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Fermented Rice Beverage of Northeast India: A systematic review

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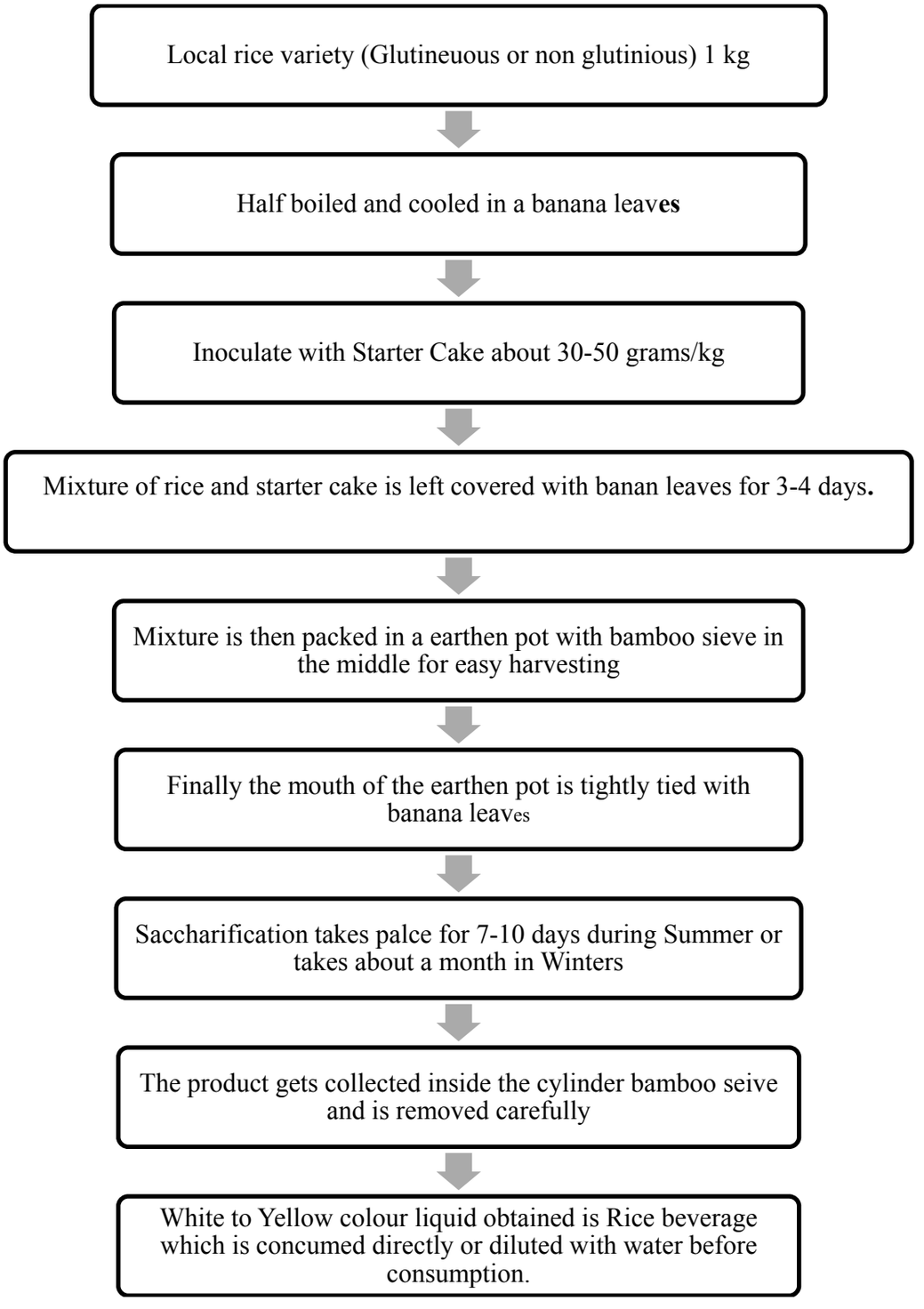
Abstract

Northeast India is the eastern most region of India. It comprises the eight states Sikkim, Assam, Meghalaya, Mizoram, Nagaland, Manipur, Tripura and Arunachal Pradesh. This review reflects the indigenously prepared fermented rice beverages by different tribes from different states of North-east India. Many researchers have studied on traditionally prepared rice beverages but limited information is available on commercialization of beverages like *Sake* of Japan. At present, traditional fermented rice beverages are prepared for local consumption only at house-hold level without much consideration about Good Manufacturing Practices (GMP). Studies have shown that fermented rice beverages are rich source of nutrients and have therapeutic values which help to prevent diarrhoea and diabetes. It is generally prepared by adding varieties of medicinal herbs in their starter culture inoculums which are also rich in micro-organism like yeasts, moulds and lactic acid bacteria. These micro-organisms results in the formation of alcohol which is consumed by the local tribal communities without much knowledge about its quality and shelf life of the product. Scientific and systematic approach would help to standardise high quality stable product with increased shelf life and help the tribal communities economically produce it for their livelihood.

