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REVIEW PAPER

Plants Used in the preparation of Amylolytic Starters for Cereal-based Alcoholic Fermentation: A Mini-review

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Abstract

The use of herbs for preparing cereal-based alcoholic beverages probably dates back to ancient times. Although the database of such plants is still far from complete, literatures show that this practice prevails in South Asia, the Indian subcontinent, and the neighboring countries in particular. These plants (hereinafter called starter-plants) are used for the preparation of amylolytic starters, which in turn are used for the preparation of a range of traditional alcoholic beverages (both distilled and undistilled) and are also sold in the market as means of livelihood. Based on reports by different authors, the present review lists species of starter-plants from some 36 genera. The starter-plants serve as sources of essential microorganisms (yeasts, molds, and bacteria) for fermentation. However, except for articles written by few authors, work on isolation and identification of microbial flora from starter plants is virtually non-existent. Both starter plants and amylolytic starters have significant socio-economic contributions in the lives of ethnic people of South Asia. Some starter plants fetch very high price on selling and this has led to, at least in some places, their rapid dwindle. For instance, Polygala arillata has become commercially threatened and Inula sp. has become rare.

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Introduction

Herbal formulation for yeast culture for brewing alcoholic beverage from cereals is probably the most ancient method (Hill, 1937). The use of plants (hereinafter called starter-plants) for the preparation of traditional amylolytic cultures in the Indian subcontinent has been reported by many workers, including Das & Deka (2012), KC et al. (1999), Sekar & Mariapan (2007), and Tamang et al. (2012). However, except for the fragmentary work carried out by Rai & Subba (2003) and KC et al. (1999), research on phylloplane and/or rhizoplane floras of the starter-plants is relatively scant. The database of such plants is also far from complete. The latest work by Chaudhary et al. (2023) gives a comprehensive account of ethnic alcoholic beverages (and the plants used for their preparation) of Nepal Himalaya but fails to mention that these plants serve as an inexhaustible source of essential microorganisms (amylolytic molds and fermentative yeasts). This paper attempts to conduct an inventory, based on different reports and journals, of the plants used in South Asia (the Indian subcontinent in particular) for preparing amylolytic starters for cereal-based alcoholic fermentation.

Review of Literature

The use of herbs for preparing cereal-based alcoholic beverages probably dates back to ancient times (Hill, 1937). This ancient practice has been handed down through generations and has become a subject of renewed interest in the scientific community. Literatures show that this practice prevails in South Asia, the Indian subcontinent, and adjoining countries in particular. Fermentation using fungal starters prepared by incorporating starter-plants is the standard practice today. Direct use of starter-plants is probably not practiced.

Review of early literature on fungal amylolytic preparations by Kozai (1901) credits Hoffman & Korshelt as the first writers on this subject (in the late 1870's) in the context of sake (Japanese rice wine) (Reese, 1947).

The rationale for using plant ingredients for amylolytic starter preparation

It is generally considered that plants used in the preparation of amylolytic starters are an inexhaustible source of essential microorganisms (yeasts, molds, and bacteria) (KC et al., 2001) but some authors (Saikia et al., 2007) propose that leaves of a few wild plants act as attracting agent of yeast – *Saccharomyces cerevisiae*. Tanti et al. (2010) mention that plants used in starter

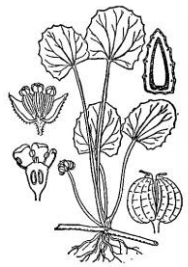
making give intoxicating property to the liquor and the use of *Datura metel* (Indian thorn apple / devil's trumpet) seeds by Ahom community of Assam can be taken as an example.

Polygala arillate

Piper nigrum

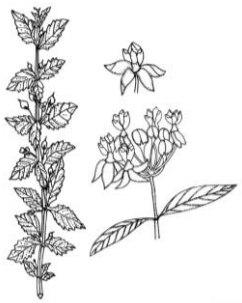
Elephantopus scaber

Vernonia cinerea



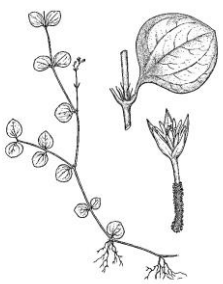
Centella asiatica

Buddleja asiatica



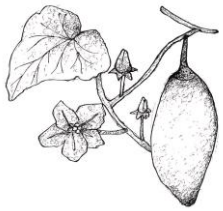
Scoparia dulcis

Christella appendiculata



Drymaria cordata

Vernonia cinerea



Coccinia grandis

Buddleja asiatica

Figure 1
Some plants used in starter making

As such, all parts of *Datura metel* contain dangerous levels of tropane alkaloids, which are toxic even in small quantities (McGuigan et al., 2001). Thakur & Bhalla (2004) stated that herbal mixtures in traditional alcoholic beverages provide bioactive compounds as well as stimulatory effects. Study carried out by Panda & Bastia (2014) in Odisha (India) revealed that the tribals had no idea about the authentic role of plants in the fermentation. According to their (native's) knowledge, either yeast is formed from these plants, or these plants are responsible for the yeast's action in fermentation. These authors also carried out quantitative phytochemical analysis of several plants used for starter preparation and found presence of alkaloid, flavonoid, carbohydrate, protein and amino acids, tannins, and phenolic compounds, and saponins in most plants. The authors concluded that the plants they studied had antimicrobial properties.

Table 1
Brewing Potentials of Pure Yeast Cultures Isolated from 4 *Murcha* and 2 Non-*murcha* Plants

Source (plant)	***Part(s) used***	***Yeast***	***Beverage quality***
Hibiscus rosa-sinensis* (L.)	Flower	*Zygoascus hellenicus*	Unacceptable (putrid)
Scoparia dulcis* (L.)	Whole plant	*Zygosaccharomyces bailii*	Unacceptable (putrid)
***Vernonia cinerea* (L.) Less**	Whole plant	*Saccharomyces cerevisiae*	Good (clean)
***Vernonia* spp.**	Whole plant	*Pichia anomala*	Good (clean) Good (note of acetone) Good (note of foreign odor)
Polygala arillata	Root bark	*Filobasidium capsuligenum*	Sour (note of acetic acid and lactic acid)
***Lantana camara* (L.)**	Fruit	Unidentified	No perceptible change)

Note. * Non-murcha plant

Panda et al. (2014) claimed that sweetness of liquor is developed by the use of tuberous roots of *Coccinia grandis* (L.) (Voigt.), whole plant (including fleshy roots) of *Vernonia cineria* (L.) (Lessing) and leafy twigs of *Scoparia dulcis* (L.). Similarly, they report that young and soft leaves of *Clerodendrum viscosum* (Ventinat), barks of Rauwolfia serpentine (L.) Benth. and

Wattakaka volubilis (Hoof. F.) Staph. produce a bitter taste. Leafy branches of *Plumbago zeylanica* (L.) act as a process enhancer. Roots of *Stephania japonica* (Thumb.) Miers and *Stephania glabra* (Roxb.) Miers are used for long storing. Roots of *Mussaenda roxburghii* (Hook. f.) and leaves of *Artocarpus heterophyllus* (Lamk) impart sweetness and yellowish tint to the liquor. The alcoholic beverage produced using *ranu* has low alcohol content and does not make the consumer alcoholic. Rather, the fermentation product increases the antimicrobial potential along with the growth of probiotic LAB and yeast.

