



## Biochemical Indices and Consumption Pattern of Traditional Alcoholic Beverages by Tribal Communities of North-East India: A Review

BHASKARJYOTI BHATTACHARYA and DIBAKAR CHANDRA DEKA\*

Department of Chemistry, Gauhati University, Guwahati, Assam-781014, India.

### Abstract

The North-Eastern part of India consists of seven states namely Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. This region is popularly referred to as seven sisters, and is inhabited by different tribal communities, each of which has unique cultural and linguistic identity. All the communities are known for their traditional homemade alcoholic beverages prepared from rice. These rice-based alcoholic beverages are parts of their food and socio-cultural life as well as used to earn a livelihood by some families. In this article, we have made an effort to review the biochemical indices of the beverages such as physical state, color, taste, pH, total solid content, opacity, sugar content, total acidity, volatile acidity, carbohydrate content, protein content, amino acid content, ethanol content, non-reducing sugar content, etc. along with the consumption pattern within the communities.



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### Introduction


North-Eastern (NE) states of India (Fig. 1) occupy 8% of the total geographical area of the country and are inhabited by 3.76% of the population.<sup>1</sup> The region is culturally diverse and inhabited by more than 200 tribes out of total 635 tribal groups recorded in India.<sup>1</sup> Most of the tribes have their distinct languages, ethnic foods and cultures.<sup>1,2</sup> Their ethnic alcoholic beverages are parts not only of their food habits but also inseparably knitted with cultural practices.<sup>3-7</sup> Although the alcoholic beverages of different ethnic groups are known by different names, these are all prepared from rice, and also there are

some commonalities in the methods of preparation. More or less, the preparation method for all types of rice beers is almost same. Firstly, rice (different rice varieties are used by different communities) is cooked and spread to cool down over a bamboo mat. Now, the starter culture or the yeast cake (known by different names among different communities) is powered by mortar and pestle, and mixed with the cool cooked rice in a ratio of approximately 1:50 (w/w). The ratio may slightly differ among different communities. The whole mixture is then put into a pot (usually an earthen pot is used) of appropriate size and shape. Water is added, mouth of the

**CONTACT** Dibakar Chandra Deka ✉ [dcdeka@rediffmail.com](mailto:dcdeka@rediffmail.com) 📍 Department of Chemistry, Gauhati University, Guwahati, Assam-781014, India.



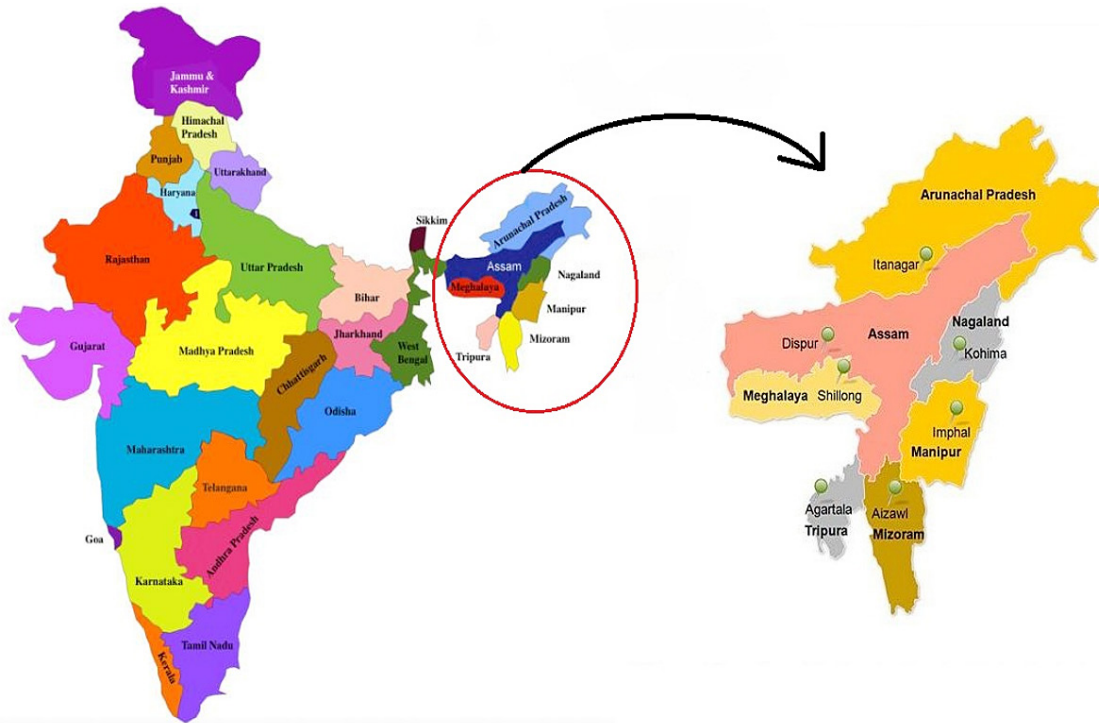
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pot is closed, and the pot is left in a shady place for a few days to allow fermentation to happen. After 7-8 days of fermentation, whole mixture is filtered with cotton cloth. The filtrate is known as rice beer. The main difference in this method by different communities is observed in the quality of rice and the plant materials used, thus imparting differences in their qualities such as unique taste, smell, nutritional and therapeutic values etc. All the tribes are very conscious about the use of medicinal plants in the preparation step of the starter cakes which provide the necessary enzymes to make the fermentation of rice happen to impart the taste and characteristic flavor of the alcoholic beverages.<sup>4,8,10,12</sup> Apart from the use of ingredients, the tribes follow

their traditional rituals while preparing the starter cakes and the beverages.<sup>4,5,6</sup> The ethnic beverages are consumed by the communities on the daily basis, and are considered good for health as well as believed to provide energy to work.<sup>4,8,10</sup> Use of ethnic beverages is believed to prevent kidney stone, body and headache, insomnia, diarrhea, urinary problems, etc.<sup>3,5,8,12</sup> It is well-established that high level of alcohol consumption is injurious to health, especially it leads to liver cirrhosis, loss of productivity, family breakdown, accidental death etc.<sup>9</sup> Here, we are reporting the biochemical indices of the ethnic alcoholic beverages of North-East India and their consumption pattern.