Keywords: Fermentation, Rice Beverage, Starter culture, Yeast, Lactic acid bacteria

Fermentation comes from the Latin word "*fermentare*", *meaning* "*to leaven*." It means chemically breaking down of a substances by yeasts, bacteria or other microorganisms, typically involving exothermic reaction. Fermented rice beverage is the most common alcoholic beverages of North-east India consumed by most of the native tribal communities, inhabitant of the mountains and foothills of Himalayas. In the Indian subcontinent, traditionally prepared fermented food and beverages using locally available raw materials and other biological resources have been prepared since generations and is being practice even today by the descendents[1]. A complete process of preparation of Rice beverage is shown in Flowchart 1. North-east India comprises of Assam, Manipur, Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Tripura, and Sikkim. It is located between latitude 20° and 22° North and longitude 89°46′ and 97°5′ East. It is mostly covered by forest, hills and mountains and wild topography. It is reported that approximately 225 out of the recorded 450 tribes of India reside in this region, representing different ethnic groups with distinct culture entities and rich traditional knowledge[2,3]. These rice beverages are known by various names by different tribal communities. They are called as *apong* in Adi, *bunkchung* in Monpa, *chi* in Lepcha, *laopani* in Aka, *ijaduijang* in Naga, *jumai*/*jou*by Bodos, *suze* by Deoris, *morpo* by Mikirs, *jou* by Meches and Dimasas,



Flowchart 1: Steps involved in the preparation of Rice Beverage

zu by Tiwas,*Chubitchi* by Garos, *Kyaid* by Khasis/ jaintias, *apong* by Mishings, *laopani* and *mod* by some other tribal communities. These products are similar to *shaosingiji* and *laochao* of China, *sake* of Japan, *brem bali*, *tape-ketan* and *tapuy* of Indonesia, *khaomak* of Thailand, *chongju* and *takju* of Korea and *tapai pulul* of Malaysia[4], *Makgeolli* in Korea, *ruou de* or *ruou nep*in Vietnam[5,6] etc. Rice beverage plays an important role in the socio-cultural life of the tribal people as it is considered sacred for offering to God and other religious ceremony such as child birth, marriages, festivals and even death ceremonies. It is claimed by the tribal people that due to the use of medicinal herbs in preparation of starter culture it possesses medicinal properties which help to cure health problems. They have reported that drinking rice beverages in small quantity helps to reduce fatigue, tiredness, headache, digestion problem, and also diabetes and pressure. It still requires scientific approaches to learn more about these. As this rice beverage is prepared entirely with traditional knowledge which have been passed on from generations, the production technique is yet to be standardised to produce commercially. Researchers have reported different fermented rice beverages of different tribes and states which are tabulated in Table 1.

RICE BASED TRADITIONAL BEVERAGES

Chubitchi

Chubitchi is traditional rice based alcoholic beverages of Garo tribes in Meghalaya. It is mostly prepared by locally available glutinous rice with addition of starter culture known as *Wanti*. *Chubitchi* is a staple beverage of the Garos which is consumed on daily basis and also as an offering to God, during their famous *Wangala* festival, marriage ceremony and even death ceremony. *Wanti*, starter cake is prepared by using medicinal plants called *Achetra* (*Plumbago*

Table 1: Fermented Rice Beverage of North-East India

Fermented Rice Beverage	Starter Cake	Tribe	State	Ingredients used	References
Chubitchi	*Wanti*	Garo	Meghalaya	Rice and Medicinal herbs and chillis	7
Kiad / Sadhier	*Thiat*	Pnar/Jaintias, Khasis	Meghalaya	Rice and Medicinal herbs	8
Choko/jonga Mod	*Bakhor/ Surachi/ Phap*	Rabhas	Assam	Rice and Medicinal herbs	9
Jou	*Amao*	Bodo	Assam	Rice and Medicinal herbs	10
Hor-alank	*Thap*	Karbi	Assam	Rice and Medicinal herbs	11
Xaj pani	*Vekur pitha*	Ahoms	Assam	Rice and Medicinal herbs	12
Apong	*Apo pitha*	Misings	Assam	Rice and Medicinal herbs	13
Sujen	*Perok kushi*	Deoris	Assam	Rice and Medicinal herbs	14
Judima	*Humao*	Dimasa Kacharis	Nagaland	Rice and Medicinal herbs	12
Zutho	*piazu*	Angamis	Nagaland	Sprouted rice	15
Duizou	*Khekhrii*	Naga	Nagaland	Rice and Medicinal herbs	16
Opo	*Siiyeh*	Adi-Galos	Arunachal Pradesh	Rice and Medicinal herbs	12
Apongg	*Ipoh*	Monpa, Apatani, Nishi	Arunachal Pradesh	Rice and Medicinal herbs	17
Pona	*Ipoh*	Monpa, apatani, nishi, adi	Arunachal Pradesh	Rice and Medicinal herbs	17
Ennog	*Ipoh*	Monpa, Apatani, Nishi, Adi	Arunachal Pradesh	Rice and Medicinal herbs	17
Langi/chuwak	*Chuwan*	tripuris	Tripura	Rice and Medicinal herbs	18
Atingba/yu	*Hamei*	Meitei	Manipur	Rice and Medicinal herbs	19
Bhaati jaanr	*Marcha*	Gorkhas	Sikkim	Rice and medicinal herbs	19
Poko	*Manapu*	Gorkhas	Sikkim	Rice and medicinal herbs	17

zeylanica L), *Samaki* (*Cherodendrum cordatum*) and *Sarath* (*Thelypteris clarkei*). It is known that *Sarath* is used when rice beverage with higher alcohol is preferred. The glutinous rice; *Menil* is preferred for rice beverage preparation because of its sweet taste and aroma. *Wanti* is prepared by mixing appropriate amount of rice, medicinal herbs, chillies and little inoculums of old *Wanti* cakes which are kneaded to make soft dough. Further smallflattened cakes are made out of the dough and sun dried by placing them on a traditional bamboo baskets called *Dokee dona* covered with clean dry straw for at least five to seven days. Once the *Wanti* is dried, it is stored and preserved for future use. For preparing *Chubitchi*, *Menil* is soaked and cooked. Both polished and unpolished varieties of *Menil* are used which gives unique taste and flavour. It is found that red variety gives sweeter taste and sometimes roasting of rice also gives smoky flavour to the beverage.

