Section A-Research paper

ETHNIC FERMENTED FOODS AND BEVERAGES OF NORTH-EASTERN INDIA: A COMPREHENSIVE REVIEW

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Review article

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Abstract

Fermented foods became an important part of the diet in many nations as it is unswervingly associated with many health benefits. Fermentation process and the resulting fermented foods have in recent times been paid attention by the scientific community. Northeast India is distinctive for its diverse culture and traditional practises by tribal groups indigenous to the region. These tribal groups are known to practise the knowledge of fermenting foods since ancestral times which form a fundamental part of their culture and tradition. Study on these fermented foods in the recent decades has shown the potential health benefits and medical properties present in them. The current review deals with the preparation methods and various raw materials used in the fermented foods that are unique to the region compared to the other parts of the world. The fermented alcoholic beverages have unique methods of preparation and are an integral part of the socio-economic life of these people. These fermented foods serve as a source of economic sustenance to them who prepare and sell the foods locally in rural market. It is important to study the techniques of preparation of these beneficial fermented foods and formulate standard techniques to increase their shelf life and facilitate the commercialization of these products.

Keywords – Alcoholic beverages, Fermentation, Microbial flora, Northeast India, Starter culture.

Introduction

North-East India which is located at the foothills of Eastern Himalayas comprise of seven sister states namely Tripura, Mizoram, Meghalaya, Manipur, Arunachal Pradesh, Nagaland and Assam which harbours more than 166 number of ethnic tribal groups. These ethnic tribes such as *Ahom, Bodo, Rabha, Monpa, Apatani, Meitei, Naga, Garo, Khasi, Gorkha, Mizo, Chakma* and *Jamatia* produces a number of locally available traditional fermented foods rich in nutritive values and beneficial probiotic properties illustrated in figure 1. (Majumdar *et al.,* 2016; J. P. Tamang *et al.,* 2012). The knowledge of preparation of these fermented foods using simple processing techniques have been practised since ancient times and passed on through generations (Nehal 2013). Traditional fermented foods have been found to be a rich source of LAB (lactic acid bacteria) which are used as probiotics (Satish Kumar et al. 2013). Lactic acid bacteria are known for production of antimicrobial compounds such as hydrogen peroxide, organic acids and bacteriocin that inhibit growth of pathogenic bacteria (Prabhurajeshwar and Chandrakanth, 2017). They also exhibit serum cholesterol lowering property that can help to prevent coronary heart disease (Shehata et al. 2016).

In 1994, due to increasing antibiotic resistance against commonly prescribed antibiotics, the World Health Organisation (WHO) considered probiotics as the next most important immune defence (Levy 2000). In 2006, WHO/FAO defined probiotics as live microorganisms which when administered in adequate amounts results in health benefits. Lactic acid bacteria (LAB) are probiotics that helps to attenuate or prevent symptoms of viral diseases (Al Kassaa et al. 2014). They help the immune system to eliminate the viruses and are also known as immunobiotics (Chiba et al. 2013). Probiotics also have immunomodulatory properties which are used for the treatment of gastrointestinal diseases such as inflammatory bowel disease (IBD) (Miele et al. 2009). Studies suggest that probiotics can also help in normalisation of gut microbiota and prevent abnormal behaviour of animal due to intestinal microbiota alterations (Gareau et al. 2011).

The microbial fermentation of food plays a pivot role in the process of enriching the fermented food with probiotic bacteria (Hill *al.,* 2017). The process involves micro-organisms such as yeast, fungi and bacteria to produce secondary metabolites, biomass, enzymes and recombinant products either in household or industrial scale (Paulová, Patáková, and Brányik 2013). Fermentation is an economic and oldest method for improving shelf life and preserving nutritive value of the food. Fermented foods are enriched in flavour and texture, rich in essential amino acids, have bioactive compounds that promote health,

vitamins and minerals, impart anti-oxidant and anti-microbial activities and improve digestibility in humans (Farhad, Kailasapathy, and Tamang 2010). Fermentation assist in the detoxification of compounds found in raw foods such as tannins, phytates and polyphenols (Jeyaram et al. 2009a). The traditional method for fermentation at household level uses simple processing techniques and facilities to obtain such products.

The process of preparation of traditional fermented foods differs among the various ethnic tribes of North-East India. The large variety of microflora found in these foods and their nutritive value is because of the differences in substrate and process of fermentation (J. P. Tamang et al. 2012). These ethnic tribes possess the beneficial knowledge of such fermented foods that have been gained through the generations depending on the forests, plant products and herbs for various purposes. Learning about these various practices in preparation of fermented foods by the tribes of North-East India reflects their close relationship with nature (A. J. Das, Deka, and Miyaji 2012). The various region specific beneficial fermented foods, beverages and their preparation processes are discussed in this paper.

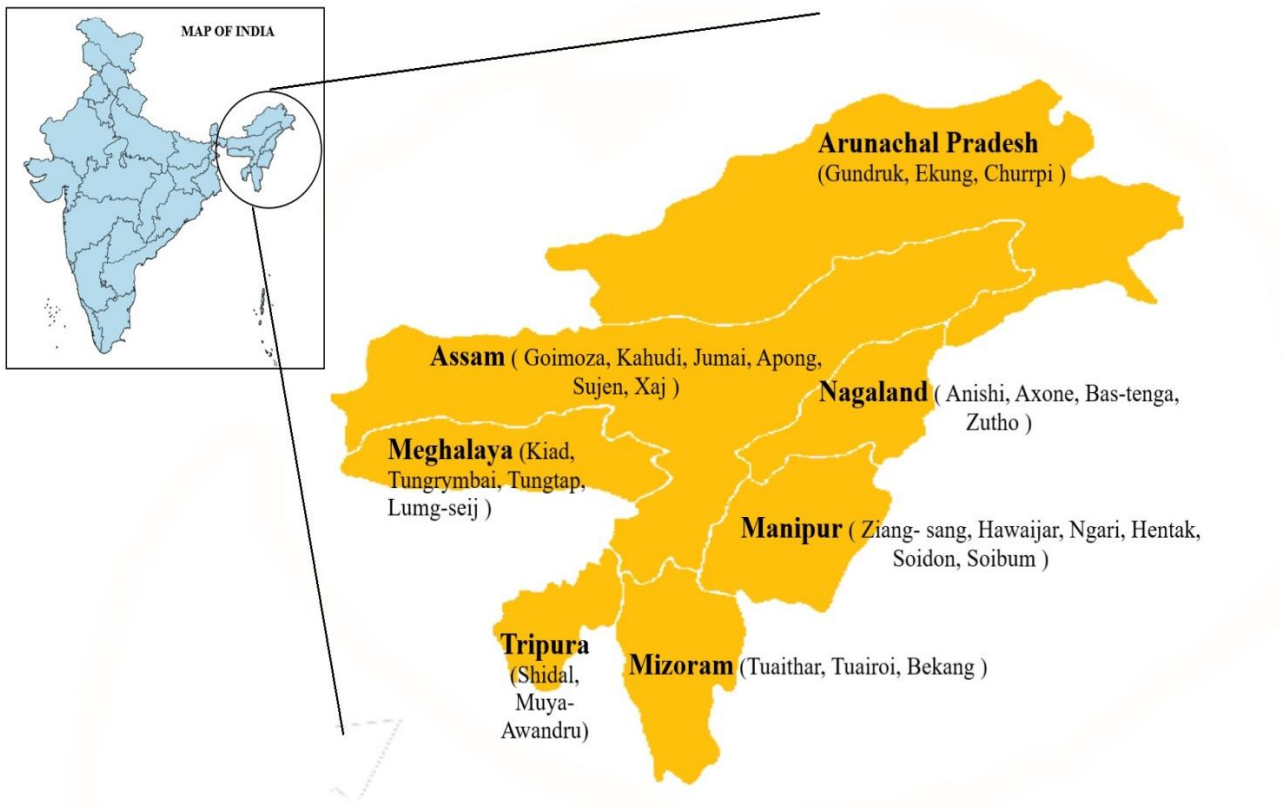

Figure 1: Map of Northest India showing the Seven Sister states and their distinct ethnic fermented foods.

