples which is due to the presence of compounds such as phenolic acids, polyphenols, and flavonoids (Nath et al. 2019).

Assam is home to diverse ethnic communities and tribal groups, mostly of Mongoloid origin, such as *Ahom*, *Rabha*, *Deori*, *Tiwa*, *Bodo*, *Karbi*, *Mishing*, *Sonowal Kachari*, etc. (Sharma 2017). These communities have been preparing and consuming traditional rice beer for about 2500 years and possess a good deal of knowledge about fermented food products (Tamang 2010). As such, a variety of cereal-based alcoholic beverages are prepared and consumed by these communities during many occasions such as ritual ceremonies, marriages and merry-making, festivals and

even death ceremonies (Saikia et al. 2007; Das et al. 2012). The fermentation methods are similar among the ethnic groups with some variations in the preparation of starter cakes which occasionally contain various herbs and rice flour (Das et al. 2012; Das et al. 2019). The current research deals with the ethnobotanical research of important plants used for the preparation of traditional alcoholic beverages by four major ethnic communities (*Ahom, Bodo, Karbi, and Mishing*) of Assam, India

MATERIALS AND METHODS

The field study was conducted in six districts of Assam, namely Baksa, Biswanath, Golaghat, Lakhimpur, Sivasagar, and Sonitpur because several ethnic communities reside in these districts (Figure 1), which falls within the upper zone of the state. The boundary of the state extends from 89° 42' E to 96° E longitudes and 24° 8' N to 28° 2' N latitudes and covers an area of 78,438 km². The elevation ranges from 45 to 1,960 meters above mean sea level and the temperature from 35-38 °C (95-100 °F)

during summers and 6-8°C (43-46°F) during winters. It has a mean annual rainfall of 1,524.6 mm. The present population is 31 million and the literacy rate is 72.19% (Census 2011).

Field investigations were conducted from October 2019 to March 2020 to cover thirty two villages of six districts of Assam, India. Selection of respondents was done through purposive stratified sampling from those villagers who accepted the request for an interview voluntarily. A total of 202 respondents (i.e., mostly age-old folks and women), present in these villages were selected for data collection. Data was collected through interviews by various participatory rural appraisal tools such as semi-structured questionnaires and personal interviews. Collection of plant species was done in the presence of respondents and was later processed following the methods of Jain and Rao (1976). It was then identified using relevant literatures (Hooker 1897; Kanjilal et al. 1934-1940), and consulting voucher specimens present in regional herbaria (ARUN, ASSAM) and submitted in Herbarium of Rajiv Gandhi University, Arunachal Pradesh, India.

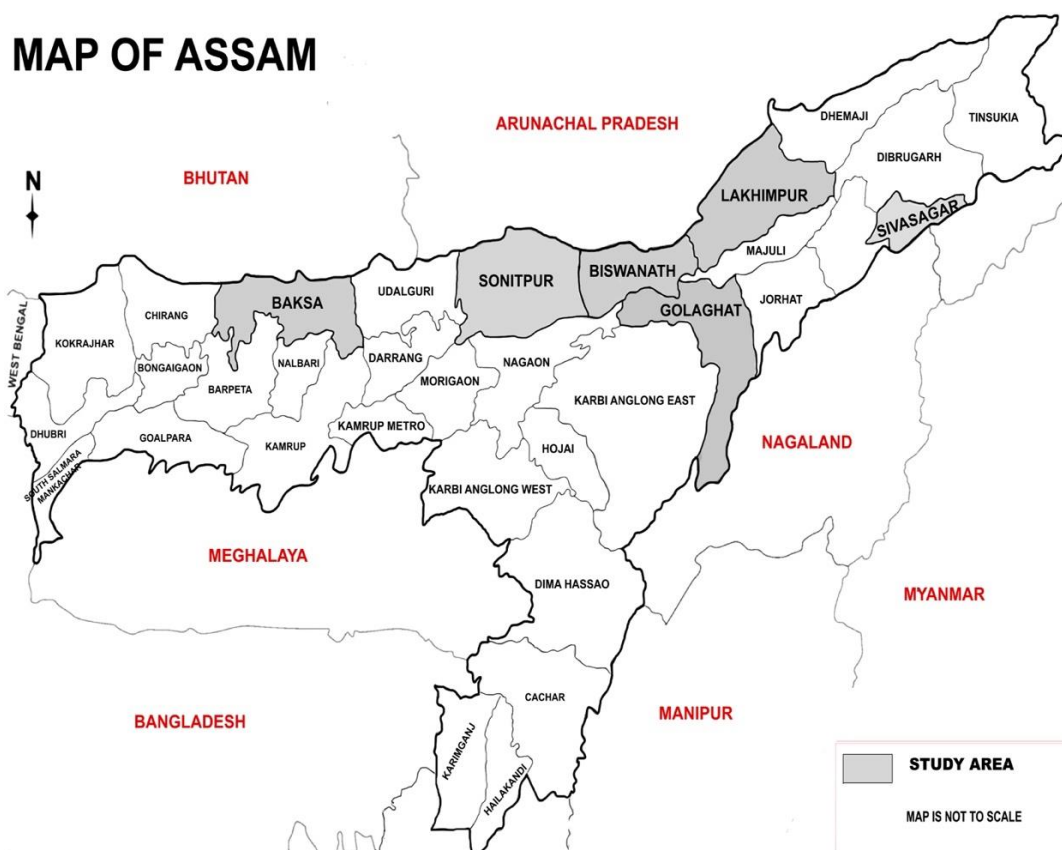


Figure 1. Map of Assam showing study area, i.e. 6 districts of Assam, India

RESULTS AND DISCUSSION

The study reported a total of 129 plants falling under 107 genera and 54 families used by four major ethnic communities of Assam used for the preparation of traditional alcoholic beverages (Table S1). Among the 54 families, Lamiaceae and Lauraceae were the most dominant families with eight species each, followed by Asteraceae (7 spp.), Rubiaceae and Polygonaceae with 6 spp. each (Table 3). Leaf (88%) is the most commonly used plant part, followed by twig (4%) and root (3%) (Figure 2). A brief pictorial account of traditional alcoholic beverages prepared by major ethnic communities *Ahom*, *Bodo*, *Karbi* and *Mishing* of Assam is depicted in Figure 3.