**Fig .1: The map of the north-eastern states of India with their capitals**

**Assam**

Assam is the gateway to the North-East of India.<sup>1</sup> The major part of it is inhabited by at least 18 different tribes, some of which are listed in Table 1. Among the different ethnic groups such as Bodos, Ahoms, Tiwas (Lalung), Misings, Rabhas, Sonowal Kacharis, Deoris, Adivasis, Mech Kacharis, Karbis, Bhutias, Nepalis etc., Bodos are the single largest ethnic tribal community and they belong to a still larger

ethnic group known as Kacharis.<sup>1</sup> All these tribes are known for their traditional alcoholic beverages and all of them, except Nepalese use rice grain along with medicinal plants as the main ingredients.<sup>21</sup> Nepalese produce their alcoholic beverage, *Chaang* using millet, barley, rice, and yeast along with medicinal herbs.<sup>21</sup> *Ananas comosus*, *Plumbago zeylanica*, *Artocarpus heterophyllus*, *Capsicum annum*, *Oryza sativa*, *Piper nigrum*, *Saccharum*

*officinarum*, *Ochthochloa coracana*, *Plumbago indica*, *Cinnamomum tamala*, *Centella asiatica* are some of the medicinal herbs which are used to prepare the starter culture by different indigenous tribes of Assam.<sup>6,8,4,17,18,20,34</sup> Complete biochemical analysis of most of the traditional alcoholic beverages in Assam is hitherto unreported. Reports of partial

biochemical analyses of a few traditional alcoholic beverages such as *jou* of Bodos, *xaj* by Ahoms, *sujen* by Deoris, *apong* by Misings are reported by Deka *et al.*<sup>6,10,11,12,13</sup> Available biochemical analyses of some of the traditional alcoholic beverages are recorded in Table 2.

**Table 1: Traditional alcoholic beverages by different ethnic groups of Assam**

Tribal community	Starter culture	Alcoholic beverages	Major inhabited districts
1. Adivasi <sup>1,2,25,66</sup>	Laddu, <sup>2,25,66</sup> Dabai <sup>2,25,66</sup>	Laopani, <sup>2,25,66</sup> Haria <sup>2,25,66</sup>	Morigaon, Golaghat, Sonitpur, Nagaon, Jorhat, Bongaigaon
2. Ahom <sup>3,4,6,10,13,</sup>	Vekur pitha, <sup>3,6,10,15</sup> Xajar pitha <sup>6,10</sup>	Xajpani, <sup>3,4,6,10, 15,24, 25,34</sup> Laopani <sup>3,25,34</sup>	Golaghat, Jorhat, Sivasagar, Dibrugarh, Tinsukia
3. Bodo <sup>3,4,5,11,12,14,15, 16, 25,33,34,56,66,85</sup>	Amao, <sup>15</sup> Angkur <sup>3,34</sup>	Joufinai, <sup>11</sup> Joubidwi, <sup>11</sup> Jougwan (distilled), <sup>11</sup> Joubishi, <sup>3,4,25</sup> Jumai, <sup>16</sup> Bishi <sup>34</sup>	Kokrajhar, Chirang, Baksa, Udalguri
4. Deori <sup>3,4,6,10,15,18, 24,56,85</sup>	Mod pitha, <sup>3,6,10</sup> Perok kushi <sup>4,15</sup>	Sujen <sup>3,4,6,10,24</sup>	Jorhat, Majuli, Tinsukia
5. Hmar <sup>33</sup>	Bakhor <sup>33</sup>	Zu <sup>33</sup>	North Kachar Hill District
6. Karbi <sup>3,4,5,7,15,16,25,33, 34,56,57,66,85</sup>	Thap <sup>3,7</sup>	Hor, <sup>3</sup> Har alank (undistilled), <sup>4,7,25,34,57</sup> Horpo (undistilled), <sup>57</sup> Horo, <sup>16</sup> Har arak (distilled), <sup>57</sup> Phangbuitang (distilled) <sup>57</sup>	Karbi Anglong
7. Mech Kachari <sup>33,56</sup>	Haaz pitha, <sup>33,56</sup> Zu, <sup>33,56</sup> Bakhar <sup>33,56</sup>	Haaz, <sup>33,56</sup> Photika, <sup>33,56</sup> Jau <sup>33,56</sup>	Udalguri, Kokrajhar, Goalpara
8. Mishimis <sup>33</sup>	Yu pitha <sup>33</sup>	Yu <sup>33</sup>	Tinsukia, Dhemaji, Dibrugarh
9. Misings/ Miris <sup>3,5,8, 15,16,19,26,27,33,34,37,56, 85</sup>	Apop pitha, <sup>3,34</sup> Apong kasure <sup>37</sup>	Poro apong (Sai mod), <sup>34</sup> Nugin apong (Haaz) <sup>37</sup>	Dhemaji, Lakhimpur
10. Nepali <sup>21,35</sup>	Pitha <sup>21,35</sup>	Chaang <sup>21,35</sup>	Sonitpur
11. Rabha <sup>3,15,17,33</sup>	Bakhor, <sup>3</sup> Surachi, <sup>3</sup> Phap <sup>3</sup>	Chokko or Jonga <sup>3</sup>	Goalpara, Bongaigaon, Udalguri
12. Sonowal Kachari <sup>3,33,56, 85</sup>	Saoul pitha/ Mod pitha <sup>3</sup>	Rohi <sup>3</sup>	Dibrugarh, Sivasagar
13. Tiwa (Lalung) <sup>33,94</sup>	Bakhor <sup>33,94</sup>	Jhu, <sup>33,94</sup> Kesha mod <sup>33,94</sup>	Morigaon, Nagaon
14. Zeme Naga <sup>33</sup>	Pitha <sup>33</sup>	Ijaduijang <sup>33</sup>	Karbi Anglong, Goalpara, North Kachar Hill District