Fermented vegetables

Gundruk

Gundruk is fermented vegetable product prepared by the Nepali community of the Eastern Himalayan regions of India, Bhutan and Nepal. Gundruk is prepared by using different varites of mustard plant leaves (*Brasicca rapa* var. *cuneifolia*, *Brasicca juncea* etc.), radish (*Raphanus sativus L.*) and cauliflower (*Brasicca oleracea*). It is produced during the winter season when the leaves of mustard, radish and cauliflower are available in abundance locally (Dutta 2019).

The leaves are first washed and cleaned. They are then wilted and shredded into smaller sizes followed by crushing and pressing them into a clean earthen pot or container. The pot or container is then tightly sealed and left for fermentation to occur naturally upto 7-10 days. After this period, the completion of fermentation process is marked by a mild acidic taste. It acts as a good appetizer when consumed as soup. It is also used as pickles. *Nepali* women play a major role as producers of Gundruk. It is available locally in markets and produced by the village women of Darjeeling hills and also Sikkim for their economy sustenance (Bam 2017).

Sinki

Sinki is a fermented food produced from radish tap root by the Nepali community through pit fermentation method. A pit of 1m in depth and 1/2m in radius is dug in a dry place and cleaned. The pit is fully plastered with mud and heated with fire. The ashes are then removed and the pit is lined up with paddy straw and bamboo sheaths. Tap roots of radish are dried in the sun for 2-3 days and crushed. It is soaked in lukewarm water, squeezed with hand and then transferred into the pit. The pit is covered with dry leaves and plastered with mud. It is left for fermentation to occur naturally for 22-30 days. After the fermentation period, it is taken out and cut into smaller pieces which are dried in sun for 2-3 days. The final product is obtained for consumption which can be stored for upto two years in room temperature (J. P. Tamang, Chettri, and Sharma 2009).

Sinki is consumed either as soup or pickle. It is used for preparation of soup and is considered as a good appetizer. The highly acidic flavoured sinki is useful as a cure for indigestion. Women sell sinki in local markets to sustain their livelihood (Dutta 2019).

Ziang – sang

Ziang – sang is a fermented traditional food prepared from leaves of *Brassica* by tribes of Manipur and Nagaland. They are mainly consumed by the Naga tribe. Naga women are the major producers of the food product. Ziang – sang is produced during the winter season. Mustard leaves (hangam) are withered for 2-3 days and crushed in traditional wooden mortar and pestle. They are dipped in warm water and squeezed by hand to remove excess of it. It is then put in bamboo container and allowed to ferment for 7 – 10 days at room temperature. After fermentation, the semi-solid product is squeezed by hand to extract the juice. This is called Ziang – dui. It is boiled to concentrate and store in a bamboo container for a year as reserve. The semi – solid extract is sun-dried for 4 – 5 days and is stored in containers at room temperature for as long as a year. The fermented juice is often used as a condiment in traditional meals. It is locally sold in markets of Nagaland and Manipur (B. Tamang and Tamang, 2009).

Anishi

Anishi is a fermented food prepared by the Ao Naga tribe of Nagaland. Leaves of *colocasia* species also known as cocoyam are used in the preparation of the traditional fermented cake. Fresh leaves of *colocasia* are first washed and staked above each other. It is then wrapped in a banana leaf and left for a week in a clean dry place. The leaves turn yellow which are then grounded into a paste from which the cakes are made. The cakes are placed above the fireplace and dried in the kitchen (Mao and Odyuo, 2007). Anishi is used as a condiment. It is produced mainly by the men and women of *Ao* tribe. It is cooked especially with dry meat of pork which is a favourite dish of the Ao. Anishi is available in the local markets of Nagaland (Jamir and Deb, 2014).

Akhone /Axone

Akhone also known as Axone according to ‘Sema Naga’ dialect is an ethnic sticky fermented food prepared from locally available soybean (*Glycine max L.*) in Nagaland. It is prepared by various tribes of Nagaland such as the Sema, Angami, Ao, Lotha and Kuki (Mao and Odyuo, 2007; B. R. Singh *et al.*, 2014).

Locally available soybean seeds are first boiled till it becomes soft. Any excess water is drained off and then packed in banana leaves or *Macaranga indica Wight* (*Euphorbiaceae*) in 50g – 100g packets and left for fermentation above a fireplace for about a week. Completion

of fermentation of the soybean renders it a stringy lemon colour and sticky in nature. Freshly prepared akhone have a maximum shelf life of a week. It is sold locally in vegetable markets of Nagaland mainly by women. Akhone is used in chutney preparation and consumed by the locals with pork or as an accompanied side dish with steamed rice (J. P. Tamang, 2015; Jamir and Deb, 2014).

Goimoza

Goimoza is a fermented food product prepared by the people of Assam. It is an important part of traditional Assamese culture and is used in local rituals and customs. Goimoza or fermented areca nut is also known as tamul and paan locally. It is served in traditional utensil called sarai and batha (Dutta 2019). Two types of fermentation process are available for production of Goimoza. In one method, a hole is dug about 2.5 feet in depth and covered all sides with leaves of areca nut. The areca nuts are then put in the hole and covered with jute bag, some cow dung and soil. It is left to ferment for 3 - 4 months after which it is taken out ready for consumption. The properly fermented areca nuts can be stored for 2 years or more. In other method, the areca nuts are taken and put into a jute bag and the mouth is tied properly. The jute bag is then submerged under water in a pond and left for fermentation for about 3 - 4 months and the final product can be preserved for 4-5 months (Narzary et al. 2016).

Kahudi

Kahudi also known locally as Pani tenga is a fermented food product from mustard prepared by the indigenous assamese folks of Assam. Black and/or white mustard seeds are first cleaned and washed properly. It is dried and then lightly roasted in a pan. The dried seeds are then crushed into granular coarse form and mustard oil is mixed thoroughly with it. Ripe Thekera (*Garcinia pedunculata*) or tamarind or lime juice and salt are also added to it and kneaded into dough. Small ball shaped mass is made from the dough and inserted in a bamboo chamber (bahor chunga) and left to ferment for 7 – 14 days over the fire place. Kahudi has a strong flavor and is served with traditional assamese meal (Goswami et al. 2017).

Hawaijar

Hawaijar is a fermented food produced from soybean traditionally in Manipur. The traditional preparation prefers the use of small or medium sized soybean seeds. The soybean seeds are first subjected to boiling and then washed with hot water. Then they are packed into a small bamboo basket tightly lined with fig leaves (*Ficus hispida*) or banana leaves and covered with a lid (ngarubak). The basket is then left for fermentation to occur in ambient temperature for 3 -5 days in the kitchen. A distinguished ammonia flavour together with a sticky mucilage fibre in or on the fermented soybean seeds indicates the good hawaijar quality. Hawaijar is used as a condiment or eaten directly as chutney or made into a curry. It is sold abundantly in local markets throughout Manipur. Women mainly sell Hawaijar as the food product (Jeyaram et al. 2009a).

