Mili and Sundriyal *Journal of Ethnic Foods* (2023) 10:47
https://doi.org/10.1186/s42779-023-00214-2

Journal of Ethnic Foods

ORIGINAL ARTICLE

Open Access

ÉPOP (traditional starter culture): a complex composition of plant resources prepared by the Misings of Assam, Northeast India

Rajiv Mili[1,2*] and R. C. Sundriyal[1,3]

Abstract

Ethnic practices with relation to starter culture reflect a region-specific traditions; therefore, documentation of such knowledge is key to improvise basic understanding as how traditions, cultures, and processes are linked to local dietary systems, food and nutrition security, and social connection. Considering this, the present study aims to investigate the Mising ethnic tribal group, Assam state in Northeast India, with a focus to investigate mode of starter culture making for preparing local beverage along with plant species being used, time of collection, procedure of making starter culture, and how it is preserved. The community maintains an agrarian culture and is closely associated with forest-based natural resources. This group of people consumes various foods prepared from wild plants and crops along with meat and fish. *Apong* is one of the most important components of their culture, used as a beverage made up of rice by using starter culture locally known as *ÉPOP*. Detailed process of making of starter culture was documented. A total of 31 plant species varying from 22 families belonging to both flowering and non-flowering plants were recorded used by the community. Eight species also comprised market potential for diverse uses besides being used in starter culture preparation. The source of the collected resources varied from fallow land to forest, with the highest collection concentration in the forest (35.5%), mostly collected in the afternoon (51.61%) to ensure a quality of the plant material. The collected plant materials are mixed with soaked glutinous rice and made into starter cultures of different sizes that have a shelf life of 6 months. The study highlights that use of starter culture is consistent and harmless with distinct flavor and taste that apt to local appetite. Conserving community knowledge on starter culture making, however, requires appropriate policy planning and action line. The investigation not only increases our understanding on local food tradition but also has potential for applications in fermented food industry and thus opens up a new line of research in future.

Keywords Starter culture, Traditional knowledge, Mising tribe, Plant ingredients, Policy planning

*Correspondence:
Rajiv Mili
rajivmili125@gmail.com
Full list of author information is available at the end of the article

Introduction

Ethnic practices with relation to traditional foods and beverages comprised a great significance in local sociocultural traditions, dietary systems, food and nutrition security, and societal connection, thus having high implications for future development [1, 2]. India's northeastern region is well-known around the world for its rich biological variety and cultural legacy. Living on the fringes of the forests, the ethnic communities in the area meet their diverse daily requirements for food, medicine, and other essentials from forests and possess extensive expertise on sustainable resource management [3]. The hilly, irregular topographic conditions, different forest classes and land uses, comparatively poor connectivity, etc., make the region a better habitat for lush flora growth and a suitable home for endangered fauna. The natural resources available to them are used sustainably by the communities, although most of them have relied on agriculture for their livelihood and are therefore closely linked to their culture [4, 5]. Apart from wild-grown natural resources, cultivated agronomic products harvested by farmers are used as food for both self-consumption and feeding livestock, as well as fertilizer [6]. Both wild habitat natural resources and cultivated or managed products are used as food with traditionally acquired innovative methods so as to preserve them for a longer period of time as a reserve food source for lean periods, either in processed form or in raw form, or sometimes both [7].

Traditionally processed foods in fermented form are highly valued all over the world because they not only meet the nutritional needs of people living in distant or geographically and socially isolated locations but also reflect the living ethnic culture and have always been popular [7, 8]. In general, they extract resources from nature, and their processing into edible foods is the result of an art based on traditional ecological knowledge combined with the skillful management of resources for sustainable management by ethnic communities and considered a good source of nutrients and minerals that are important for human health [8–10].

Most tribal communities across Northeast India, particularly in Arunachal Pradesh and Assam, commonly use a traditional alcoholic drink 'Apong' that is mainly rice-based using local starter culture [11–15]. Mising community was among the earliest user of Apong using local resources [16, 17]. *Apong*, a traditional alcoholic beverage, is used extensively by families among the Mising tribe of Assam, where rice is the principal ingredient. Depending upon the color and processing, it is of two types, namely *Noggin Apong* and *Poro/Por Apong* [18]. The *Noggin Apong*is a whitish liquid substance extracted by hand from fermented material. In the case of *Poro Apong*, ash material made from rice bran is mixed with cooked rice before fermentation and then distilled to produce a light, blackish liquid with a lower-density gradient than the former. Apart from their regular consumption, both are occasionally used in rituals and rites for various worshipped deities. There are mainly three different glutinous rice types, viz. *bao, amdang,* and *guni*. *Bao* rice is a semi-deep-water variety that is commonly grown in lowland crop fields where water remains stagnant for several months. The hull color, which ranges from mostly red to purple-blackish, is thought to be the best ingredient for brewing beer. *Amdang,* or sali rice, is sticky in nature and is grown in semi-deep water, whereas *Guni* is broadcast directly in the field. Use of rice beer dated back to time immemorial perhaps began with the evolution of crop cultivation. Farmers would refresh themselves with a bowl of *apong* after a long day's activities in the crop field. Sometimes, villagers also come to help families in their farming, for whom offering *apong* is a minimum courtesy. So, it is an integral part of their culture and is used widely in all aspects of social life in Mising society [19].

Mising is a second most populous tribe of Northeast India that belong to the Tibeto-Burman group of Mongoloid origin and inhabitants of Brahmaputra valley covering 10 districts in Assam (Tinsukia, Dibrugarh, Sivasagar, Charaideo, Majuli, Jorhat, Golaghat, Dhemaji, Lakhimpur, and Sonitpur), and a sporadic distribution of populations is seen in Kamrup (metro) and two districts (East Siang and Namsai) in the state of Arunachal Pradesh [20]. Their distinctive food habits, colorful dresses, language, and housing culture distinguish them from the other major ethnic communities in the state. Like other ethnic communities, they have distinct food recipes and local beverages that differ significantly from those of their neighbors. There have been several studies related to diverse aspects of Misings culture, phytoresource use, food habits, ethnomedicinal and traditional health care systems, and beverages used by them [11, 21–32]. Some studies also elaborated on value addition and commercial aspects to local plants and beverages [33].