**Table 2: Biochemical analyses of some of the traditional alcoholic beverages of Assam**

Parameter	Tribal Communities of Assam							
	Adivasi	Ahom	Bodo	Deori	Misings/ Miris	Karbi		
	Lao Paani	Xajpani	Jou	Jumai/ Jougwan	Sujen	Apong	Poro	Horo
Acidity (Total) (w/v)%	0.4 <sup>22</sup>	1.61 <sup>24</sup>	1.48 <sup>14</sup>	NA	1.49 <sup>24</sup>	1.83 <sup>24</sup>	NA	NA
Acidity (Volatile) (w/v)%	1.18 <sup>22</sup>	NA	NA	NA	NA	NA	NA	NA
Amino acid content (g/100 mL)	NA	NA	0.31 <sup>14</sup>	0.02 <sup>16</sup>	NA	NA	0.02 <sup>16</sup>	0.02 <sup>16</sup>
Carbohydrate content (g/100 mL)	NA	3.04 <sup>24</sup>	4.80 <sup>14</sup>	1.32 <sup>16</sup>	1.54 <sup>24</sup>	1.79 <sup>24</sup>	1.40 <sup>16</sup>	1.23 <sup>16</sup>
Colour (EBC-European Brewery Convention)	Whitish <sup>22,25</sup>	Creamy yellow <sup>24</sup>	Light golden <sup>14</sup>	Creamy white <sup>16</sup>	Creamy yellow <sup>24</sup>	Whitish <sup>24</sup>	Red <sup>16</sup>	White <sup>16</sup>
Ethanol content (v/v)%	3.99 <sup>25</sup>	5.9 <sup>24</sup>	10.79 <sup>12</sup>	40.10 <sup>16</sup>	5.48 <sup>24</sup>	6.02 <sup>24</sup>	22.88 <sup>16</sup>	36.00 <sup>16</sup>
Opacity	NA	NA	Transparent <sup>14</sup>	NA	NA	NA	NA	NA
pH	4.56 <sup>25</sup>	3.90 <sup>24</sup>	4.21 <sup>14</sup>	4.40 <sup>16</sup>	3.98 <sup>24</sup>	3.76 <sup>24</sup>	5.60 <sup>16</sup>	5.00 <sup>16</sup>
Protein content (g/100 mL)	0.47 <sup>22</sup>	0.09 <sup>24</sup>	0.13 <sup>14</sup>	0.62 <sup>16</sup>	0.08 <sup>22</sup>	0.09 <sup>22</sup>	0.57 <sup>16</sup>	0.32 <sup>16</sup>
Reducing sugar (g/100 mL)	0.23 <sup>22</sup>	NA	0.35 <sup>14</sup>	NA	NA	NA	NA	NA
Solid content (Total) (g/100 mL)	NA	2.22 <sup>24</sup>	0.04 <sup>14</sup>	NA	2.22 <sup>24</sup>	NA	NA	NA

\*NA: Not Available

**Arunachal Pradesh**

Arunachal Pradesh is known as the land of the Dawn-lit Mountains of India.<sup>1</sup> In land coverage, it is the largest north-eastern state but thinly populated.<sup>1</sup> As per the census of 2011, it has 13.83 Lakh population.<sup>1</sup> Adis are the major tribe of this state and it is divided to 15 sub-tribes such as Ashing, Bori, Karko, Milang, Padam, Pang, Ramo, Tangam, Bokar, Gallong, Komkar, Minyong, Pailibo, Pasi and Shimon.<sup>1,2,3,4,42,43,71</sup> Almost all the tribes are known for their homemade alcoholic beverage (Table 3), but till now only few of them are reported. Medicinal plants like *Plumbago zeylanica*, *Artocarpus heterophyllus*, *Capsicum annum*, *Saccharum officinarum*, *Dennstaedtia scabra*, *Ochthochloa coracana*, *Plumbago indica*, *Cinnamomum tamala*, *Scoparia dulcis*, *Hydrocotyle sibthorpioides*, *Piper betel*, *Cyclosorus dentatus* are some of plants used by Arunachali tribes to prepare starter cultures.<sup>86,87,88,89,93</sup> Rice and medicinal herbs are the main ingredients of the starter culture. Some of the tribes of this state

prepare millet based fermented beverage which is known as Modua Apong.<sup>42</sup> Biochemical analyses of Arunachali traditional alcoholic beverages are scarcely reported (Table 4).

**Manipur**

The state of Manipur consists of Imphal Valley surrounded by hills.<sup>1</sup> Almost all the tribes living there have unique style of culture and food habit.<sup>2,3,62,78,79,80</sup> *Sekmai* and *Atingba Yu* are two popular traditional alcoholic beverages in Manipur.<sup>15,61,66,73,74,80,81</sup> *Atingba Yu* is specially prepared from grapes, the other from rice and medicinal plants<sup>15,66,73,74,80,81</sup> Kukis are an important major tribe of Manipur and they prepare alcoholic beverages which is akin to the Japanese Sake *Chong Ju* and Korean Sake *Tak Ju*.<sup>74,80</sup> Naga tribes residing in Manipur prepare banana wine by fermenting banana in a closed container with little water.<sup>2,48,54,62,74,75,76,79</sup> Though several types of rice beer are known in Manipur (Table 5), virtually none of them is analyzed fully.

**Table 3: Traditional alcoholic beverages of Arunachali tribes**

Tribal community	Starter culture	Alcoholic beverages	Major inhabited districts
1. Adi <sup>1,2,3,4,15,69</sup>	Pee, <sup>15</sup> Ipoh <sup>15</sup>	Opo, <sup>15,25</sup> Pona, <sup>15</sup> Ennog <sup>15</sup>	Lower Dibang Valley, Lohit, Namsai
2. Apatani <sup>1,3,15,42,43,66,85,87,88</sup>	Chu, <sup>15</sup> Ipoh, <sup>15</sup>	Opo, <sup>15</sup> Apong, <sup>15</sup> Pona, <sup>15</sup> Ennog, <sup>15</sup> Chu <sup>3</sup>	Ziro valley of Lower Subansiri district
3. Deuri <sup>3</sup>	Si-ye <sup>3</sup>	Poka <sup>3</sup>	Lohit, Patkai foothills
4. Galos <sup>3,4,15,25,90,91</sup>	Siiyeh <sup>15</sup>	Opo, <sup>4,15,25</sup> Poka <sup>3</sup>	West Siang, Lepa Rada, Lower Siang
5. Hill Miri <sup>3</sup>	Bokha <sup>3</sup>	Mingri <sup>3</sup>	Upper Subansiri, Kamle
6. Jaintia <sup>15</sup>	Thiat <sup>15</sup>	Sadhiar, <sup>15</sup> Chu, <sup>15</sup> Kiad <sup>15</sup>	Kra Daadi, Kurung Kumey, Papum Parey, Kamle, East Kameng, West Kameng
7. Khampuri <sup>3</sup>	Si-ye <sup>3</sup>	Poka <sup>3</sup>	Namsai, Lower Dibang Valley
8. Lisu <sup>3</sup>	Aje <sup>3</sup>	NA	Changlang
9. Miji or Sojolang or Damai <sup>3</sup>	Ipoh <sup>3</sup>	Rakshi <sup>3</sup>	West Kameng and East Kameng
10. Mishmi <sup>3</sup>	Pee <sup>3</sup>	Opo <sup>3</sup> Yu <sup>3</sup> Idu <sup>3</sup>	Lower Dibang Valley, Lohit, Anjaw
11. Monpa <sup>3,15,71</sup>	Pham <sup>15</sup> Ipoh <sup>15</sup>	Bunk Chung/ Bhang Chang <sup>3,15,71</sup> Apong <sup>15</sup> Pona <sup>15</sup> Ennog <sup>15</sup>	Tawang
12. Nocte <sup>3,83</sup>	Pee <sup>3,83</sup>	Jumin <sup>3,83</sup>	East Kameng, West Kameng, Papum Pare, Kamle, Lower Siang, West Siang
13. Nyishig <sup>3</sup>	Pee <sup>3</sup> Paa <sup>3</sup>	Jaar Opo <sup>3</sup>	Kra Daadi, Kurung Kumey, Papum Pare, Kamle, Pakke Kesang, Lower Siang, West Siang
14. Nishi <sup>15,87</sup>	Ipoh <sup>15</sup>	Apong <sup>15</sup> , Pona, <sup>15</sup> Ennog <sup>15</sup>	East Kameng, West Kameng, Papum Pare, Kamle, Pakke Kesang, Kurung Kumey
15. Singpho <sup>3</sup>	Chho <sup>3</sup>	NA	Lohit, Changlang
16. Sulung <sup>3</sup>	Epop <sup>3</sup>	NA	Tirap, Lohit
17. Targin <sup>3</sup>	Phab <sup>3</sup>	NA	Tirap
18. Thangsa <sup>3</sup>	Ipoh <sup>3</sup>	Apong <sup>3</sup>	Changlang
19. Yobin <sup>3</sup>	Aje <sup>3</sup>	NA	Changlang

