Preparation of Alcoholic Beverages by Tribal Communities in the Indian Himalayan Region: A Review on Traditional and Ethnic Consideration

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The Indian Himalayan Region (IHR) is the center of the diverse food culture comprising fermented and non-fermented ethnic foods and alcoholic beverages. Diverse tribal communities in IHR (Uttarakhand, Himachal Pradesh, Jammu and Kashmir, Ladakh, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, and Tripura) have been long known for their rich culture and food habits. Having strong ritual importance among the ethnic people of the IHR, alcoholic beverages are being consumed in various cultural, social, and religious events for ages. Consumption of in-house prepared alcoholic beverage is the socio-cultural tradition in India as well as across the globe. The processes and ingredients involved in alcoholic beverage preparations vary with raw material availability in different regions. The majority of the fermented drinks are cereal-based with a significant proportion of various plants and fruits as the main raw material, making a beverage more unique in taste. Some plant ingredients used for traditional alcoholic beverages have potential nutraceutical as well as therapeutic properties that are well documented. These properties could constitute an additional economic value for traditional alcoholic beverages commercialization, which, in turn, could promote the local rural economy. Until now, such beverages have only received marginal attention by ethnobotanists and few studies concern traditional fermented beverages in the IHR. In this view, the current review focused on preparation, diversity, cultural, and economic significance and health benefits of ethnic beverages used by tribal communities in the IHR.

Keywords: alcoholic beverages, socio-cultural tradition, fermented drinks, indigenous people, Indian Himalayan Region

INTRODUCTION

The Indian Himalayan Region (IHR) is host to the world's highest ecosystems, which includes Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, Darjeeling hills, Arunachal Pradesh, and some hilly regions of northern Assam (Tamang, 2001; Nehal, 2013). The ethnic tribes of IHR, living in high-altitude areas, are known for their traditional knowledge and complex life system all over the world. They are unique, due to their geographical condition, food preference, and lifestyle (Tamang, 2010a). Being a distinctive component, uses and preparations of alcoholic
beverages among the tribal communities have been a part of traditional knowledge for thousands of years (McGovern, 2009; Dutfield, 2010; Egea et al., 2015).

Fermentation of beverages is a 5000-year-old tradition in India. Soma is the most talked about and most mysterious of the Indian beverages. The entire 9th Mandala in Rig-Veda (1700 BC) is dedicated to Soma and it is elevated to the position of moon Goddess (https://www.arishtam.com/indian-traditional-beverages/home-brew-tutorials/accessed on October 24, 2020). The preparation of the ethnic beverages using the fermentation process by the tribal people of India is well known and documented by several workers (Kumar and Rao, 2007; Rivera et al., 2012a,b). It is reported that more than 350 types of major traditional beverages are prepared using indigenous knowledge. These homemade beverages, prepared informally at the local or family level, are region-specific and prepared manually by mixing old starter culture with the raw material (Kishor et al., 2013; Nath et al., 2019). The World Health Organization (WHO, 2014) has also reported the importance of traditional beverages in cultural and social events. It is important to mention that these traditional alcoholic beverages also contain extract of plant parts and a good source of minerals and bioactive compounds beneficial for health (Darby, 1979; Campbell-Platt, 1994; Steinkraus, 1996; Tamang and Fleet, 2009).

Although traditional alcoholic beverages are an important part of the cultural and social life of tribal communities, these beverages received minor attention from researchers and ethnobotanists so far especially in India. Several ethnobotanical studies on traditional alcoholic beverages used by the tribal communities have been published, but the details of ingredients, preparation methods, cultural significances, etc. have not been explored properly (Kishor et al., 2013; Nath et al., 2019). It is also observed that the investigation based on ethnobotanical field surveys, social and cultural engagements, and possible nutraceutical values are substantially lacking in IHR. Therefore, this review has been focused on the preparation and cultural significance of traditional alcoholic beverages in the IHR.

**MATERIALS AND METHODS**

In the present comprehensive review, an extensive database on various aspects of traditional alcoholic beverages in the IHR was searched using the most relevant search engines. For the compilation of the review, online original research articles, review articles, book chapters, published books, conference proceedings, and reports available on authentic and reputable scientific search engines like ScienceDirect (www.sciencedirect.com), PubMed (https://pubmed.ncbi.nlm.nih.gov/), Scopus (https://www.scopus.com), National Library of Medicine (https://www.nlm.nih.gov/), Google Scholar (https://scholar.google.com/), and Web of Science (https://webofknowledge.com) were searched. The literature was searched for alcoholic beverages in the IHR using keywords like indigenous beverages, Himalayan beverages, traditional beverages, ethnic beverages, starter culture, substrates etc. A detailed bibliographic search was made using 83 references from 1974 until 2020 in the present review.

**DIVERSITY AND PREPARATION OF TRADITIONAL ALCOHOLIC BEVERAGES**

There are a variety of traditional alcoholic beverages, commonly or lesser known (Chhang, Judima, Jann, Chakti, Angoori, Daru, etc.), that are produced by tribes of IHR using fruits, cereals, grains, etc. as raw material (Tamang, 2001). Based on the used raw materials and preparation methods, these beverages can be classified into various types such as rice and cereal wine, palm wine, distilled spirit, and distilled alcoholic beverages (Bluhm, 1995; Thakur et al., 2004; Franz et al., 2011). Traditional alcohol brewing is a home-based industry run by tribal women using indigenous knowledge of the fermentation process. Tribes of the high-altitude Himalayan region have developed their own cultures for the preparation of fermentation-based alcoholic beverages using the available natural resources in the region (Roy et al., 2004). The preparation of traditional beverages is not only a means of livelihood in the hill regions but an important household-cum-societal drink associated with religious ceremonies (Sharma and Mazumdar, 1980). As listed in Table 1, quite a few indigenous beverages are known by different local names for their unique taste, aroma, and process of preparation. However, all tribes across the Himalayan region mostly share a similar method, which is cooking of raw material, drying, and incorporation of starter culture, fermentation, and the extraction of the final product.