Similar to other tribal communities of the region, *Apong* is an integral part of local sociocultural milieu of Mising community [11, 18, 31]. It is an outcome of the starter culture used as the source of yeast material that converts carbohydrates into alcohol. In the recent past, a few attempts have been made to understand the methods of preparation, nutritional and biochemical aspects of *Apong* [18, 21]. Besides, enumeration of wild relative plants used as ingredients for the preparation of rice beer in the community and its medicinal properties have also been investigated [11]. The traditional way of preparing starter culture is common among tribes in Northeast India [32, 34, 35]. Starter culture, also called starter cake or yeast tablet, is an indispensable ingredient for the

preparation of local alcoholic beverages [36]. It is a complex mixture of plants and wild relative ingredients of different parts, which are prepared with great care to obtain a healthy drink. In the recent past, available reports have shown that rice beer prepared using starter cultures has numerous health benefits [11, 36]. However, the reports lack information on systematic studies on the utilized plants, formulations, conditions of their habitat, regular collection, etc. Considering this the present study was carried out to understand the existing practice of starter culture preparation by the Mising tribe in the Sivasagar district, Assam with the objectives of inventorying plant species being used along with documenting systematic use of herbal ingredients, their collection, management, and social implications of starter culture maintenance. It is expected that the study will further increase the understanding on preparing starter culture by tribal communities.

Materials and methods

Study area

The study was conducted in the Sivasagar district (27.0031° N and 94.6450° 25° E) in the upper zone of the state of Assam that is bordered by Brahmaputra in the north, Dibrugarh and Charaideo in the east, and Jorhat district of Assam in the west, and Mon district of Nagaland in the southeast. The target district comprised an area of 1598.85 km^2 with a population of 692,435 having a literacy rate of 78.41% as per the 2011 census. The district is home to numerous ethnic groups, mainly the *Ahoms*, as well as by scheduled tribes and scheduled castes, namely the *Misings, Deoris, Mech-Kacharis, Kaibotras, Kalitas, Chutias*, etc. The district is also known for the cultivation of tea, and extraction of limestone and coal. The Mising mostly settles near rivers, although some have also settled in towns. Brahmaputra River flows through the district along with Desang, Dikhow, Dihing, Darika, and Janjhi. The district comprised diverse forest and various reserves (Panidihing Bird Sanctuary, 1997; Dihing Reserve Forest; Abhayapur Reserve Forest; and parts of Joipur Rain Forest, etc.). Climatic of the area exhibited high humidity, rainfall, and moderate temperatures without extreme heat or cold. In this area, temperatures rise from March onwards and reaches its peak in August (32 °C), while January exhibits minimum temperature (17.8 °C).

Social structure of the community

The Mising community is agrarian and also engages in fishing and livestock rearing. Rice is the staple food with *Bao, Guni,* and *Amdang*as important indigenous varieties that are grown as per season and field condition. Mustard, turmeric, and black mung beans are other important crops grown by farmers [21]. All families also maintain a homestead garden that is used for growing vegetables, spices, fruits, and other plants. Other than agriculture, the community also collect a large variety of plants from forests and wild areas for meeting their diverse needs. A typical Mising house is made of bamboo, thatch, cane, reed, etc., and built on a raised platform locally known as *Ukum*or *Okum* [21, 37]. Important tree species namely *Mesua ferrea* L., *Bombax ceiba* L., *Gmelina arborea* Roxb. ex Sm., *Lagerstroemia speciosa* (L.) Pers., *Alstonia scholaris* (L.) R. Br., *Bischofia javanica* Blume, *Terminalia myriocarpa* Van Heurck & Mull.Arg., etc., mainly used as wooden poles and extracted from the surrounding forests.

Like other ethnic tribal communities in northeastern India, the Misings have a traditional village council known as *Kebang* that look after routine matters of the village and mainly comprised elderly persons. Until the introduction of the Panchayati Raj Institutions (PRI) system, the *Kebang* was supreme in all sociopolitical and religious decisions in a village [37]. Traditionally, the community has a patriarchal structure followed by exogamic clans [21]. The community celebrates *Ali-Aye-Ligang*, a post-harvest festival in February. Other important rituals and festivals are *DoburUie, Po-rag,* etc. *Oi ni-tom*, *Kaban*, and *A:bang* are popular folk songs, *Gumarg* is most common dance [38].

Scouting and documentation of starter culture

The study documented the traditional method of preparation of starter culture (ÉPOP) of the Mising community based on an extensive field survey in 15 randomly selected villages in Sivasagar district. Thereafter, two representative sample villages, namely Majorbari and Ligiribari, were selected for an in-depth study (Fig. 1). Information was gathered on plant species used, herbal ingredients, their collection and management, place of collection and its land uses, and the social implications of starter culture maintenance. Knowledgeable women from the selected villages were interviewed formally and informally using a semi-structured questionnaire. Observations were made during the collection of plant ingredients from their natural habitat for starter culture preparation. The collected specimens were identified with the help of taxonomists from the Botanical Survey of India (BSI), Arunachal Station, Itanagar, and the herbarium was prepared by comparing them with regional herbaria deposited with ARUN and ASSAM and by consulting the regional floras [39–42]. The composition of the plant ingredients, the source of collection, and the method of preparation of the starter culture were recorded through close observation while it is practiced by women. The plant species used to prepare the