Rai (2006) stated in his dissertation work that inclusion of plant parts (*murcha* plants) not only supplies fermentation flora but also contributes to increased surface area (by giving porous structure) of the starter cake, thereby providing adequately aerobic environment for the profuse growth of the essential microorganisms. The plant fibers also function as a binder and prevent the otherwise brittle *murcha* cake from falling apart during handling.

Literatures abound on the different types of plants used by native peoples of different countries of South Asia and so do on different amylolytic starters and the range of microorganisms they (the starters) harbor. It is very strange, except for the articles by KC et al. (1999) and Rai & Subba (2003), none of the works so far available report presence of yeasts and molds in the ingredient plants. The authors have also devised methods for screening, characterization and preservation of the yeast flora and evaluation of brewing value of the ingredient plants. Their articles have the following conclusion:

"*Murcha* trade is a lucrative business among many ethnic groups of Nepal. The over-harvesting and indiscriminate cattle-grazing of the *murcha* plants have resulted in rapid dwindling of many such plants. The present study can be useful in controlling this situation. Introduction to the ethnic groups of simplified protocol for maintaining yeast culture rather than raping the countryside each time they need the plant could have far-reaching consequences: it will not only improve the livelihood of the *murcha* makers (by enabling them to produce and sell *murcha* of consistent quality) but also help maintain the floral diversity. The method described therein shows that not all *murcha* plants are equally good for *murcha* making. In fact, some could be excluded (and therefore spared) from the formulation. Finding the right plant, traditionally, is a very tedious process. The method described in the authors' work can be a simple and rapid alternative for the primary screening of *murcha* plants with excellent brewing potential. The method used here for the preservation of the culture can also be modified to suit local conditions".

According to Rai & Subba (2003) 10 plants, viz., *Buddleja asiatica* Lour., *Centella asiatica* (L.), *Christella appendiculata* (Bl.) Holtt., *Clematis grewiaeflora* Buch. Hum., *Drymaria cordata* Willd., *Elephantopus scaber* (L.), *Piper nigrum* (L.), *Polygala abyssynica*, *Scoparia dulcis* (L.) and *Vernonia cinerea* (L.) Less all showed presence of *Saccharomyces* spp. in the molasses enrichment medium the authors used.

An earlier study carried out by KC et al. (1999) to isolate fermentative yeasts from 6 plants (4 *murcha*- and 2 non-*murcha*) showed that 3 *murcha* plants produced organoleptically acceptable beverages while both the non-*murcha* plants produced beverages of unacceptable (putrid) quality (Table 1). These investigators' findings indicate that not all plants have brewing values and even among the *murcha* plants, brewing values differ. Although *Polygala arillata* has been traditionally prized for *murcha* making, the authors observed contradictory results. The plant was found to harbor *Filobasidum capsuligenum* which, unfortunately, is a non-maltose fermenter.

The contribution of *Filobasidum capsuligenum* yeast (and hence the host plant) to cereal-based fermentation is therefore questionable. *Scoparia dulcis*, one of the plants used for starter preparation, also appeared useless.

A recent study (unpublished) on *Polygala arillata* roots (collected from Sangu, Taplejung district, Nepal) by the present authors in 2016 showed the presence of three morphologically distinct yeast types. Unfortunately, none of them were found to have brewing potential. This finding agrees with the earlier speculation about the questionable brewing value of this plant.

Rai (2006) claimed that *murcha* makers are very particular about the choice of plants (or their parts) for *murcha* making and the findings of KC et al. (1999) also corroborate the claim. Rai (2006) further maintains, because many of the *murcha* plants are already rare and/or threatened, isolation of the desirable microorganisms from the starter and propagation in the laboratory for use in *murcha* making can be considered ecologically justifiable.

Starter-plants used in Southeast Asia and neighboring countries

Sota & Tetsuo (2011) have compiled from 19 different sources 69 starter-plants used in starter making in Southeast Asia and neighboring regions. The authors list 29 plants (their parts) for starter making in India and Nepal, viz., *Albizia kalkora* (bark), *Albizia myriophylla* (bark), *Amomum subulatum*, *Artocarpus heterophyllus*, *Asclepias acida*, *Asplenium esculentum*, *Buddleja asiatica* (leaf), *Capsicum* spp. (fruit, leaf), *Cinnamomum glanduliferum* (leaf, bark), *Cinnamomum zeylanicum*, *Cissampelos pareira* (whole, tuber), *Cynodon dactylon* (whole), *Ficus religiosa*, *Gaultheria* spp. (leaf), *Imperata cylindrica* (tuber), *Leucas aspera* (leaf, flower), *Lygodium salicifolium* (whole), *Madhuca longifolia* (flower), *Piper betle* (leaf), *Piper longum*, *Plumbago zeylanica* (root), *Ruellia suffruticosa* (root), *Rumex* spp., *Saccharum officinarum*, *Scoparia dulcis* (whole), *Solanum indicum* (leaf, fruit), *Syzygium cumini* (fruit), *Vernonia cinerea* (leaf, flower), and *Zingiber officinale* (rhizome). A few important starter plants used in southeast Asia are shown by line diagrams in Figure 1.

Starter-plants used in Cambodia

Sota & Tetsuo (2011) have mentioned wide use of spices, herbs, and a sweet ingredient to make starters in Cambodia (Table 2).

They have discussed the two different methods of starter production, viz., (i) based on rice wine culture and (ii) based on rice liquor culture. The dispersal routes of starter cultures in Southeast Asia remain unknown because there are few historical documents in this region, unlike in China, Korea, and Japan. Although there have been many microbiological studies on starters, e.g., those by Hesseltine et al. (1988), Tamang et al. (2007), Tamang & Fleet (2009), Tamang (2010), there is little information on the production process in this region, partly because the techniques are often practiced as a hereditary trade that is secretly passed from parents to children.