**PREPARATION OF STARTER CULTURE**

The majority of the alcoholic beverages are prepared from cereals, mostly rice (46%) followed by millets (17%), barley (12%), wheat (10%), maize (10%), and sorghum (5%), as mentioned in Supplementary Figure 1. The raw materials for different beverages are used as a substrate for the growth of microorganisms such as yeasts, molds, and bacteria (Dung et al., 2006; Nath et al., 2019). The microbial starter culture is prepared through grinding the rice and local herbs and plant parts followed by mixing and preparing starter cake in some places whereas some communities prefer to use it in powdered form (Tsuyoshi et al., 2005). The details of medicinal plants used for the preparation of starter culture are presented in Table 2. There are a variety of starters used by the tribes of IHR to prepare alcoholic beverages. Keem is a starter cake used to prepare an alcoholic beverage popularly known as Soor in Garhwal Himalaya of Uttarakhand state (India). It is prepared using Cannabis sativa and Sapindus mukorossi, including 40 other herbs (Rana et al., 2004; Sekar and Mariappan, 2007). Balam is a wheat-based starter used to prepare Jaan and Daru. It is made by the Bhotiya community of high-altitude regions of Uttarakhand Himalaya. During the preparation of Balam, roasted wheat flour as a substrate is mixed with various herbs and spices such as Cinnamomum zeylanicum, Armonium subulatum, Piper longum, Ficus religiosa, and wild chilies (Das and Pandey,
| State                  | Tribes/Community/Region                          | Ethnic Beverages | Substrate | Starter/Microbes | Health Benefits                                      | References                                      |
|-----------------------|-------------------------------------------------|------------------|-----------|------------------|-----------------------------------------------------|------------------------------------------------|
| Laddakh              | Bhoto community in Leh, Nubra valley            | Chhang/Lugri     | Barley    | Phab (Yeast)     | Treatment of arthritis, joint pain                  | Targais et al., 2012; Angmo and Bhalla, 2014 |
|                      |                                                |                  |           |                  |                                                     |                                                |
| Himachal Pradesh      | Lahaul and Spiti, Kinnaur region                | Chhang           | Wheat     | Phab (Yeast)     | Protection against cold                             | Kanwar et al., 2011                           |
|                      | Kinnaur region                                  | Lugari           | Rice      | Phab (Yeast)     | Protection against cold                             | Savitri and Bhalla, 2019                      |
|                      | Kangra region                                   | Lugdi            | Rice      | Phab             | Rich in protein and phenolic compounds              | Kumar et al., 2019                            |
|                      | Lahaul and Spiti, Kinnaur region                | Aara             | Barley    | Phab (Yeast)     | Protection against cold                             | Savitri and Bhalla, 2007                      |
|                      | Kullu, Kangra, Mandi region                     | Sura, Sur        | Finger millet | Dhaeli or Dhehli | Rich in Vitamin B                                   | Thakur et al., 2004; Joshi et al., 2015       |
|                      | Kinnaur region                                  | Angoori          | Rice      | Phab             | Protection against cold                             | Thakur et al., 2004; Savitri and Bhalla, 2019 |
|                      | Kinnaur region                                  | Chulli           | Wild apricot | Phab            |                                                     |                                                |
|                      | Kinnaur region                                  | Behmi            | Apple     | Phab             |                                                     |                                                |
|                      | Kinnaur region                                  | Ana/Arak         | Apple, barley, pear | Phab       |                                                     |                                                |
|                      | Shimla and Kullu region                          | Chakki/Jhol      | Jaggery   | Phab             |                                                     |                                                |
| Uttarakhand           | Bhotiya tribes in Johar valley                  | Jaan             | Rice      | Balam (Yeast)    | Treatment of fever, dysentery, cough and cold, stomach ailments | Sekar and Mariappan, 2007; Kishor et al., 2013 |
|                      |                                                |                  |           |                  |                                                     |                                                |
|                      | Bhotiya tribes in Johar valley                  | Kacchi           | Barley    | Balam (Yeast)    | Cholera, treating weakness of cattle                 | Kishor et al., 2013                            |
|                      | Jaunsari community in Tons valley               | Soor             | Barley    | Keem             | Protection against cold                             | Sekar and Mariappan, 2007                      |
|                      | Bhotiya tribes in Johar valley                  | Daru             | Rice, jaggery | Balam (Yeast)   | Protection against cold                             | Roy et al., 2004; Sekar and Mariappan, 2007    |
| Sikkim and Darjeeling | All tribes                                      | Jnards           | Finger millet | Murcha (Bacteria and Yeast) | Protection against cold | Tamang et al., 1988; Sekar and Mariappan, 2007 |
|                      | Gorkha, Bhutia, Lepcha, Monpa tribes            | Kodo ka jaan     | Finger millet | Chyang         |                                                     | Chetia and Borgohain, 2020                    |
|                      | Gorkha tribes                                   | Poko             | Rice      | Manapu           |                                                     |                                                |
|                      | All tribes                                      | Chhayang         | Finger millet/barley | Yeast, Lacto acid bacillus |                                                     | Tamang, 2010b                                  |
|                      | Gorkha tribes                                   | Baati jhar       | Finger millet | Marcha         |                                                     | Chetia and Borgohain, 2020                    |
|                      | Nepalese, Tibetan community                     | Chhaang          | Finger millet | Marcha         |                                                     | Nath et al., 2019                             |
|                      | Lepcha, Bhutia and Nepali community             | Rokshi           | Maize     | Mold and Yeast  |                                                     | Sekar and Mariappan, 2007                      |
| State                | Tribes/Community/Region                          | Ethnic Beverages | Substrate | Starter/Microbes | Health Benefits                  | References                                      |
|----------------------|-------------------------------------------------|------------------|-----------|------------------|----------------------------------|------------------------------------------------|
| Arunachal Pradesh    | All tribes                                      | Jhara            | Various plants | Ranu Dabai       | Protection against cold          | Tiwari and Mahanta, 2007; Chetia and Borgohain, 2020 |
|                      | Monpa, Apatani, Nishi tribes                    | Apong            | Rice       | Ipoh             |                                  |                                                 |
|                      | Monpa, Apatani, Nishi tribes                    | Ennog            | Black rice | Ipoh             |                                  | Shrivastava et al., 2012                       |