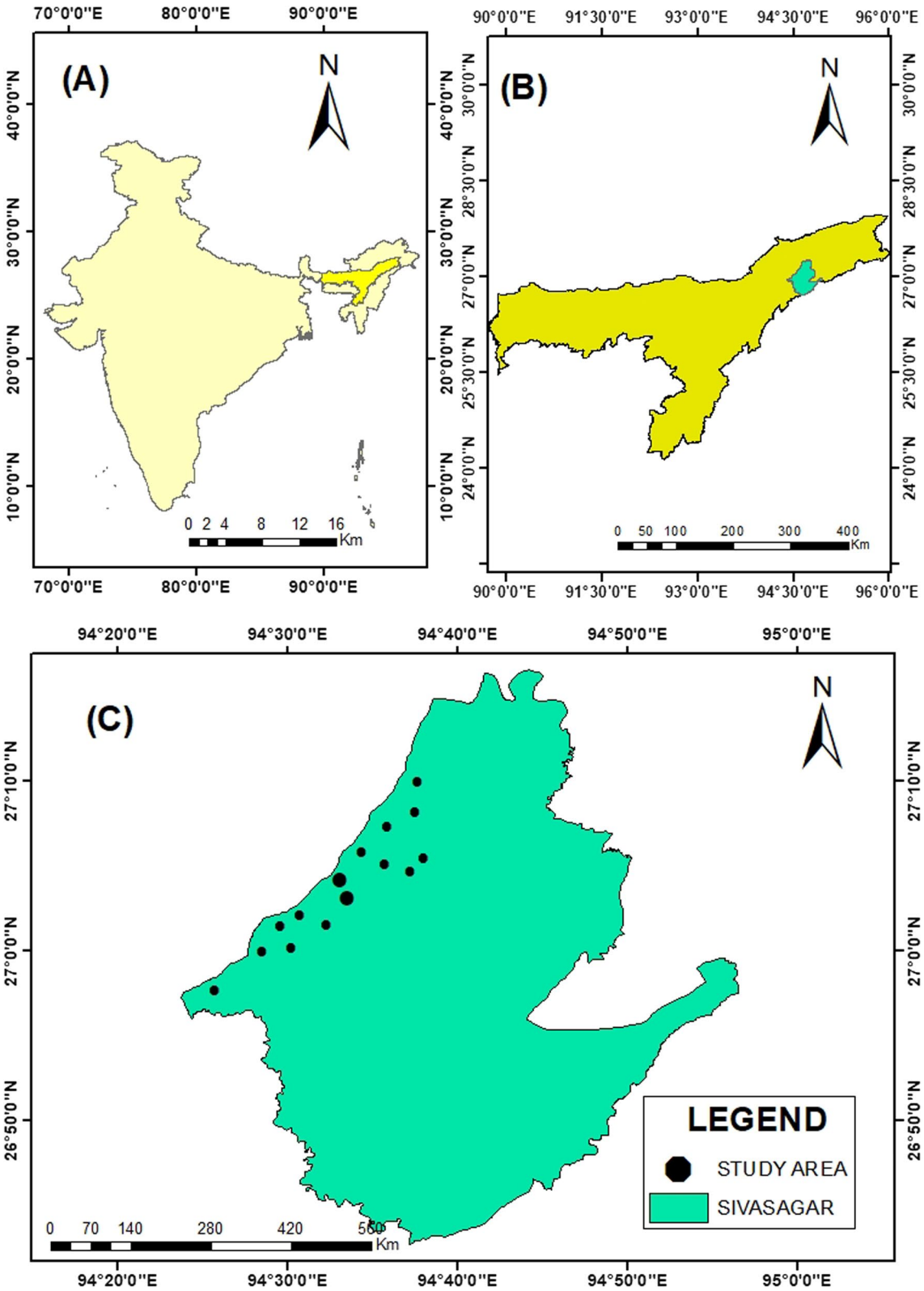

Fig. 1 Map of the study site depicting Northeast India, Assam, Sivasagar district and the sampled villages

cake were recorded in a field notebook [40]. An effort was also made to collect plant resources from its original habitats and land uses. Information on collection of plant ingredients, systematic processing and vernacular uses other than starter culture was also interviewed and documented. All the data were cross-checked with other stakeholders. A market potential of selected species was also assessed through discussion with the community.

Data compilation and analysis was undertaken using usual procedures. The basic information for inventorying plant species being collected and used, place and time of collection, land use of the location wherefrom the species collected, and process of making starter culture and its use were qualitative, therefore transcribed texts of interviews, and group discussions combined with direct field and participants observations were compiled. The information was tabulated and presented in figures and diagrams in order to interpret communities' reflection about herbal ingredients they use and how they exercise practices related to making and use of starter culture.

Results

Plant species used as ingredients

An inventory of plant species being used in preparation of starter culture was made (Table 1). It was interesting to note that a total of 31 plant species belonging to 30 genera and 22 families were used for starter culture preparation. It comprised 27 angiosperms and 4 pteridophytes (fern). An analysis of plant habit revealed that herbs comprised 41.94%, trees 38.71%, shrubs 12.90%, and climbers 6.45% of total species (Fig. 2). Some commonly collected herbaceous species used in starter culture cake preparation were *Hydrocotyle sibthorpioides* Lam., *Ageratum conyzoides* L., *Eupatorium odoratum* L., *Desmodium oxyphyllum* D.C., *Leucas aspera* Spreng., *Sansevieria thyrsoides*, *Spilanthes acmella* Murr., *Saccharum officinarum* L., *Polygonum plebejum* R.Br., *Bonnaya antipoda* (L.) Druce, *Scoparia dulcis* L., *Pteris semipinnata* L., and *Dryopteris filix*-mas (L.) Schott. (Fig. 2). With the exception of *Polygonum plebejum* R. Br., the rest of the herbaceous plants were collected from wild habitats. Notable tree species recorded during the survey were *Alstonia scholaris* (L) R.Br., *Actephila excelsa* (Dalzell) Mull.Arg.,*Cinamomum tamala* Fr. Nees., *Neolitsea* sp., *Litsea polyantha* Juss., *Litsea salicifolia* Roxb.,*Melia azadirach* L., *Albizzia lucida* Benth.,*Artocarpus heterophyllus* Lam, *Psidium guajava* L., *Premna benghalensis* Clarke, etc. These trees occur mostly in forests, with the exception of guava, which was in homestead gardens. Occasionally these trees were also found in crop fields and fallow lands. Besides, climbers/ vine, viz., *Piper longum* was cultivated in the homestead garden, while *Mikania scandens* (L) Willd. was an invasive species across all habitats. Among the shrubs, *Dracaena trifasciata* (Prain) Mabb, *Croton caudatus* Geiseler, *Jasminum multiflorum* (Burm. f.) Andrews, and *Saccharum officinarum* L. were frequently available in the homestead gardens. The taxonomic enumeration revealed that most species belonged to the families Asteraceae and Lauraceae (with 4 species each), followed by Scrophulariaceae and Verbinaceae with 2 species each, while the remaining families are represented by only one species. It is important to document the distribution of species by recording the sources of the material collection with knowledgeable individuals, which helps in the identification of site-specific conservation needs for ethnobotanical plant bioresources. Herbal ingredients are collected from a variety of land use types (Table 1). Forests are the biggest source (35.53%), followed by fallow land (23.68%), agricultural fields (21.05%), and homestead gardens (19.74%).