Bekang

Bekang is a fermented food product prepared by the Mizo women of Mizoram. For preparation, small sized soybeans (*Glycine max*) are preferred. The soybean seeds are soaked in water for 10-12 hrs and boiled in warm water. It is then packed in leaves of *Calliparpa aroria* (nuhlhan in Mizo) or leaves of *Phrynium sp* (hnahthial). They are put inside the bamboo basket and the basket is placed near the earthen fire in the kitchen and left to ferment for 3-4 days. Sticky beans characterized with ammoniacal flavour are produced. It is consumed as curry with rice and often used as a seasoning. The fermented soybean seeds are also fried, crushed into fine particles and added to tea in some places to prepare a special tea. Mizo women sell it locally in the markets (Jeyaram et al. 2009b).

In bekang, it is found that phytic acid is degraded by 45% of LAB strains, raffinose by 35% and 20% degraded both raffinose and phytic acid. This shows it is fit for consumption as it has lowest level of oligosaccharides and phytic acid (Chettri and Tamang, 2014).

Tungrymbai

Tungrymbai is a fermented food prepared from soybean by the ethnic Khasi tribe of Meghalaya. Soybeans are washed and cleaned properly. It is soaked in water for about 4-6 hours. The skin of soybean seeds are removed and then cooked for an hour till water is absorbed. The soybeans are cooled and wrapped with leaves of lamet (*Clinogyne dichotoma*) lined around the small bamboo basket which is then covered by a piece of cloth. It is then left

to ferment for 3-5 days near the fireplace. The finished product is obtained. Khasi women are the major producer of the fermented product. It is sold locally in the markets of Meghalaya (LP.B. Lalthanpuii, 2015;Sohliya *et al.*, 2009).

In Tungrymbai, it is found that phytic acid is degraded by 34.5% of LAB strains, raffinose by 43% and 19% degraded both raffinose and phytic acid (Mishra, Hati, and Das 2019).

Fermented fish

Northeast India is known for preparing many of the traditional food items including fermented fish products which constitute a large portion of daily food items in the region. Fermented fish products have several local names such as 'numing' and 'hukati' in Assam, 'Tungtap' in Meghalaya, 'Hentak' and 'Ngari' of Manipur, 'sepaa' and 'shidal' in Mizoram and Nagaland. The ethnic tribes of north-east prepare the fish products traditionally by smoke processing, sun – dried and mainly fermentation (Majumdar *et al.*, 2016; Kakati and Goswami, 2013). Some of these traditionally prepared fermented fish products are discussed here.

Ngari

Ngari is a traditional fermented fish of Manipur mainly consumed by the Meitei people. The Meiteis consume Ngari as hot chutney (Irongba, Kangsoi) or as an ingredient in their daily cuisines. Locally available freshwater fish *Puntius sophore* and *Tenualosa ilisha* (Phabounga and Ilisha) are used in the preparation of "ngari*"*. These fishes are procured from rivers or wetlands (local beels) or local fish markets of Brahmaputra valley in Assam and West Bengal (Bam 2017).

The fishes are first cleaned thoroughly by removing unwanted fishes, weeds, snails, fibers etc. with the help of a porous bamboo basket (polang). The water is allowed to drain overnight and then it is properly dried in the sun after rubbing some oil on it. The Phoubu nga *(Puntius sophore)* after drying is pounded with long handled hammer (Droomboos/Tamper) to crush the heads and bones of the fish. It is believed that the oil released during crushing initiates fermentation. The crushed fishes are then tightly pressed in pots (ngari-chafu) by legs or a wooden pestle/mallet (shuk). Skilled labors are often used in the production of Ngari. A new earthen pot (ngari-chafu) requires 8-10 times oil coating in the inner wall with an interval of 7 to 10 days. The oil coating creates an anaerobic ambience inside the earthen

pots. A single oil coating inside old earthen pots is sufficient for quality fermentation. The pots are then tightly packed and sealed with a dough-like paste prepared from discarded fishes and fish scales. They are dried, grounded into fine powder and made into dough like paste by mixing with water. It is further covered with banana leaves and a thick layer of mud/clay is smeared over it to seal the pots. The pots are left for 6-12 months for fermentation in a dark room at ambient temperature (A. A. Singh and Devi, 2012; Soibam and Ayam, 2018).

The final product is packed and readily sold locally in the markets of Manipur such as the Ema keithel. The best quality Ngari appears to be dull white in colour which gradually turns light to deep brownish upon exposing to ambient air (Thapa 2016).

Hentak

Hentak is a paste of fermented fish prepared by the Meiteis of Manipur. It is a traditional food product used as a condiment in food or curry. Finger sized local fish species *Puntius sophore* (Phabou nga*)* and *Esomus danricus* (Ngasang) are washed properly and dried in sun. It is then crushed into powder in a wooden mortar (Sumban) and a wooden pastel (Suk). Slices of petioles of wild grown *Alocasia macrorhiza* (Hongu) or *Colocasia esculenta* (Lampal) is crushed and mixed equally in ratio with the powdered fish to make a paste. It is then rolled into balls and kept in an earthen pot for fermentation upto 2 weeks. The final product can be stored upto 6 months wrapped in a banana leaf and stored in an earthen pot. Hentak is sold locally in markets of Manipur. It is cooked as a main ingredient or component of a curry. It is also consumed directly by roasting or steaming and as hot chili-chutney (Soibam and Ayam, 2018). Traditionally, it is prescribed during post-pregnancy and to recovering patients from sickness or injury. Meitei women consume *Lactococcus* for better health and recovery (Kakati and Goswami, 2013). However, hentak containing *Colisa fasciatus, Trichogaster fasciata* (Ngapemma) are not consumed during post-pregnancy. Onion is used as an alternative to *Alocasia macrorrhiza* (Hongu) but it reduces the storage time (Thapa 2016).

Shidal

Shidal is a popular non-salted fermented fish of Tripura and consumed by almost all tribe of Tripura. It is prepared from *Puntius sp.* (locally called puthi shidal) and *Setipinna phasa* (locally called Baspati shidal) by fermenting using traditional earthen pot called Mutka. Shidal is consumed by different tribe as traditional recipe: Godak (Debbarma, Uchoi,

Chakma, Jamatia tribe), Chakhoe (Debbarma tribe), Shidal chutney (Bengali tribal community) etc (Thapa, 2016; Uchoi *et al.*, 2015).

To prepare fish oil Bulged abdomen *Puntius sp.* are used. Fishes are degutted partially to take out entrails of the abdomen but keeping attached to the pharynx and transferred to largemouth earthen pot. A small amount of water is used to stir vigorously for 10- 20 minutes for extraction of fish oil. The oil gathers on the inner wall of mutka collected by scrapping and stored in a steel or glass pot. The oil is boiled and stored for future use in a bottle. The fish oil is used to prevent air permeability so as to minimize the desiccation through evaporation from minute pore of mutka. The oil is smeared on the inner wall of mutka and sun-dried. This process is done for upto 10 days until the inner wall become completely saturated with fish oil and unable to absorb any more oil (Boruah and Abhijit, 2017; Muzaddadi and Basu, 2012).