|                      | All tribes                                      | Madua            | Finger millet | -                |                                  |                                                 |
|                      | Monpa tribes                                    | Themasing        | Finger millet | -                |                                  |                                                 |
|                      | Karbi tribes                                    | Bankhe-kham      | Tapioca (<em>Mannihot esculenta</em>) a tuber | Khamtip (fermented mixture) |                                  |                                                 |
|                      | Karbi tribes                                    | Shhang or Ccharo-kham | Barley       | Khamtip (fermented mixture) |                                  |                                                 |
|                      | Adi, Nyshing, and Mishmi tribes                 | Opo              | Rice       | Pee              |                                  | Shrivastava et al., 2012; Nath et al., 2019   |
|                      | Monpa tribes                                    | Mingri, Lohpani, Bhang chang | Finger millet, rice, maize, or barley | Pham             |                                  |                                                 |
|                      | Hill miri tribes                                | Mingri           | Rice       | Bokha            |                                  | Nath et al., 2019                             |
|                      | Apatani tribes                                  | Opo              | Rice       | Chu              |                                  |                                                 |
|                      | Monpa, Miji, Mishmi tribes                      | Rakshi           | Finger millets, rice, barley grains | Ipoh             |                                  | Shrivastava et al., 2012; Nath et al., 2019   |
|                      | Deuri and Khampuri tribes                       | Poka             | Cereals    | Si-ye            |                                  | Nath et al., 2019                             |
|                      | Singpho tribes                                  | Rice bear*       | Cereals    | Chho             |                                  |                                                 |
|                      | Nyshing tribes                                  | Rice bear*       | Cereals    | Paa              |                                  |                                                 |
|                      | Tagin tribe tribes                              | Rice bear*       | Cereals    | Phab             |                                  | Nath et al., 2019                             |
|                      | Lisu or Yobin tribes                            | Rice bear*       | Cereals    | Aje              |                                  |                                                 |
|                      | Sulung tribes                                   | Rice bear*       | Cereals    | Epop             |                                  | Nath et al., 2019                             |
|                      | Nocte tribes                                    | Rice bear*       | Cereals    | Pee              |                                  |                                                 |
|                      | Thangsa tribes                                  | Apong            | Cereals    | Ipoh             |                                  |                                                 |
|                      | Adi Galos tribes                                | Kala-apang, Ennog | Rice       | Kshai            |                                  | Chetia and Borgohain, 2020                    |
|                      | Monpa, Apatani, Nishi tribes                    | Pona             | Rice       | Ipoh             |                                  |                                                 |
|                      | Adi Galos tribes                                | Opo              | Rice       | Sijeh            |                                  |                                                 |
| State             | Tribes/Community/Region   | Ethnic Beverages | Substrate       | Starter/Microbes          | Health Benefits                  | Reference                                                                 |
|-------------------|---------------------------|------------------|-----------------|---------------------------|----------------------------------|--------------------------------------------------------------------------|
| Assam             | Mishings tribes           | Apong            | Rice            | Ipoh, Apong-pith          | Protection against cold          | Tiwari and Mahanta, 2007; Kardong et al., 2012; Bhuyan and Baishya, 2013; Handique and Deka, 2016; Chetia and Borgohain, 2020 |
| Ahom tribes       | Haj pani or Koloh pani or Xajpani | Bora rice        | Vekur pitha     |                           |                                   | Chakrabarty et al., 2009; Das and Deka, 2012; Handique and Deka, 2016; Bhuyan and Baishya, 2013; Chetia and Borgohain, 2020 |
| Zemenaga tribes   | Dekujao                    | Sprouted rice grain | Saccharomyces cerevisiae |                           |                                   | Chakrabarty et al., 2009; Das and Deka, 2012                             |
| Dimasa tribes     | Juddha                    | Rice             | Humao           |                           |                                   | Deka and Sharma, 2010; Bhuyan and Baishya, 2013; Chetia and Borgohain, 2020 |
| Rabha tribes      | Jonga Mod, Chako/phab     | Rice             | Bakhor, Surachi or Phap |                           |                                   | Deori et al., 2007, Nath et al., 2019, Chetia and Borgohain, 2020       |
| Sonowal tribes    | Rohi                      | Rice             | Saoul pitha     |                           |                                   | Bhuyan and Baishya, 2013; Chetia and Borgohain, 2020                   |
| Deori tribes      | Sujen                     | Rice             | Mod-pitha, Perokkushi |                           |                                   | Teron, 2006, Bhuyan and Baishya, 2013; Chetia and Borgohain, 2020       |
| Bodo tribes       | Jou bishi/Jumai           | Rice             | Angkur, Amao    |                           |                                   |                                                                                       |
| Karbi tribes      | Hör-Alank, Horlang        | Rice             | Thap            |                           |                                   |                                                                                       |
| Manipur           | Tankhul tribes            | Yu angouba       | Sticky rice     | Hamei                     | Beneficial like milk             | Devi and Kumar, 2012                                                      |
| Meitei tribes     | Atingba/Yu                | Rice             | Hamei           |                           |                                   | Chetia and Borgohain, 2020                                               |
| Tankhul tribes    | Atingba                   | Rice             | Ham             |                           | Protection against cold          | Jeyaram et al., 2009; Devi and Kumar, 2012                               |
| Sherdukpen tribes | Rice bear*                | Cereals          | Paa             |                           |                                   | Nath et al., 2019                                                         |
| Naga tribes       | Banana wine               | Ripe banana      | -               |                           |                                   | Devi and Kumar, 2012                                                     |
| Meghalaya         | Pnar/Jaintias, Khasis tribes | Kiad            | Red rice        | Thiat (Yeast)             |                                   | Samati and Begum, 2007; Chetia and Borgohain, 2020                     |