\*NA: Not Available

**Table 4: Reported biochemical analyses of Arunachali traditional alcoholic beverages**

Parameter	Adi Galo (Community) Opo (Beverages)
Acidity (Total) (w/v)%	0.32 <sup>22</sup>
Carbohydrate content (g/100mL)	0.11 <sup>22</sup>
Colour (EBC)	Whitish <sup>22</sup>
Ethanol content (v/v)%	4.35 <sup>22</sup>
pH	5.07 <sup>22</sup>
Protein content (g/100mL)	0.28 <sup>22</sup>
Reducing sugar (g/100mL)	0.21 <sup>22</sup>

**Table 5: Traditional alcoholic beverages in the state of Manipur**

Tribal community	Starter culture	Alcoholic beverages	Major inhabited districts
1. Attiva <sup>61,74,80</sup>	NA	Sekhmai yu <sup>61,74,80</sup>	Chandel, Kakching
2. Chothe <sup>78</sup>	Hamei <sup>78</sup>	Hamei beer <sup>78</sup>	Bishnupur, Ukhrul
3. Kuki <sup>74,80</sup>	NA	Zawlaidi, <sup>74,80</sup> Atingba <sup>74,80</sup>	Churachandrapur, Chandel, Kangpokpi, Tengnoupal
4. Mao Naga <sup>48</sup>	NA	Zhuchu <sup>48</sup>	Pherzawal, Jiribam, Ukhrul, Thoubal, Senapati
5. Meitei or Meitei Manipuri <sup>15,66,73,74,81</sup>	Hamei <sup>15</sup>	Atingba yu, <sup>15</sup> Atingba, <sup>15</sup> Atingba ju or Ju, <sup>66,73,74,81</sup> Puk-yu, <sup>66,73,74,81</sup> Chameli <sup>66,73,74,81</sup>	Imphal Valley Region, Bishnupur, Ukhrul, Thoubal, Jiribam
6. Sherdukpen <sup>3</sup>	Paa <sup>3</sup>	NA	Pherzawal, Jiribam, Ukhrul, Thoubal
7. Zeme Naga <sup>79</sup>	Zutho <sup>79</sup>	NA	Tamenglong, Senapati

\*NA: Not Available

**Table 6: Traditional alcoholic beverages in the state of Meghalaya**

Tribal community	Starter culture	Alcoholic beverages	Major inhabited districts
1. Garo <sup>3,15,39,40,41</sup>	Wanti <sup>15</sup>	Chubitchi, <sup>15</sup> Dika, <sup>3,15,39,40,41</sup> Chubok, <sup>3,15,39,40,41</sup> Minilbitchi, <sup>3,15,39,40,41</sup> Bitchi <sup>3</sup>	Garo Hills, Khasi Hills, Ri Bhoi
2. Jaintia <sup>15,53</sup>	Thiat <sup>15</sup>	Sadhiar, <sup>15</sup> Chu, <sup>15</sup> Kiad <sup>15</sup>	West Jaintia Hills, East Jaintia Hills
3. Khasi <sup>3,15,66</sup>	Thiat <sup>15</sup>	U-phandeing, <sup>3</sup> Chu, <sup>15</sup> Sadhiar, <sup>15</sup> Kiad <sup>15,25</sup>	East Khasi Hills, West Khasi Hills, Ri Bhoi, West Jaintia Hills, East Jaintia Hills
4. Pnar <sup>15,53,95</sup>	Thiat <sup>15,53</sup>	Kiad, <sup>15,53</sup> Sadhiar <sup>15</sup>	West Jaintia Hills, East Jaintia Hills
5. Synteng <sup>95</sup>	NA	Kiad <sup>15</sup>	Ri Bhoi, North Garo Hills, East Garo Hills

\*NA: Not Available

**Meghalaya**

Meghalaya, the state known as the abode of clouds is inhabited by three major tribes, namely Khasis, Pnar (Jaintia) and Achiks (Garos).<sup>1</sup> Khasi is a generic term that includes Khyntiam, Pnar, Bhoi, War, Lyngngam and Diko people.<sup>3,15,66</sup> Rice is the staple food for all the tribes and they use rice to prepare their traditional alcoholic beverages (Table 6) using a starter culture which is prepared by mixing rice with medicinal plants like *Hydrocotyle sibthorpioides*, *Plumbago zeylanica*, *Saccharum officinarum*, *Dennstaedtia scabra*, *Plumbago indica*, *Cinnamomum tamala*, *Ochthochloa coracana*,

*Scoparia dulcis*, *Piper betel*, *Cyclosorus dentatus*, *Capsicum annum*, *Artocarpus heterophyllus*, *Sonbarial*, *Phirphiria pat*, *Tezmuri*, *Senikuthi*, *Gorobchoi*, etc.<sup>2,3,4,15,39,40,41,53,66,84,95</sup> Reported biochemical analyses are shown in Table 7.

