Bamboo Shoots for Food in North-East India: Conventional and Contemporary

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Abstract

North-East India is endowed with abundance of natural resources and bamboo is one such resource. The region is rich in diversity as well as stock of bamboo, not only in India but by extension in the entire South-East Asian region. Bamboo is a way of life and culture in the region and used for almost all purposes like surgical blades for cutting the umbilical cord of new born babies to food and medicines. Bamboo was wood for all types of construction; it was a material for making all types of household utensils, agricultural and fishing implements to fuel for cooking and warming up the homes. One extensive use of bamboo in this region is the usage of young shoots as food. Young bamboo shoots of almost all species are eaten in various forms in the region and people have developed their own techniques and methods of preserving and processing of bamboo shoots for long term usage as well. They are also aware about the nutritional value of the young bamboo shoots which has now been substantiated by scientific studies. Bamboo being a promising natural resource, the contemporary usage of bamboo shoots shall help in the socio-economic and food security of the region and accordingly people are trying to use bamboo in various new and innovative ways for the well being, good health and prosperity.

Key words: Bamboo shoots, nutritional value, traditional and contemporary food items

Introduction

Bamboo, an invaluable gift of nature to the people of North-East India, is a multipurpose plant which has become a way of life in North-East India and is tightly interwoven with the daily life and culture of the region. In fact, about fifty years back bamboo was a solution for everything in the region right from blade for cutting the umbilical cord of a new born baby to food for survival. Bamboo was for entertainment with bamboo pole dance (Chiraw in Mizo tribe) and music with bamboo flute and drums and finally bier or coffin to the dead body. Traditionally bamboo is used for construction of houses, shades and habitats for man and domestic animals, agricultural and fishing implements, bridges, household utensils and storage containers, food and medicine. In some regions, like Manipur, a house without a bamboo grove was not considered a happy one and growing of a bamboo grove was a must (Naithani et al 2010). In some parts of North-East India, bamboo is in excess as in Mizoram (Around 43.68 % of the geographic area is covered with bamboo) and known for the adverse impact of bamboo that is famine (Thingtam and Mautam) due to periodic bamboo flowering and seed production in abundance (Mohan Ram and Harigopal 1981; Ramanayake and Yakaandawala 1998; Singha et al 2003). In this present time of plastic and steel, bamboo has not lost its value in the daily life of the people of North-East India. Rather it has entered a new era, not only in North-East India but in the entire world. It is now christened as the 'timber of 21st century', 'green gold' or 'wood and food for 21st century' and poised to replace wood for almost all practical purposes.

Theme: Food and Pharmaceuticals

Besides various uses of bamboo in the region, the young shoots are also used as food. There are a number of ways, fresh, dried and fermented, that bamboo shoots are consumed as food almost in entire region of North-East India (Mao and Odyuo 2007; Tamang and Tamang 2009;Bisht et al 2012). Since long, people in North-East region of India have well established procedures, skills and traditional knowledge of using bamboo as food and flavoring agent (Sarangthem and Singh 2003; Mao and Odyuo 2007; Jeyaram et al 2009; Tamang and Tamang 2009). However, bamboo shoot processing, fermentation, preparation of food items from shoots and storage of shoots for long term usage have always remained a household business in the region which is mainly handled by women. Now there are various scientific studies which are proving bamboo shoots not only nutritious but as health food and being promoted as functional and nutraceutical foods (Nirmala et al 2011,2014; Chandramawli and Vishwanath 2012) and further needs to be promoted at industrial level in the region for health benefits, food security and socio-economic development.

Bamboo as a natural resource in the North-East India

Due to favourable climatic and soil conditions North-East India is rich in diversity, acreage and stock of bamboo (Scurlock et al 2000; Bisht and Naithani 2010). It is widely distributed in the North-East region except at few areas of higher mountains in Sikkim and Arunachal Pradesh. Around ten per cent (spread over 27,598 sq km) of the total geographic area of eight North-Eastern Indian states is covered with bamboo, which accounts for 24.29 per cent of the total bamboo coverage of the country (Table 1). Even there are states like Mizoram where forest meant bamboo forest only, as around 43 per cent of the total geographic area of Mizoram is covered with bamboo (Table 1). Similarly states like Meghalaya, Sikkim, Manipur and Tripura, have bamboo spread over 13 to 22 per cent of their total geographic area or 21 per cent to 35 per cent of their total forest area (Table 1). However, two largest states (in terms of area) of the North-East India, Arunachal Pradesh (Geographic area 83,743 sq km) and Assam (Geographic area 78,438 sq km) have comparatively less bamboo coverage (on 5.5 per cent of the total geographic area of Arunachal Pradesh and on less than 5 per cent of the total geographic area in Assam) may be due to reasons like higher altitude in the former and agricultural expansions in the latter. In Nagaland around 5.6 per cent of the total geographic area or 8.8 per cent of the total forest area is covered with bamboo which is also comparatively lesser than other mountainous states of North-East India (Table 1). In terms of stock North-Eastern India is the richest region in the country as well, having around 66 per cent of the total bamboo stock of the country which is approximately 80.42 million tonnes (Bisht and Naithani 2010).