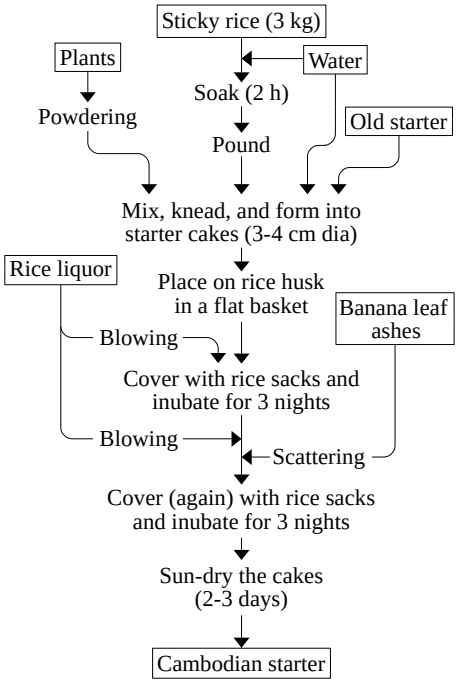


Figure 2
Starter preparation in Cambodia

Table 2
Starter-plants used in starter making in Cambodia

Local name	*Scientific name*	*Users (n=69)*	*Plant parts*
Mtés	*Capsicum annuum*	57	Fruit, calyx
Rum'dé:ng	*Alpinia galanga*	51	Tuber, stem
Chhë 'aèm	*Albizia myriophylla*	44	Bark, root
Mré:ch	*Piper nigrum*	27	Dried fruit
Âmpöw	*Saccharum officinarum*	26	Stem, leaf
Khtüm sâ:	*Allium sativum*	25	Bulb
Khnhéi	*Zingiber officinale*	16	Tuber
Chhë plë:ng	*Unidentified*	10	Bark
Ngamngaam	*Unidentified*	9	Stem, root
Déi phléi	*Piper retrofractum*	7	Dried fruit
Phka chan'	*Illicium verum*	7	Dried fruit
Chondok	*Boesenbergia pandurata?*	5	Tuber
Krâva:nh	*Amomum krervanh*	4	Fruit, tuber
Chophkrong	*Solanum spp.*	4	Fruit, leaf, root
Smau se	*Cyperus rotundus*	4	Root
Chaplu:	*Piper lolot*	3	Root
Chë:ng cha:b	*Dasymaschalon lomentaceum*	3	Root
Donka:y	*Lepisanthes rubiginosa?*	3	Stem, root, leaf
Khnaö(r)	*Artocarpus heterophyllus*	3	Leaf
Mboong	*Unidentified*	3	Root, stem, leaf
Phrit	*Musa spp.*	3	Root, pericarp
Prèah khlâ:b	*Mimosa pudica?*	3	Root
Teppiru:	*Cinnamomum tetragonum*	3	Bark
Maak phao	*Cocos nucifera*	2	Root
Kâkâhs	*Sindora siamensis*	2	Fruit
Krâvan'	*Mitrella mesnyi*	2	Stem
Law haw	*Myristica fragrans*	2	Dried fruit
Nhô	*Morinda spp.*	2	Root
Pea chaa:b	*Costus speciosus?*	2	Root
Phlang	*Glycosmis pentaphylla*	2	Root
Rumdenh miëhs	*Prismatomeris tetrandra*	2	Root
Sla:	*Areca catechu*	2	Root
Smach'	*Melaleuca cajuputi*	2	Stem
Ângkât khmau	*Diospyros bejaudi*	1	Root
Chumpu:	*Syzygium jambos*	1	Root, leaf
Kânh ché ba:y da:ch	*Capparis micracantha*	1	Root
Khvöt	*Limonia acidissima*	1	Bark
Klam' pu:	*Syzygium aromaticum*	1	Bud
Kôki	*Hopea odorata?*	1	Root
Kôor	*Ceiba pentandra*	1	Dried flower
Khua khao hor'	*Tinospora crispa*	1	-
Mchul miëhs	*Ixora spp.*	1	Root
Mré:ch tônsa:y	*Baechea frutescens*	1	Root
Mrèahs pröw	*Ocimum tenuiflorum*	1	Stem, leaf
Phoo kiau	*Piper betel*	1	Dried leaf
Sdau	*Azadirachta indica*	1	Bark
Smau kântroëy	*Chrysopogon aciculatus*	1	Root
Smau' phluk	*Panicum repens*	1	Root
Thaloong	*Carica papaya*	1	Fresh root
Yar hua	*Smilax glabra*	1	Root

Yoshida (1993) attempted to reveal the dispersal routes of fermentation starters by means of a field survey in Southeast Asia. He pointed out that the process of producing alcoholic beverages, including starters, in Borneo appeared similar to that used in mainland Southeast Asia, and he hypothesized that the use of charcoal and capsicum (chili peppers) in rituals related to alcoholic beverages might have been introduced into Borneo from the mainland after the 15th century.

Sota & Tetsuo (2011) have reported that the traditional production of amylolytic starters in Cambodia is gradually dying. Based on his interview of 39 Khmer respondents, the main reasons for this were the tedious nature of production (especially pounding the rice and plants), difficulty in collecting the required plants, and easy access to markets where inexpensive starters were available – although many people complained that the rice wine or liquor made with Vietnamese or Chinese starters gave them a bad headache or stomach problems.

Starter-plants can be roughly divided into two categories (Sota & Tetsuo, 2011): (i) spices and herbs (*Capsicum* spp., *Alpinia* spp., *Zingiber officinale*, *Cinnamomu* spp., etc.) and (ii) sweet ingredients (*Albizia* spp., *Cinnamomum* spp., *Saccharum officinarum*, etc.).

Method of starter preparation in Cambodia

Several basic production processes of fermentation starters in Cambodia are described in considerable detail by Sota & Tetsuo (2011) and Yamamoto (2016). The starter is variously named (depending on the ethnic group), such as *dombae*, *mae sra*, *pru* (*bru*), *praa*, *paeng*, *krrow*, etc. One process that entails use of plant materials is as in Figure 2.

Starter-plants used in Nepal

The amylolytic starter (usually ball- or cake-shaped) used in Nepal (also in parts of India, and Bhutan) for the preparation of traditional alcoholic beverages (mainly cereal-based) is called *murcha* (Rai & Subba, 2016). *Jand* (cereal beer) and *raksi* (distilled alcohol) are the most important alcoholic beverages produced in Nepal using murcha starter. KC et al. (2001) surveyed 10 districts and 27 localities of eastern Nepal to include 16 ethnic groups and found use of 42 plants (2 ferns, 5 monocots and 35 dicots) for the preparation of *murcha*. The details of the plants are shown in Table 3.

According to the authors' report, of the plants presented in Table 2, two species, viz., *Polygala arillata* and *Inula* sp. can be considered rare. Katz (2012) recounted use of about 13 plants (banana leaves and peels, sugarcane leaves, young pineapple leaves, ginger root, hot pepper flakes and leaves, among others) for *marcha* [sic] making in Nepal. The author also describes a typical method of *murcha* cake preparation. Tamang & Sarkar (1995) have mentioned the use of *chitu* (*Plumbago zeylanica* (L.)), *Bhimsenpate* (*Buddleja asiatica* Lour), ginger and chili as plant ingredients for *murcha* (Figure 3).

KC et al. (2001) reported that *Polygala arillata* as the most prized *murcha* plant, with its semi- dried rook-bark and flowers selling at 270 (NRs) per kg (back in 1999). A recent communication by one of the authors of this paper revealed that the price of the same item has reached NRs 4000 per kg (as of 2020). The authors have also reported that *murcha* makers are very particular about the choice of plants (or their parts) for *murcha* making.

According to earlier report, the top ten *murcha* plants (in descending order of importance) are *Polygala arillata*, *Vernonia cinerea*, *Clematis grewiaeflora*, *Buddleja asiatica*, *Christella appendiculata*, *Polygala* sp. and *Inula* sp. Poudel (2008) has dubbed *Polygala arillata* as *marcha* [sic] plant and mentions its use as compulsory and effective in *murcha* making.