Table 2. Traditional alcoholic beverages of major tribal communities residing in Assam

Community	Alcoholic-beverage	Starter culture
Ahom	<i>Haaj, Laupani</i>	<i>Haajpitha, Vekurpitha</i>
Bodo	<i>Jou, Bishi</i>	<i>Amao, Angkur</i>
Karbi	<i>Hor/Hor-alank</i>	<i>Thap</i>
Mishing	<i>Poro apong, Sai mod</i>	<i>Apoppitha</i>

Table 3. Table showing ten dominant families of plants used in preparation of traditional alcoholic beverages in Assam, India

Family	Number of species
Asteraceae	7
Fabaceae	5
Lamiaceae	8
Lauraceae	8
Moraceae	4
Piperaceae	5
Poaceae	4
Polygonaceae	6
Rubiaceae	6
Solanaceae	5

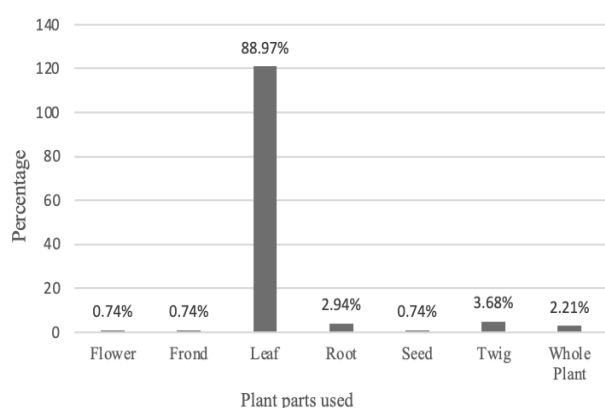


Figure 2. Bar diagram showing the percentage of plants parts used in preparation of traditional alcoholic beverages in Assam, India

Preparation of starter cakes

The preparation of starter cakes usually begins with the collection of various plants which add to the starter cakes and are believed to add certain flavor/medicinal value/nutrients to it (Figure 5). The collected plant parts were washed properly and used in either fresh form or dried. Drying was done under smoke or sun for a couple of days. At the same time, rice grains were soaked in water for about 2 to 6 hours and then rinsed to drain out the excess water and ground into powder. The dried plant parts are also grounded separately and mixed with the powdered rice. Subsequently, the dough was prepared, adding a small amount of finely powdered previously prepared starter cake (which serves as inoculants). Small-sized round balls were prepared from the dough, which is then dried and stored above the fireplace until further use. Dried leaves of *Thelypteris parasitica* (L.) Tardieu, *Musa balbisiana* Colla, and paddy hay were used to keep the starter balls free from harmful pests and moisture and increase the longevity of the product. The starter cakes and alcoholic beverages acquired different names in different tribal dialects (Table 2).

Preparation of rice beer

Traditional rice beer is usually prepared by fermenting boiled rice mixed with starter cakes (Figure 5). The process starts with the boiling of rice (preferably glutinous varieties). The cooked rice was then spread on banana leaves placed in a winnowing basket and allowed to cool to room temperature. The powdered starter cakes were mixed with the boiled rice and filled in an earthen pot or any vessel, and sealed with banana or *Alpinia* leaves, straw and a piece of clean cloth. The incubation period of fermentation varied from 5-9 days depending on the season and the climate of the region. After the incubation period, the mixture was taken out and filtered to separate the alcoholic liquid from the fermented rice. The filtered liquid or rice beer is now ready for consumption. Several tribal nomenclatures of rice beer and the materials used are mentioned in Table 2.

Preparation of *Po:ro apong*

It is worth mentioning that the process of rice beer preparation of all the studied tribes of Assam (*Ahom*, *Mishing*, *Bodo*, and *Karbi*) was more or less similar, differing only in the plants used (Table S1). But the *Mishing* tribe is known to prepare an additional unique rice beer known as *Po:ro apong*. The preparation technique, as well as extraction process of this alcoholic beverage, was slightly different from its counterparts (Figure 6). To prepare this beverage, paddy husk and dried paddy straw were partially burnt to collect the ash in a separate container. The collected ash along with the powdered starter cake was mixed along with the boiled rice. The mixture was then added to an earthen pot (severely fumigated pot, turning its color into blackish) and the mouth was sealed with the help of straw and leaves of *Thelypteris parasitica* (L.) Tardieu. The fermentation usually takes a week or two (depending on the season of preparation, warmer the climate faster the fermentation process or vice versa, and amount of starter used).



Figure 3. Traditional alcoholic beverages of Assam: A-B. Starter cakes, C. Vessel for rice beer preparation, D. Rice beer (*Xaajpani* of Ahom), E. *Po:ro apong* filtration unit, F. The mixture of *Po:ro apong*, G-H. Distilled alcohol distillation unit

For the extraction of liquid, the cone-shaped bamboo basket called *Ta:suk* was hung from a post. The interior walls of the bamboo basket were covered with banana leaves. A pack of paddy straw (*Amrong*) was placed at the base of the bamboo basket which serves as a sieve for filtration. The prepared fermented mixture (boiled rice + ash) was then poured inside the *Ta:suk* and warm water were poured from above which usually extracts the soluble components of the rice beer including alcohol. Coldwater is poured at first, to cool the fermented mixture, then hot water is slowly poured, sequentially, however, the filtrate remains cool for the first batches, until the filtrate turns hot, then the process is stopped. The filtrate (*Apong*) was then collected in a container placed just below the bamboo basket. But excess addition of water is not advised as it is believed to decrease the intoxicating effect as well as the sweetness of the beverage. Nevertheless, the production of *Po:ro apong* is considered to be a tedious process; thus, it is usually prepared in case of large and important

community gatherings such as festivals, rituals and other cultural gatherings.