Different plant parts used for preparation of starter culture range from single leaf or stem to whole plant parts (Fig. 3). The most important plant ingredient was the leaf (69.23%), followed by young shoot (20.51%), and whole plant (10.26%). Further, timing of plant material collection was equally important for starter culture preparation. Depending on the time of plant material collection, most species (51.61%) were collected in the afternoon, followed by the morning and bright day (16.13%), bright days (9.68%), and the early mornings and afternoons (6.45%) (Fig. 4). Some plants are collected in the evening due to their aromatic properties, which are very important for the maintenance of quality products. Important herbal ingredients such as the leaves of *Alstonia scholaris*(L.)R.Br. release latex after plucking, so they should preferably be collected in broad daylight or the morning. Similarly, ingredients such as *Ageratum conyzoides*L., *Chromolaena odorata*, *Mikania scandens*, *Sellaginella* sp., etc., were collected in bright daylight or the morning.

The logic behind explicit time of collection was that plants possess maximum desirable characteristics that are useful for preparing starter culture. Women comprised comprehensive knowledge of location of plant species, plant part used, time and mode of collection, maturity status of the plant, and quantity to be extracted along with process of starter culture preparation, which is important for sustainable resource management.

Preparation of Starter culture: the- ÉPOP

The preparation of the starter culture is accomplished in a few steps (Fig. 5). As initial step, the herbal ingredients were collected for desired plant parts before they reach the flowering stage. The harvested plant material is washed cautiously in water and then allowed to dry uninterrupted in the sun for three to four days. After drying,

Table 1 Enumeration of the herbal ingredients used and their potential source of collection dependency from given land uses

Species					Availability in land use			
Angiosperm	**Local Name**	**Habit**	**Part Used**	**Period of collection**	**Forest**	**Home Garden**	**Agril. Field**	**Fallow Land**
Hydrocotyle sibthorpioides Lam. (Apiaceae)	Manimuni	Herb	Whole plant	F	–	–	*	–
Alstonia shcolaris (L) R.Br. (Apocynaceae)	So-ti	Tree	Leaf	BDL/M	*	*	–	–
Ageratum conyzoides L. (Asteraceae)	Namying-gomying	Herb	Leaf/Young shoot	BDL/M	*	*	*	**
Eupatorium odoratum L. (Asteraceae)	Bagbon	Herb	Leaf	BDL/M	–	–	–	**
Mikania scandens Willd. (Asteraceae)	Sinalota	Climber	Leaf/Young shoot	BDL/M	**	–	–	*
Spilanthes acmella Murr. (Asteraceae)	Marsang	Herb	Leaf/Young shoot	A	*	**	–	–
Actephila excelsa (Dalzell) Mull. Arg. (Euphorbiaceae)	Diking Somkong	Tree	Leaf	A	*	–	–	–
Croton caudatus Geiseler (Euphorbiaceae)	Pumrig	Shrub	Leaf	M/F	*	*	–	–
Desmodium oxyphyllum D.C (Fabaceae)	Tanggom	Herb	Leaf/Young shoot	M/F	*	–	*	*
Leucas aspera Spreng. (Lamiaceae)	Drun bon	Herb	Leaf/Young shoot	A	*	–	*	*
Cinnamomum tamala Fr. Nees (Lauraceae)	Tespat	Tree	Leaf	A	**	–	–	–
Neolitsea sp. (Lauraceae)	Kalang	Tree	Leaf	F	***	–	*	*
Litsea polyantha Juss. (Lauraceae)	Tapit	Tree	Leaf	BDL	**	–	*	*
Litsea salicifolia Roxb. (Lauraceae)	Jegloti/Dighloti	Tree	Leaf	BDL	**	*	-	*
Dracaena trifasciata (Prain) Mabb (Asparagaceae)	Tabi-gonggab	Shrub	Leaf	A	**	*	–	–
Melia azadirach L. (Meliaceae)	Guranim/Ghuraneem	Tree	Leaf	A	**	*	–	–
Albizzia lucida Benth. (Mimosaceae)	Langgit	Tree	.Leaf	A	**	*	*	*
Artocarpus heterophyllus Lam (Moraceae)	Belang	Tree	Leaf	BDL/M	*	***	–	–
Psidium guajava L. (Myrtacaceae)	Muduri	Tree	Leaf/Young shoot	A	–	**	–	–
Jasminum multiflorum (Burm. f.) Andrews (Oleaceae.)	Injari	Shrub	Leaf/ Young shoot	A	***	–	*	*
Piper longum L. (Piperaceae)	Peepoli	Climber	Leaf	A	*	***	–	*
Saccharum officinarum L. (Poaceae)	Tabad	Shrub	Leaf	A	–	**	–	–
Polygonum plebeium R.Br. (Polygonaceae)	Bonjaluk	Herb	Whole Plant	A	***	–	*	**
Bonnaya antipoda (L) Druce. (Scrophulariaceae)	Ngen-ngen	Herb	Whole Plant	F	**	–	*	**
Scoparia dulcis L. (Scrophulariaceae.)	Tisur-kosur	Herb	Whole Plant	F	**	–	*	**
Premna benghalensis Clarke. (Verbenaceae.)	Go-rang	Tree	Leaf	F	**	*	–	–

Table 1 (continued)