Fishes of same sized with no injury are descaled, degut and washed properly and sun-dried. The half-dried fishes are then smeared with fish-oil and transfer in the oil processed mutka and sealed with cover paste which is prepared by crushed dried fishes and covered with a banana leaf. After a week the leaf is removed and mutka is sealed air tight with thick layer of clay which ensures anaerobic condition for fermentation for 4-6 months. *Shidal* will become sticky and dark brown in colour and soft texture with typical *shidal* smell and flavour after the completion of fermented process. In commercial procedure dry fished are washed with water and dried overnight and then transfer in oil-processed mutka without smearing the fish oil. It has found that in this process the quality of shidal become highly inferior to that of traditional process in respect of colour texture smell and flavour of product (Dutta, 2019; Muzaddadi and Basu, 2012).

Tungtap

Tungtap is a traditional fermented fish paste prepared from *Puntius spp.* or *Danio spp.* by Khasi people and Jaintia tribe from Meghalaya. The fishes are mainly collected from local rivers of southern Meghalaya such as the Dawki and Shella also known as Brahmaputra Valley and Bangladesh. The fishes are dried in sun for 3-4 days. They are then stored in jute bags. Salting of fish is done in fish: salt ratio of 10:1 in batches of 30-40kg dried fish. Fish fats are also added to it and packed tightly in earthen pots. Polythene sheets or Mud, fish scales and fish oil slurry is used to seal the earthen pot airtight and facilitate semi-anaerobic

growth condition. The earthen pots are stored at room temperature for 4-6 months. The finished product is then obtained which is sold in the markets locally. The fermented product is pale brownish in colour with a unique aroma. Consumption of Tungtap is done either as pickle or taste enhancer (Rapsang and Joshi, 2012; Kakati and Goswami, 2013).

Many of the traditionally prepared fermented foods and alcoholic beverages of Northeast India have been found to be rich in beneficial microbial flora especially Lactobacillus spp. and also rich in nutritive value. Table 1 summarizes the various locally available fermented foods and beverages that are prepared by the indigenous tribal population of the region.

Table 1: Traditional fermented foods and beverages found in Northeast India.

Sl No	Local Name of food	Type of food	Shelf life	Nutritive value	Microbial Flora	References
1	**Anishi**	Fermented leaves of *colocasia* sp.	12 months	Protein: 34.19% Crude fibre: 12.26%	*Bacillus subtilis* and *Bacillus licheniformis* and *Enterococcus faecalis*	(Mao & Odyuo, 2007; Jamir and Deb, 2014)
2	**Apong**	Fermented alcoholic beverage	12 months	Carbohydrate: 46.62% Protein: 1.05%	*Lactobacillus sp., Saccharomyces boulardii, Lactobacillus plantarum* and *Bacillus velezensis*	(A. Das, 2016; Handique and Deka, 2016; Pawe, Dimbo and Gogoi, 2013; Kardong *et al.*, 2012)
3	**Axone**	Fermented soybean	1 week	Moisture: 48%. Carbohydrate: 35.8%, Ash: 5.9%, Protein: 34.8%, lipid: 23.5%	*Bacillus pantothenticus, Bacillus coagulans* , *Bacillus stearothermophilus*, *Bacillus subtilis* and *Bacillus lentus*	(Mao and Odyuo, 2007; Jamir & Deb, 2014; B. R. Singh *et al.*, 2014; J. P. Tamang, 2015)
4	**Bas tenga**	Fermented bamboo shoot (*Dendrocalamus hamiltonii, Bambusa tulda)*	12 months	-	Lactobacillus sp.	(Jamir and Deb, 2014)
5	**Bekang**	Fermented soybean	1 week	Protein: 21.13%, Fat: 0.85%, Carbohydrate: 4.66%, Moisture: 21.5% Ash: 1.31%	*Lactobacillus sp.* and *Bacillus sp.*	(Jeyaram *et al.*, 2009a; Chettri & Tamang, 2014; Thanzami *et al.*, 2019)
6	**Ekung**	Fermented Bamboo shoot (*Dendrocalamus hamiltonii, Bambusa tulda, Dendrocalamus giganteus Munro* and *Bambusa balcooa*)	12-24 months	Protein: 24.62%, Fat: 2.80%, Carbohydrate: 17.34%, Moisture: 51.65% Ash: 15.74% Fibre: 12.75%	*Lactobacillus casei, Lactobacillus brevis, Lactobacillus plantarum and Tetragenococcus halophilus*	(B. Tamang and Tamang, 2009; Sonar *et al.*, 2015)
7	**Gundruk**	Non-salted dried fermented	12 months	Moisture: 15%, Carbohydrate: 38.3%,	*Pseudoplantarum, Lactobacillus fermentum,*	(J. P. Tamang *et al.*, 2012; B.

		leafy vegetable		Protein: 38.7%, Fat: 2.1%, Ash: 22.2%	*Lactobacillus plantarum, Lactobacillus casei, Lactobacillus casei subsp,* and *Pediococcus pentosaceus*	Tamang and Tamang, 2010)
8	**Hawaijar**	Fermented soybean	1 week	Moisture: 45.5%, Protein: 47.7%, Fat: 17% and Ash: 7.2%	*Alkaligenes sp, Bacillus cereus, Bacillus subtilis, Bacillus licheniformis, Staphylococcus aureus, Staphylococcus sciuri* and *Staphylococcus aureus*	(Jeyaram *et al.*, 2009a; Bam, 2017)
9	**Hentak**	Fermented fish (*Puntius sophore* and *Esomus danricus*)	6 months	Moisture: 40%, Fat: 13.6%, Protein: 32.7%, Carbohydrate: 38.7% and Ash: 11.43%.	*Lactococcus lactis subsp cremoris, Lactococcus plantarum, Enterococcus faecium, Lactobacillus amylophilus, Lactobacillus coryniformis subsp torques, Lactobacillus fructosus* and *Lactobacillus plantarum*	(Thapa, 2016; Bam, 2017; Soibam & Ayam, 2018; Kakati and Goswami, 2013)
10	**Hirring**	Fermented bamboo shoot (*D. giganteus, P. assamica, B. tulda*)	12-24 months	Protein: 25.57%, Fat: 2.14%, Carbohydrate: 25.88%, Moisture: 32.98% Ash: 12.93% Fibre: 19.71%	*Lactobacillus brevis, L. plantarum, L.curvatus, L. lactis*	(Nongdam, 2015; Sonar *et al.*, 2015)
11	**Jumai (Jou)**	Fermented alcoholic beverage	12 months	Carbohydrate: 48%, protein: 1.26 %	-	(Basumatary *et al.*, 2014; Narzary *et al.*, 2016)
12	**Kahudi**	Fermented rapeseed	3-4 months	-	*Lactobacillus fermentum, Lactobacillus plantarum* and *Lactobacillus casei*	(Goswami et al. 2017)
13	**Khoricha**	Fermented bamboo shoot	12 months	-	*Lactobacillus plantarum, Lactobacillus brevis*	(Roy et al. 2014)
14	**Kinema**	Fermented soybean	1 week	-	*Bacillus subtilis, Enterococcus faecium, Candida parapsilosis, Geotrichum candidum*	(B. Tamang and Tamang, 2009)
15	**Lung-seij**	Fermented Bamboo shoot (*Dendrocalamus hamiltonii*)	10-12 months	-	*Lactobacillus brevis, L. curvatus,Leuconostocmesenteroides,L. fallax, L. lactis* and *L. citreus*	(Jamir and Deb, 2014; B. Tamang and Tamang, 2009)
16	**Mesu**	Fermented bamboo shoot	6 months	-	*Lactobacillus plantarum, L. brevis, L. curvatus, Leuconostoc Citreum* and *Pediococcus pentosaceous*	(Roy et al. 2014)
17	**Miyamikhri**	Fermented bamboo shoot	6 months	-	Lactobacillus sp.	(Roy et al. 2014)
18	**Ngari**	Fermented fish (*Puntius sophore*)	12-18 months	Protein: 34.1%, Fat: 13.2%, Carbohydrate: 31.6%, Moisture: 18% Ash: 11%.	*Lactococcus lactis* subspecies *cremoris, Lactococcus plantarum, Enterococcus faecium, Lactobacillus fructosus, Lactobacillus amylophilus, Lactobacillus corneformis* subspecies *torquens* and *Lactobacillus plantarum.*	(Thapa, 2016; Bam, 2017; Jeyaram *et al.*, 2009a; A. A. Singh and Devi, 2012; Thapa, 2016)
19	**Shidal**	Fermented fish	2 months	Protein: 2.40%,	*Staphylococcus aureus,*	(Dutta, 2019;