Preparation of distilled alcohol

The distillation of alcohol was observed among the three studied communities except for the *Ahoms* (Figure 7). For distillation, the fermented rice beer was diluted by adding water and stored for some time. At the same time, the distillation process can be carried out either at the early stage of rice beer preparation or after harvesting of rice beer. The complete process of distillation may take 4 hours. The quality of alcohol is strong if prepared before harvesting rice beer by adding more amounts of starter cakes, or by adding less water while diluting.

The traditional distillation apparatus has three different chambers which consist of: (i) The lower chamber consists of a metallic utensil containing diluted fermented rice beer. (ii) The middle chamber consists of an earthen pot with a perforated base. It also has a small bowl over the

perforation, inside the pot which acts as a receiver to contain the distilled alcohol. In certain cases, the earthen pot was also found to be fitted with a long bamboo cylindrical tube on the side of the pot, which permits the flow of the distilled alcohol outside of the apparatus. The distilled alcohol is collected in a utensil placed at the end of the cylindrical tube. (iii) The upper chamber entails a metallic utensil, filled with cold water which acts as a condenser.

To prevent the leakage of vapors from the apparatus, the gap between the utensils was sealed with a moist muslin cloth, mud or with the residue of rice beer.

On constant heating, the filtered rice beer in the lowermost utensil forms vapor, passes through the perforated base of the middle compartment before hitting the base of the condenser, after which it settles down and collected by the bowl placed above the perforation, or through the tube directly into a bottle. The water of the condenser was repeatedly replaced so that the condensation continues. The more the alcohol is distilled, the less is the concentration.

The study unveiled the association of traditional alcoholic beverages with the rich indigenous knowledge system of the region. The finding also revealed the varied forms of protocol followed by different tribes of Assam for the preparation of traditional liquors. The starter culture was usually used as a source of yeast strains in the fermentation process. Also, they included various plant species in preparation for starter culture. Such starter culture usually persists for several months at room temperature and in a dry place (Tamang and Sarkar 1998).

There are several pieces of literature mentioned in Table S1 (last column) that corroborate the current findings. Thus, total 39 plants from our record were already reported by previous workers. While, a total of 90 plant species were newly recorded among the *Ahom*, *Mishing*, *Bodo* and *Karbi* for the preparation of traditional alcoholic beverages. Also, the most commonly added plants were *Ananas comosus* (L.) Merr., *Capsicum annuum* L., *Centella asiatica* (L.) Urb., *Clerodendrum infortunatum* L., *Lygodium flexuosum* (L.) Sw., *Oryza sativa* L., *Piper nigrum* L., *Saccharum officinarum* L. and *Scoparia dulcis* L.. The neighboring Northeastern states of India also retain their unique way of brewing alcohol. For instance, the addition of leaf extracts of *Clerodendrum viscosum* Vent. (synonym of *Clerodendrum infortunatum* L.) and *Calotropis gigantea* (L.) W.T.Aiton to rice, millet and corn to prepare beers in Sikkim (Tsuyoshi et al. 2005). Production of fermented spirit from rice called *U Phandieng* and cocktail of millet and rice beer called *KaKiad* among the Khasis of Meghalaya (Ahmed and Borthakur 2005). Addition of extract of tree barks and fern leaves to rice beer by *Meithei* tribe of Manipur (Hodson 1999). Germinated rice grains are mixed with powdered rice to produce *Peyazu* by *Angamis* of Nagaland (Sharma et al. 2019). The addition of ash and extracts of *Eleusine coracana* (L.) Gaertn. and *Saurauia roxburghii* Wall. to the broth containing dried or boiled millet or rice and starter yeast powder (called *epo*) by the *Apatani* tribe of Arunachal Pradesh (Tanti et al. 2010).

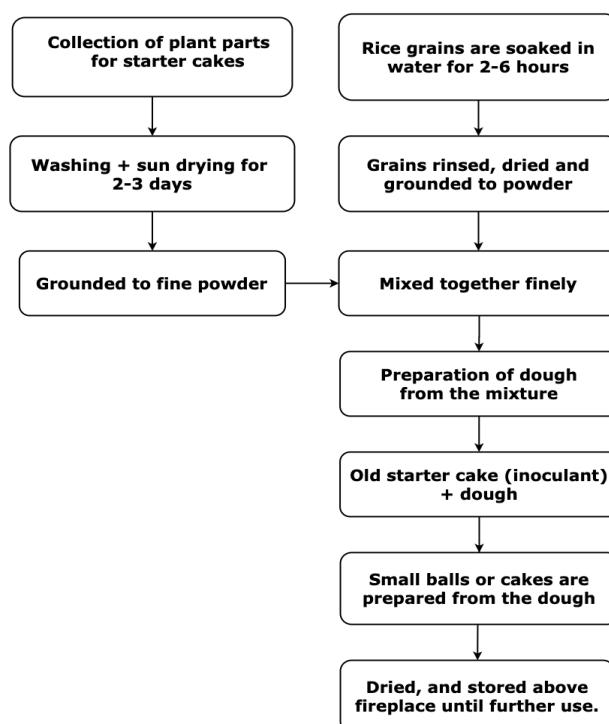


Figure 4. Steps for preparation of starter cakes by tribal communities of Assam, India

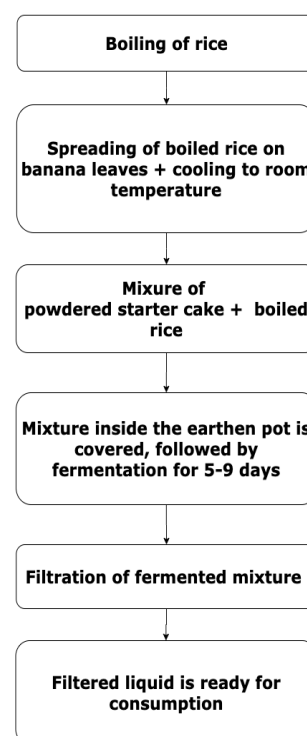


Figure 5. Steps for preparation of rice beer by tribal communities of Assam, India