Table 3
Particulars of *Murcha* plants from Eastern Nepal

Plant	*Vernacular name*	*Plant part(s) used*
***Ananas comosus* (L) Mer.**	*Anaras*	Leaf
Anaphalis triplinevis	*Buki phool*	Whole
***Artocarpus heterolphyllus* Lamk.**	*Rukh katahar*	Fruit-stalk, leaf and bark
***Asparagus racemosus* Willd**	*Kurilo*	Root
***Buddleja asiatica* Lour.**	*Bhimsenpati*	Leaf and tender shoot
***Capsicum annum* (L.)**	*Khursani*	Fruit
***Carica papaya* (L.)**	*Mewa*	Root
***Centella asiatica* (L.)**	*Ghodtapre*	Whole
Clematis grewiaeflora	*Mahagagro*	Whole
***Clerodendrum indicum* (L.) Kize**	*Bhatu*	Tender shoot
***Christella appendiculata* (Bl.) Holtt**	*Pire uneu*	Tender leaf
***Dolichos lab-lab* (L.)**	*Hiude simi*	Root
Drymaria cordata Willd.	*Abhijalo*	Whole
***Elephantopus scaber* (L.)**	*Mulapate*	Root
***Elephantopus* spp.**	*Anglah lena*	Whole
***Geniosporum coloratum* D. Don**	*Sengreng*	Tender shoot and flower
***Ichnocarpus fructescens* R. Br**	*Dudhe*	Whole
***Ichnocarpus* spp.**	*Tite*	Root bark
***Inula* spp.**	*Chhatre*	Whole
***Juglan regia* (L.)**	*Okhar*	Bark
***Ophiopogon parviflorus* (Hook. f)**	*Lasunpate*	Root-tuber
Piper chaba Hunder	*Chabo*	Whole
***Piper longum* (L.)**	*Pipla*	Whole
***Piper nigrum* (L.)**	*Marich*	Whole
***Plumbago zeylanica* (L.)**	*Chitu*	Whole
***Polygala abyssinica* Buch. Hum.**	*Gahate jhar*	Whole
***Polygala arillata* Buch. Hum**	*Khedeii*	Root bark and flower
***Polygala triphyla* Buch. Hum.**	*Pulukna*	Whole
***Polygala* sp.**	*Angtellek*	Whole
***Pteridium revolutum* (Bl.) Nakai**	*Uneu*	Tender leaf
***Scoparia dulcis* (L.)**	*Chini jhar*	Whole
***Sida acuta* Burm F**	*Khareto*	Leaf
***Spergula arvensis* (L.)**	*Lwangta*	Whole
***Spilanthus acmella* (L.) Less**	*Pire jhar*	Whole
***Vernonia cinerea* (L.) Less**	*Phulange*	Whole
***Vernonia* spp.**	*Nighare*	Whole
***Woodfordia fructicosa* Kurtz**	*Dhaenro*	Flower
***Zingiber officinale* Roxb.**	*Aduwa*	Rhizome

However, the illegal trade, high demand, and unsustainable harvesting practice in Nepal has made it an indeterminate plant toward the risk of extinction.

Methods of *murcha* preparation in Nepal

The method of *murcha* preparation varies from place to place, depending on the availability of the raw materials (plant ingredients and substrate) and the know-how handed down to the generation. The *murcha* maker may use one to as many as 12 plants in a single *murcha* formulation (Katz, 2012; Tamang & Sarkar, 1995; Rai & Subba, 2003). Despite this variation, every *murcha* maker invariably uses a *murcha* from previous batch as the mother culture (the back-slopping process).

Murcha thus prepared can be stored for more than a year. This art and technology are protected as hereditary trade and passes from mother to daughter. The *murcha*-making villages have linkages to nearby markets where *murcha*-makers sell the products once or twice a week in Sikkim. *Murcha* is similar to amylolytic mixed starters of other regions of Northeast India such as *hamei* of Manipur, *pham*, *ipoh* and *phab* of Arunachal Pradesh, *hunao* of Assam and *thiat* of Meghalaya (Tamang et al., 2012).

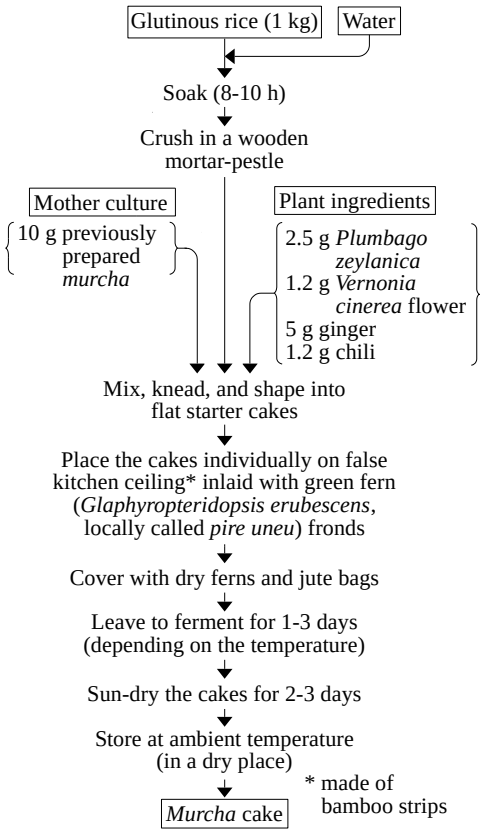


Figure 3
Murcha preparation in Nepal

Table 4
Starter-plants used by the Deori Tribes for *Mod Pitha* preparation

Plant name {Family}	*Local name*	*Plant parts*
Allium sativum* (L.) *{Liliaceae}	*Nohoru*	Bulb
Artocarpus heterophyllus* Lamk. *{Moraceae}	*Kathal*	Leaves
Ananas comosus* (L.) Merr. *{Bromeliaceae}	*Anaras*	Bark
Alpinia malaccensis* Rosc. *{Zingiberaceae}	*Dubushining*	Leaves
Alternanthera sessilis* (L.) R. Br. ex DC. *{Amaranthaceae}	*Khutura*	Leaves
Capsicum annuum* (L.) *{Solanaceae}	*Jolokia*	Fruit
Cinnamomum bejolghota* (Buch.-Ham) Sw. *{Lauraceae}	*Kotokou*	Leaves
Centella asiatica* (L.) Urban. *{Apiaceae}	*Mani moni*	Leaves
Coffea bengalensis* Roxb. *{Rubiaceae}	*Lata duamali*	Leaves
Costus speciosus* J. E. Sm. *{Costaceae}	*Jomlakhuti*	Leaves
Desmodium* spp. *{Papilionaceae}	*Bonguti*	Leaves
Cyprus* spp. *{Cyperaceae}	*Karkatua bon*	Leaves
Desmodium pulchellum* (L.) Benth. *{Papilionaceae}	*Sepeta bonguti*	Leaves
Equisetum* spp. *{Equisetaceae}	*Nangoljuradia bon*	Leaves
Lygodium flexuosum* (L.) Sw. *{Lygodiaceae}	*Sisia dhekiya*	Leaves
Melastoma malabathricum* (L.) *{Melastomataceae}	*Thut kola agg*	Leaves
Mussaenda roxburghii* Hook. f. *{Rubiaceae}	*Peseka*	Leaves
Myxopyrum smilacifolium* (Wall.) Bl. *{Oleaceae}	*Khorkhoria kula*	Leaves
Naravelia zeylanica* (L.) DC. *{Ranunculaceae}	*Garapchoi*	Leaves
Oryza sativa* (L). *{Poaceae}	*Dhan*	Rice grains
Psidium guajava* (L.) *{Myrtaceae}	*Modhuri*	Leaves
Pothos scandens* (L.) *{Araceae}	*Kokalsia*	Leaves
Pteridium aquilinum* (L.) *Kuhn. {Pteridaceae}	*Bihlongoni*	Fronds/ roots
Pycnarrhena pleniflora Miers. {Menispermaceae}	*Khorkhoria pat*	Leaves
Rubus* spp. *{Rosaceae}	*Belipoka pat*	Leaves
Saccharum officinarum* (L.) *{Poaceae}	*Kuhianar*	Leaves
Selaginella semicordata* (Wall) Spreng *{Selaginellaceae}	*Kopau dhekia*	Leaves
Scoparia dulcis* (L.) *{Scrophulariaceae}	*Bon dhuniya*	Leaves
Solanum torvum* Sw. *{Solanaceae}	*Bhekuri*	Leaves
Thunbergia grandiflora* Roxb. *{Acanthaceae}	*Phirphiria pat*	Leaves
Zanthoxylum oxyphyllum* Edgw. *{Rutaceae}	*Tesmoi lota*	Leaves
Zingiber officinale* Rosc. *{Zingiberaceae}	*Ada*	Bulb