After the rice is cooked it is spread on a clean bamboo mat and allowed to cool down. It is then mixed well with appropriate amount of *Wanti*, about 10g per 4-5 kg of cooked rice. Garo tribes use large earthen pots called *Dika* for fermentation of rice. The pots are washed properly with clean water and sun dried completely and kept over the fire place for further drying and smoking. The mixture of rice –*Wanti* is then kept inside the earthen pot and a bamboo sieve is kept inside for easy harvesting of beverage. Finally the mouth of the pot is sealed tightly with banana leaves and clean cloth and left for fermentation for almost a week during summer and about a month in winters at room temperature[7]. The yeast responsible for fermentation is identified as *S. cerevisiae, W. anomalus, R. Mucilaginosa*[39]. It is believed to have many health benefits and neutraceutical properties like antioxidant and antidiarrhoeal properties because of the medicinal herbs used in making of rice beverage which is yet to be explored further.

Sadhier* or *Kiad

Sadhier or *Kiad* is a traditional rice beverage prepared by *Pnar* people in Jaintia hills of Meghalaya. The method of preparation consisted mainly of two parts, *Thiat*, starter cake preparation, and *Kiad* brewing. For preparation of *Kiad*, leaves of *Khaw- iang*/ *Haw-iang* (*Amomum aromaticum Roxb*); *Sla-pashor* – leaves of banana (*Musa paradisiacal L.*) are sun dried and grounded into powder added to *Kho-so* (*Oryza sativa L.*) – a local red rice. It is mixed together and made into a sticky paste and small round cakes are prepared with size of 4-5 cm. It is sun dried to harden before being used for rice brewing as natural yeast. For brewing of rice, *Kho-so*is mixed with water and cooked. It is then taken out and spread over banana leaves for cooling and drying. 1-2 *Thiat*, starter cakes are finely crushed and mixed together with hands. The mixture is then put inside the *Shang* (coned shaped basket) and kept for fermentation for 2-3 days. The fermented mixture is yellowish white in colour and it is locally known as *Sadhiar.* Boiling of this *Sadhiar* in a set of apparatus called as *Shet- kiad* are used to produce distilled beverage known as *Kiad*. Ethnic tribal people believe that it is known to cure dysentery and urinary trouble when consumed. It is advisable as a health tonic when consumed in small quantity on a daily basis, but excess consumption may lead to intoxication and could be harmful. *Kiad* production serves as a good source of income for livelihood of the local people and a good source of income. The nutritional and medicinal potentials of *Kiad* need to be studied further and standardization of the process could be explored further[8].

Choko* or *Jonga-mod

Rice beverage is popularly known as *Choko* or *Jonga-mod* by the Rabha tribe of Assam. The starter cake is known as *Bakhor, Surachi* or *phap*. To prepare Choko, paste of rice (*Oryza sativa L.*) is mixed with ten varieties of medicinal herbs mentioned in Table 2 that are found locally. A considerable amount of old starter cake is mixed along with these plant materials to prepare fresh cakes. The cakes are prepared each of 50 g which is round in shaped. Different parts of ten plant species are used in particular amount to prepare the cake. To prepare *Choko* or *Jonga*, fresh rice is tightly cooked using less amount of water. After cooking, it is scattered on a bamboo mat to cool down.

Table 2: Various plants used for the preparation of Rice Beverages by Different tribes

Local name	Plant varieties used	Nutraceutical Potential	Reference
Bhaati jaanr, Sikkim	*Guliyo jara* (*Plumbago zeylanica*), *Bheemsen paate* (*Buddleja asiatica*), *Sengreknna* (*Vernonia cinerea*),.	In order to gain strength, ailing persons and post-natal women in the Himalayas consume *bhaati jaanr* extract	19
Apong, Arunachal pradesh	*Veronia cinerea, Amomum aromaticum, Cissampelos pareira, Clerodendron viscosum, Leucas aspera, Solanum nigram, Cinnamomum gladuliferum, Artocarpus lakoocha, Cinnamomum glanduliferem, Albizia myriophylla, Clerodendrum indicum, Cissampelos pariera, Buddleia macrostachya, Mangifera indica, Melia azedarach, Sapindus mukorosi, Plumbago zeylanica, Acacia farnesiana, Cyperus, Phryium capitulam, Rotundus.*	Antioxidant, medicinal herbs are believed to cure cough, diabetes, dysentery and malaria	36, 13
Jumai, Assam	*Kanthal* (*Artocarpus heterophyllus* Lamk.), Dongpang rakeb (*Scoparia dulcis* L.), Talir (*Musa paradisiacal),* Agwrsita (*Plumbago zeylancia* L.), Anaros (*Ananas comosus* L. Merr.), Lwkhwna (*Clerodendron infortunetum* L.)	Refreshing and relaxing body. Removes tiredness and fatigueness.	10
Sujen, Assam	*Desmodium pulchellum, Cinnamomum bejolghota, Costus speciosus,Coffea bengalensis, Cyperus* species, *Lygodium flexuosum, Melastoma malabathricum, Equisetum* species, *Mussaenda roxburghii, Myxopyrum smilacifolium, Pothos scandens, Psidiumguajava, Naravelia zeylanica, Pteridium aquilinum, Pycnarrhena pleniflora, Rubus* species, *Scoparia dulcis, Thunbergia grandiflora, Zanthoxylum oxyphyllum, Artocarpus heterophyllus.*	Removes tiredness and relaxes the body	14
Choko/jonga, Assam	*Anaros* (*Ananas conmosus*), *Pan-chung* (*Artocarpus heterophyllus*), *Akhomhang* (*calotropis gigantean*), *Jhaluk* (*Capsicum frutescens*), *Holitita* (*Cleodenndrum viscosum*), *Bisdhinkia* (*Dennstaedtia scabra*), *Kuchibum* (*Ochthochloa coracana*), *Agiachit* (*Plumbago indica*), *Kurchi* (*Saccharum officinarum*), *Phap jibra* (*Scoparia dulcis*).	Relieves rheumatic pain, stomach ache, constipation.	9
Apong, Assam	*Lygodium flexuosum, Centella asiatica, Hydrocotyle sibthorpioides, Cyclosorusex lensa, Oldenlandia corymbosa, Drymeria cordata, Saccharum officinarum, Clerodendrum viscosum, Ipoemea* sp., *Scoparia dulcis, Capsicum annuum, Ananas comosus*	Apart from its role as an energy booster, it is also used as medicines against insomnia, dysentery, headache, body ache and urinary problems.	37
Xaj, Assam	*Hydrocotyle sibthorpioides, Lygodium* sp, *Piper nigrum, Centella asiatica, Cissampelos pareira, Oldenlandia corymbosa.*	Energy drink, Relieves body ache, urinary disorders, dysentery, headache.	37