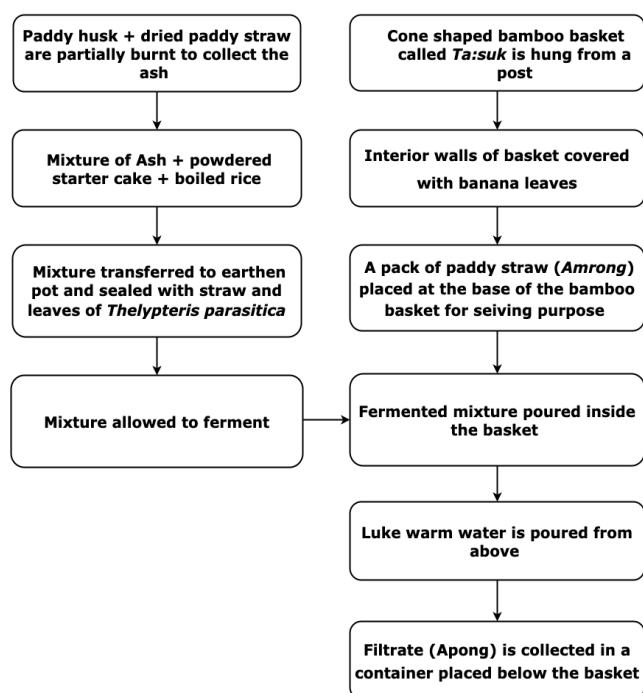


Figure 6. Steps for preparation of *Po:ro apong* by Mishing community of Assam, India

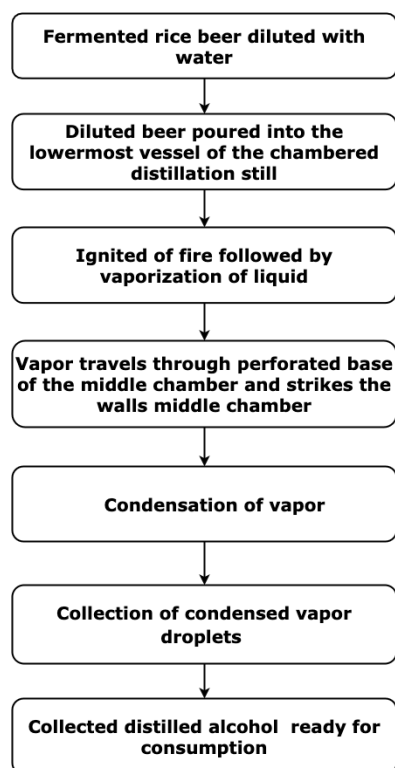


Figure 7. Steps for preparation of distilled alcohol by tribal communities of Assam, India.

Our findings assumed that the process of distillation of alcohol which was executed by the three studied tribes of Assam was almost similar. Likewise, in other parts of India, such distilled alcoholic liquor is very commonly consumed, such as *Yu angouba* of Manipur (Singh and Singh 2006), *Chulli* of Himachal Pradesh (Thakur and Savitri 2004), *fenny* of Goa (Nayak and Prabhu 2013), *Mahua* of Central India (Yadav et al. 2009), *Mahuli* from Orissa (Behera et al. 2016), *Soor* from Uttarakhand and Himachal Pradesh (Rana et al. 2004) and *Chhang* of Western Himalayan region (Ahuja et al. 2014), etc.

In conclusion, the rich traditional knowledge of brewing alcohol and the plant species used in the process were worth documenting considering the alteration of traditional society with the modernization. Also, considering the on-going rapid industrialization, the successful relocation of the traditional beverages from the household to the industrial-scale production with improved quality from a microbiological stance may stimulate the rural economy.

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Table S1. Plants used for the preparation of traditional alcoholic beverages by major ethnic communities of Assam: Parts used and previous records. *Note:* Ah, A= *Ahom*; Mi, M= *Mishing*, Bo, B= *Bodo* and Ka, Ga, G= *Karbi*