Species					Availability in land use			
Angiosperm	**Local Name**	**Habit**	**Part Used**	**Period of collection**	**Forest**	**Home Garden**	**Agril. Field**	**Fallow Land**
Vitex negundo L. (Verbenaceae.)	Sopotia/ Posotia	Tree	Leaf	A	**	***	*	*
Pteridophytes								
Dryopteris filix-mas (L.) Schott (Dryopteridaceae)	Rugji	Herb	Foliar Part	A	***	*	*	**
Lygodium flexuosum(L.) Sw. (Lygodiaceae.)	Rakat	Herb	Foliar Part/Young Shoot	A	***	–	*	**
Pteris semipinata L. (Pteridaceae)	Rakat	Herb	Foliar Part	A	*	–	*	*
Selaginella sp (Selaginellacea)	Rakat	Herb	Foliar Part	M	***	–	**	–

Name within brackets are family of the plant. *M* Morning, *F* Forenoon, *BDL* broad day, *A* afternoon, * indicates the degree of dependency for collection. * Low; **Medium; *** High;- NIL; Agril Field: -Agricultural Field

the material crushed in a pounder. The next step is to prepare the glutinous rice, which is soaked in water in a container for 2–3 h. The soaked rice is crushed in a traditional rice picker (*KI-PAR*). Then, previously pounded plant ingredients are mixed together and crushed again until they turn partially powdered. The ratio of plant ingredients to soaked rice is 1:5. The composite mixture is then pressed into oval or round shapes of the same size, preferably 20–25 g each, from 1000 g of rice (Fig. 6). An already prepared starter cake containing yeast strains is ground and sprinkled evenly over the prepared cakes. Two large cakes (*GAI*) are prepared in oval and egg shapes, which are kept separately as stock material for later use. A bunch of bracken (*Cyclosorus extensa* Nees) is sprayed on the freshly prepared cake to prevent the undesirable fungal infestation of the final product. The prepared starter cultures are then dried both in the sun and over a fire to achieve a good drying time of at least seven days. After complete drying, they are stored in a cool, dry place, preferably in an earthen container (*KI-LING*). Freshly prepared starter cultures can be stored for up to six months.

Socioeconomic perspectives of Starter culture

Preparation of rice beer, a local refreshing beverage using starter culture, is an integral part of local sociocultural system of Mising society. It is used at all spiritual, religious, and social events in the house or the community. Guests are greeted with a bowl of such beverage as a mark of respect. Starter culture has always played a pivotal role in linking sociocultural attributes in Mising society. Traditionally, the Misings use two types of rice beer, namely *Poro Apong* and *Noggin/Nogin Apong*. In the former one, ash from rice husks or bran is mixed with cooked rice, while in the latter, only rice is used. Generally, women were more involved in this process from collection, the selection of the day for collection, processing, and preparation of starter culture. During the preparation, family members were restricted to collect forest resources, and avoid to cross rivers and long journeys, etc. Besides, a woman who is menstruating and her family members are restricted from attending the processing site on the given day. This taboo applies to children as well. In addition, processing and application of starter culture are bar if the member is away from home on the day. The gathering of resources is done on a holy day, preferably on Wednesday, by a group of women from the village in the specified area. On both Saturdays and Tuesdays, a taboo is observed for resource gathering and processing.

Sharing and offering a starter culture is a common practice among families. Relatives are offered starter culture on festive occasions, such as major community rituals like *Dodg-ang*, *Po-rag*, and *Dobur uie*, festivals like *Ali Aye: Ligang*, and also major family celebrations like wedding ceremonies. Buying and selling of starter cultures was limited, although women in the village sell surplus starter culture in small quantities. The starter culture was also used in the treatment of some human and animal ailments.

During the survey, as many as eight species were found be used for various other purposes than just preparing the starter cultures (Table 2). These species are sold in the market for culinary uses, health drinks, and ritualistic purposes. Plant species such as *Hydrocotyle sibthorpioides* Lam., *Spilanthes acmella* Murr., and *Leucas aspera* Sprengare sold as vegetables, while *Cinnamomum tamala* Fr. Nees. and *Piper longum* L. are used as

Fig. 2 Few plant species used for starter culture preparation

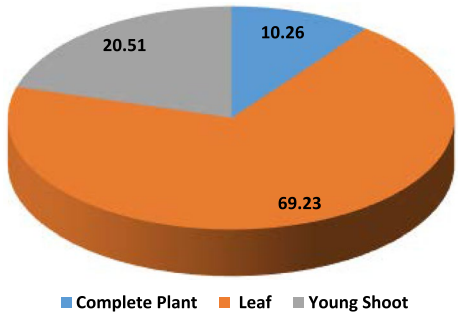

Fig. 3 Plant parts utilized (%) as ingredient for yeast cake preparation by Mising Tribe

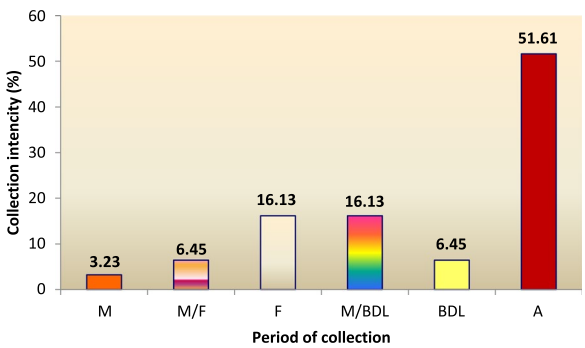

Fig. 4 Collection intensity of phytoresources corresponding to the time period. (M: Morning; F: Forenoon; BDL: Broad day; A: Afternoon)

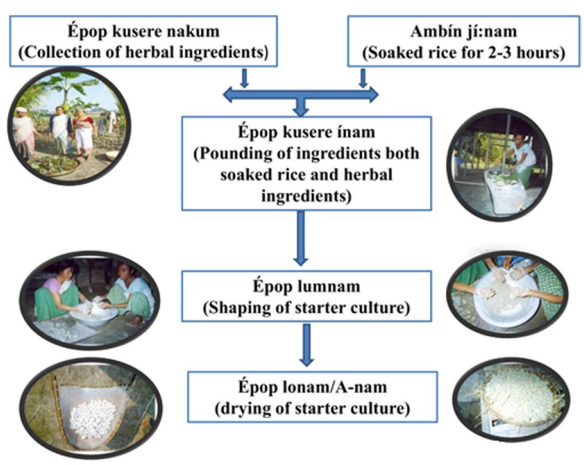

Fig. 5 Flowchart of preparing starter culture by Misings in Northeast India

spice condiments. The fruits of *Artocarpus heterophyllus* Lam and *Psidium guajava* L. are consumed for both good health as well as relief from ailments. On the other hand, the stem of *Saccharum officinarum* L. is used for the extraction of juice for health drinks as well as in ritual activities. Mainly women folks involved in such business though in low quantity.