Langi, Tripura	Drumstick (*Moringaoleifera Lam.*), Rosewood (*Dysoxylum Blume*), *Khae* (*Markhamia stipulata*), Jackfruit (*Artocarpus heterophyllus* Lam.) Sugarcane (*Saccharum officinarum* L.), *Meda* (*Litsea monopetala* Roxb.), Pineapple (*Ananas comosus* Mill.), *Rabo De Ranton* (*Casearia aculeate* Jacq.), *Kamala bukur* (*Citrus sinensis* (L.) Osbeck), *Chindrema* (*Allophylus serratus* Kurz.), *Amang* (*Aporusadiocia* Roxb. Muell), Rangoon creeper (*Combretum indicum* (L.) DeFilipps.), Night Jasmine (*Nyctanthesarbor-tristis* L.).	*Markhamia stipulata (Wall.) Seem.* is used in treating nervous disease, *Saccharum officinarum L.* is used to get relief in constipation, *Artocarpus heterophyllus Lam.* is helpful in treating skin disease and as an antihelminthic plant, *Moringa olifera Lam.* is used in treating common cold and jaundice, the leaf of *Ananas comosus Mill*. is used against helminthic infections, *Litsea monopetala (Roxb.)* Pers. has antioxidant properties and is used for preventing degenerative diseases including inflammation, the plant is also believed to be have dysuria, alexipharmic, antitussive, antidiarrheal, and antirheumatic effects, *Casearia aculeate* Jacq. has antibacterial activity, *Allophylus serratus Kurz.* is used in treatment of gastrointestinal disorder, inflammation, elephantiasis, and osteoporosis, *Citrus sinensis (L.) Osbeck*. has antifungal, antidiabetic, antibacterial, cardio protective, anticancer, and anti-inflammatory properties.	24,18
Atingba, Yu, Manipur	*Vangueria spinosa, Hanurei,Kharam leishok, Albizia myriophylla.*	Regulates menstrual flow in women, obesity and loss of appetite.	19, 38
Hor-alank	*Themra* (*Acacia pennata*) plant leaves of *Marthu* (*Croton joufra*), *Hisou-kehou* (*Solanum viarum*), *Janphong* (*Artocarpus heterophyllus*), *Jockan* (*Phlogocanthus thysiflorus*		12
Chubitchi, Meghalaya	*Achetra* (*Plumbago zeylanica L*), *Samaki* (*Cherodendrum cordatum*) and *Sarath* (*Thelypteris clarkei*).	Helps in relaxing of body and aids in digestion.	39

Then 2-3 pieces of starter cake are powdered and used for 2 kg of cooked rice. The mixture is placed inside an earthen pot known as *Jonga*. A special type of cylinder made of bamboo known as *Janthi* is placed inside the earthen pot for easy harvesting of *Choka*. At last, open mouth of *Jonga* is tightly sealed with banana (*Musa balbisiana*) leaf warmed in fire and placed in a dark place. *Rabhas* also put a small amount of charcoal over the lid of *Jonga* to ward off the effect of evil spirit. After 4-5 days of fermentation, *Choka* or *Jonga-mod* is ready for harvesting. *Rabhas* usually store *Choka* in matured fruit of *Langenaria siceraria Standl* after making a hole in the dried shell of matured fruit. Usually after harvesting, particular amount of water is again added to allow further fermentation and after 3-4 days the *Choka* is collected and distilled through a local process by using 3 different earthen pots (*hadi/ laduki*), placing one over another. The second and third pot having hole is placed at the bottom. The whole apparatus is made air tight using jute (*Corchorus capsularis* L.) fibre and mud at the junctions. The distilled drink is strong liquor known as *Fotika. Rabhas* believe that the drink has many nutritional and medicinal properties and it is known to cure psychiatric patients, promotes sleeping tendency relieve headache, body ache diarrhoea, urinary problems and has a purgative effect. Sometimes it is also given to bulls as a tonic to promote body strength and also cures swelling of legs in cattle. It is still scientifically not proven hence

a wider approach in terms of technology is required to explore its potential value[9].