Starter-plants used in Assam (India) by the Deori tribes

Deori et al. (2007) have listed 32 plants used by Deori tribes of Assam, India for the preparation of mod *pitha*, a natural starter

for local rice beer called *sujen* (Table 4). According to the authors, the methods of preparing *mod pitha* among the tribal members were the same. However, the number of plant species used varied from family to family.

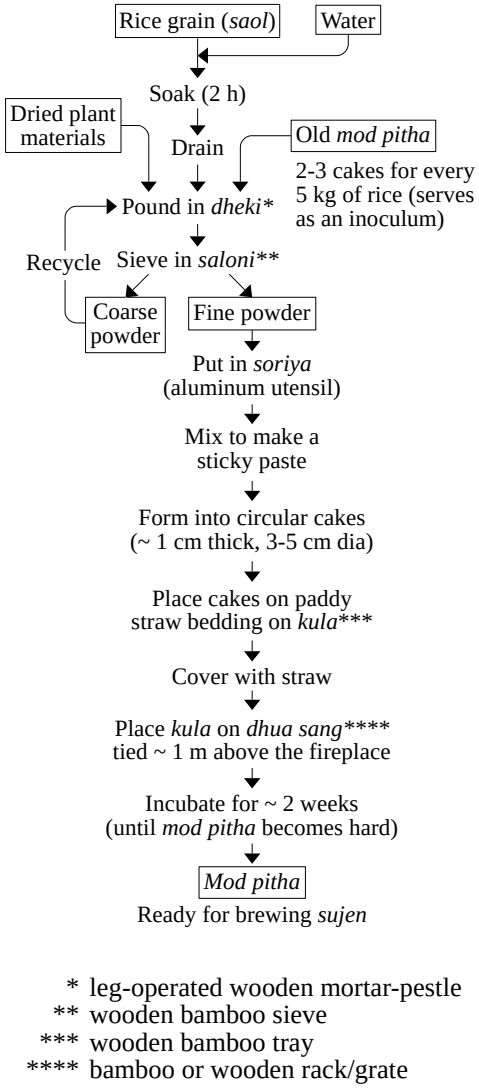


Figure 4
Mod pitha preparation by Deori tribes

Method of starter preparation by Deori tribes

The general method of *mod pitha* preparation is given in Figure 4 (Deori et al., 2007).

Deori et al. (2007) mention that now-a-days only a few plant species are being used. Of all the total 32 plants they collected, only 20 plants, viz., *Artocarpus heterophyllus*, *Cinnamomum bejolghota*, *Costus speciosus*, *Desmodium pulchellum*, *Coffea bengalensis*, *Cyperus* species, *Equisetum* species, *Lygodium flexuosum*, *Melastoma malabathricum*, *Mussaenda roxburghii*, *Myxopyrum smilacifolium*, *Naravelia zeylanica*, *Pothos scandens*, *Psidium guajava*, *Pteridium aquilinum*, Pycnarrhena *pleniflora*, *Rubus* species, *Scoparia dulcis*, *Thunbergia grandiflora*, and *Zanthoxylum oxyphyllum* were reported to be essential and the rest give flavor to *sujen*. The authors have not mentioned in their work as to why these plants are essential.

Table 5
Starter-plants used in the preparation of *ranu* tablets

Plant name	*Local name*	*Plant parts*
***Asparagus racemosus* Willd.**	*Gaisiro*	Root
***Cissampelos pareira var. hirsuta* (Buch.-Ham. Ex DC.) Forman**	*Andiakidula*	Root, Leaf
***Clerodendrum serratum* (L.) Moon**	*Samarkand*	Root, Leaf
***Coccinia grandis* (L.) Voigt**	*Banokunduri*	Root tuber
***Dioscorea* spp.**	*Sanga*	Root tuber
***Dipteracanthus suffruticosus* (Roxb.) Voigt**	*Chaulia*	Root
***Elephantopus scaber* (L.)**	*Tatmuli*	Root
***Gardenia gummifera* (L.) f.**	*Bhurudu*	Young shoot
***Holarrhena pubescens* (Buch.-Ham.) Wall. ex. G. Don**	*Kuruchi*	Bark, Seed
***Homalium nepalense* (Wall.) Benth.**	*Danmari*	Bark
***Lygodium flexuosum* (L.) Sw.**	*Mahajal*	Root
***Madhuca longifolia* (Koenig) MacBride var. *latifolia* Roxb.**	*Matkam*	Seed, Leaf, Bark
Ochna obtusata* DC. var. *obtusata	*Otchampa*	Root
***Orthosiphon rubicundus* (D.Don) Benth.**	*Chandua*	Root tuber
***Polygala crotalarioides* Buch.-Ham. ex. DC**	*Lilkathi*	Bark
***Phoenix acaulis* Roxb. ex. Buch.-Ham.**	*Khajuri*	Root
***Rauwolfia serpentina* (L.) Benth.**	*Patal Garuda*	Root
***Smilax macrophylla* Roxb.**	*Ramadantani*	Root, Stem
***Woodfordia fruticosa* (L.) Kurz**	*Icheba*	Flower
***Xantolis tomentosa* (Roxb.) Raf.**	*Ghurmur*	Fruit

Starter-plants used in Northern Odisha, India

Panda et al. (2014) have compiled from 29 sources a total of 20 plant species (belonging to 18 genera) used in the preparation of *ranu* or *bhakar* tablets. These tablets are used as starters for preparing traditional, cereal-based alcoholic drinks, e.g., *hadia* or *haria* or *handia*. *Handia* is a very popular drink among the tribals of northern Odisha (formerly rendered Orissa), India. A truncated form of the list is shown in Table 5. According to Panda and Bastia (2014), some species, viz., *Asparagus racemosus* (Willd.), *Cissampelos pareira* var. *hirsuta* (L.) (DC) Forman, *Clerodendrum serratum* (L.) Moon, *Coccinia grandis* (L.) Voigt, *Holarrhena antidysenterica* Wall. ex. A. DC., *Woodfordia fruticosa* (L.) Kurz., and *Rauwolfia serpentina* (L.) Benth. are commonly used by the people of all localities while plants such as *Madhuca longifolia* (Koenig), *Smilax macrophylla* (Roxb.), *Elephantopus scaber* (L.), *Gardenia gummifera* (L.) f., and *Dioscorea* spp. are rarely used.