Discussion

Ethnic communities have been using fermented foods and beverages in various sociocultural occasions in Northeast India since time immemorial [7, 8, 13, 14], and Mising tribe is no exception to that [15, 16, 21]. In fact, they have been the earliest users of the *Apong* [17]. Starter cultures forms a vital constituent of all traditional beverages across all tribal communities [13, 17]. As such, a starter culture is a microbial preparation that produce different enzymes to facilitate fermentation process when mixed with the fermenting compound [1]. However, the focus of this article is to assess mode of starter culture making, plant species being used, time of collection, and procedure of making starter culture. Although the beverage is known for its shooting effect, it is believed to possess many remedial and therapeutic properties [11, 19]. For instance, manimuni (*Hydrocotyle sibthorpioides* Lam.), durun bon (*Leucas aspera* Spreng.), muduri (*Psidium guajava* L.), peepoli (*Piper longum* L.), tabad (*Saccharum officinarum* L.), etc. comprised medicinal properties [11, 43, 44]. Besides being used in starter cultures, many plants also had diverse uses in the day-to-day life of the Mising society.

The significance of investigating starter culture are many. It increases our understanding on local food tradition besides having applications for fermented food industry. The study highlights that use of starter cultures is consistent, expected, and harmless. It gives fermented product a distinct flavor, taste, and appetite perhaps through promotion of beneficial microbes. The recent times, the starter culture industry has largely grown up and supply starter cultures for nearly all type of fermented food and beverages. However, an investigation of traditional starter culture may provide some new microbes that could be beneficial to such industries. However, it requires further investigation on bacterial connection of such food systems.

To maintain the standard quality of the product may not be as easy as for an individual or group of people considering all circumstances, starting from a conservation perspective to commercialization for livelihood generation. In recent years, the historical legacies on the management of starter cultures are remarkably contested, and many a time the quality has been compromised due to a lack of skilled people, which signifies shortage of actual knowledge holders. Researchers have categorically mentioned that the impact of globalization, especially in an economic context, in Mising society also involves the changing of culture due to the changing of place, i.e., shifting from rural to urban settlers who are

Fig. 6 Methods of processing starter culture preparation and application

more accustomed to modern food habits than traditional ones, which have terribly affected the quality of the product [47–49]. Therefore, to maintain the traditions and the knowledge, appropriate policy and action line are desired. A few possible efforts could be:

(a) *Managing Intellectual Property Rights*: Proper documentation of community knowledge for product making is highly desirable as it varies from place to place. Documentation of such information is key to establish its novelty, originality, uniformity, and

Table 2 Plant species with market potential

Species	Local name	Part used for starter culture	Uses other than starter culture	Market price (Rs./Kg)
Hydrocotyle sibthorpioides Lam	Manimuni	Whole plant	Vegetable, medicine	200
Spilanthes acmella Murr	Marchang	Aerial part/Young shoot	Vegetable	100
Leuca aspera Spreng	Durun bon	Aerial part/Young shoot	Medicine	150
Cinnamomum tamala Fr. Nees	Te-s paat	Leaves	Infusion drink	300
Artocarpus heterophyllus Lam	Bélang	Fruit, Seed	Vegetable, fodder	25
Psidium guajava L	Muduri	Fruit	Medicine	50
Piper longum L	Peepoli	Inflorescence	Spice condiments, medicine	300
**Saccharum officinarum* L	Tabad	Stem	Medicine, rituals	100

NB: * in lots; 1 lot = 5 stems

uniqueness. More studies are required on nutritional and biochemical aspects of starter cultures and *Apong* to validate its use. Also, preservation and enhancement of shelf life of product needs to be developed. Protection of intellectual property rights of the community, particularly for getting a geographical indication (GI) tag, should be processed.

(b) *Conserving plant resource*: Protection of herbal materials being used in starter culture is an important aspects so that such resources are maintained sustainably. At times, community members complain about the lack of easy availability of the plant material. Therefore, domesticating selected species could reduce the time to search for them in natural habitats. Besides, plants with diverse uses and commercial value could also be domesticated to increase local income. Also, there is a need to create awareness among masses for the conservation of these plants from time to time in a routine, which not only protects the ecological balance but also helps in the contiguous maintenance of the socio-cultural aspect of the tribe.

(c) *Commercialization of starter culture*: As this material is intricately linked with the ethnic culture and a sizable number of the populations have been using it in day-to-day life, looking for a commercial aspect is the need of the hour. Quality maintenance, proper packaging, branding, and popularization of the product are indispensable parts of a successful business model. For that reason, the value addition of the finished product is essential, and the same can be done through food processing agencies and institutions. A capacity-building program may be taken up for the youths through imparting training programs on quality product development and maintenance, processing and cultivation of resources, etc., to inspire them not only for commercialization but also to check the risk of traditional knowledge erosion in the tribe.

Policy planners must take appropriate decision on the above said measures as well as developing strategies to attract investors, food industries, and financial institutions on such subjects. Although some self-help groups are working for making processed food products. However, proper mechanisms must be prepared so that the custodian can ensure and enjoy the actual benefit of sharing their knowledge system. This may be a potential option to go for a global level playing field with grassroots community innovations.