Table1: Bamboo as a natural resource in North-East India (Bisht and Naithani 2010; FSI 2011)

North-East Indian states	**Geographic area, Sq km**	**Forest area, Sq km**	**Area covered with bamboo, Sq km**	**Bamboo area (per cent of geographic area)**	**Bamboo area (per cent of total forest area)**	**Bamboo stock (1000 tons)**
Assam	78,438	27,692	1,813	2.31	6.56	9844
Arunachal	83,743	67,353	4,596	5.5	8.52	1616

Pradesh						
Manipur	22,327	17,280	3,692	16.5	21.81	11470
Meghalaya	22,429	17,321	3,102	13.8	32.67	4407
Mizoram	21,081	19,240	9,210	43.7	57.80	10890
Nagaland	16,579	13,464	758	4.6	8.8	3657
Tripura	10,486	8,073	3,246	22.8	29.69	860
Sikkim	7,096	3,357	1,181	16.64	35.18	-
India	32,87,266	6,90,899	1,13,610	3.55	16.44	-

The North-Eastern region of India is also the richest part of India in terms of bamboo species diversity. Out of the 125 species of bamboo reported from India, more than 60 species (belonging to 18 different genera) are found in North-East India (Tewari 1992). States like Manipur (35 species), Arunachal Pradesh (42 species) and Meghalaya (35 species) are the richest states in bamboo diversity (Tewari 1992; Kharlyngdoh and Barik 2008; Naithani et al 2010). Dominant genera of bamboo in the region are *Bambusa* with 23 species, *Dendrocalamus* with more than 12 species, *Schizostachyum* with 11 species, *Drepanostachyum* and *Gigantochloa* with seven species each (Tewari 1992). There are genera like *Arundinaria, Gigantochloa, Melocanna*, *Neomicrocalamus* and *Thyrsostachys* which are found only in North-East India not in other parts of the country (Tewari 1992). There are a number of species and varieties which are endemic to the region. Some of the endemic species of the region are *Arundinaria clarkei*, *A. debilis*, *Bambusa balcoa*, *B. jaintiana*, *Dinochloa mclellandii*, *Dendrochalamus longifimbriatus*, *Neomicrocalamus prainii*, etc (Naithani et al 2010).

Bamboo shoots as food

Bamboo is food to many animals. Some species, like giant panda, red panda and golden bamboo lemur (*Hapalemur aureus*) exclusively live on bamboo diet, whereas bamboo shoots are seasonal favourites for mountain gorillas of Africa. In Japan, the bamboo shoot is called "King of Forest Vegetables" and during the Tang Dynasty (618-907 AD) of China, bamboo was considered treasure dish (See Nirmala et al 2011). Bamboo shoots have also been food for the North-East Indian people since time immemorial, which may have learnt from animals to use only the young tender shoots for food, as depicted in the folk tales of the Mizo (people of Mizoram state). According to these stories, a tortoise ate young bamboo shoots for three months then did not eat anything rest of the year. The tortoise still remained healthy until the end of year. Accordingly, people consider bamboo shoots a healthy food and consume a lot during the season in various forms like pickles, condiments, soups, side dish or as complete vegetable (Bisht et al 2012). All the tribes and localities have their own ways of processing bamboo shoots for food. People also have their own preference for a particular species or variety for food and for other uses like pickle, condiments or flavoring agent. Now people are also trying to use bamboo shoots in various forms like powder, paste, fiber extract, fermented shoots and preparing different food items like chapatti, parantha, bakery and steamed products and various vegetables, soups and sweet meats.