		(*Puntius sp.* and *Setipinna phasa*)		Fat: 0.22%, Carbohydrate: 2.07%, Moisture: 88.65% Ash: 2.85%	*Bacillus sp.* and *Escherichia coli*.	Boruah, Abhijit, 2017; Muzaddadi and Basu, 2012)
20	**Sinki**	Non-salted fermented radish tap root (*Raphanus sativus* L.)	24 months	Moisture: 22.8%, Protein: 14.9%, Fat: 1.4%, Ash: 15.6%	*Lactobacillus casei, Lactobacillus plantarum, Leuconostoc fallax* and *Lactobacillus brevis*	(J. P. Tamang *et al*., 2012; Dutta, 2019; Bam, 2017)
21	**Soibum**	Fermented bamboo shoot (*Dendrocalamus hamiltonii , D. giganteus, Melocana bambusoide, Bambusa tulda, B. balcooa* and *B. pallia*)	12 months	Protein: 23.61%, Fat: 2.58%, Carbohydrate: 14.63%, Moisture: 38.25% Ash: 6.55% Fibre: 5.92%	*Lactobacillus. brevis, Lactobacillus coryniformis, Lactobacillus delbrueckii, Leuconostoc fallax, Lactobacillus lactis, Leuconostoc mesenteroides, Enetrococcus durans, Streptococcus lactis, B. subtilis*	(Soibam and Ayam, 2018; Sonar *et al*., 2015)
22	**Soidon**	Fermented bamboo shoot (*Melocana bambusoides Trin, Dendrocalamus giganteus Munro, Bambusa tulda Roxb* and *Teinostachyum wightii*)	12 months	Protein: 20.65%, Fat: 3.65%, Carbohydrate: 10.25%, Moisture: 50.79% Ash: 10.99% Fibre: 4.38%	*Lactobacillus lactis, Leuconostoc fallax* and *Lactobacillus brevis*	(Soibam and Ayam, 2018; B. Tamang and Tamang, 2009; Sonar *et al*., 2015)
23	**Tuairoi**	Fermented bamboo shoot (*Melocanna bambusoides Trin., Dendrocalamus hamiltonii Nees. et Arn. ex Munro and Bambusa tulda Roxb*)	6 months	-	*Leuconostoc mesenteroides, Lactobacillus plantarum, Pediococcus pentosaceous, Enterococcus faecium, Bacillus cereus, Bacillus laterosporus, Bacillus stearothermophilus, Bacillus circulans* and *Bacillus firmus*	(Chakrabarty *et al*., 2014; J. P. Tamang *et al*., 2012)
24	**Tuaithar**	Fermented bamboo shoot (*Melocanna bambusoides Trin., Dendrocalamus hamiltonii Nees. et Arn. ex Munro and Bambusa tulda Roxb)*	12 months	-	*Lactobacillus brevis, L.curvatus, L.plantarum, Bacillus circulans, B. firmus, B. sphaericus, B. subtilis*	(Chakrabarty *et al*., 2014; Nongdam, 2015)
25	**Tungrymbai**	Fermented soybean	1 week	Protein: 45.9 %, Fat: 30.2% , Fiber:12.8%	*Lactobacillus brevis, Enterococcus durans, Enterococcus faecium, Enterococcus raffinossus, Enterococcus hirae,* and *Enterococcus cecorum*	(Chettri and Tamang, 2014;J. P. Tamang, 2015; Sohliya *et al*., 2009; Mishra *et al*., 2019)
26	**Tungtap**	Fermented fish (*Puntius spp.* or *Danio spp.*)	2 months	Protein: 32.0%, Moisture: 35.40%, Fat: 12.0%,	*Lactococcus lactis subsp. cremoris, Lactobacillus amylophilus, Lactococcus*	(Kakati & Goswami, 2013; Thapa, 2016;

				Ash: 18.9%.	*plantarum, Lactobacillus plantarum, Lactobacillus corynifomis, Enterococcus faecium, Bacillus pumilus,* and *Bacillus subtilis*	Rapsang and Joshi, 2012)
27	**Ziang-sang/Ziang-dui**	Fermented leafy vegetable	12 months	Moisture content: 17.6% Ash content: 16.9%, Protein: 38.7%, Fat: 3.2%, Carbohydrate: 41.2%	*Lactobacillus brevis, Lactobacillus plantarum and Pediococcus acidilactici*	(Jeyaram *et al.*, 2009a; B. Tamang and Tamang, 2009)
28	**Zutho**	Fermented alcoholic beverage	12 months	-	*Saccharomyces cerevisiae*	(Jamir and Deb, 2014)

*'-' signifies no data is available.

Fermented bamboo shoot

Bamboo shoots have a long history of consumption by humans either in fresh or fermented form for long term preservation as pickles, water soaked or canned. Bamboo shoots are also known as nutraceuticals or natural medicine as they contain phytosterols and fiber that can lower cholesterols and anticarcinogenic activity (Chongtham, Bisht, and Haorongbam 2011).

North east India houses a large number of the fermented bamboo shoots prepared traditionally and is a vital part of food consumption of these people. These bamboo shoots are subjected to natural fermentation process done by a number of Lactic acid bacteria including *Lactobacillus plantarum, L. brevis, Lactobacillus casei*, *Lactobacillus* coryniformis, *Lactobacillus fermentum*, *Tetragenococcus halophilus*, *Leuconostoc mesenteroides*, *Lactococcus lactis*, and *Streptococcus lactis*, etc. (Thakur 2016). The fermented bamboo shoots are a rich source of bioactive nutrients and functional probiotic properties. They act as B-vitamin provider for the human body (Jeyaram et al. 2009b). A number of these fermented bamboo shoot product preparation processes are described below.

Soidon

Soidon is prepared from tips of bamboo shoot from species *Melocana bambusoides Trin, Dendrocalamus giganteus Munro, Bambusa tulda Roxb* and *Teinostachyum wightii*. It is mainly produced in Manipur dominantly by the Meitei women and sold in markets locally such as Ima Keithel in Manipur (Figure 2). Bamboo shoots are collected and their outer sheath is removed. These are sliced and chopped finely and put in an earthen pot. Milky fermented fluid (soijim) is added from previous batch of 1:1 dilution which acts as a starter culture. It is then sealed and stored at room temperature for fermentation for 3-7 days (B.