(Continued)
PREPARATION OF SOME POPULAR ALCOHOLIC BEVERAGES

The preparation of alcoholic beverages is very common in tribal communities of IHR. They use different types of starters (described above) to prepare a variety of alcoholic beverages. Jann is a traditional beverage made from rice, wheat, jau, etc. (Roy et al., 2004). It is prepared and consumed by the Bhotiya community of Uttarakhand state in India. High-quality Jann is made from local millet koni (Setaria italica). The quality of Jann is judged by its taste (sweetness), smell, and strength. Generally, it is known for low alcohol concentration. The preparation of Jann is very common and prepared by the community efforts (Roy et al., 2004). Tribes of Uttarakhand and Himachal Pradesh (both are hill state of the IHR) also prepare a local alcoholic beverage Sur (30–40% alcohol) using cereals and fruits (Rana et al., 2004; Sharma, 2013). Tribes of these regions consume Sur to tolerate adverse climatic conditions. They also consume Sur at family functions and festivals. Chhang is a popular indigenous alcoholic beverage that is also called Jhol and Chakti. Tribes of Lahaul and Spiti, Kullu, and Kangra prepare this ethnic beverage by a solid-state fermentation process using the sherokh (huskless) variety of 2007). Mana is a granular-type starter culture prepared from wheat flakes (Tamang, 2010a). Another ethnic starter is Ragi, which is prepared by rice or millet mixed with herbs and spices (Tamang, 2012). The mixture is mixed with water and 2–4% powder of old Ragi and mixed thoroughly. The prepared mixture is shaped into balls for fermentation (72 h at 23–25°C) in a humid environment. After sun drying, these starter balls are used to prepare alcoholic beverages (Saono et al., 1974). Koji is another starter made with steamed rice that is prepared until mycelium growth in the fermentation process (Lotong, 1985; Tamang, 2010b). Dhehli is a herbal starter used to prepare Sur or Sura beverage in Himachal Pradesh, India. It is prepared from 36 fresh herbs such as *Pistacia integerrima*, *Solanum canthocamptid*, *Clitoria ternatea*, *Aegle marmelos*, *Viola cinerea*, and *C. sativa* collected from the forest by elderly people in an annual community effort (Thakur et al., 2004; Tamang, 2010a; Sharma, 2013; Joshi et al., 2015). The extract with plant biomass is added to roasted barley flour to prepare Dhehli (Thakur et al., 2004; Sharma, 2013). Phab is another traditional starter used in Ladakh and the hilly areas of Himachal Pradesh (Thakur et al., 2004; Tamang, 2010b). It is used to prepare Chhang. Phab is prepared using roasted barley with black pepper, dried ginger, crushed paddy, wild herbs, and earlier made Phab starter. Marcha is another known starter used in Darjeeling hills and Sikkim in India (Tamang et al., 1988, 2010; Dung et al., 2006; Bhuyan and Baishya, 2013). It is prepared by crushing soaked glutinous rice. Plant parts, e.g., *Plumbago zeylanica*, *Buddleja asiatica*, and *Vernonia cinerea*, along with old starter powder, were also added to it (Tamang et al., 1988; Thapa, 2002; Tsuyoshi et al., 2005). Hamei is a rice-based starter of northeast hilly areas of India. It is prepared by mixing *Albizia myriophylla* in soaked rice and a pinch of old Hamei (Jeyaram et al., 2009; Tamang, 2010b; Tamang et al., 2010).
| State (Tribe/Region) | Tribes/Community/Region | Starter/Microbes | Medicinal Herbs | References |
|----------------------|-------------------------|------------------|----------------|------------|
| Ladakh               | Bhoto community         | Phab (Yeast)     | Artemisia sp.  | Angmo and Bhalla, 2014 |
|                      | Lahul and Spiti, Kannah, Kangra region | Phab (Yeast) | Artemisia sp. | Joshi et al., 2015 |
| Mandi region         | Dhaeli or Dheli         | Varbascum thapsus, Bistorta amplexicaule, Viburnum grandifolia, Impatiens recemosa/sulcata, Arisaema sp., Arisaema tortuosum, Ajuga brevifolia, Ajuga bractosa, Viola canescens, Morus seratta, Cuscuta europiana, Cannabis sativa, Solanum pseudocaptsicum | | |
| Kullu region         | Dhaeli or Dheli         | Varbascum thapsus, Bupleurum lanceolatum/ Valeriana jatamansi, Cannabis sativa | | Thakur et al., 2004 |
| Kangra region        | Dhaeli or Dheli         | Swertia chirayata, Salinum tenuifolium, Silene griffithii, Polygonum allatum, Polygonum sp., Centella asiatica, Picrorhiza kuruooa, Varbascum thapsu | | |