Jou

Jou is a traditional alcoholic rice beverage prepared by Bodo tribe in Bodoland region in Assam. It has been prepared since ages and is associated with social life of Bodo people. *Jou* is prepared by using starter cake known as *Amao* which contains varieties of medicinical herbs mentioned in Table 2[10]. Different parts of the plants like leaves, roots, and stems are used for the preparation of *Amao*. This plant parts are sundried and grounded into a fine powder and added with soaked rice known as *Mairong* (*Oryza sativa L.*). A particular quantity is added to *Mairong* and grounded into fine powder using *Ual* (mortar) and *Gaihen* (pestle). Previously prepared old starter cake is added to the fresh preparation as inoculums. A small amount of water is added to make a sticky paste and then made into small round flat cakes which are 2-3 cm in diameter and 1 cm in thickness. The cakes are kept on a clean, dry *Dingkia* leaves (fern leaves) in a round bamboo craft known as *Songrai* and again covered with *Dingkia* leaves. The *Songrai* is usually kept near a fire place or a warm place so that the starter cake is covered in thick mycelium growth after 3-4 days. This process continues for a couple of weeks until the cake becomes hard and ready for used in brewing *Jou*. It is known that the quality of *Amao* is effective upto 5-6 months. It is usually stored tight in a cotton cloth inside Dwihu (Small earthen pot). For preparation of *Jou,* varieties of rice (glutinous or brown sticky rice) is cooked properly and spread over *Songrai* to cool down. 1-2 pieces of *Amao* per 1 kgs of rice is then crushed with cleaned hands and mixed nicely which is then covered with *Talir bilai* (banana leaves) and left for 2-3 days without any disturbance. This mixture is known as *Jumai.* After 2-3 days, *Jumai* is transferred in *Maldang* (big earthen pot) and a special conical bamboo sieve "*Janta*" is placed inside. The mouth of the *Maldang* is covered with banana leaves and wrapped nicely with cloth and kept for fermentation. After 5-6 days a golden yellow juice is formed which is called *Jou* which can be harvested from inside the conical bamboo sieve *Janta*. After harvesting a particular amount is added and left for 3-4 days for further fermentation. *Jou-gwran* which is the distilled form of *Jou* is prepared by local distillation process. *Jou* is harvested and diluted with water and kept for 2-3 h. the equipments for distillation consist of 3 parts. The lower part is a silver pot where Jou is kept and the middle part which has holes in it is known as *Mwkwra Koro*. Inside this a small bowl is kept for receiving of the distilled alcohol *Jou Gwran*. The upper pot with short neck and open mouth acts as a condenser which is filled with cold water during the distillation process. The junctions of the pots are sealed using cloth and mud so that the vapour passes through the small holes of *Mwkra koro* and reaches the cool base of the upper pot. *Jou gwran* is highly alcoholic when compared to *Jou* and it is believed to cure various diseases like jaundice, diarrhea, cholera, gastro intestinal disorder, urinary disorder and keeps the body healthy and relaxes the body when taken in appropriate quantity. *Jou* is also known as source of livelihood earnings in rural part of Bodoland region. If standardization and technical approach is taken *Jou* could be a great source of medication as it is known to heal various diseases and its shelf life could also be studied.

Judima

Judima is the traditional alcoholic rice beverage prepared by the tribe Dimasa Kacharis, one of the indigenous ethnic tribes of Nagaland. Dimasa Kacharis are also inhabitant of Assam. They starter cake is known as *Umhu* or *Humao* which is prepared by adding of medicinal bark of *Thempra* (*Acacia pennata*) plant with local variety of rice. Rice is soaked for overnight and grinded into a fine powder with the help of mortar and pestle known as *Rimin*. *Thempra* is sun dried and added to the rice powder and grinded properly. A particular amount of water is added to make a thick paste which is then made into small round cakes of 2-3 cm in size. *Umho* or *Humao* is then sun dried till it is hard enough to use. This starter cake can be stored upto 1 year. For preparing of alcoholic rice beverage *Judima*, local variety of glutanous rice is

cooked and spread over a banana leaf to cool down. After that *Umho* or *Humao* is crushed and mixed with the cooked rice. This acts as inoculums of yeast for the preparation of beverage. This mixture is further transferred to a large container and the mouth is sealed with jute gunny bags. After 5-6 days of fermentation, a slightly yellowish juicewhich forms is the pure form of *Judima.* This liquid is filtered and consumed directly. Sometimes this is further diluted with water and left for fermentation. This drink is rich in nutrients and is consumed on daily basis by the locals to get rid of body ache after working in the farm. It is known to give good sleep and good digestion[12].

Zutho

Another traditional rice beverage of Nagaland is *Zutho* prepared by *Angamis* tribe. They are one of the major tribes in Nagaland and have distinct culture and identity having warrior background. *Zutho* is prepared using rice and starter cake known as *Piazu. Piazu* is prepared from sprouted rice. The un-hulled rice is soaked for 3-4 days and after draining the water it is left for1 week or more until it germinates. After this the sprouted rice grains are pounded into a powder using mortar and pestle. This powder is known as *Piazu*. For preparing *Zutho*, local rice is first boiled and cooked properly which is then spread over a bamboo mat to cool down. After cooling down 10 g of *Piazu* per 1 kg of rice is added and mixed well. The mixture is then kept in a large container to the fermentation to take place. Fermentation usually takes 4 days in summer and about a week in winter. After the stipulated time, particular amount of water is added to *Zutho* and filtered and served directly[15].

Opo

Adi- Galos are one of the major tribes in the state of Arunachal Pradesh. They have rich traditional culture and bear their own cultural resemblance among many other tribes in Arunachal Pradesh. The local alcoholic rice beverage prepared by them is known as Opo which is prepared by using starter culture known as *Siiyeh* or *Opop*. *Siiyeh* or *Opop* is prepared by using medicinal plants like *Dhapat* (*Clerodendron viscosum*) and *Lahpohi* (*Veronia* sp). These plants are washed and sun dried properly before grinding into a fine powder. These powdered herbs are then mixed with rice which was soaked overnight and pounded into powder. Previously prepared *Opo* is added as inoculums to make paste out of it which is made into flat cakes of 10-11 cm in diameter. This *Opop* is then placed in the bamboo mats for drying till it hardens. For preparing *Opo*, rice husk known as *Ampe* is fried till it is half burnt and turns black in colour. This burnt rice husk is then boiled and cooked properly and spread over *Peche* (bamboo mat) for cooling. It is then mixed with powdered *opop* (about 100 g of *opop* for 10 kg of rice). This mixture is then placed in a container generally a large plastic bucket after lining the walls of the bucket with leaves of a locally available herb called as *oko* (*Zingiberaceae* family). After placing the mixture the mouth of the bucket is sealed tightly with *oko* leaves and is left untouched for a week. After a week the fermented mixture are again mixed well and left for a longer duration. The fermented rice beverage *Opo*becomes yellowish in colour after twenty days of fermentation and is ready for harvesting. Sometimes to achieve more alcohol it is kept for longer period of. For harvesting of *Opo*, fermented mass is filtered through a funnel called as *perpur* where *oko*leaves are used as the filter where hot water is poured slowly in order to obtain the *opo* as the filtrate. The quantity of water poured depends on the desired concentration of the final product[12].