Table 6
Starter-plants used in the preparation of *ranu* tablets

Plant name	*Local name*	*Plant parts*
***Argyreia bella* (C. B. Clarke) Raizada**	*Chhit*	Root
***Bombax ceiba* (L.)**	*Semar*	Root
***Buchanania lanzan* Spreng.**	*Char*	Leaves
***Casearia graveolens* Dalz.**	*Chilhi*	Root
***Cassine glauca* (Rottb.) O. Ktze**	*Jamrasi*	Stem bark
***Cissampelos pareira* (L.)**	*Parhi*	Root
***Crotalaria albida* Heyne ex Roth**	*Choate ghurguli*	Root
***Cryptolepis buchanani* Roem. & Schult.**	*Kali dudhi*	Root
***Datura metel* (L.)**	*Dhatura*	Root
***Elephantopus scaber* (L.)**	*Manjur choti*	Root
***Euphorbia prolifera* Buch. – Ham. ex D. Don**	*Tisi*	Root
***Hemidesmus indicus* (L.) R.Br.**	*Dudhiya*	Root
***Holarrhena pubescens* Wall. ex Don**	*Korya*	Root/stem bark
***Knoxia sumatrensis* (Retz.) DC.**	*Khudi kanda*	Whole plant
***Pueraria tuberosa* (Willd.) DC.**	*Patal kumhra*	Root
***Scoparia dulcis* (L.)**	*Bhui dhania*	Root/Whole plant
***Senecio nudicaulis* Buch.-Ham. ex D. Don**	*Ban sarson*	Root
***Symplocos racemosa* Roxb.**	*Lodh*	Stem bark
***Tylophora rotundifolia* Buch.- Ham. ex Wt.**	*Bhuli*	Root
***Wattakaka volubilis* (L. f.) Stapf**	*Gai lakhan*	Leaves

Pandia & Bastia (2014) report that depending on the season and availability in a particular locality, plant parts of one or more species are used. The exact ratio of different plants used for *ranu* preparation could not be ascertained as the informants were reluctant to disclose the same. However, *Cissampelos pareira* var. hirsuta (Buch.-Ham. Ex DC.) Forman forms the major part in most of the preparations (70%) followed by other plants in combination (1-30%).

Kumar & Rao (2007) have reported use of 20-25 plant species in the preparation of amylolytic starter tablets *ranu* (or *ranu goti*) (Table 6).

Ranu is used in the preparation of rice beer *handia* by the tribals of Central India and Northern Odisha. The list of plants tabulated in Table 5 has some differences when compared with that reported later by Panda et al. (2014). The authors of this review suspect that the term *handia* comes from *handi* (clay pot) that is normally used for the fermentation of rice beer.

Method of starter preparation in Odisha

A typical process of *ranu* or *bhakar* production is given in Figure 5 (Panda et al., 2014). Literatures reveal that there are some differences in the method of preparation of *ranu*. According to Kumar & Rao (2007), *ranu* tablets play an important role in the preparation of *handia*: it acts as yeast starter or fermenter and help in fermentation of *handia*. The authors define *ranu* tablets or *ranu goti* as the mixture of roots, barks and rhizomes of about 20-25 plant species bound with rice flour. For preparation of tablets, rice is soaked in water, pounded, and kept in shady place for drying.

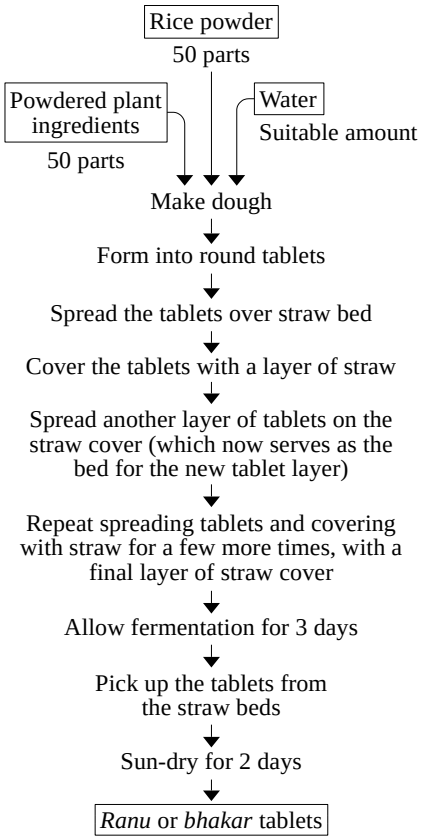


Figure 5
Ranu (*bhakar*) preparation in Odisha

The plant species used in preparation of *ranu goti* are collected mostly from forests, and sometimes grown in the kitchen garden. The roots, leaves, bark, seeds of the plants are sun-dried and pounded into powder. The powder is mixed with flour thoroughly in the ratio 1:2 (powder: rice flour) and rolled into small pieces in the form of small cakes. These tablets are kept in a closed room for drying. After drying, the *ranu* tablets are used for preparing local beverages.

Starter-plants used in Northeast India

Das et al. (2012) carried out a field survey in the tribal communities of Northeast India (rural areas of the states of Assam, Nagaland and Arunachal Pradesh) in 2010 to find out the methodology of rice beer preparation and the various plant

materials used in starter culture preparation. The authors' findings on plant materials are presented in Table 7.

Tanti et al. (2010) also surveyed 11 ethnic tribal population of Northeast India. Their data on plants used for starter preparation is shown in Table 8. However, these authors have mentioned nothing regarding the specific plant parts and the amounts used for starter preparation. The authors have listed two plants used by local Nepalese people.

Method of starter preparation in Tons valley, Uttarakhand, India

The natives (the Jausari tribe) of Ton valley (Uttarakhand, India), use a starter called *keem* to produce ethnic drinks like *soor* (distilled) and *pakhoi* (produced by fermenting jaggery and barley). In the process of *keem* preparation, villagers collect different species of plants during the rainy season (Rana et al., 2004; Tomar et al., 2023a; Tomar et al., 2023b).

About 8 kg of chopped fresh twigs of *Cannabis sativa*, 5 kg leaves of *Sapindus mukorossi* and 10-15 kg in total of different plant species (as listed in Table 9) are dried in the shade and powdered. The powder prepared from the plants is mixed with about 50 kg of barley flour. To the desired quantity of above dry mixture is added a sufficient quantity of *jayaras* (an infusion prepared by keeping finely chopped leaves and tender parts of *Melia azedarach*, *Zanthoxylum armatum*, *Leucas lanata*, and *Dicliptera roxburghiana* in a big container for whole night) and doughed into a round cake of about 1-2 kg weight. By repeating this process many cakes are prepared for use round the year.

The cakes so formed are further processed by placing them on plant bed (locally called *sathar*) made up of tender shoots of *Cannabis sativa* and *Pinus roxburghii* alternately between the cakes in a closed room. The whole setup is allowed to remain undisturbed for 24 days. On the 25th day, the room is opened and the cakes are put upside down and allowed to remain there for 12 days. The cakes are then taken out and allowed to dry in the sun or open air. When the cakes dry up, they are ready for use as the starter for fermentation of liquor called *soor*, a distilled beverage with 35-40% alcohol (Rana et al., 2004).

The plants used for preparing *keem* are locally known as *jadiya* and the people involved in this job are known as *jadayi*. About 10-15 *jadayi* are involved in the process of cake preparation at a time. The plants used for this purpose vary slightly from place to place (Rana et al, 2004).

The authors of this review speculate that the name of the Nepalese cereal beer '*jand'* might have been derived from the term *jadiya* used by the people of Tons valley.