Tribal community	Updated name	Family	Local name	Parts used	Collection number	Previous records
Ah	<i>Achyranthes aspera</i> L.	Amaranthaceae	Uvotahoth (A)	Leaf	TG 1078	-
Ah	<i>Acmella oleracea</i> (L.) R.K. Jansen	Asteraceae	Huhoni bon (A)	Leaf	TG 1079	-
Ah	<i>Acmella paniculata</i> (Wall. ex DC.) R.K. Jansen	Asteraceae	Huhoni bon (A)	Leaf	PB 1039	-
Ah	<i>Actinodaphne</i> sp.	Lauraceae	Baghnola pat (A)	Leaf	TG 1080	-
Ah	<i>Alternanthera sessilis</i> (L) R. Br. ex DC.	Amaranthaceae	Matikaduri (A)	Leaf	PB 1043	Deori et al. 2007; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah	<i>Amaranthus viridis</i> L.	Amaranthaceae	Khutura (A)	Leaf	PB 1059	-
Ah, Bo	<i>Ananas comosus</i> (L.) Merr.	Bromeliaceae	Anarokh/Mati-kathal (A), Rwimali (B)	Leaf	BG 003; PB 1073; JB 027; TG 1082	-
Ah	<i>Aporosa octandra</i> (Buch.-Ham. ex D.Don) Vickery	Phyllanthaceae	Khokoraheloch (A)	Leaf	TG 1142	-
Ah	<i>Ardisia solanacea</i> Roxb.	Primulaceae	Tuluthapoka (A)	Leaf	TG 1083	-
Ah	<i>Argyrea nervosa</i> (Burm.f.) Bojer	Convolvulaceae	Bridhodaroklota/Hunporuah lota/ Tukoriyaalu (A)	Leaf	TG 1143	-
Ah	<i>Artocarpus chama</i> Buch.-Ham.	Moraceae	Sam kathal (A)	Leaf	TG 1085	-
Ah, Mi, Bo	<i>Artocarpus heterophyllus</i> Lam.	Moraceae	Belang (M), Kothal (A), Khatol/ Khanthal (B)	Leaf	CM 108; BG 002; PB 1030; JS 2346; JB 021; TG 1084	Baruah et al. 2010; Deka and Sarma 2010; Bhuyan and Baishya 2013; Gogoi et al. 2013; Pawe and Gogoi 2013; Basumatary et al. 2014; Basumatary and Gogoi 2014; Senapati and Gurumayum 2016; Das 2016; Bhuyan and Rajak 2019
Ah	<i>Averrhoa carambola</i> L.	Oxalidaceae	Kordoi (A)	Leaf	PB 1056	-
Ah	<i>Bambusa tulda</i> Roxb.	Poaceae	Baah pat (A)	Leaf	PB 1071; TG 1086	-
Ah	<i>Bonnaya ciliata</i> (Colsm.) Spreng.	Linderniaceae	Kasidaria/ Horukasi-doriya (A)	Leaf	PB 1057; TG 1145	-
Ah	<i>Bonnaya ruellioides</i> (Colsm.) Spreng.	Linderniaceae	Bor kasi-doriya (A)	Leaf	TG 1146	-
Ah	<i>Callicarpa arborea</i> Roxb.	Lamiaceae	Tangloti (A)	Leaf	TG 1087	-
Ah	<i>Callicarpa longifolia</i> Lam.	Lamiaceae	Gorokhiyakorai (A)	Leaf	TG 1088	-
Ah	<i>Cannabis sativa</i> L.	Cannabaceae	Bhang gos (A)	Leaf	PB 1068	-
Ah	<i>Capsicum annuum</i> L.	Solanaceae	Jolokia (A)	Leaf	TG 1089	Baruah et al. 2010; Deka and Sarma 2010; Pawe and Gogoi 2013; Gogoi et al. 2013; Bhuyan and Baishya 2013; Basumatary et al. 2014; Das and Hazarika 2015; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Mi	<i>Capsicum frutescens</i> L.	Solanaceae	Mirsi (M)	Leaf	CM 111	-

Ah	<i>Centella asiatica</i> (L.) Urb.	Apiaceae	Bor mani-muni (A)	Whole plant	BG 004; TG 1090	Deori et al. 2007; Baruah et al. 2010; Das et al. 2012; Kardong et al. 2012; Gogoi et al. 2013; Pawe and Gogoi 2013; Bhuyan and Baishya 2013; Senapati and Gurumayum 2016; Handique and Deka 2016; Bhuyan and Rajak 2019; Nath et al. 2019
Ah	<i>Chloranthus elatior</i> Link	Chloranthaceae	Gathikaliya (A)	Leaf	TG 1147	-
Ah	<i>Cinnamomum bejolghota</i> (Buch.-Ham.) Sweet	Lauraceae	Patihunda/Naga dalseni (A)	Leaf	TG 1148	-
Ah	<i>Cinnamomum tamala</i> (Buch.-Ham.) T.Nees & C.H.Eberm	Lauraceae	Tezpat (A)	Leaf	PB 1074	Baruah et al. 2010; Gogoi et al. 2013; Senapati and Gurumayum 2016
Ah	<i>Cinnamomum verum</i> J.Presl	Lauraceae	Dalseni pat (A)	Leaf	TG 1091	-
Ah	<i>Cissampelos pareira</i> L.	Menispermaceae	Bor tubukilota (A)	Leaf	TG 1092; TG 1149	Saikia et al. 2007; Das et al. 2012; Bhuyan and Baishya 2013; Handique and Deka 2016; Senapati and Gurumayum 2016; Nath et al. 2019
Ah	<i>Citrus × limon</i> (L.) Osbeck	Rutaceae	Nemutenga (A)	Leaf	TG 1094	-
Ah, Mi	<i>Clematis apiifolia</i> DC.	Ranunculaceae	Horusoi/ Horugoropsoi (A), Ramnam bon (M)	Leaf	CM 117; TG 1150	-
Ah	<i>Clematis zeylanica</i> (L.) Poir.	Ranunculaceae	Gop-sori/Soi pan/ Gorobsoi (A)	Leaf	PB 1027; TG 1119	Deori et al. 2007; Baruah et al. 2010; Kardong et al. 2012; Bhuyan and Baishya 2013; Gogoi et al. 2013; Handique and Deka 2016 Senapati and Gurumayum 2016; Bhuyan and Rajak 2019; Nath et al. 2019;
Ah, Bo	<i>Clerodendrum colebrookeanum</i> Walp.	Lamiaceae	Nefafu (A), Mwkhwna (B)	Leaf	JB 024; PB 1038; JS 2345	-
Ah, Bo, Ga, Mi	<i>Clerodendrum infortunatum</i> L.	Lamiaceae	Dhopattita (A), Pakkom (M), Samaki (G)	Leaf	JS 001; JS 012; TG 1095	Tanti et al. 2008; Baruah et al. 2010; Deka and Sarma 2010; Das et al. 2012; Bhuyan and Baishya 2013; Gogoi et al. 2013; Pawe and Gogoi 2013; Basumatary et al. 2014; Basumatary and Gogoi 2014; Brahma et al. 2014; Das 2016; Handique and Deka 2016; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019; Nath et al. 2019
Ah	<i>Commelina benghalensis</i> L.	Commelinaceae	Kona himolu (A)	Leaf	PB 1046	-
Ah	<i>Cordyline fruticosa</i> (L.) A.Chev.	Asparagaceae	Panormahi (A)	Leaf	TG 1151	-
Mi	<i>Coriandrum sativum</i> L.	Apiaceae	Dhania (M)	Twig	JS 002	-
Ah	<i>Crassocephalum crepidioides</i> (Benth.) S.Moore	Asteraceae	Bon kopahi (A)	Leaf	TG 1152	-
Ah	<i>Croton caudatus</i> Geiseler	Euphorbiaceae	Lotamahudi/Mahudi (A)	Leaf	BG 005; PB 1042; TG 1096	Senapati and Gurumayum 2016; Nath et al. 2019
Ah, Ka	<i>Croton joufra</i> Roxb.	Euphorbiaceae	Gochmahudi (A), Marthu (K)	Leaf	DB1067; TG 1097	Teron 2006; Baruah et al. 2010; Bhuyan and Baishya 2013; Senapati and Gurumayum 2016
Ah	<i>Curcuma longa</i> L.	Zingiberaceae	Halodhi (A)	Leaf	TG 1098	Das 2016; Bhuyan and Rajak 2019
Mi	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Rabonlota (M)	Root	JS 004	-
Ah	<i>Cyanthillium cinereum</i> (L.) H.Rob.	Asteraceae	Hohodevi bon (A)	Leaf	TG 1099	-
Ah	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Dubori bon (A)	Leaf	PB 1031	-
Ah	<i>Cyperus mindorensis</i> (Steud.) Huygh	Cyperaceae	Keya bon (A)	Leaf	PB 1048	-