Atingba

The largest ethnic group of the state of Manipur known as *Meitei* prepare *Atingba* which is an alcoholic beverage preparedfrom glutinous rice. The starter culture used for the preparation of *Atingba* is called *Hamei*. The methodology for their preparation are being kept traditional and passed on from generation to generation[19]. For the preparation of *Hamei*,raw rice is grounded with barks of the plant *Yangli* (*Albizia myriophylla*) (0.25 kg per kg of rice) and kneaded to soft dough. To inoculate the dough with natural yeast, previously made *Hamei* is added to the dough and

mixed well. From this, small flat cakes of size 2-7 cm in diameter and 0.6-1.5 cm thickness are made. These cakes are then kept on dry rice husks and covered with banana leaves and kept on the floor or bamboo baskets for 2 to3 days at room temperature. After fermentation the cakes swell, produces alcoholic flavour and colour turns yellowish which can be dried in the sun for as required and storedfor up to a year[19,21,22]. The lactic acid bacteriaisolated from samples of *Hamei* have been identified as *Pediococcus pentosaceus* and *Lactobacillus plantarum*[23]. The Yeast and molds associated with fermentation are identified as *Pichia anomala, Saccharomyces cerevisiae, C. Montana, P. guilliermondi, Candida tropicalis, C.parapsilosis, Trichosporon* sp.and *Torulaspora delbrueckii*[21]. For the production of *Atingba,* local glutinous rice iscooked with excess water to soften the rice then cooled by spreading in a bamboo mat or plastic sheets over the banana leaves. When the temperature is around 40 degree, crushed *Hamei* is mixed well with hands usually 5 cakes for 10 kgs of cooked rice. This mixture is thenleft for fermentation by putting inside the large clay pots covered with '*Hangla*' (*Alocasia* sp.) for 3-4 days during summer and 6-7 days in winter. This is followed by 2-3 days of submerged fermentation in earthen pots. The yellowish beverage which is obtained after filtration of the fermented product is called *Atingba*[22].

Langi

Tripura is the homeland of 19 different tribes divided into three major groups: Firstly Bodo group having aboriginal tribes like Tripuri or Debbarma, Reang, Jamatia, Noatia, Uchai and Garos. Secondly, Kuki group consisting of Lusai, Koloi and Molsom. Thirdly, Arakan group consisting of Chakmaand Mog. The recipes of rice beverage varies community wise having diversity in aroma, taste and alcoholic content which was conserved generation after generation. The ethnic group Tripuris prepare *Gora bwtwk* which is the undistilled form of rice beverage and *Langi/ Chuwak* which is the distilled form of rice beverage. The starter culture is known as *Chuwan beleb* which is prepared by grounding rice with various leaves and barks mentioned in Table 2. This is added with local *atop mairom* (rice), *Rishum* (garlic), *Mosokwthai* (red chilli). These plants are known to have many medicinal benefits preventing degenerative diseases and skin diseases, in treating of common cold and jaundice, nervous diseases etc as mentioned in Table 2. For preparation of *Chuwan beleb*, initially rice is soaked for 2 hours and grinded with all the raw materials and made into dough. Out of this, small flat cake weighing 50-100g is made which is sun dried and kept for future use. This *Chuwan beleb* is used as starter culture for preparation of beverage. For preparation of *Gora bwtwk,* rice is cooked and spread over a bamboo mat for cooling for 2 hours. After cooling, an appropriate amount of *Chuwan beleb* is added to the cooked rice and mixed well (50g in 1 kg). The mixture is kept inside a large container (*batikasla*) and banana leaves are placed on top of it to allow minimum escaping of air. This is kept for 3 days after sealing the mouth of the container with cloth. After fermentation, water is added and kept again for 2 days. The yellowish substance is extracted out and consumed as undistilled rice beverage known as *Gora bwtwk*. For distilled rice beer, *Gora bwtwk* is heated till the vapour gets accumulated in another container (*batibakhrak*) placed on the top of the container, the vapours from *batibakhrak* is then allowed to pass through a bamboo (*batisabasa*) into another container containing cold water (*patini*) for distillation to take place. The distilled liquid so obtained is *Langi/chuwak* which is consumed directly[24].

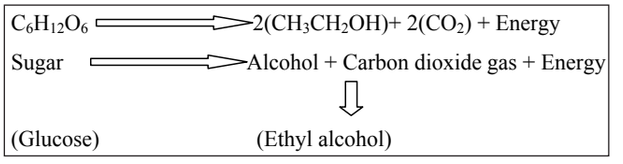
Bhaati jaanr

Bhaati jaanr is a famous traditionally prepared alcoholic beverage consumed by the Nepali tribe of Sikkim, Nepal and Bhutan. It is an inexpensive high calorie mild-alcoholic beverage prepared from locally available glutinous rice. The starter culture cake is called *Marcha*[23,24,25]. During *Marcha* preparation, soaked glutinous rice is mixed with roots of *Guliyo jara* (*Plumbago zeylanica*), leaves of *bheemsen paate* (*Buddleja asiatica*), flowers of *Sengreknna* (*Vernonia cinerea*), ginger, red dry chilli and a pinch of powdered old *Marcha*. The mixture is grounded into paste by adding