| Lug valley of Kullu region | Dhaeli or Dheli     | Pistacia integerrima, Solanum xanthocarpum, Citrinia ternatea, Angel marmelos, Viola cinerea, Cannabis sativa, Trachyspernum pictum, Micromeria bilfora, Spiranthes aurisarla, Saussurea sp., Bupleurum lanceolatum, Drosera lanata, Salvia sp., Arisaeam hellebontifolium, Fragaria sp. | | |
| Himachal Pradesh     | Lahul and Spiti, Kangra region | Dhaeli or Dheli | Varbascum thapsus, Bistorta amplexicaule, Viburnum grandifolia, Impatiens recemosa/sulcata, Arisaema sp., Arisaema tortuosum, Ajuga brevifolia, Ajuga bractosa, Viola canescens, Morus seratta, Cuscuta europiana, Cannabis sativa, Solanum pseudocaptsicum | Joshi et al., 2015 |
|                      | Mandi region            | Dhaeli or Dheli  | Varbascum thapsus, Bupleurum lanceolatum/ Valeriana jatamansi, Cannabis sativa | Thakur et al., 2004 |
|                      | Kullu region            | Dhaeli or Dheli  | Varbascum thapsus, Bupleurum lanceolatum/ Valeriana jatamansi, Cannabis sativa | Thakur et al., 2004 |
|                      | Kangra region           | Dhaeli or Dheli  | Varbascum thapsus, Bupleurum lanceolatum/ Valeriana jatamansi, Cannabis sativa | Thakur et al., 2004 |
|                      | Lug valley of Kullu region | Dhaeli or Dheli | Varbascum thapsus, Bupleurum lanceolatum/ Valeriana jatamansi, Cannabis sativa | Thakur et al., 2004 |
| Uttarakhand          | Bhotiya tribes          | Balam (Yeast)    | Cinnamomum zeylanicum, Ammomon subulatum, Piper longum, Ficus religiosa | Das and Pandey, 2007; Sekar and Mariappan, 2007 |
|                      | Janusari community      | Keem             | Cannabis sativa, Sapindus mukorossi, Melia azedarach, Zanthoxylum armatum, Leucas lanata, Dictytera roxburghiana | Sekar and Mariappan, 2007 |
| Sikkim and Darjeeling | Nepalese, Tibetan, Gorkha community | Marcha          | Plumbago zeylanica, Buddleja asiatica, Vernonia cinerea, Zingiber officinale | Tamang et al., 2012; Nath et al., 2019 |
|                      | All tribes              | Ranu Dabai       | Cocconia grandis, Vernonia cinerea, Clerodendrum viscosum, Plumbago zeylanica, Stephania japonica, Stephania glabra, Oroxyrum indicum, Mussaenda roxburghii, Scoparia dulcis, Rauvolfia serpentina, Artocarpus heterophyllus, Wattakaka volubilis | Sekar and Mariappan, 2007 |
| Arunachal Pradesh    | All tribes              | Ipoh             | Cinnamomum glanduliferum, Cissampelos pareire, Cynodon dactylon, Leucas asperra, Lygodium salicifolium, Piper longum, Scoparia dulcis, Veronica cinera | Greeshma et al., 2006 |
|                      | Adi, Nyshing, and Mishmi tribes | Pee             | Clerodendrum indicum, Cissampelos | Nath et al., 2019 |
|                      | Monpa tribes            | Pham             | Solarum khasianum | |
|                      | Hill mini tribes        | Bokha            | Cinnamomum glanduliferum, Solarum nigrum | |
|                      | Apatani tribes          | Chu              | Solarum khasianum | |
|                      | Thangsua tribes         | Ipoh             | Scoparia dulcis, Leucas lanata | |
|                      | Deuri and Khampuri tribes | Si-ye          | Leucas asperra, Piper longum | |
|                      | Singpho tribes          | Chho             | Piper longum, Scoparia dulcis | |
|                      | Nyshing tribes          | Paa              | Cissampelos pareire, Clerodendron viscosum | |
|                      | Tagin tribes            | Phab             | Cinnamomum glanduliferum | |
|                      | Lisu or Yobin tribes    | Aje              | Albizia myriphylla | |
|                      | Sulung tribes           | Epop             | Veronia cinerea, Amomomn aromaticum | |
|                      | Nocte tribes            | Pee              | Piper longum | |
|                      | Miji tribes             | Ipoh             | Artocarpus lakoocha, Mangifera indica | |
| Assam                | Mishing tribes          | Ipoh             | Cissampelos dulcis, Amblovenatum opultentum, Justicia adhastoda, Zanthoxylum nitidum, Phlegacanthus thyrsiflorus, Centella asiatica, Andrographis paniculata, Chelochostus speciosus, Piper nigrum, Salaginella sp., Piper longum, Naravelia zeylanica, Solena amplexicaulis | Kardong et al., 2017 |