**Mizoram**

Known as the land of blue mountains, the state of Mizoram has the highest concentration of tribal people among all the states of India.<sup>1</sup> Mizos and Nepalis are the two major tribes that reside in the state.<sup>1,2,66,70</sup> Mizo's traditional alcoholic beverage, *Zawlaidi* is prepared from grapes and medicinal

plants, and it is akin to the Japanese sake.<sup>70</sup> Traditional alcoholic beverages of Mizoram are listed in Table 8 and no biochemical analysis been available.

**Table 7: Reported biochemical analyses of Meghalaya traditional alcoholic beverages**

Parameter	Tribal communities of Meghalaya and their beverages	
	Garo Chubitchi	Khasi Kiad
Acidity (Total) (w/v)%	0.88 <sup>48</sup>	0.76 <sup>22</sup>
Carbohydrate content (g/100mL)	NA	0.37 <sup>22</sup>
Clarity	7.88 (a) <sup>48</sup>	NA
Colour	7.05 (a) <sup>48</sup>	Whitish <sup>22</sup> (EBC)
Ethanol content (v/v)%	11.20 <sup>48</sup>	4.30 <sup>22</sup>
pH	3.87 <sup>48</sup>	3.35 <sup>22</sup>
Protein content (g/100mL)	NA	0.25 <sup>22</sup>
Reducing sugar (g/100mL)	NA	0.20 <sup>22</sup>

\*NA: Not Available

\*a means the degree of redness (+) and greenness (-)

**Table 8: Traditional alcoholic beverages in Mizoram**

Tribal Community	Starter Culture	Alcoholic Beverages	Ingredients	Major inhabited districts
1. Mizo <sup>1,2,4,84,70</sup>	NA	Zawlaidi (a type of wine) <sup>4,84,70</sup>	Grapes & Medicinal herbs <sup>4,84,70</sup>	Aizawl, Lunglei, Saiha
2. Nepali <sup>66</sup>	Bakhar, <sup>66</sup> Marcha <sup>66</sup>	Tongba, <sup>66</sup> Jaar <sup>66</sup>	Rice & Medicinal herbs <sup>66</sup>	Saiha, Champhai, Aizawl

\*NA: Not Available

**Table 9: Traditional alcoholic beverages of Nagaland**

Tribal community	Starter culture	Alcoholic beverages	Major inhabited districts
1. Angami <sup>3,4,15,52,66</sup>	Piazu, <sup>3,15</sup> Yei <sup>3</sup>	Litchumasu, <sup>3,4</sup> Khe, <sup>52,66</sup> Zutho <sup>4,15,52</sup>	Wokha, Kohima, Dimapur
2. Ao Naga <sup>25, 58,94</sup>	Anishi <sup>58</sup>	Mejemstu, <sup>25,58,94</sup> Madhu, <sup>25,58,94</sup> Litchumasu <sup>25</sup>	Northern part of Nagaland
3. Dimasha <sup>5,15,16,45,66</sup>	Humao <sup>15</sup>	Judima <sup>4, 15,25</sup>	Dimapur
4. Khasi <sup>66</sup>	U phandeing <sup>66</sup>	NA	Longleng, Mon, Pereng, Nolak, Kiphire, Peren
5. Naga <sup>3,15,52</sup>	Khekhrii, <sup>15</sup> Grist <sup>3</sup>	Duizou, <sup>15</sup> Indian Madhu, <sup>3,15,52</sup> Zutho, <sup>52</sup> Ijadijang <sup>3,15,52</sup>	Dimapur, Kohima, Phek, Kiphire
6. Zeme Naga <sup>3,52,59</sup>	Grist <sup>3</sup>	Zutho, <sup>52</sup> Ruhi, <sup>3,52,59</sup> Dzutse, <sup>3,52,59</sup> Ijadijang <sup>3,52,59</sup>	Peren

\*NA: Not Available



**Nagaland**

Known as the land of festivals, the state of Nagaland is inhabited by many tribes and sub-tribes, as many as not less than 16 tribes such as Sumi, Mao Naga, Dimasha, Zeme Naga.<sup>1</sup> Most of the tribes are unique and have distinct characteristics in terms of language, customs and attires.<sup>1</sup> Rice is the staple food of Nagaland tribes and they prepare their traditional alcoholic beverages from rice using a starter culture prepared by mixing rice with medicinal herbs like *Plumbago zeylanica*, *Artocarpus heterophyllus*, *Capsicum annum*, *Saccharum officinarum*, *Dennstaedtia scabra*, *Ochthochloa coracana*, *Plumbago indica*, *Cinnamomum tamala*,

*Scoparia dulcis*, *Hydrocotyle sibthorpioides*, *Piper betel*, *Cyclosorus dentatus*, *Durun*, *Kapou dhekia*, *Belipoka*, *Bhimkol*, *Goropsoi*, *Pipoli*, *Titaphool*, *Banjuluk*, *Madhuriam*, *Bhunin komora*, *Bihlongoni*, *Senikuthi*, *Gorobchoi*, *Bhekuri tita* etc.<sup>4,5,15,16,45,66,84</sup> *Judima* is a very popular alcoholic beverage prepared by Dimasha tribes of Nagaland.<sup>4,5</sup> It has very strong alcoholic power.<sup>5</sup> As per reported data, *Judima* contains highest percentage of alcohol i.e., 16 v/v% which is almost 4 times higher as compared to *Zutho* of Angami and *Litchumsu* of Ao tribe.<sup>5,16,45,58,94</sup> Traditional alcoholic beverages of Nagaland are shown in Table 9, and reported biochemical data in Table 10.

**Table 10: Biochemical Analysis of the traditional alcoholic beverages of Nagaland**

Parameter	Tribal communities of Nagaland and their beverages		
	Angami	AO Naga	Dimasha
	Zutho	Litchumsu	Judima
Acidity (Total) (w/v)%	5.1 <sup>22</sup>	NA	NA
Amino acid content (g/100mL)	NA	NA	0.022 <sup>16</sup>
Carbohydrate content (g/100mL)	0.76 <sup>22</sup>	NA	1.20 <sup>16</sup>
Colour	Creamy yellow (2.1 SRM) <sup>22</sup> [SRM-Standard Reference Method]	13.77 (L) <sup>25</sup> 0.77 (a) <sup>25</sup> 2.65 (b) <sup>25</sup>	Yellowish <sup>16</sup>
Ethanol content (v/v)%	4.24 <sup>22</sup>	4.68 <sup>25</sup>	39 <sup>16</sup>
Fats (%)	0.76 <sup>22</sup>	NA	NA
pH	4.63 <sup>22</sup>	4.24 <sup>25</sup>	4.2 <sup>16</sup>
Protein content (g/100mL)	0.51 <sup>22</sup>	NA	0.42 <sup>16</sup>
Reducing sugar (g/100mL)	0.21 <sup>22</sup>	NA	NA
Total sugar (g/100mL)	1.29 <sup>22</sup>	NA	NA
Solid content (Total) (g/100mL)	NA	NA	0.001 <sup>16</sup>
Starch content (%)	1.38 <sup>22</sup>	NA	NA