water and kneaded into soft dough from which flat cakes of varying sizes and shapes are made. This is then placed on a bed of ferns locally called *Pireuneu* (*Glaphylopteriolopsis erubescens*) and covered with dry ferns and jute bags and kept on the ceiling floor made up of bamboo stripes above the kitchen. These are left to ferment for 1–3 days and sun dried for 2–3 days after which the *Marcha* is ready for use. During production of *Bhaati jaanr*, glutinous rice is cooked properly spread on abamboo mat for cooling (~40°C). After cooling, about 2% *Marcha* is powdered and mixed well with cooked rice and kept in an earthen pot or a vessel for 1–2 days at room temperature for saccharification. After saccharification, the mouth of the vessel is sealed and made airtight and left for fermentation for 2–3 days in the summer and 7–8 days in the winter. After fermentation, fermented mass or *Bhaati jaanr* is stirred with the help of a hand-driven wooden or bamboo-made stirrer and is consumed directly. Sometimes, *Bhaati jaanr* is further stored for a week or more after desired fermentation is completed to obtain a yellowish-white supernatant liquor called *nigaar*, which is consumed neat or after addition of water. It is said that *Bhaati jaanr* is an high-calorie beverage for post-natal women and helps in ailing old persons in the villages who believe it helps to regain their strength and relaxes the body pain. Strains of LAB, Yeast and moulds were isolated from *Marcha* and *Bhaati jaanr.* Molds isolated are *Rhizopus chinensis, Mucor circinelloides* and *Rhizopus stolonifer*. Yeasts were identified as *Pichia anomala, Saccharomycopsis fibuligera, Candida glabrata* and *Saccharomyces cerevisiae.* Among the yeast population, *Saccharomycopsis fibuligera* was found to be more dominant. Recovery of these strains of yeasts in *bhaati jaanr* correlates their sources from marcha [25] which is used in preparation of *bhaati jaanr*. *Lactobacillus bifermentans* and *Pediococcus pentosaceus* were identified as the dominant lactic flora during fermentation of *bhaati jaanr*.

FERMENTATION PROCESS

Ethnic foods are fermented naturally but alcoholic rice beverages require starter cultures and rice for rice beverage production. Although the compositions and techniques differs for the preparation of starter culture and rice beverage, the principle is the same that is fermentation of rice by yeast, moulds and bacteria present in the starter cake. Fermentation is the conversion of complex carbohydrates to simple alcohol and CO_2 or organic acids using bacteria or yeast under anaerobic conditions[27]. The process which occurs in fermentation is the biochemical changes that are saccharification of starch by naturally present yeast and molds. Mold produces the enzyme amylases which help to degrade starch into simple sugar compounds, and these fermentable sugars are converted to alcohol by Yeast. It is simply the process of chemical conversion of complex organic substances into simpler compounds. The traditionally prepared alcoholic beverages made from rice grain and starter cake is through traditionally followed fermentation method which has been passing down from generation to generation. Rice beverages result from the fermentation of rice starch, which is converted into glucose through the process of saccharification by molds present in the starter cake. Further yeast converts this available simple glucose compound to alcohol by the process of amylolysis by secreting enzymes. During the process yeast cells get the energy from the conversion of the glucose into CO_2 and alcohol. Lactic acid bacteria (LAB) and yeasts are responsible for most of these fermentations[29, 2]. The complete fermentation process is to convert glucose sugar ($C_6H_{12}O_6$) to alcohol (CH_3CH_2OH) and Carbon Dioxide (CO_2)[29]. The overall chemical reaction is as follows:



NEUTRACEUTICAL HEALTH BENEFITS

Fermentation is the oldest method of preservation known. It not only helps in preservation but also enhances the nutritional quality of the food, improves flavour and taste by imparting vitamins, amino acids,

Figures showing the steps involved in preparation of Rice Beverage

Fig. 1: Starter Rice Cake covered with Ferns for Fermentation

Fig. 2: Rice starter caked prepared with various medicinal herbs

Fig. 3: Rice is cooked and spread for coolingbefore mixing with Starter Cake

Fig. 4: After fermentation, it forms yellowish beverage ready for harvesting

Fig. 5: Fermented mass is heated in a specially designed set up to obtain distilled Rice Beverage after Distillation process

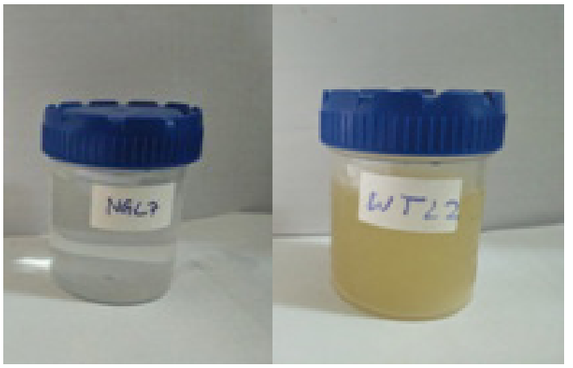


Fig. 6: Undistilled and Distilled Form of Rice Beverages

Figures showing the Rice Beverages of Different Tribes in North-East India

Fig. 1: *Opo, Adi-Galos* Tribe in Arunachal Pradesh

Fig. 2: *Atingba, Meitei* tribe from Manipur

Fig. 3: *Choko* or *Jonga-mod* served with Pork of Rabha Tribe of Assam

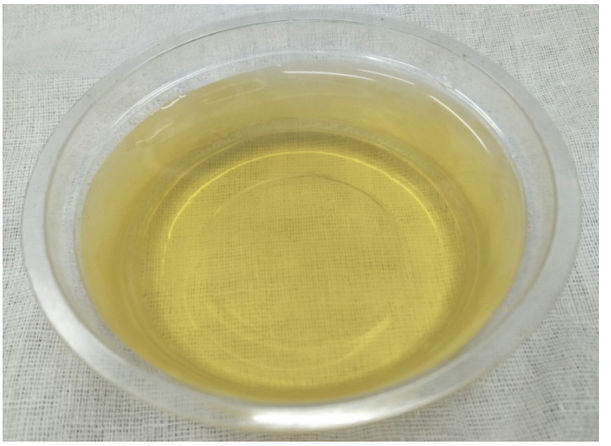


Fig. 4: *Sadhier* or *kiad*, Pnar Tribe of Meghalaya

Fig. 5: *Chubitchi*, Garo tribe of Meghalaya

Fig. 6: *Judima*, Dimasa kachariis of Nagaland[40].