Tamang and Tamang, 2009**)**. For enhancing the flavour of soidon, leaves of *Garcinia pedunculata Roxb.* (heibung) is added. After initial fermentation, the fermented product is removed which can be stored in an airtight container for a year at room temperature. Washed rice water (Chinghii) is often added to improve the colour and quality of the soidon. The liquid formed during fermentation (soijim) is used as a flavor enhancer or condiment in curry of Manipuri dishes. Soidon is consumed as pickle or curry by the manipuris (Soibam and Ayam, 2018).

(A) **(B)**

Figure 2: (A) Packed Soidon from Manipur market. (B) Women vendor selling Soidon in Ima Keithel market.

Lung-seij

Lung-seij is a traditional fermented bamboo shoot product of Meghalaya. It is mainly produced by the Khasi tribe dominantly by Khasi women. Shoots of *Dendrocalamus hamiltonii* are used for preparing the food product (A. J. Das and Deka, 2012). Young bamboo shoots are first taken and their upper casings are removed. These are washed and cleaned and then finely sliced and chopped. The chopped pieces are pressed in either a bamboo cylinder or a glass jar. The bamboo cylinder is sealed with leaves and tying up the rims. Care is taken so that no accidental seepage of water into the glass jar or bamboo cylinder happens which turn the final product black in colour may unfit for consumption. The sealed jars are submerged in water and left for fermentation for 1-2 months. It is recommended to store lung-seij in glass jar for fermentation as the shelf life is 10-12 months compared to lung-seij prepared in bamboo cylinders which is 1 or 2 months. Lung-seij is consumed with meat and fish (B. Tamang and Tamang, 2009).

Bas-Tenga

Bas-tenga is a fermented bamboo shoot product made from succulent bamboo shoots (*Dendrocalamus hamiltonii, Bambusa tulda*) by the Lotha Naga tribe in Nagaland. Young bamboo shoots are taken and their sheaths are removed to expose off the soft white part of the shoot. The shoots are then cut and sliced into small pieces. It is pressed tightly in a bamboo basket and covered with banana leaves. A small hole is carved in the middle so and the juice is drained out. The preparation is maintained for about 2-3 weeks until the bamboo shoot is completely drained out of its juice. The fermented bamboo shoots are then taken out and dried. Various grades of dried bamboo shoots are available depending on the way they are chopped and sliced. The juice of *Bas-Tenga* can be stored for years for consumption (Jamir and Deb, 2014).

Ekung

Ekung is a traditional fermented bamboo shoot produced in Arunachal Pradesh from tender bamboo shoots of *Dendrocalamus hamiltonii Nees. et Arn. Ex Munro, Bambusa tulda Roxb, Phyllostachys assamica Gamble ex Brandis, Dendrocalamus giganteus Munro* and *Bambusa balcooa Roxb*. Ekung is available during mid-April to early September when succulent young shoots of bamboo are in plenty (Sonar et al. 2015). Bamboo shoots are collected and their outer sheaths are removed exposing the soft part. The soft edible part of shoot is chopped and sliced into small pieces. It is then washed and pressed tightly in a bamboo basket and sealed with leaves. The bamboo basket is laid into the pit which is lined with leaves. The excess water is drained from the bamboo shoots and left for fermentation for 1-3 months. Ekung can be stored in an air tight container for about a year. It is dominantly produced by the Nyishing women. Ekung is consumed raw or is cooked for flavour with vegetables, meat and fish. It is sold locally in most markets of Arunachal Pradesh by Nyishing women (J. P. Tamang et al. 2009).

Muya Awandru

Muya Awandru is an indigenous fermented bamboo shoot of Tripura. It is produced from non-bitter variety of bamboo shoot such as *Melocanna baccifera (Roxb.) Kurz syn. Melocanna bambusoides Trin.* which is locally known as Warthwi Muya by Debbarma and Uchoi tribes of Tripura. Muya Awandru is made using bamboo shoot wrapped in long leaves like banana so as to provide the ideal environment for fermentation and also protecting it from any contaminants and tied with bamboo strip. It placed over a raised platform locally

known as Baka (bamboo rake) to keep it in an undisturbed condition. It is left in this condition to ferment for 2-3 days. Muya Awandru contains 8 essential and 2 semi-essential amino acid, fiber and potassium. Studies shows that it has a potent antioxidant property due to phenolic compounds present in it. It helps in improved digestion, curing cardiovascular diseases, weight loss and even cancer (Uchoi et al. 2015).

Tuaithar

Tuaithar is a fermented bamboo shoot product consumed mainly by the Hmar, Baite and Hrangkhol tribes of Assam and Mizoram. The traditional preparation of Tuaithur involves young tender bamboo shoots of *Melocanna bambusoides Trin., Dendrocalamus hamiltonii Nees. et Arn., Bambusa tulda Roxb*. and *Ex Munro* (Nongdam 2015). They are collected and the hard outer casings are removed. The soft inner portion are chopped and sliced into finer pieces, washed and cleaned thoroughly with water and tightly pressed in a bamboo cylinder or in glass jar. Bamboo shoot water is drained continuously for 2 to 3 days. A small quantity of fresh water is mixed with it and stored in an air-tight container for anaerobic fermentation for 6-7 days. After fermentation, Tuaithur is ready for consumption. It can be stored for few months in an air-tight container at ambient temperature. It is consumed as curry with meat or fish and also with vegetables such as brinjal, Arum stems, etc. Pickle is also produced from it which can be preserved for several months. It can be found locally in markets of Mizoram. pH of Tuaithar is found to be between 4.0-6.0 and food value or calorie value of Tuaithar is 398.6 Kcal/100 g (Chakrabarty, Sharma, and Tamang 2014).

Tuairoi

Tuairoi is a dry fermented bamboo shoot product produced and consumed by the Baite and Hrangkhol tribe of Assam and Mizoram. It is slightly acidic in nature with a sour taste. Tender bamboo shoots of *Melocanna bambusoides Trin., Dendrocalamus hamiltonii Nees. et Arn. ex Munro and Bambusa tulda Roxb.* are collected and their outer sheath are removed to expose the soft inner part (J. P. Tamang et al. 2012). They are washed properly and then chopped into finer small pieces. It is boiled for a few minutes and excess water is drained away. It is then spread over a bamboo mat and sun dried for about 6 to 7 days. The final product obtained is called Tuairoi which is ready for consumption. It can be stored in airtight container for a few months. Tuairoi is consumed with meat and dry fish. Curry is prepared with vegetables and eaten with boiled rice. Tuairoi is available in local markets during the months of June – September when young bamboo shoots grow in plenty. pH of Tuairoi is

found to be between 4.0-6.0 and food value or calorie value of Tuairoi is 330.5 Kcal/100g (Chakrabarty, Sharma, and Tamang 2014).

Fermented alcoholic beverages

Traditional alcoholic beverage or rice beer is an integral part of the socio-cultural life of ethnic tribal people of North East India. Rice beer is related to their day to day life with many occasions such as worship and rituals, birth ceremonies, marriages, festivals and death rites (Senapati and Gurumayum 2016). These rice beers are prepared from rich starter cakes or starter cultures formulated from a number of local plant species. The local plants are often rich in medicinal qualities rendering the alcoholic beverages with ethno medicinal and curative properties for humans such as urinary problems, gastroenteritis, throat infection, tonsillitis and body ache (A. Das, 2016; Bhuyan and Baishya, 2013). Some of these alcoholic beverages are discussed here.