Ah	<i>Desmodium</i> sp.	Fabaceae	Bionihabota (A)	Leaf	PB 1033; TG 1101	-
Ah, Mi	<i>Drymaria cordata</i> (L.) Willd. exSchult.	Caryophyllaceae	Lai jabori (A), Dobag/porog-tape (M)	Leaf, Twig	PB 1051; CM 112; TG 1102	Baruah et al. 2010; Das et al. 2012; Gogoi et al. 2013; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	Kehraj (A)	Leaf	PB 1054	-
Ah	<i>Eryngium foetidum</i> L.	Apiaceae	Maandhanian (A)	Leaf	PB 1075	-
Ah	<i>Ethulia conyzoides</i> L.	Asteraceae	Bon-jira (A)	Leaf	TG1908	-
Ah	<i>Eurya acuminata</i> DC.	Pentaphylacaceae	Murmuri pat (A)	Leaf	TG 1103	-
Ah, Mi	<i>Flemingia strobilifera</i> (L.) W.T.Aiton	Fabaceae	Makhioti (A, M)	Leaf	JS 005; PB 1035; TG 1104	-
Ah	<i>Glochidion zeylanicum</i> var. <i>Tomentosum</i> (Dalzell) Trimen	Phyllanthaceae	Pani madhuri (A)	Leaf	TG 1105	-
Ah	<i>Grewia serrulata</i> DC.	Malvaceae	Kukurhuta (A)	Leaf	TG 1106	-
Ah	<i>Grona triflora</i> (L.) H.Ohashi&K.Ohashi	Fabaceae	Goyona bon (A)	Leaf	TG 1153	-
Mi	<i>Hellenia speciosa</i> (J.Koenig) S.R.Dutta	Costaceae	Jomlakhuti (M)	Leaf	JS 003	Deori et al. 2007; Das et al. 2012; Kardong et al. 2012; Gogoi et al. 2013; Pawe and Gogoi 2013; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah, Mi	<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Leunaapum (M), Joba (A)	Leaf	JS 006; PB 1060	-
Ah	<i>Hydrocotyle sibthorpioides</i> Lam.	Araliaceae	Horumani-muni (A)	Whole plant	BG 008; PB 1034; TG 1107	Baruah et al. 2010; Das et al. 2012; Kardong et al. 2012; Bhuyan and Baishya 2013; Handique and Deka 2016; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019; Nath et al. 2019;
Ah	<i>Ixora polyantha</i> Wight	Rubiaceae	Dhepajamu/Matikathalua (A)	Leaf	TG 1154	-
Ah	<i>Jasminum</i> sp.	Oleaceae	Duamali (A)	Leaf	BG 009	-
Ah	<i>Leea indica</i> (Burm.f.) Merr.	Vitaceae	Kukurathengia (A)	Leaf	PB 1072	-
Ah, Bo	<i>Leucas aspera</i> (Willd.) Link	Lamiaceae	Durun bon (A), Khansisa (B)	Leaf	PB 1037; JB 025; TG 1108	Saikia et al. 2007; Das et al. 2012; Pawe and Gogoi 2013; Gogoi et al. 2013; Das 2016; Handique and Deka 2016; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019; Goswami 2020
Mi	<i>Lippia alba</i> (Mill.) N.E.Br. ex Britton &P.Wilson	Verbenaceae	Pohukata (M)	Leaf, Flower	JS 007	-
Ah	<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	Lauraceae	Ganhualu (A)	Leaf	TG 1109	-
Mi	<i>Litsea monopetala</i> (Roxb.) Pers.	Lauraceae	Tapid (M)	Leaf	CM 116	-
Ah	<i>Litsea nitida</i> (Roxb. ex Nees) Hook.f.	Lauraceae	Kothlua pat (A)	Leaf	TG 1110	-
Ah	<i>Litsea salicifolia</i> (Roxb. ex Nees) Hook.f.	Lauraceae	Dighloti pat (A)	Leaf	TG 1111	-
Ah, Mi	<i>Lygodium flexuosum</i> (L.) Sw.	Lygodiaceae	Kapau-dhekia (A), Tisurkosang (M)	Twig	BG 010; PB 1021; CM 113; TG 1112	Deori et al. 2007; Saikia et al. 2007; Baruah et al. 2010; Das et al. 2012; Bhuyan and Baishya 2013; Gogoi et al. 2013; Pawe and Gogoi 2013; Handique and Deka 2016; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019;