Acknowledgements
The authors thank Director, GB Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand, for providing facilities. We extend our gratitude to the Director, National Innovation Foundation-India, Gramabharti, Gandhinagar, Gujarat, for his encouragement toward the review of this monograph. Thanks are also due to the villagers of Majorbari, Ligiribari, Afala, Balama, and Charaipora of DisangMukh; Dolopa, Balikur, Samukjan, Kotiari, and Milanpur of Rajabari; and Gumutha, Ramnagar, and Balikuthi of Charaideo for their support during the field visits. The authors appreciate Mrs. Anuprava Mili Taid, Mrs. Paani Pangging, Mrs. Rasawati Mili, and Mrs. PushpalataYein, who helped us collect the plant materials from different land uses for the present article. Dr. Ritesh Kr. Chowdhury of Botanical Survey of India, Itanagar station, deserves special thanks for his help during the plant identification. Mr. Rakesh Mili (Horu Bhaity) is appreciated for helping with the drawing of the map. Mr. Shiva Pd. Mili, Sr. Assistant Professor, Sibsagar Girls' College deserves thanks for his support in arranging some photographs.

Author contributions
Authors have read and approved the final manuscript.

Funding
Not applicable.

Availability of data and materials
Not applicable.

Declarations

Competing interests
The authors declare that there is no competing interest.

Author details
[1]G.B. Pant National Institute of Himalayan Environment, NE Unit, Vivek Vihar, Itanagar, Arunachal Pradesh 791113, India. [2]National Innovation Foundation-India, Guwahati Cell for NE Region, Technology Complex, IIT Guwahati, Guwahati, Kamrup, Assam 781039, India. [3]Department of Forestry and Natural Resources, HNB Garhwal University, Srinagar (Garhwal), Uttarakhand 246174, India.

Received: 18 July 2023 Accepted: 24 November 2023
Published online: 06 December 2023