\*NA: Not Available

\*L indicates the degree of lightness or darkness (L=0 means perfect black & L=100 means most perfect white)

\*a means the degree of redness (+) and greenness (-)

\*b indicates degree of yellowness (+) and blueness (-)

**Tripura**

Tripura is a land of diversity, and inhabited by many tribal communities among which Tripuri, Santhal, Jamatia, Debbarma, Molsom, Santhal are the major tribal communities.<sup>1</sup> Their staple food is rice, and they prepare their own alcoholic beverages using a starter culture which is prepared by mixing grinded rice with medicinal plants.<sup>3,4,49,67</sup> *Plumbago*

*zeylanica*, *Artocarpus heterophyllus*, *Capsicum annum*, *Saccharum officinarum*, *Dennstaedtia scabra*, *Ochthochloa coracana*, *Plumbago indica*, *Cinnamomum tamala*, *Scoparia dulcis*, *Hydrocotyle sibthorpioides* are some of the medicinal plants used by the tribes of Tripura.<sup>3,4,15,49,67,84</sup> *Chuwaraak*, a type of whiskey is prepared in Tripura by mixing rice, jackfruit, and pineapple with medicinal herbs.<sup>3,49,67</sup>



All the alcoholic beverages prepared in Tripura (Table 11) have a high level of alcohol content and among them, *Chuwak* prepared by Jamatia tribe records the highest level of alcohol content (Table 12).<sup>3,49,67</sup>

**Table 11: Traditional alcoholic beverages of Tripura**

Tribal community	Starter culture	Alcoholic beverages	Major inhabited districts
1. Debbarma <sup>3,49,67</sup>	NA	Chuwak <sup>3,49,67</sup>	Sepahijala, West Tripura, Unakoti, Dhalai
2. Jamatia <sup>3,49,67</sup>	NA	Chuwak <sup>3,49,67</sup>	Khowai, West Tripura, Unakoti
3. Koloj <sup>3,49,67</sup>	Chuwan beleb, <sup>3,49,67</sup> Hamei <sup>3,49,67</sup>	Chuwak, <sup>3,49,67</sup> Gora <sup>3,49,67</sup>	Khowai, West Tripura, North Tripura
4. Molsom <sup>3,49,67</sup>	NA	Rakju <sup>3,49,67</sup>	Khowai, South Tripura
5. Tripuris <sup>15</sup>	Chuwan <sup>15</sup>	Langi, <sup>15</sup> Chuwak, <sup>15</sup> Aaraak <sup>15</sup>	Khowai, Gomati, North Tripura, South Tripura, West Tripura

\*NA: Not Available

**Table 12: Biochemical Analysis of the traditional alcoholic beverages of Tripura**

Parameter	Tribal Communities of Tripura and their beverages				
	Debbarma	Jamatia	Kalai		Molsom
	Chuwak	Chuwak	Chuwak	Gora	Rakju
Acidity (Total) (g/100 mL)	0.193 <sup>67</sup>	0.127 <sup>67</sup>	0.059 <sup>67</sup>	NA	0.217 <sup>67</sup>
Acidity (Volatile) (g/100 mL)	0.352 <sup>67</sup>	0.026 <sup>67</sup>	0.020 <sup>67</sup>	NA	0.020 <sup>67</sup>
Carbohydrate content (g/100mL)	0.04 <sup>67</sup>	0.05 <sup>67</sup>	0.05 <sup>67</sup>	NA	0.08 <sup>67</sup>
Colour	Pale yellow <sup>67</sup>	Pale yellow <sup>67</sup>	Pale yellow <sup>67</sup>	Butyrous, White and light cream <sup>67</sup>	Pale yellow <sup>67</sup>
Ethanol content (v/v)%	6.13 <sup>67</sup>	9.48 <sup>67</sup>	10.06 <sup>67</sup>	6.40 <sup>67</sup>	7.38 <sup>67</sup>
Ethanol content distillate (v/v)%	28.14 <sup>67</sup>	30.41 <sup>67</sup>	35.18 <sup>67</sup>	NA	26.38 <sup>67</sup>
Moisture content (%)	89.33 <sup>67</sup>	86.0 <sup>67</sup>	85.5 <sup>67</sup>	NA	86.5 <sup>67</sup>
Opacity	Opaque <sup>67</sup>	Opaque <sup>67</sup>	Opaque <sup>67</sup>	NA	Opaque <sup>67</sup>
pH	3.64 <sup>67</sup>	3.61 <sup>67</sup>	3.70 <sup>67</sup>	3.63 <sup>67</sup>	3.52 <sup>67</sup>
Protein content (g/100mL)	0.96 <sup>67</sup>	1.14 <sup>67</sup>	1.15 <sup>67</sup>	NA	1.24 <sup>67</sup>
Reducing sugar (g/100mL)	0.01 <sup>67</sup>	0.11 <sup>67</sup>	0.01 <sup>67</sup>	NA	0.01 <sup>67</sup>
Non-Reducing sugar (g/100mL)	0.04 <sup>67</sup>	0.04 <sup>67</sup>	0.05 <sup>67</sup>	NA	0.08 <sup>67</sup>
Taste	Sweet, Tongue sensitizing <sup>67</sup>	Sour, Tongue sensitizing <sup>67</sup>	Sour, Tongue sensitizing <sup>67</sup>	Sweet <sup>67</sup>	Sweet, Tongue sensitizing <sup>67</sup>