Fig. 7: *Langi*, Rice beverage from Tripura

Fig. 8: *Zutho*, Angami tribe from Nagaland[41]

Fig. 9: *Jou*, Bodo Tribe from Assam

Fig. 10: *Bhaati jaanr*, Nepali Tribe from Sikkim

fatty acids and protein solubility. Fermented products also help in easy digestion and impart nutritional and functional properties of food. Since fermentation takes place by microorganism, these helps in the breakdown of complex food compounds producing various bioactive peptides, leading to considerable increase in the available nutrients of the food[30]. Furthermore, literature has revealed that fermented food products are a good source of amino acids and peptides[31,32,33]. Fermentation may also help in the detoxification of certain undesirable compounds like Tannins, phytates and polyphenols which is formed or present in our body due to consumption of various raw foods. It is also reported that fermented foods helps to control cholesterol, it has anticancer effects, anti-hypertensive effect, and anti-diabetic effect. It also boosts immunity and longevity[34]. The medicinal herbs used in the making of rice beverage give its colour and taste. The microflora also enriched the beverage with flavour and texture. Apart from imparting colour, flavour and sweetness to the beverage, the various plants used in the starter culture are also known to have many medicinal properties. The quality of the starter culture is also known to be dependent on different plant parts used. It is noted that maintenance of proper sanitary

conditions while fermentation is equally important to avoid spoilage of the rice beverage. The nutrients present in the finished product give energy besides its soothing effect and other medical properties to the consumer. It is found to be effective against body ache, headache, insomnia, inflammation, urinary problems, diarrhea, and expelling worms and as a treatment of cholera[8, 9].

Literature surveys reveal that rice beverage is rice in nutritional properties. Some researchers have reported nutritional findings of rice beverages like *Bhaanti jaanr* contains Protein: 9.5%, Carbohydrate: 86.9%, Crude fiber: 1.5%, Fat: 2.0%, Food value: 404.1 kcal/100 gm, K: 146.0 mg/100 gm, P: 595.0 mg/100 gm, Ca: 12.8 mg/100 gm, Fe: 7.7 mg/100 gm, Mg: 50.0 mg/100 gm, Zn: 2.7 mg/100 gm and Mn: 1.4 mg/100 gm[35]. Apart from this the medicinal herbs which are used in the preparation of Rice beverage impart medicinal quality to the beverage which gives its nutraceutical properties.

RICE BEVERAGE AS PROBIOTICS

The Indigenous fermented rice beverage is rich in microbial diversity which could be promising probiotics. Studies have revealed that fermented food products are rich in microbial diversity. Filamentous Moulds- *Mucor circinelloides, Rhizopus chinensis*, Yeast *Saccharomycopsis fibuligera, Pichia anomala, Saccharomyces cervisiae, Candida glabrata: lactic acid bacteria- Pediococcus pentosaceus, Lb. bifermentans* was isolated from Rice beverage, Bhaati jaanr from Sikkim[37]. The starter culture cake Marcha which is used to prepare Bhaati jaanr also contains Filamentous moulds- *Mucor circinelloides, M. heimalis, Rhizopus chinensis* and *R. stolonifer variety lyococcus:* Yeast – *Saccharomyces fibuligera, Saccharomyces capsularies, P. burtonii, Pichia anomala, S. bayanus, Saccharomyces cerevisiae and candida glabrata* and *LAB- Pediococcus pentosaceus, Lb brebis* and *Lb. bifermentans*[25]. Another starter cake Hamei also contains microflora like *Rhizopus* spp., *Mucor* spp.*;* Yeast- *S. cerevisiae, Pichia anomala, P. guilliermondi, P. fabianii, C. parapsilosis, Trichosporon sp., Candida tropicalis, C. Montana and Torulaspora delbrueckii;* LAB- *Lb. brevis, Pediococcus pentosaceus*[19]. Lactic Acid Bacteria and Yeast could be used further as probiotics which will impart health benefits to the consumer.

CONCLUSION

The North-Eastern states have diverse culture and tradition and rich in natural resources. The ethnic indigenous tribal people have been doing fermentation preservation practices since ages. The rich fermented food products like rice beverages, fermented soybean, fermented bamboo shoots, fermented fish and meats shows microbial diversity that reflects how the indigenous ethnic tribal people have been harnessing indigenous microbiota for fermentation. Studies on the microbial diversity and medicinal plant parts used may reveal and prove claimed medicinal properties and beneficial effects of the medicinal herbs used in this beverage. Modern scientific and technological approach should be applied to explore this traditional beverage to produce beneficial outcome. Further development of value added products by selecting potential microbial strains, process improvement, improving process control, raw material improvement, genetic improvement, the use of immobilised systems and/or enzymes, study of probiotic activity and use of well characterized organisms will lead to commercialization of this product. All the different types of rice beverages produced by different ethnic tribes should be documented in a database that can be done by surveying and documenting all the rice beverages manufactured by different ethnic groups of the region, along with raw materials used, different process adapted, nutritional value of the local herbs used, microflora involved in fermentation and the cost involved. These traditional manufacturing techniques of fermentation and preservation could be further improved in terms of standardization, commercialisation and productivity if further research is conducted with support of governing bodies and institutes.

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