References

1. Durso L, Hutkins R. Starter cultures. In: Encyclopedia of food sciences and nutrition (Second Edition), 2003. 5583—5593. Academic Press (ISBN 978-0-12-227055-0).
2. Ojha SN, Anand A, Sundriyal RC, Arya D. Traditional dietary knowledge of a marginal hill community in the Central Himalaya: implications for food, nutrition, and medicinal security. Front Pharmacol. 2022;12:1–22. https://doi.org/10.3389/fphar.2021.789360.
3. Dollo M, Singh KI, Saha D, Chaudhury S, Sundriyal RC. Livelihood and natural resource utilization pattern in an ethnically diverse area in Arunachal Pradesh. In: Bhatt BP, Bujarbaruah XKM editors. Agroforestry in North East India: opportunities and challenges, 2005; pp. 55–70. ICAR Research Complex for NEG Region, Umiam, Meghalaya
4. Mili R, Samal PK, Dollo M. Extraction of non-timber forest produces from shifting agriculture fallow land by Adi tribe in Siang districts of Arunachal Pradesh, North East India. J Non-Timber Forest Prod. 2010;17(1):7–18. https://doi.org/10.54207/bsmps2000-2010-ADU6D3.
5. Sundriyal RC. Arunachal Pradesh: integrating culture and natural resource management for sustainable development. Ishani. 2008;2(3):22–9.
6. Sarmah R, Arunachalam A. Contribution of non-timber forest products (NTFPS) to livelihood economy of the people living in forest fringes in Changlang district of Arunachal Pradesh, India. Indian J Fundam Appl Life Sci. 2011;1(2):157–69.
7. Tamang JP, Cotter P, Endo A, et al. Fermented foods in a global age: east meets West. Compr Rev Food Sci Food Saf. 2020;19:184–217. https://doi.org/10.1111/1541-4337.12520.
8. Upreti TC, Dollo M, Sundriyal RC. Indigenous fermented foods and beverages of tribal communities of Arunachal Pradesh. J Non-Timber Forest Prod. 2007;14(4):327–34.
9. Saikia P, Deka DC. Mineral content of some wild green leafy vegetables of North–East India. J Chem Pharm Res. 2013;5(3):117–21.
10. Samal PK, Mili R, Dollo M. Local knowledge in managing upland agriculture by the Adis in Arunachal Pradesh, Northeast India. In: Behera MC, editor. Shifting perspectives in tribal studies from an anthropological approach to inter disciplinarily and consilience. Berlin: Springer; 2019. p. 329–49.
11. Gogoi B, Dutta M, Mondal P. Various ethno medicinal plants used in the preparation of Apong, a traditional beverage use by Mising tribe of upper Assam: a review. J App Pharm Sci. 2013;3(4 Suppl 1):S85–8.
12. Chakravorty J, Ghosh S, Meyer-Rochow VB. Practices of entomophagy and entomotherapy by members of the Nyishi and Galo tribes, two ethnic groups of the state of Arunachal Pradesh (North–East India). J Ethnobiol Ethnomed. 2011;7(1):5. https://doi.org/10.1186/1746-4269-7-5.
13. Das A, Deka SC, Miyaji T. Methodology of rice beer preparation and various plant materials used in starter culture preparation by some tribal communities of North-East India: a survey. Int Food Res J. 2012;19(1):101–7.
14. Deka D, Sarma GC. Traditionally used herbs in the preparation of rice-beer by the Rabha tribe of Goalpara district. Indian J Tradit Knowl. 2010;9(3):459–62.
15. Pawe D, Gogoi R. Ethnobotany of PoroApong or Chai Mod—a local rice beer of Mishing tribes of Assam. NeBIO. 2013;4(2):46–9.
16. Baruah M, Kalita D. Ethnomedicine used by mishings tribes of Dibrugarh district, Assam. Indian J Tradit Knowl. 2007;6(4):595–8.
17. Tanti B, Gurung L, Sarma HK, Buragohain AK. Ethnobotany of starter cultures used in alcohol fermentation by a few ethnic tribes of Northeast India. Indian J Tradit Knowl. 2010;9(3):463–6.
18. Lalmuanpuii R, Zodinpuii B, Lalbiaknunga J, Zothanpuia. Traditional food preparation of wild edible vegetables among the ethnic groups of Mizoram, North East India. J Ethnic Food. 2021;8:26. https://doi.org/10.1186/s42779-021-00104-5.
19. Kardong D, Deori K, Sood K, Yadav RNS, Bora TC, Gogoi BK. Evaluation of Nutritional and Biochemical aspects of Po:ro apong (Saimod)—a homemade alcoholic rice beverage of Mising tribe of Assam, India. Indian J Tradit Knowl. 2012;11(3):499–504.
20. Kakoti N. The mising tribe of North East India- A Glimpse. Int J Appl Manag Sci. 2017;3:9.
21. Pegu NC. The mishings of brahmaputra valley. Kulajan, Dhemaji: Monumati Pegu; 1981. p. 178.
22. Singh J, Bhuyan TC, Ahmed A. Ethnobotanical studies on the Mishing tribes of Assam with special reference to food and medicinal plants-I. J Econ Taxon Bot. 1996;12:350–6.
23. Baruah M, Kalita D. Ethnomedicine used by Mishingstribe of Dibrugarh district. Assam Indian J Tradit Knowl. 2007;6(4):595–8.
24. Hazarika P, Pandey BK. Traditional phyto-remedies for worm infestations of two important tribal communities of Assam. India Asian J Tradit Med. 2010;5(1):32–9.
25. Kutum A, Sarmah R, Hazarika D. An ethnobotanical study of Mishing tribe living in fringe villages of Kaziranga National Park of Assam, India. Indian J Fundam Appl Life Sci. 2011;1(4):45–61.
26. Shankar R, Lavekar GS, Deb S, Sharma BK. Traditional healing practice and folk medicines used by Mishing community of North East India. J Ayurveda Integr Med. 2012;3:124–9.
27. Gam NK. Ethno medicinal claims existing among Mising tribes of Assam. IJSIT. 2013;2(4):284–91.
28. Sarma J, Devi A. Role of dicot angiosperms in the livelihood of Mishing community in Sonitpur district, Assam, India. Trop Plant Res. 2016;3(3):662–72. https://doi.org/10.22271/tpr.2016.v3.i3.087.
29. Sharma UK, Pegu S. Ethnobotany of religious and supernatural beliefs of the Mising tribes of Assam with special reference to the 'DoburUie.' J Ethnobiol Ethnomed. 2011;7:16. https://doi.org/10.1186/1746-4269-7-16.
30. Das AK, Hazarika M. Study of diversity of ethnobotanical plants used by the Mishing tribes of Golaghat district, Assam and their conservation. Int J Recent Sci Res. 2015;6(7):4992–8.
31. Bhuyan M. Traditional health care practice in a Mishing society: a study on ethnomedicine. Int J Human Soc Sci. 2015;1(4):73–7.
32. Soren M, Dutta BK, Das AK. Ethnobotanically useful Plants of Mising Tribe residing in fringe villages of Nambor-Doigrung wildlife sanctuary of Golaghat, Assam, India. Int J Innov Res Sci Technol. 2015;1(11):157–9.
33. Mili R. Mising bhasha aru sanskriti (Mising Language and culture written in Assamese language). Published by Mrs. Jini Pegu Doley. Gogamukh, Dhemaji, 2019. pp: 200–219
34. Pegu R, Gogoi J, Tamuli AK, Teron R. *Apong*, an alcoholic beverage of cultural significance of the Mising community of Northeast India. Glob J Interdiscip Soc Sci. 2013;2(6):12–7.
35. Mao AA. Ethnobotanical observation of rice beer Zhuchu preparation. Bull Bot Surv India. 1998;40(1–4):53–7.
36. Tamang JP. Himalayan fermented foods: microbiology, nutrition and ethnic value. New York: CRC Press, Taylor and Francis Group; 2010.
37. Nath N, Ghosh S, Rahaman L, Kaipeng DL, Sharma BK. An overview of traditional rice beer of North-east India: ethnic preparation, challenges and prospects. Indian J Tradit Knowl. 2019;18:744–57.
38. Bhuyan B, Baishya K. Ethnomedicinal values of various plants used in the preparation of traditional rice beer by different tribes of Assam. Drug Invent Today. 2013;5(4):335–41. https://doi.org/10.1016/j.dit.2013.09.002.
39. Padun N. Mising Sanskritir Patabhumi. Mising Agom Kébang, Karichuk, Dhemaji, Assam. 2016 (Reprinted 2017) pp. 107–109
40. Mipun J. The mishings (Miris) of Assam: development of a new lifestyle. New Delhi: Gian Publishing House; 1993.
41. Sharma JR, Mudgal V, Hajra PK. Floristic diversity- review, scope and perspectives. In: Floristic diversity and conservation strategies in India. Botanical Survey of India, Calcutta, 1997.I:1–45.
42. Jain SK, Mudgal V. A Hand Book of Ethnobotany. Bishan Singh Mahendra Pal Singh, Dehra Dun, India; 1999.
43. Sarma B. Udbhid Gyanakosh: a treatise on plant in Assamese. Bani Mandir, Guwahati, India. 2002. p. 245
44. Hooker JD. The flora of British India, vol. 7. London: L. Reeve & Co.; 1872.

45. Saikia AP, Ryakala VK, Sharma P, Goswami P, Bora U. Ethnobotany of medicinal plants used by Assamese people for various skin ailments and cosmetics. J Ethnopharmacol. 2006;106(2):149–57. https://doi.org/10.1016/j.jep.2005.11.033.
46. Mili R, Islam M. On the occurrence and distribution of *Psammophytes* and their local uses: a case study from Dibrugarh district of Assam, North East India. Int J Innov Sci Eng Technol (IJISET). 2022;09(12):2348–7968.
47. Rawat JM, Pandey S, Debbarma P, Rawat B. Preparation of alcoholic beverages by tribal communities in the Indian Himalayan Region: a review on traditional and ethnic consideration. Front Sustain Food Syst. 2021;5:672411. https://doi.org/10.3389/fsufs.2021.672411.
48. Tamang JP, Tamang N, Thapa S, Dewan S, Tamang B, Yonzan H, Rai AK, Chettri R, Chakrabarty J, Kharel N. Microorganisms and Nutritional value of Ethnic fermented foods and alcoholic beverages of North East India. Indian J Tradit Knowl. 2012;11(1):7–25.
49. Kumari P, Dutta SK. Changing eating pattern of mising food culture. Int J Humanit Soc Sci. 2012;2(2):211–9.

Publisher's Note