(Continued)
| State (Tribe/Region) | Tribes/Community/Region | Starter/Microbes | Medicinal Herbs                                                                 | References                  |
|---------------------|-------------------------|------------------|--------------------------------------------------------------------------------|-----------------------------|
| Karbi tribes        | Thap                    | Croton jouha, Amomum corynastachyum, Acacia pennata, Artocarpus heterophyllus, Oryza sativa, Phlogacanthus thrysiflorus, Solanum torvum | Teron, 2006; Bhuyan and Baishya, 2013 |
| Ahom tribes         | Vekur patha             | Centella asiatica, Cinnamomum beijolghota, Cissampelos pareira, Cleodendrum viscosum, Pteridium aquilinum, Piper nigrum, Sida rhombifolia, Smilax perfoliata | Bhuyan and Baishya, 2013    |
| Mishing tribes      | Apop-pitha              | Ananas comosus, Artocarpus heterophyllus, Adhatoda vasica, Actinodaphne obovata, Cinnamomum tamala, Costus speciosus, Centella asiatica, Drymeria cordata, Hydrocotyl rotundifolia, Hydrocotyle sibthorpioides, Lygodium flexuosum, Lygodium japonicum, Melothria heterophylla, Naravelia zeylanica, Oldenlandia corymbosa, Oryza sativa, Piper longum, Piper nigrum, Phogocanthus thyrsiflorus, Pteridium aquilinum, Scoparia dulcis, Selaginella sp., Swertia chirata, Saccharum officinarum, Vitex negundo, Zanthoxylum herintonian | Kardong et al., 2012       |
| Rabha tribes        | Bakhor, Surachi or Phap | Ananas comosus, Artocarpus heterophyllus, Calotropis giganteana, Capicicum frutescens, Cleodendrum viscosum, Dennstaedtilia scabra, Ochthochloa coracana, Plumbago indica, Saccharum officinarum, Scoparia dulcis, Sida rhombifolia | Deka and Sharma, 2010; Bhuyan and Baishya, 2013 |
| Bodo tribes         | Angkur                  | Clerodendrum viscosum, Oryza sativa, Scoparia dulcis, Xanthium strumarum | Bhuyan and Baishya, 2013    |
| Sonowal tribes      | Saoul pitha             | Centella asiatica, Clerodendrum viscosum, Corchorus olitorius, Naravelia zeylanica, Oryza sativa, Pteridium aquilinum, Sida rhombifolia | Bhuyan and Baishya, 2013    |
| Deori tribes        | Mod Pitha               | Allium sativum, Artocarpus heterophyllus, Ananas comosus, Alpinia malaccensis, Alternanthera sessilis, Capicicum annuum, Cinnamomum beijolghota, Centella asiatica, Coffea bengalensis, Costus speciosus, Cypris sp., Desmodium sp., Desmodium pulchellum, Equisetum sp., Lygodium flexuosum, Melastora malabathricum, Mussaenda roxburghii, Myxopyrum smilacifolium, Naravelia zeylanica, Oryza sativa, Psidium guajava, Pothos scandens, Pteridium aquilinum, Pycnanthera pleniflora, Rubus sp., Saccharam officinarum, Selaginella semicordata, Scoparia dulcis, Solanum torvum, Thunbergia grandiflora, Zanthoxylum oxyphyllum, Zingiber officinalis | Deori et al., 2007         |
| Manipur Tankhul tribes | Hamei                  | Allobizia myrophiyla | Jeyaram et al., 2009 |
| Sherdugan tribes    | Paa                     | Buddleia macrostachya, Plumbago zeylanica | Nath et al., 2019 |
| Meghalaya            | Thiat                   | Amomum aromaticum, Musa paradisica | Samati and Begum, 2007 |
| Tripura Kalai tribes | Chuwan                | Dysoxylum blume, Litsea monopetala, Moringa oleifera, Saccharum officinarum | Ghosh et al., 2016         |
| Jamatia tribes       | Chuwan                | Ananas comosus, Casearia aculeata, Dysoxylum, Markhamia stipulate |               |
| Debbarma tribes      | Chuwan                | Allophyllus serratus, Ananas comosus, Aporusa dioica, Combretum indicum, Cirtus sinensis, Markhamia stipulate |               |
| Molisom tribes       | Chuwan                | Artocarpus heterophyllus, Litsea monopetala, Markhamia stipulate, Nyctanthes arbor-tristis |               |
barley locally called grim (Thakur et al., 2004; Targais et al., 2012). It is presented to visitors, priests, and even deities during every social gathering like childbirth, marriage, or other celebrations. Chhang is known to provide energy and refreshment (Targais et al., 2012). All these alcoholic beverages are prepared by women tribes at the family level. After preparation, beverages are carefully tested and evaluated by older ladies of the family or community.

FERMENTATION

Fermentation is a microbiological process. The knowledge of microbial activities or fermentation is hardly recognized by indigenous people. Fermentation takes place when raw materials are mixed with starter culture and kept in a closed container. Starter cultures are nothing but inoculums containing microorganisms that are required to initiate the fermentation process. A schematic diagram has been presented (Supplementary Figure 2) to show the fermentation steps involved in ethanol production from cereal grains and microorganisms associated with it. These microorganisms could be present in the environment, raw materials, or the utensils used to prepare the drink. The selection of the microorganism depends on adaptation to the substrate and the fermentation conditions (Tamang, 1998). Many research groups indicated that the fermentation process varies from 5 to 25 days based on the flavor, taste, temperature, and alcohol content (Kanwar et al., 2011; Tamang et al., 2015; Chetia and Borgohain, 2020). The fermentation processes are used to prepare alcoholic beverages in the Himalayan region, which experiences low temperatures; therefore, resilient microorganisms capable of surviving and performing fermentation at low temperature are used for the preparation of foods and/or beverages.