\*NA: Not Available

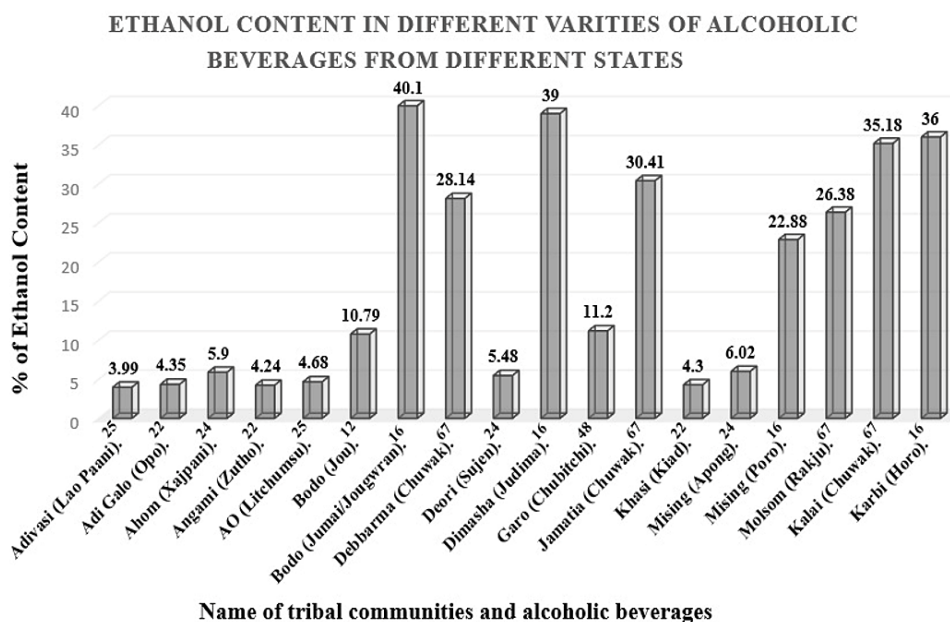
**Comparison of Biochemical Parameters of various Types of Alcoholic Beverages**

Diverse types of alcoholic beverages have been reported from different tribal communities of north-eastern India by different researchers. There is further

scope of research to analyze all the biochemical parameters. Each of beverages is associated with the preparation of a starter cake by mixing grinded rice with some medicinal plants.<sup>3,4,8</sup> More or less, all types of beer possess therapeutic values. Depending

upon the method of preparation, the storage time, and the starter culture, each of the beverages has different biochemical indices. Among the reported alcoholic beverages from Assam, Bodo's Jou has highest level of carbohydrate content and Bodo's Jumai/Jougwrn (distilled alcohol) has the highest level of ethanol content (Figure 2).<sup>3,5,12,14,15,16,33,56,66,85</sup> From Arunachal Pradesh, Rakshi, the beverage by Miji tribe contains 13% ethanol but several other biochemical parameters are still unknown.<sup>3</sup> In 2014, Deka *et al.* carried out research on Bodo's Jou and they reported that percentage of ethanol content increased with the increase of fermentation period.<sup>12</sup> In 2015, J Arjun studied about *Judima*, Jumai, Horo, Poro respectively by Mising, Karbi,

Dimasha and Bodo people, and reported that Jumai contained highest level of ethanol content.<sup>16</sup> He made a comparison among the above-mentioned alcoholic beverages with Beer Kingfisher, Gin Blue Riband, Vodka White Mischief, Rum McDowell, Whisky McDowell etc. He reported that commercial liquor contains more alcohol but less carbohydrate than the alcoholic beverages of north-east India.<sup>16</sup> In 2014, Bhuyan *et al.* analyzed nutritional properties of north-east beverages reporting that Hor by Karbi tribe of Assam was used as a medicine to cure pharyngitis and dysentery; Yu by Meitei women was used to cure weak health conditions due to irregular menstruation cycle, loss of appetite, infertility factors etc.<sup>29</sup>



**Fig. 2: Bar Diagram showing the ethanol content of different alcoholic beverages**

**Study of Biochemical Indices with Respect to Time Period**

Some of the earlier researchers have studied how biochemical indices change with duration of fermentation. From their data, it is almost clear that at the initial stage carbohydrate content becomes highest.<sup>35</sup> As time passes, amount of carbohydrate goes on decreasing and with the same rate ethanol content increases due to increase in fermentation time, carbohydrate gets fermented to ethanol.<sup>35</sup> Fermentation cannot make any change on maltotetrose and higher polymers of glucose, only the six membered carbohydrates are fermented.<sup>35</sup> Therefore, maltotetrose and higher polymers of

glucose are the main reasons of carbohydrate content in rice based alcoholic beverages.<sup>35</sup> As the level of carbohydrate is decreased and alcohol content is increased with the increase of fermentation period, it means that the storage technique for fermentation is scientifically validated.<sup>35</sup> The bar diagrams (Figure 3 and Figure 4) are represented to show the change in carbohydrate and ethanol contents in Jou samples with different fermentation period according to the information given by Deka *et al.*<sup>12,35</sup> Mishra *et al.* made a systematic analysis on the bio-functional properties and storage study of 'Chubitchi'- a fermented rice beverage of Garo Hills, Meghalaya, and this is presented in Figure 5.<sup>48</sup>