						Nath et al. 2019
Ah	<i>Macaranga indica</i> Wight	Euphorbiaceae	Sikamorolia pat (A)	Leaf	TG 1114	-
Ah	<i>Maesa chisia</i> D.Don	Primulaceae	Rajmoni (A)	Leaf	TG 1155	-
Ah	<i>Maesa indica</i> (Roxb.) Sweet	Primulaceae	Ouwapat/Maspua/ Checuriya (A)	Leaf	TG 1156	-
Ah	<i>Melastoma malabathricum</i> L.	Melastomataceae	Phutkola (A)	Leaf	PB 1040; TG 1115	Deori et al. 2007; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah	<i>Mesua ferrea</i> L.	Calophyllaceae	Nahor (A)	Leaf	TG 1157	-
Ah	<i>Mimosa pudica</i> L.	Fabaceae	Lajuki bon (A)	Leaf	PB 1062; TG 1116	-
Ah	<i>Morinda angustifolia</i> Roxb.	Rubiaceae	Aasugoch, Daruhoridra pat (A)	Leaf, Root	TG 1117	-
Ah	<i>Morus rubra</i> L.	Moraceae	Nuni (A)	Leaf	PB 1061	-
Ah	<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae	Norohingha (A)	Leaf	PB 1045	-
Ah, Bo	<i>Musa balbisiana</i> Colla	Musaceae	Bhimkol (A)	Leaf	TG 1118	-
Ah, Bo	<i>Mussaenda roxburghii</i> Hook.f.	Rubiaceae	Naga bali/Sorairatha (A), Bose (B)	Leaf	JB 026; TG 1158	Gogoi et al. 2013; Das and Hazarika 2015; Basumatary and Gogoi 2014; Senapati and Gurumayum 2016
Ah	<i>Nelsonia canescens</i> (Lam.) Spreng.	Acanthaceae	Udbhedeli/Baghkaniya (A)	Leaf	TG 1159	Deori et al. 2007; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah	<i>Olex acuminata</i> Wall. ex Benth.	Olacaceae	Kopohua (A)	Leaf	TG 1120	Bhuyan and Rajak 2019
Ah	<i>Oldenlandia corymbosa</i> L.	Rubiaceae	Bon jaluk (A)	Whole plant, Leaf	BG 011; PB 1026; TG 1121	Baruah et al. 2010; Das et al. 2012; Gogoi et al. 2013; Pawe and Gogoi 2013; Senapati and Gurumayum 2016; Handique and Deka 2016; Bhuyan and Rajak 2019
Ah	<i>Ophiorrhiza</i> sp.	Rubiaceae	Nakulastha/Harpo shree/Matirahipora (A)	Leaf	TG 1160	-
Ah	<i>Oryza sativa</i> L.	Poaceae	Dhan (A)	Seed	BG 012	Deori et al. 2007; Baruah et al. 2010; Gogoi et al. 2013; Bhuyan and Baishya 2013; Basumatary et al. 2014; Basumatary and Gogoi 2014; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019; Nath et al. 2019
Ah	<i>Oxalis debilis</i> Kunth	Oxalidaceae	Tengesi (A)	Leaf	PB 1052	-
Ah	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	Panounua (A)	Leaf	PB 1050	-
Ah	<i>Persicaria chinensis</i> (L.) H.Gross	Polygonaceae	Madhuhuleng (A)	Leaf	PB 1070	-
Bo	<i>Persicaria glabra</i> (Willd.) M.Gomez	Polygonaceae	Bisongali (B)	Leaf	JS 2347	-
Ah, Mi	<i>Persicaria hydropiper</i> (L.) Delarbre	Polygonaceae	Leubo (M), Pothoruabihlongani (A)	Twig	JS 009; TG 1127	Das and Hazarika 2015
Mi	<i>Persicaria microcephala</i> (D.Don) H.Gross	Polygonaceae	Nekungkune (M)	Leaf	JS 010	-
Ah	<i>Persicaria perfoliata</i> (L.) H.Gross	Polygonaceae	Baghaasur/ Baghasura (A)	Leaf	PB 1069; TG 1122	-
Ah	<i>Phyllanthus fraternus</i> G.L.Webster	Phyllanthaceae	Bon aamlokhi (A)	Leaf	PB 1044	-
Ah	<i>Physalis angulata</i> L.	Solanaceae	Pokmou (A)	Leaf	PB 1076	-
Ah, Mi	<i>Piper betle</i> L.	Piperaceae	Paan (M)	Leaf	CM 110; TG 1123	Saikia et al. 2007; Das et al. 2012; Arjun et al. 2014; Bhuyan and Rajak 2019
Ah	<i>Piper longum</i> L.	Piperaceae	Pipolee (A)	Leaf	TG 1124	Kardong et al. 2012; Pawe and Gogoi 2013; Das and