Table 7
Various plants used in the preparation of starter culture for rice beer preparation in Northeast India

Tribe/state	*Local name*	*Scientific name {Family}*	*Parts used*
Bodo Assam, India	*Agarsita*	*Xanthium strumarium {Asteraceae}*	Whole plant
	Dongphang rakhep	*Scoparia dulcis {Scrophulariaceae}*	Leaves
	Lokhunath	*Clerodendrum viscosum {Verbanaceae}*	Leaves/roots
Karbi Assam, India	*Marthu*	*Croton joufra {Euphorbiaceae}*	Leaves
	Jamphong	*Artocarpus heterophyllus {Moraceae}*	Leaves
	Jockan	*Phlogocanthus thysiflorus {Acanthaceae}*	Leaves
	Hisou-kehou	*Solanum viarum {Solanaceae}*	Leaves
	Therma	*Acacia pennata {Fabaceae}*	Leaves
Ahom Assam, India	*Banjaluk*	*Oldenlandia corymbose {Rubiaceae}*	Leaves
	Kopou lota	*Lygodium spp. {Lycopodiaceae}*	Leaves
	Huruminimuni	*Hydrocotyle sibthorpioides {Apiaceae*	Whole plant
	Bormanmunii	*Centella asiatica {Mackinlayaceae*	Whole plant
	Tubuki lota	*Cissampelos pareira {Menispermaceae}*	Leaves
	Jaluk	*Piper nigrum {Piperaceae}*	Seeds
Mising Assam, India	*Bormanimuni*	*Centella asiatica {Mackinlayaceae}*	Whole plant
	Horumanimuni	*Hydrocotyle sibthorpioides {Apiaceae}*	Leaves
	Banjaluk	*Oldenlandia corymbosa {Rubiaceae}*	Leaves
	Kuhiar	*Saccharum officinarum {Poaceae}*	Leaves
	Dhapat tita	*Clerodendrum viscosum {Verbanaceae}*	Leaves
	Bhilongoni	*Cyclosorus exlensa {Thelypteridaceae}*	Leaves
	Bam kolmou	*Ipoemea spp. {Convulvulaceae}*	Leaves
	Senikuthi	*Scoparia dulcis {Scrophulariaceae}*	Leaves

Tribe/state	*Local name*	*Scientific name {Family}*	*Parts used*
Mising Assam, India	*Lali jabori*	*Drymaria cordata {Caryophyllaceae}*	Leaves
	Jalokia	*Capsicum annuum {Solanaceae}*	Leaves
	Anaras	*Ananus comosus {Bromeliaceae}*	Young leaves
	Kopou dhekia	*Lygodium flesuosum {Lycopodeaceae}*	Leaves
Deori Assam, India	*Bhatar daumali*	*Jasminum sambac {Olaceae}*	Leaves
	Thok thok	*Cinnamomum byolghata {Lauraeceae}*	Leaves
	Tesmuri	*Zanthoxylum hamiltonianum {Rutaceae}*	Leaves
	Zing zing	*Lygodium flexuosum {Lycopodiaceae}*	Leaves
	Zuuro	*Acanthus leucostychys {Acanthaceae}*	Leaves
	Bhilongoni	*Cyclosorus exlensa {Thelypteridaceae}*	Leaves
	Sotiona	*Alstonia scholaris {Apocynaceae}*	Leaves
	Bubusiring	*Alpinia malaccensis {Zingiberaceae}*	Roots
	Jomlakhoti	*Costus speciosus {Costaceae}*	Stem, rhizome
Adi-galo Arunachal Pradesh, India	*Dhalpat*	*Clerodendrum viscosum {Verbanaceae}*	Leaves, barks
	Lohpohi	*Vernonia spp. {Asteraceae}*	Leaves
Dimasa Nagaland, India	*Thempra*	*Acacia pennata {Fabaceae}*	Barks
Angami Nagaland, India	*Dhan*	*Oryza sativa {Poaceae}*	Sprouted grains

Plants used in Tai Ahom, Asom

The native people of Ahom, Asom (formerly called Assam) use a number of wild plants for the preparation of amylolytic starter cake called *vekur pitha*. Among the plant materials used are *Lygodium flaxuosum* Linn., *Leucas aspera* Spreng., *Cissampelos pareira* Linn., *Scoparia dulcis* Linn., *Cinnamomum glanduliferum* Meissn., and *Piper betle* Linn. (Saikia et al., 2007). In addition, Tanti et al. (2010) mention the use of *Datura metel* seeds by the Ahom people.

Table 8
Starter-plants used in Northeast India

Tribal community	*Plant name {Family}*	*Local name*
Adivasi	*Polygonium hydropiper* L. *{Polygonaceae}*	*Bishdhektia*
	Nicotania tabacum L. *{Solanaceae}*	*Dhapat*
Dimasa	*Hedyotis diffusa* Willd. *{Rubiaceae}*	*Banjaluk*
	Solanum ferox (L.) *{Solanaceae}*	*Katahibengana*
Karbi	*Dryopteris* spp. *{Polypodiaceae}*	*Dhektia*
Ahom	*Datura metal* (L.) *{Solanaceae}*	*Dhutura*
	Zanthoxylum nitidum (Roxb.) DC. *{Rutaceae}*	*Tazmui*
	Clerodendrum viscosum Vent. *{Verbenaceae}*	*Dhapat tita*
	Adenanthera lucidor (Steud.) Nielson *{Mimosaceae}*	*Mishagach*
	Solanum viarum Dunal. *{Solanaceae}*	*Titabhakuri*
Mishing	*Artocarpus integrifolia* (L.) *{Moraceae}*	*Kathal*
	Ananus comosus (L.) Merr. *{Bromeliaceae}*	*Anaras*
	Saccharum officinarum (L.) *{Poaceae}*	*Kunhiar*
	Psidium guajava (L.) *{Myrtaceae}*	*Madhuriam*
	Musa balbisiana Colla. *{Musaceae}*	*Bhimkal*
	Capsicum annum. L *{Solanaceae}*	*Jalakia*
	Polygonum hydropiper (L.) *{Polygonaceae}*	*Bihlangani*
	Piper nigrum (L.) *{Piperaceae}*	*Jaluk*
Bodo	*Clerodendrum viscosum* Vent. *{Verbenaceae}*	*Dhapat tita*
	Polygonum hydropiper (L.) *{Polygonaceae}*	*Bihlangani*
	Artocarpus integrifolia (L.) *{Moraceae}*	*Kathal*
Meithei	*Clerodendrum colebrookianum* Walp. *{Verbenaceae}*	*Nephaphu*
	Dryopteris spp. *{Polypodiaceae}*	*Dhekia*
Apatani	*Eleusine coracana {Poaceae}*	*Babachabon*
	Sauruia roxburghii Wall. *{Saurauiaceae}*	*Banpachala*
Nepali	*Calotropis gigantea* (L.) *{Asclepiadaceae}*	*Akan*
	Clerodendrum viscosum Vent. *{Verbenaceae}*	*Dhapat tita*
Angami	*Oryza sativa* (L.) *{Poaceae}*	*Dhan*
Khasi	*Costus speciosus* (Koen.) Smith. *{Costaceae}*	*Yamlakhuti*