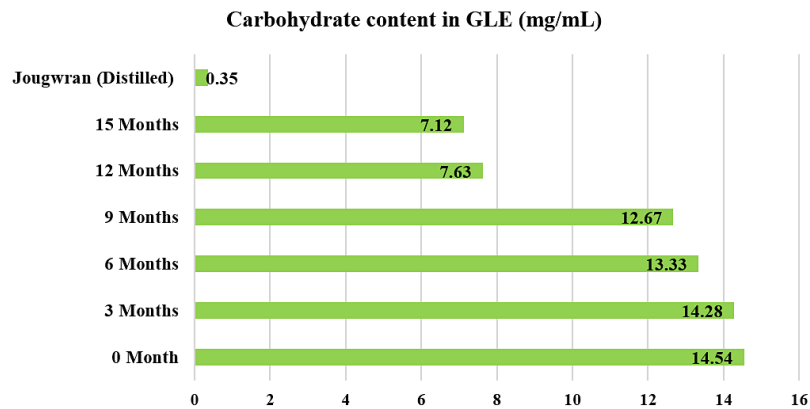


Fig. 3: Bar Diagram showing carbohydrate content in Jou Samples<sup>35</sup>

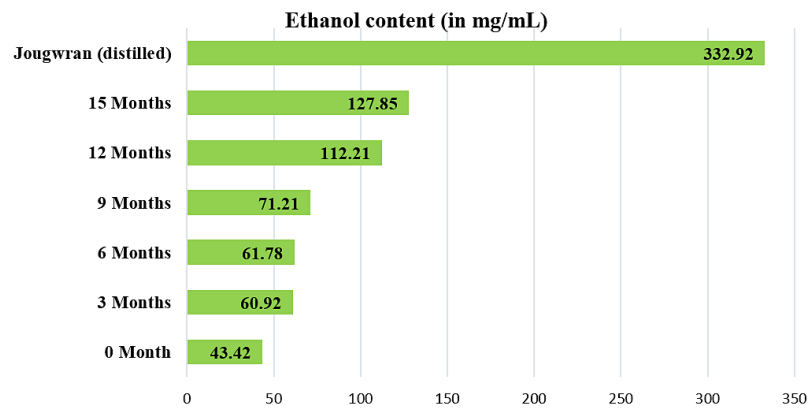


Fig. 4: Bar Diagram showing ethanol content in Jou Samples<sup>35</sup>

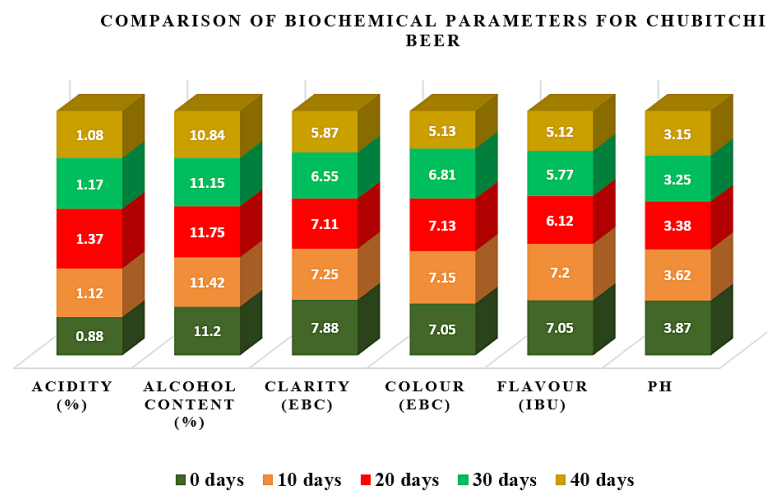


Fig. 5: Bar diagram showing the biochemical parameters for Chubitchi Beer as reported by Mishra *et al.*<sup>48</sup>

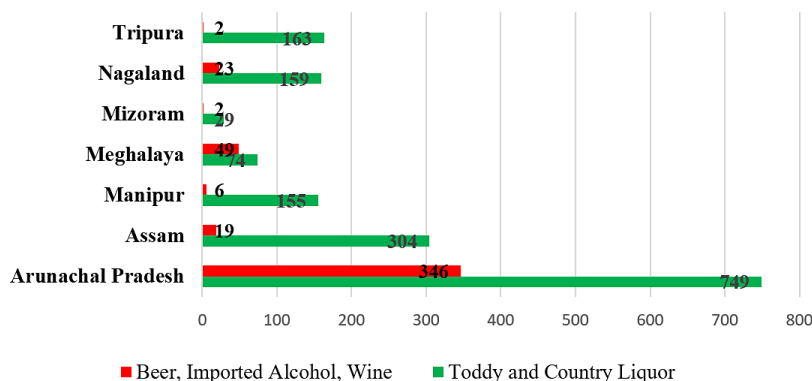
From the above bar diagram for Chubitchi beer, it is clear that colour goes on increasing up to 10 days; after 10 days, it slowly decreases. Beer colour is generally due to presence of protein and sugar in the beer sample.<sup>36,44</sup> Again, the transparency/ clarity order goes on decreasing with the increase of fermentation period. Flavor is very sharp within 10 days of fermentation. Alcohol content is found to be highest on the 20<sup>th</sup> day of storage. It is clear from the data that all parameters will not run parallel with fermentation period. There is a sudden jump of most of the parameters with fermentation time. This means that the storage technique is not scientifically validated over time.

**Consumption Pattern and Therapeutic Use**

Though rice-based beverages have lots of nutritional values, yet an excess of it is very harmful. Higher dose consumption of it may cause to violence, accidents,

mental as well as other health problems, and also may cause diseases like infections, diabetes, arthritis, cardiovascular diseases, cancer, Alzheimer disease, etc.<sup>9,46</sup> Consumption of beverages is very common during the time of festivals, election time, ritual ceremonies etc.<sup>9</sup> People consume it for various reasons such as to express happiness, and for various issues like family problem, financial problem, lack of employment, etc. Traditional alcoholic beverages of north-east India can be a potent source to earn livelihood as well as revenue source for government. Alcohol consumption per capita per week (in mL) as of 2011-12 in north-eastern states is shown in Figure 6.<sup>9</sup> There is a need to complete and report the biochemical analyses of all types of alcoholic beverages. Rice beer has some positive impacts on the health, which cannot be ignored. Therapeutic uses of some traditional rice based alcoholic beverages are discussed in Table 13.

**ALCOHOL CONSUMPTION IN NORTH -EASTERN STATES (PER CAPITA PER WEEK, in mL)**



**Fig. 6: Bar Diagram showing alcohol consumption in north-eastern states (per capita per week, in mL) as reported by Choudhury et al.<sup>9</sup>**

**Table 13: Therapeutic uses of rice-based alcoholic beverages**

Beverages	Therapeutic use
Apong <sup>3,5,8,15,16,19,26,27,33,36,37,56,85</sup>	Prevent the formation of kidney stones, headache, body ache, insomnia, diarrhea, urinary problems.
Jou <sup>3,5,12,14,15,16,33,56,66,85</sup>	Helps from causing jaundice and urinary disorders
Judima <sup>5,15,16,45,66</sup>	Anti-inflammatory, anti-allergic, anti-oxidant, anti-bacterial, anti-fungal, antispasmodic, neuron protective, anti-ageing, anti-diabetic potentialities
Zutho <sup>3,15,52,66</sup>	Immune system booster, anti-diabetic, prevents loss of appetite, expels bad cholesterol, assists in wound healing by preventing infection

### Conclusion

The present study reports the physicochemical parameters of different types of rice beers available in north-eastern states of India. Reported data have been analyzed, and a comparison among the different traditional alcoholic beverages has been presented. This report has revealed that there is wide scope of research on traditional alcoholic beverages of north-eastern states of India. Since there is high consumption of traditional alcoholic beverages among the different tribal communities of north-eastern states, it is essential that thorough scientific study on all unreported alcoholic beverages be carried out to reveal their potential health benefits or otherwise. Commercialization of traditional alcoholic beverages of north-eastern states of India is immense. In the Indian sub-continent, seven

north-eastern states including Assam are known for the rich heritage of traditional alcoholic beverages prepared from rice. To know more please rich this article which has cited as many as 97 references.

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### Conflict of Interest

The authors declare no conflicting interests.

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