Jumai

Jumai or Jou is a traditional alcoholic beverage prepared by the bodo tribes of Assam particularly belonging to the ethnic group called the bodo – kachari. They are centred around bodoland districts of kokrajhar, udalguri and baksa. It is made from locally available varieties of rice and thus categorized as a rice beer. It is a semi-transparent liquid produced by fermentation of cooked rice (jumai) and starter culture amao (Bhuyan and Baishya, 2013).

Amao is a flattened round yeast cake made of soaked rice grains and plants leaves of *Oryza sativa L., Cyclosorus dentatus, Musa balbisiana, Plumbago zeylanica, Scoparia dulcis, Arthocarpusheterophyllus, Clerodendron infortunatum L, and Ananascomosus L*. These plant materials are grinded in a wooden mortar and pestle called uwal and gaihen respectively. A small amount of water is added to make it sticky and flattened round cakes are made. The powder of old amao is often sprinkled over the freshly prepared once and then kept in a cool moisture free environment for 4-5 days to dry (Basumatary et al. 2014).

Jou or Jumai is made from cooked rice mixed with two – third parts of amao and then covered with banana leaves. It is left for 18-48 hours and then transferred to maldang (earthen pots) for fermentation. A cloth is used to tightly seal the pot. The time period for fermentation varies from 3 days in summer to 5-7 days in winter. The rice beer is often distilled further to produce local alcohol called jou gwran (Narzary et al. 2016). Figure 3 shows the various steps during preparation process. Jou is considered to have therapeutic properties and health

benefiting qualities as it helps against urinary disorder and jaundice and relax the body when consumed in appropriate quantity. The alcoholic drink appears light golden brown with an acidic pH range of 4.16 – 4.29 (Basumatary et al. 2014).

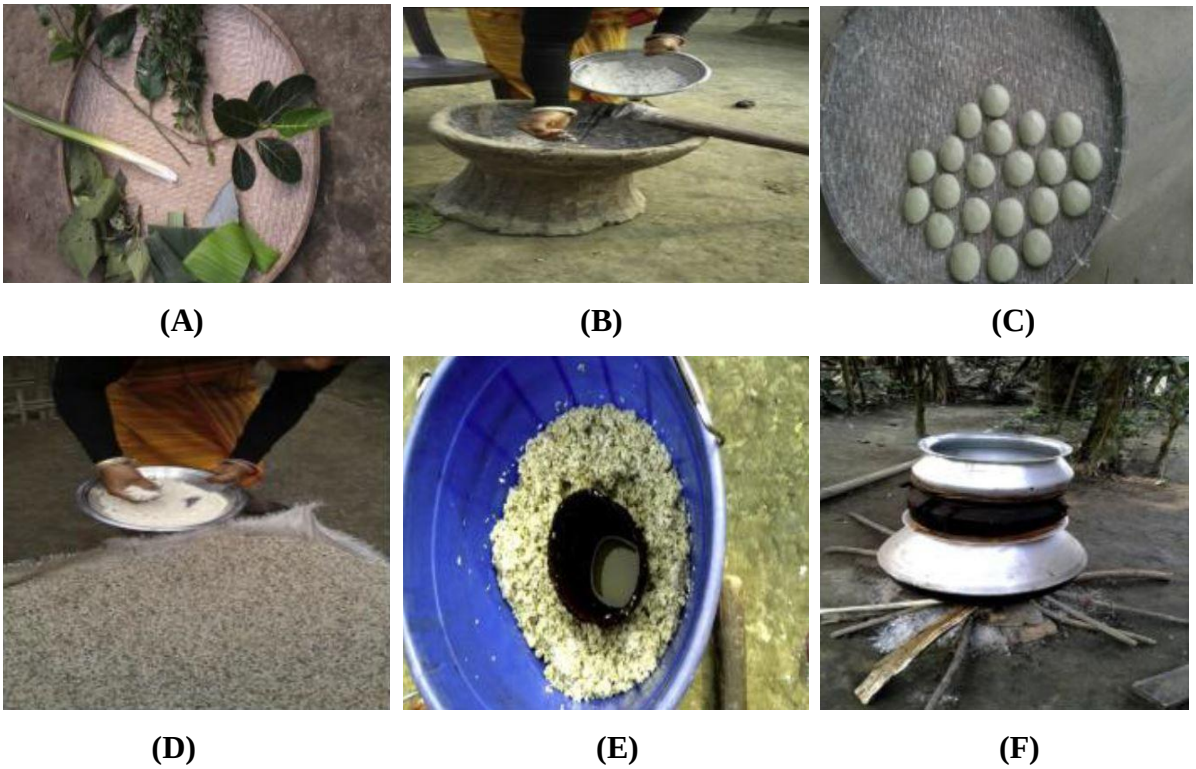

Figure 3: Jou preparation. (A) Plants used for the preparing the starter cake. (B) Woman grinding soaked rice and plant parts to prepare started cake. (C) Starter cakes dried in bamboo mats. (D) Woman sprinkling and mixing starter cake with boiled rice. (E) Rice beer collected into bamboo sieve. (F) Distillation process to prepare distilled rice beer (Narzary et al. 2016).

Apong

Apong is a traditional rice beer prepared by the mising tribe of mongoloid origin residing in the areas of Brahmaputra valley in Lakhimpur, Tinsukia, Majuli, Dhemaji, Jorhat, Golaghat, Sibasagar, Dibrugarh and districts of Sonitpur. Two types of Apong are produced: Nogin Apong from fermented rice and Po:ro Apong (saimod) produced by mixture of fermented rice and ash of paddy husk and straw (Pegu et al. 2013). It is usually prepared for rituals as Midang (traditional marriage), Tani siko (death ceremony), Ui (rituals), festivals (Po:rag, Ali a:ye li'gang, Dobur, etc) festivals and in social life. The missing women form an integral part in the production of Apong (Senapati and Gurumayum, 2016). Poro-apong helps in various ailments and diseases like urinary problem because of the presence of parts from medicinal plant and different minerals. When consumed daily in minimum quantity before meal is

considered good for health as a tonic but excess consumption may be harmful (Kardong et al. 2012).

The starter culture for Apong is known as E'pob. A number of plant leaves such as *Centella asiatica, Hydrocotyle sibthorpioides, Drymeria cordata,Clerodendrum viscosum, Saccharum officinarum, Piper nigrum, Oldenlandia corymbosa, Scoparia dulcis, Phogocanthus thyrsiflorus , Ipoemea sp, Capsicum annuum, Lygodium flexuosum, Cyclosorus exlensa, Zanthoxylum hamiltonianum, Ananas comosus, Pteridiumaquilinum,* and *Piper longum* are used in preparing E'pob (starter cake) (Gogoi, Dutta, and Mondal 2013). All the plant leaves are washed and dried in sunlight in a Salani (round bamboo utensil for sieving) for 1-2 days. Then they are powdered in a Dheki or Khubuli (wooden grinder) and mixed properly with grinded Saol (rice), preferably glutinous, soaked in water for 1-2 hrs. The powdered leaf and grinded Saol (rice) are mixed in the ratio 1:50 (w/w) and water is added adequately to make a paste. It is then kneaded by hand into round cakes (5-7 cm diam. and 3-4 cm thick). Cleaned kher (straw) is spread on a Dola where the round cakes are kept and covered by leaves of Bihalangani (*Thelypteris parasitica* and *T. dentata*, *Thelipteridaceae*). It is then left above the fireplace to dry for 3-5 days (Handique and Deka, 2016).