The Bhotiya community in the Himalayan regions of Uttarakhand uses the wheat-based starter culture Balam, which is known to have as many as 32 microbial isolates. They are dominated by Bacillus (two species) and yeasts (Saccharomyces fibuligera, Kluyveromyces marxianus, Saccharomyces sp.; Das and Pandey, 2007; Kumari et al., 2016). Previous studies by a group of researchers reported many yeasts, molds, bacteria, and fungi, viz., Saccharomyces cerevisiae, S. fibuligera, Wickerhamomyces anomalous, Candida glabrata, K. marxianus, Meyerozyma sp., and Pichia sp., among yeasts, and molds like Aspergillus penicillioideus and Rhizopus oryzae. These studies were performed using culture-dependent approaches and have drawbacks if estimating total microbial communities. Therefore, with the advancement in sequencing technologies, especially Next-Generation Sequencing, it has become possible to look into the complete microbial community composition. Recent high-throughput sequencing analysis of different fermented foods revealed the presence of bacterial community, which depict phyla Proteobacteria, Firmicutes, and Actinobacteria and genera Leuconostoc, Lactobacillus, Acetobacter, Gluconacetobacter, etc. Several studies also revealed the presence of fungal phyla Ascomycota and Zygomycota along with the genera Saccharomyces, Zygosaccharomyces, Aspergillus, Aureobasidium, Mucoa, Candida, etc., in traditional starter cultures (Thiat, Marcha, Phut, Humao, Chowan, etc.) used by indigenous people of the Indian Himalayas (Thakur et al., 2004; Sha et al., 2017).

During the preparation of the starter, microorganisms could be added in the form of old starter powder or may be present already in the raw material as indigenous microbiota. These microorganisms have been found beneficial for health (Tamang et al., 2015). The health benefits of Saccharomyces sp., Lactobacillus, and Bacillus are recently well documented and considered as potential probiotic candidates. Studies on the genes responsible for the probiotic properties have been performed on the starter cultures and fermented foods to document the role of microbes in probiotic properties in ethnic foods (Das and Pandey, 2007; Kumari et al., 2016; Syed et al., 2020; Elkhaliifa et al., 2021). Microorganisms present in these starter cultures are also known to be responsible for suppressing pathogenic population, carbohydrate metabolism, protein metabolism, etc. (Jani and Sharma, 2021). Additionally, microorganisms associated with these foods are also known for the production of several enzymes, flavoring substances, vitamins, etc., which are used in the fermentation industry for commercial purposes (Tamang et al., 2015).

CULTURAL SIGNIFICANCE OF ETHNIC BEVERAGES

Fermented foods and beverages have a strong connection with the socio-cultural lives of the various ethnic groups of the country. Traditional alcoholic beverages are not only a refreshing drink but also an integral part of the social and cultural occasions of the tribal communities in IHR in various ways (Tamang et al., 2010). These beverages are served in various functions such as wedding ceremonies, crop harvesting celebrations, offerings to traditional Gods, worshipping rituals, and death commemorations of loved ones to express togetherness, unity, joy, and sorrow. These beverages also related to the origin, habitat, religion, and overall life of tribes; therefore, they regard these ethnic beverages as their cultural heritage (Jeyaram et al., 2009; Ghosh et al., 2016). However, there is no such large-scale production unit or industry that can be seen based on a local alcoholic beverage in this region. It is only confined to each ethnic group or community of the respective state, especially women who are associated with preparing these beverages. New Year celebration and farm activities are one of the major events of tribes of Himachal Pradesh and Ladakh. They prepare Chhang, which is a traditional alcoholic beverage of Buddhists of Laddakh (also described in the Diversity and preparation of traditional alcoholic beverages section). Judima is another traditional alcoholic beverage that is very intimately related to the ritual of Dimasa tribes. Freshly prepared Judima is offered to family gods and goddesses during religious occasions, marriage ceremonies, and festivals (Chakrabarty et al., 2009). Tribes also believe that a drop of Judima to a newborn baby will be helpful for good health and also protect the baby from any evil force (Chakrabarty et al., 2009).
Traditional alcoholic beverages consumed by the local tribes in the Himalayan region not only are related to rituals and occasions but also are known to provide increased nutrition such as proteins, vitamins, added minerals, phytochemicals, phytosterols, and dietary fibers to the consumer (Vijayendra and Halami, 2015). Tribal people used to drink these alcoholic beverages mostly in the morning before having breakfast, for health benefits. Alcoholic beverages have also discussed “Ayurveda” for their medicinal importance. Several workers have reported the health benefits of traditional alcoholic beverages such as rice beer, which has been found to be effective in diarrhea and urinary problems, headache, body ache, inflammation, worms treatment, etc. (Samati and Begum, 2007; Deka and Sharma, 2010).

In the tribal community, most of the people are very much hooked to rice beer and sometimes do not realize the harmful effects of these beverages. Tribes of IHR usually believe that traditional alcoholic beverages help reduce diseases and generate energy in the body to tolerate the very low temperature of hilly areas. Due to this belief, tribes drink alcoholic beverages very frequently (Seale et al., 2002). Tribes of IHR start alcohol consumption at an early age, mostly in the teenage years, and become addicted to alcohol. In most regions, beverage consumption is very common among all family members except infants. It is regularly consumed by all male members and elder women. Young male members (16–30 years) consume ~4–5 glasses per day. However, young women used to consume it at weekly intervals or during occasions (Shrivastava et al., 2012). Gradually, such young generation of tribes have become highly addicted to alcohol, and sometimes, this habit ruins their life and livelihood. It is well known and studied that consumption of traditional alcoholic beverages in small amounts is good for the health but frequent intake of alcohol badly affects the body and leads to health problems (Luu et al., 2014). According to Luu et al. (2014), the level of risk associated with traditional beverage varies from low-risk (family and neighbors) to high-risk (by an agent) distribution. Furthermore, dilution, adulteration, and waste release increase the chances of health risk, which is related to direct consumption as well as associated local air pollution, water pollution, and bad public behavior. Therefore, awareness programs for tribal people in India is a necessity of the current scenario.