						Hazarika 2015; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah	<i>Piper nigrum</i> L.	Piperaceae	Jaluk (A)	Leaf	PB 1025; TG 1125	-
Ah	<i>Piper</i> sp.	Piperaceae	Aauni pan (A)	Leaf	TG 1126	-
Ah	<i>Plantago asiatica</i> L.	Plantaginaceae	Hinga pat (A)	Leaf	TG 1161	-
Ga	<i>Plumbago zeylanica</i> L.	Plumbaginaceae	Achetra (M)	Leaf	JS 011	Basumatary and Gogoi 2014; Basumatary et al. 2014; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah	<i>Pogostemon benghalensis</i> (Burm.f.) Kuntze	Lamiaceae	Hukloti (A)	Leaf	PB 1063	-
Ah	<i>Potentilla indica</i> (Andrews) Th.Wolf	Rosaceae	Gorukhis (A)	Leaf	PB 1058	-
Ah	<i>Pouzolzia zeylanica</i> (L.) Benn.	Urticaceae	Boralibakua (A)	Leaf	PB 1047	-
Ah	<i>Pseuderanthemum latifolium</i> (Vahl) B.Hansen	Acanthaceae	Athutangana/Hohakoniya/Pastel flower (A)	Leaf	TG 1162	-
Ah, Mi	<i>Psidium guajava</i> L.	Myrtaceae	Madhuri (A)	Leaf	CM 107; BG 013; PB 1041; TG 1128	Deori et al. 2007; Baruah et al. 2010; Deka and Sarma 2010; Das et al. 2012; Pawe and Gogoi 2013; Bhuyan and Baishya 2013; Gogoi et al. 2013; Das and Hazarika 2015; Senapati and Gurumayum 2016; Das 2016; Bhuyan and Rajak 2019; Goswami 2020
Ah	<i>Psychotria</i> sp.	Rubiaceae	Pani mudoi/Pani-moori (A)	Leaf	BG 001; PB 1023; TG 1163	-
Ah	<i>Rotheca serrata</i> (L.) Steane & Mabb.	Lamiaceae	Nangalvonga (A)	Leaf	TG 1164	Das 2016
Ah	<i>Rubus moluccanus</i> L.	Rosaceae	Jetelipoka (A)	Leaf	PB 1036; TG 1130	Bhuyan and Rajak 2019
Ah	<i>Rumex maritimus</i> L.	Polygonaceae	Lo baruah (A)	Leaf	TG 1131	-
Ah, Bo	<i>Saccharum officinarum</i> L.	Poaceae	Kuhiyar (A), Khaser (B)	Leaf	JB 023; TG 1165	Deori et al. 2007; Baruah et al. 2010; Pawe and Gogoi 2013; Gogoi et al. 2013; Das and Hazarika 2015; Senapati and Gurumayum 2016; Bhuyan and Rajak 2019
Ah, Bo, Mi	<i>Scoparia dulcis</i> L.	Plantaginaceae	Senibon/Senigutigoch/Bon tulokhi/Modhumehari (A), Jaluk bon (M), Dongfangrakheb (B)	Leaf, Young shoot	BG 014; PB 1022; JB 022; CM 112; JS 2348; TG 1132	Deori et al. 2007; Saikia et al. 2007; Baruah et al. 2010; Deka and Sarma 2010; Kardong et al. 2012; Das et al. 2012; Pawe and Gogoi 2013; Gogoi et al. 2013; Bhuyan and Baishya 2013; Basumatary et al. 2014; Basumatary and Gogoi 2014; Brahma et al. 2014; Senapati and Gurumayum 2016; Das 2016; Handique and Deka 2016; Bhuyan and Rajak 2019
Ah	<i>Selaginella</i> sp.	Selaginellaceae	Khunkhunidhekia (A)	Leaf	TG 1133	-
Ah	<i>Sida rhombifolia</i> L.	Malvaceae	Hoonbarial (A)	Leaf	PB 1053	Bhuyan and Baishya 2013; Senapati and Gurumayum 2016; Nath et al. 2019
Ah	<i>Smilax ovalifolia</i> Roxb. ex D.Don	Smilacaceae	Tikonibaruah (A)	Leaf	PB 1028; TG 1134	
Ah	<i>Sohmaea laxiflora</i> (DC.) H.Ohashi & K.Ohashi	Fabaceae	Beoni-haputa/Beonihabota/Ulutak hot (A)	Leaf	BG 007; TG 1166	Baruah et al. 2010

Ah	<i>Solanum americanum</i> Mill.	Solanaceae	Loskosi (A)	Leaf	PB 1055	-
Ah	<i>Solanum nigrum</i> L.	Solanaceae	Bhekuri (A)	Leaf	PB 1065	-
Ah	<i>Solena heterophylla</i> Lour.	Cucurbitaceae	Belipoka, Ghukusmoi (A)	Leaf	TG 1167	Kardong et al. 2012; Gogoi et al. 2013; Pawe and Gogoi 2013; Senapati and Gurumayum 2016
Ah	<i>Sphagneticola trilobata</i> (L.) Pruski	Asteraceae	Bhringraj (A)	Leaf	TG 1135	-
Ah	<i>Spondias pinnata</i> (L.f.) Kurz	Anacardiaceae	Omora (A)	Leaf	PB 1067	-
Ah	<i>Stellaria media</i> (L.) Vill.	Caryophyllaceae	Morolia (A)	Leaf	PB 1049	-
Ah	<i>Stenochlaena palustris</i> (Burm.f.) Bedd.	Aspleniaceae	Dhekia loti (A)	Leaf	PB 1032; TG 1136	-
Ah, Mi	<i>Stephania rotunda</i> Lour.	Menispermaceae	Hortubukilota/Tubukilota (A), Nginti (M)	Leaf	PB 1024; CM 114; TG 1093	-
Ah	<i>Stixissuaveolens</i> (Roxb.) Baill.	Resedaceae	Madhoimalati (A)	Leaf, Root	TG 1129	-
Ah	<i>Streblus asper</i> Lour.	Moraceae	Houra pat (A)	Leaf	TG 1137	Das 2016; Goswami 2020
Ah	<i>Tetracera sarmentosa</i> (L.) Vahl	Dilleniaceae	Ou lata (A)	Leaf	TG 1168	-
Ah, Bo, Mi, Ga	<i>Thelypteris parasitica</i> (L.) Tardieu	Aspleniaceae	Bihlongoni (A), Sarath (G), Dingkhia (B)	Frond	PB 1029; BG 006; JS 013; JB 028; TG 1081; CM 109	Pawe and Gogoi 2013
Ah	<i>Thunbergia grandiflora</i> (Roxb. ex Rottler) Roxb.	Acanthaceae	Hetaloti/Kauri thutialota (A)	Leaf	TG 1139	-
Ah, Mi	<i>Tinospora cordifolia</i> (Willd.) Hook.f. & Thomson	Menispermaceae	Amrita (M), Hogunilota (A)	Leaf	JS 008; PB 1064	-
Ah	<i>Vitex negundo</i> L.	Lamiaceae	Posotia (A)	Leaf	PB 1066	Senapati and Gurumayum 2016
Ah	<i>Zanthoxylum nitidum</i> (Roxb.) DC.	Rutaceae	Tezmui/Tezmoori (A)	Leaf, Root	BG 015; TG 1140	Tanti et al. 2008; Baruah et al. 2010; Kardong et al. 2012; Pawe and Gogoi 2013; Senapati and Gurumayum 2016; Handique and Deka 2016; Bhuyan and Rajak 2019
Ah	<i>Zingiber officinale</i> Roscoe	Zingiberaceae	Ada (A)	Leaf	TG 1141	Deori et al. 2007; Pawe and Gogoi 2013; Senapatiaand Gurumayum 2016; Bhuyan and Rajak 2019