Table 9
Important plants used for the preparation of *Keem*

Botanical name {Family}	*Vernacular name*	*Parts used*
Achyranthes aspera (L.) {Amaranthaceae}	*Litchkuri*	R
Adhatoda zeylanica Medik. {Acanthaceae}	*Baisheyi*	R
Aerva sanguinolenta (L.) Bl. {Amaranthaceae}	*Safed-phulia*	R
Alysicarpus vaginalis (L.) DC. {Fabaceae}	*Phatkaniya*	L
Arachne cordifolia (Decne.) Hurusawa {Euphorbiaceae}	*Bhartoi*	L
Artemisia roxburghiana Wall. ex Bess. {Asteraceae}	*Chamara*	R
Berberis lycium Royle {Berberidaceae}	*Chatroi, Kashmal*	R
Boerhaavia diffusa (L.) {Nyctaginaceae}	*Patharchatta*	Wp
Cajanus scarabeoides (L.) de Pitit-Thou. {Fabaceae}	*Batti*	Wp
Callicarpa macrophylla Vahl {Verbenaceae}	*Dahiya*	Wp
Cannabis sativa (L.) {Cannabaceae}	*Bhang*	L
Carissa opaca Stapf ex Haines {Apocynaceae}	*Karonda*	R
Cassia tora (L.) {Caesalpiniaceae}	*Panvar*	Wp
Cinnamomum tamala (Buch.-Ham.) Nees ex Eberm. {Lauraceae}	*Guradra*	L
Cocculus hirsutus (L.) Diels {Menispermaceae}	*Jaljamni*	Wp
Colebrookia oppositifolia Sm. {Lamiaceae}	*Bhirmoli*	R
Cymbopogon martini (Roxb.) Wats. {Poaceae}	*Parhu*	R
Datura stramonium (L.) {Solanaceae}	*Dhatura*	L
Dicliptera roxburghiana Nees {Acanthaceae}	*Kathmul*	Wp
Dioscorea bulbifera (L.) {Dioscoreaceae}	*Genthi*	Bl
Euphorbia royleana Boiss. {Euphorbiaceae}	*Surat*	R
Ficus benghalensis (L.) {Moraceae}	*Barh*	B
Geranium nepalensis Sur. {Geraniaceae}	*Laljarhi*	R
Ichnocarpus frutescens (L.) R. Br. {Apocynaceae}	*Kalidudhi*	
Indigofera linifolia (L.f.) Retz. {Fabaceae}	*Torki*	Wp
Leucas lanata Benth. {Lamiaceae}	*Bish-kopra*	Wp
Melia azedarach (L.) {Meliaceae}	-	L
Parthenocissus semicordata (Wall.) Planch. {Vitaceae}	*Dakh*	Wp
Physalis minima (L.) {Solanaceae}	*Latkaniya*	Wp
Pinus roxburghii Sargent {Pinaceae}	*Chir*	R
Punica granatum (L.) {Punicaceae}	*Dadim*	R
Rhus parviflora Roxb. {Anacardiaceae}	*Ninau*	R
Roylea cinerea (D.Don) Baill. {Lamiaceae}	*Titpat*	W
Rubus niveus Thunb. {Rosaceae}	*Kalahisar*	R
Sapindus mukorossi Gaertn. {Sapindaceae}	*Atthu*	L
Syzygium cumini (L.) {Myrtaceae}	*Jamun*	Bl
Vitex negundo (L.) {Verbenaceae}	*Shayneyi*	L
Woodfordia fruticosa (L.) Kurz. {Lythraceae}	*Dhai*	L
***Zanthoxylum armatum* DC. {Rutaceae}**	*Timur*	R

Note. L = leaves, R = roots, B = bark, Wp = whole plant, Bl = bulbils

The starter (*vekur pitha*) is used by Tai Ahom natives to prepare a kind of rice beer called *xaj-pani* (Fuloria et al., 2022) This local rice beer is frequently used in religious rites and rituals, and *Bihu* festivals of Asom (similar to *Sakela* festivals of Nepal) as a refreshing drink and it is also taken after hard labor. *Bihu* is a set of three important cultural festivals unique to Asom. *Rongali* or *Bohag Bihu* is observed in April, *Kongali* or *Kati Bihu* in October or November, and *Bhogali* or *Magh Bihu* in January. Since these techniques and methods of *vekur pitha* preparation have passed from generation to generation, the rice-based beverages do not have any specific or well-defined approach in its manufacture (Das et al., 2012) and is yet to be standardized for commercialization.

Method of starter preparation in Tai Ahom

Saikia et al. (2007) has described the preparation of vekur pitha as follows:

Plant leaves are collected from the wilderness and dried in sunlight for 1-2 days. Sun-dried leaves are ground into powder and mixed with the powder of rice grain in a vessel containing a small amount of water. Here, the powder of previously prepared *pitha* commonly called *gai pitha* is mixed with freshly prepared *pitha* as source of yeast. The semi-solid *pitha* is mixed with required ingredients and rolled into plate-disc shaped cakes. It is then wrapped with leaves of *Musa paradisiaca* Linn. and kept in air-locked condition over fire hearth. The fire heat is maintained at 90-180 cm height for 4-5 days till dry.

The disc-shaped dried *pitha* containing yeast, rice powder and plant material is known as *vekur pitha*, which is kept for future use. It is rough in texture and grey or dull white in appearance. Taboos are observed during preparation of *vekur pitha* among the Tai Ahom, which they consider sacred.

The ultimate inventory of plants used in the preparation of amylolytic starters in South Asia

The preceding tabulated lists have many plants in common. Comparing the frequency (n = 300) of their appearances in the tabulated lists in this mini review, following results (frequency in parenthesis) have been obtained:

Species of *Piper* (11), *Clerodendrum* (10), *Artocarpus* (7), *Capsicum* (6), *Cinnamommum* (6), *Lygodium* (6), *Solanum* (6), *Polygala* (5), *Saccharum* (5), *Syzygium* (5), *Centella* (4), *Costus* (4), *Elephantopus* (4), *Vernonia* (4), *Ficus* (3), Unidentified (3), *Woodfordia* (3), *Acacia* (2), *Allium* (2) *Asparagus* (2), *Buddleja* (2), *Carica* (2), *Cyclosorus* (2), *Desmodium* (2), *Dioscorea* (2), *Drymaria* (2), *Holarrhena* (2), *Hydrocotyle* (2), *Leucas* (2), *Musa* (2), *Oldenlandia* (2), *Plumbago* (2), *Psidium* (2), *Pteridium* (2), *Rubus* (2), *Smilax* (2), and the rest (1 each).

Conclusions

The foregoing mini review indicates that the preparation of amylolytic starters in South Asia entails use of hundreds of different plants. There are different opinions regarding the rationale for using these plants in starter preparation. Some claim that these plants give intoxicating properties to the product (local beer or wine), some maintain that they attract yeasts, while some have conclusively demonstrated that these are sources of yeasts, molds and bacteria needed for the fermentation. However, except for articles written by few authors, work on isolation and identification of microbial flora from starter-plants is virtually non-existent.

Both starter-plants and amylolytic starters have significant socio-economic contributions in the lives of ethnic people of South Asia. Starters are prepared for brewing a range of alcoholic beverages and are also sold in the market as a means of livelihood. Some starter plants fetch very high amount on selling and this has led to, at least in some places, their rapid dwindle. For instance, *Polygala arillata* has become commercially threatened and *Inula* sp. has become rare (at least in eastern Nepal).

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