Poro – Apong is brewed from Tuh (rice husk) and Saol (rice) with Kolpat (Banana Leaf), Kher or straw, Tum (Bamboo net basket), Heta or Durgi (Bamboo large spoon) and Kerahi (Iron pot). In summer, Saol (rice) is washed and cooked with constant stirring with Heta or Durgi to avoid burning. It is then spread over a 'Dola' and mixed with ash prepared from Kher (straw) & Tuh (rice husk) rendering it a black colour. E'pob cakes are then powdered with hand and mixed thoroughly with it in a ratio of approximately 1:45 (w/w). The mixture is then packed in a dry earthen pot called Koloh covered with straw and Rukji leaves and stored for fermentation. It is then hung over a fire place for 4-5 days. Thereafter, the mixture is taken out and mixed with water (2 litres to 5 kg). It is filtered through a cloth until the colour turns brown from black. The filtrate is called Apong and the residue is called Aaruk, which is usually used as a feed for pig, fish and cattle. Figure 4 shows the preparation steps in the complete process (Pawe, Dimbo and Gogoi, 2013; Handique and Deka, 2016).

In winter, the cooked warm rice is mixed with powdered E'pob and stored for upto 8 to 9 days for fermentation. About 100g of powdered starter culture (E'pob) is sufficient for fermentation of 3kg cooked rice. The warm Saol (cooked rice) is thoroughly mixed with the ash powder of Kher (straw) and Tuh (rice husk). It is then mixed properly with the starter culture (E'pob) and the mixture is allowed to ferment at around 30°C- 35°C. The fermented

mass called poro arouk is a black, wet solid and rough reduced in volume (Pawe, Dimbo and Gogoi 2013)**.**

Figure 4: Preparation of sai mod. (A) Straw and rice husk used to prepare ash. (B) Ash mixed with cooked rice. (C) Crushing of starter yeast cakes. (D) Crushed Starter cakes mixed with cooked rice. (E) and (F) Mixture nicely put into bamboo basket wrapped in banana leaves. (G) Mixture left for fermentation. (H) Final product sai mod or poro (Pawe, Dimbo and Gogoi 2013).

Sujen

Sujen is an indigenous traditional rice beer prepared from fermented rice by the Deori tribe of Assam. They are ethnic tribe of Assam residing in the districts of Lakhimpur, Dibrugarh, Tinsukia, Dhemaji, Sibsagar and Darrang. Sujen plays an integral part in the socio-cultural life of the Deoris and is drunk in all their life celebrations and festive occasions. The starter culture for preparation of sujen is called ‘Mod Pitha’ or ‘perok kushi’(Handique and Deka,

2016). Various items used in preparation of sujen have various health benefits such as Nohoru *(Allium sativum Liliaceae)* which is used in hypertension, gastric ulcer, loss of appetite, liver disorder and whooping Cough. Leaf juice of Kathal *(Artocarpus heterophyllus Moraceae*) is used to cure eye problem and seeds used in indigestion. Leaves, stem and bark of *Sotiana Alstonia scholaris Apocynaceae* used in sujen is good for asthma, spleen enlargement and liver disorder (Senapati and Gurumayum, 2016).

To prepare 'perok kushi' various plant leaves are used such as bhatar duamali *(Jasminum sambac),* tesmuri *(Zanthoxylum hamiltonianum),* bhilongoni *(Cyclosorus exlensa),* sotiona *(Alstonia scholaris),* zing zing *(Lygodium flexuosum),* zuuro *(Acanthus leucostychys),* thok thok *(Cinnamomum byolghata),* roots of dubusiring *(Alpinia malaccensis*) and the stem of the plant jomlakhoti *(Costus speciosus*). These plant materials are washed properly and sliced into small finer pieces. It is then pounded in a wooden mortar called as dheki. The crushed mixture is mixed with water in a vessel and now added to the grinded rice in a vessel to make dough. Round balls are made by hand of about 4 cm in diameter and sundried or dried over the fire by placing them on a bamboo (aaphey). The dried balls are placed inside a bamboo container (kula). It is sealed with kher (paddy straw) and can be stored for many months to be used as necessary (Bhuyan and Baishya, 2013).

Sujen is fermented in an earthen pot (disoh) which is washed with ash for pre-sterilization. It is placed over the fire place for drying and also fumigation. Rice is boiled first and then cooled by laying out over a banana leaves placed on an aaphey (bamboo tray). Powdered perok kushi is now added to the cooled rice (1 starter per 3 Kg of rice). The mixture is stored in an earthen container and the opening is sealed with Bihlongoni *(Cyclosorus exlensa)* followed by kol pat (banana leaves) and allowed to ferment for about 4 to 5 days. The final fermented mass can be stored for 1 to 2 months at ambient room temperature (Senapati and Gurumayum, 2016).

Zutho

Zutho is a traditional beverage of Nagaland prepared from rice (*Oryza sativa L.*) by the 'Angami*''* Naga dialect. The rice is first soaked in water for about two hours. The excess water is drained-off and then dried and crushed into powder. In another part of preparation, rice grain is dipped in water for about 2-3 days and it is allowed to germinate. The germinated grains are sun dried and crushed into powdered form. The rice powder of both preparations is mixed in 10:3 ratios and dough like paste is made by slowly mixing warm

water to it. The mixture is then incubated at room temperature for 4-5 days for fermentation. The fermented product is called 'Thoutshe'. Thoutshe is diluted with some water which is called 'Zutho' (Jamir and Deb, 2014). Zutho is off-white slurry in appearance. Its alcohol content, pH and acidity were 5.0%, 3.6 and 5.1 respectively (Teramoto, Yoshida, and Ueda 2002).

Conclusion

The Seven sister states of North-East is mainly known for agricultural practises with nearly two-thirds of the population engaged in it. Most of these lands in North-East states are covered with forests and act as a natural resource for the region. It is home to a large number of culturally different people ethnic to the region. The different ethnic people practise and produce a large variety of fermented foods which are known to impart health benefitting effects and also highlight the knowledge of people being shared through food culture. Fermented foods and beverages have a rich microbial diversity in various sources which reflects the people harnessing the indigenous knowledge. Research on traditional fermented food is important mainly for preserving the indigenous knowledge for the future. The preparation processes of the fermented foods need to be documented at the present time. These fermentation processes of indigenous food are one of the oldest processes in practise in which microbes play an important role in preservation and production. The process of fermentation helps in the improvement and enrichment of the indigenous food.

This knowledge together with Modern technologies can be combined to obtain beneficial outcomes for the people. Climatic condition also plays a major role in the production and consumption of these fermented food products. Value added product can be developed by using improved process, process control, improved raw material, use of genetically modified organism, etc. Collaborative research on traditional fermented foods of north east can help in exploration and standardization of the fermented food product. Study of probiotic activity can help in determination of potent probiotic bacteria present in such fermented food samples. Techniques for proper fermentation need to be standardized so that commercial production of fermented foods can be done by the people. Many of these fermented foods are a source of livelihood for the rural people inhabiting the various states of North-East. This will also contribute to the economy of the region. Different types of bioceuticals and novel compounds may be produced from fermented foods if proper research is carried out. The government can

lend out financial assistance in uplifting and helping in the technological development in production of indigenous fermented foods.

Conflict of Interest

The authors declare there is no competing interest.

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