DISCUSSION AND PROSPECTS

The preparation and consumption of indigenous alcoholic drinks have been known for centuries. All tribal communities in the IHR prepare their specific beverage for livelihood. The local brews or traditional alcoholic beverages also play a very significant role in the cultural and traditional aspects of tribal people residing in a particular part of the country. Besides having tremendous nutritional properties, viz., proteins, carbohydrates, ash, crude fiber, and macro- and micronutrients, ethnic beverages also have many beneficial microflora, which may exert health benefits such as probiotics, especially those that are consumed as an undistilled drink like rice beer (Tamang et al., 2012, 2015).

It is well known that tribes use many plant species that have medicinal properties to prepare traditional rice beer, which helps to reduce the toxic effect of traditional drinks (Samati and Begum, 2007; Deka and Sharma, 2010). Tribes used these traditional beverages, e.g., rice beer, for treating fever, colds and cough, body ache, etc. Tribal women used these alcoholic beverages to treat menstruation problems (Darby, 1979; Campbell-Platt, 1994; Steinkraus, 1996; Samati and Begum, 2007; Tamang and Fleet, 2009; Deka and Sharma, 2010). Tribes collect medicinal plants directly from their natural habitat for the preparation of ethnic drinks. Due to uncontrolled collection from the natural habitat and rapid urbanization, these plant species (which are used in the preparation of traditional beverages) will be depleted. Therefore, the quality, taste, and medicinal properties of traditional drinks are compromised seriously. However, medicinal properties of traditional alcoholic beverages have been documented by several workers (Darby, 1979; Campbell-Platt, 1994; Steinkraus, 1996; Tamang and Fleet, 2009); until now, very limited studies have been carried out to establish the medicinal properties of traditional alcoholic beverages. Therefore, it is required to urgently carry out the work that elaborates the nutritional and medicinal aspects of traditional alcoholic beverages.

Documentation of the fermentation process and plant species used for the production of traditional alcoholic beverages is not adequately addressed by the scientific community. Only limited and fragmented pieces of literature are available regarding the production of traditional beverages, especially in the Himalayan region. The plant parts used by tribal communities and sanitary conditions during preparation regulate the quality of the starter culture, alcohol content, and overall quality of the drink (Basumatary et al., 2014; Nath et al., 2019). Sometimes, contamination or toxicities found in prepared drinks become lethal to the community, and due to the lack of knowledge about the facts, tribal people start blaming the person who was involved in the preparation of the beverage. It has also been reported that the indigenous microorganisms (yeast strains) involved in fermentation processes during the alcoholic beverage preparation lose their effectiveness due to the use of inorganically grown substrate, i.e., rice, over the polluted areas (Kumari et al., 2016). Therefore, scientific studies are required to urgently establish the knowledge about the microorganisms (potential isolates) used in the fermentation process of ethnic alcoholic beverages so that harvesting can be done effectively. Also, it should be noted that reduction in the manufacturing of ethnic alcoholic beverages for daily use has been observed due to economic and legal bindings. Moreover, due to lack of interest and ignorance of traditional values of the young generation, there is a constant decrease in traditional knowledge. This has created a gap leading to the lack of knowledgeable and experienced people among the tribal communities.

Scientific studies may be helpful to reveal some new scope for value addition in traditionally prepared alcoholic beverages, and of course, application of modern science could be incorporated for improvement, wherever it is required (Syed et al., 2021). It is necessary to also conserve traditional alcoholic beverages and culture. As already discussed, these alcoholic beverages are enriched with some nutritional and medicinal properties, and there is a scope of improvement and drug development using biotechnological, medicinal, and food and nutrition-based research that will
be helpful for the commercialization of traditional alcoholic beverages (Sekar and Mariappan, 2007).

**CONCLUSION**

The socio-cultural life in the IHR is associated with the people of various ethnic origins, languages, faith, and traditional practices. These ethnic origins and traditional practices give rise to some unique food habits such as fermented food and beverages. The tribal communities prepare these ethnic beverages by a fermentation process and consumed them in almost every family or social gatherings. Preparations of these alcoholic drinks are well mingled with the cultural and indigenous healthcare systems of these tribes. These alcoholic beverages are enriched with many nutritional components like vitamins and proteins. Phytochemical and ethnobotanical studies have also revealed that traditional alcoholic beverages have a medicinal property to cure various diseases and have healing capacity. Based on available literature, it can be concluded that traditional alcoholic beverages play a very important role in preserving the long-standing traditions of tribes. Therefore, documentation of traditional culture is a prime necessity, which will be a valid way to conserve the ancient heritage of traditional alcoholic beverages for the future. It will be helpful to transfer this knowledge or technique from one generation to another.

Furthermore, there is an urgent need to work on the value addition (nutritional value) of these ethnic beverages by research on method improvement, microorganisms selection, raw material improvement genetic improvement, etc., which may suggest the due market value of traditional alcoholic beverages and lead to their industrialization. Such initiatives might be advantageous for mankind and the economic sustainability of the tribal communities.

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**AUTHOR CONTRIBUTIONS**

BR and JR: manuscript design and final manuscript writing and revision. SP, PD, and JR: data collection. BR, SP, and PD: data analysis. BR, JR, and PD: data interpretation. All authors contributed to the article and approved the submitted version.

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**SUPPLEMENTARY MATERIAL**

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2021.672411/full#supplementary-material

**Supplementary Figure 1** | Percentage of various cereals used by the tribal communities for the preparation of alcoholic beverages.

**Supplementary Figure 2** | Schematic diagram depicting different stages of fermented beverage production.
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