It has been observed that shoots of almost all the species are consumed by the people of North-East India, however, there are some species or varieties which are preferred most by some tribes, localities or regions (Table 2). Like the Khasi and Jaintia, the people of Meghalaya prefer the young shoots of *Dendrocalamus hamiltonii*, *D. calostachyus*, *D. hookerii*, *D. sikkimensis*, *Gigantochloa albociliata* and *G. apus* the most. The shoots are big and very good for fermentation and long term storage in plain water. The shoots are bitter in taste when raw and have high amounts of cyanogenic glucosides which are removed by storing the shoots in plain water or by submerging them in water for a few hours. The Mizo people of Mizoram mainly prefer the small and young shoots of *Melocanna baccifera* (Mautak) and *Phyllostachys mannii* (locally called Naga bamboo), which are sweet in taste and have very little cyanogenic glucoside. In the Manipur state, the Meetei people prefer the rhizomatous shoots of *Melocanna baccifera*, *Bambusa nutans*, *Dendrocalamus sikkimensis* and apical shoots of *Chimonobambusa callosa*. Consumption of specific species or varieties mainly depends on their availability and taste. People have also developed different processing methods for different species or varieties.

Table 2: Most preferred bamboo species for shoot consumption in North-East India

States of North-East India	**Species**	**Annual consumption of bamboo shoots (Bhatt et al. 2004) Tonnes**
Assam	*Bambusa burmanica*, *B. pallida*, *B. tulda*,*Dendrocalaumus hookerii*, *D. giganteus*, *D. sikkimensis, Gigantochloa rostrata*,*G. albociliata*, *Melocanna baccifera*, *Phyllostachys bambusoides*, *Schizostachyum dullooa*	-
Arunachal Pradesh	*Bambusa nutans, B. pallida*, *Chimonobambusa callosa*, *Dendrocalamus giganteus*, *D. hamiltonii*, *Gigantochloa albociliata*, *Pleioblastus simonii, Sinarundinaria elegans*	1978
Manipur	*Chimonobambusa callosa*, *Dendrocalamus asper*, *D. hamiltonii*, *D. longispathus*, *D. strictus*, *D. giganteus*, *D. latiflorus*, *D. flagellifer*, *Melocanna baccifera*, *Bambusa bambos*, *B. nutans*, *B. kingiana*, *B. nana*, *Phyllostachys hetercycla* var. *pubescence*, *P. bambusoides*, *Schizostchyum beddomei*	2187.2
Meghalaya	*Dendrocalamus hamiltonii*, *D. calostachyus*, *D. hookerii, D. sikkimensis*, *Gigantochloa albociliata*, *G. apus*, *G. rostrata*, *Schizostachyum dullooa*, *Melocanna baccifera*	4418
Mizoram	*Phyllostachys mannii*, *Bambusa longispiculata*, *Melocanna baccifera*, *Bambusa pallida*, *B. tulda*, *Chimonobambusa callosa*, *Dendrocalamus*	433

	calostachysus, *D. hamiltonii, D. hookeri*, *D. sikkimensis*,	
Nagaland	*Bambusa pallida, B. tulda*, *Chimonobambusa callossa*, *Dendrocalamus calostachyus*, *D. giganteus*, *D. hamiltonii*, *D. hookerii*, *D. sikkimensis*, *Sinarundinaria elegans*	441.52
Tripura	*Bambusa pallida*, *B. tulda*, *B. polymorpha*, *Dendrocalamus hamiltonii*, *D. longispathus*, *Gigantochloa rostrata*, *Melocanna baccifera*,	201.3
Sikkim	*Dendrocalamus hamiltonii*, *D. hookeri, D. sikkimensis,*	-

Traditional way of bamboo shoot consumption and processing

Since long, young emerging shoots of bamboo are in use for food in the North-East region as well as in many other parts of the country. But in comparison to other parts of the country bamboo shoots are popular food item in North-East region and form a major part of traditional cuisine. Earlier it was also a solution for food security in the dense forest and remote areas during lean period (Bhatt et al 2003, 2004; Tamang and Tamang 2009; Bisht et al 2012). Almost all the tribes of the region relish bamboo shoots and have their own recipes and method of using of bamboo shoots as food or flavouring agent. People have developed culinary art and processing methods of shoots for food according to the species or variety available in their areas. According to species or variety of bamboo, the shoots are consumed fresh, dried or fermented. Those species which have sweet taste are generally preferred fresh, whereas species or variety of bamboo which have shoots with bitter taste are generally fermented or dried. Like people from Mizoram state prefer fresh slender and soft shoots of *Melocanna baccifera* and *Phyllostachys manii*. Khasi, Garo and Jaintia tribes of Meghalaya prefer big, slightly harder shoots of *Dendrocalamus hamiltonii,* but after fermentation. The Meetei people of Manipur prefer fresh shoots of *Bambusa nutans* for preparing Ooti and Kangsu and fermented shoots for making Soijin-eronba. Similarly they also prefer apical shoots of *Chimonobambusa callosa* as fresh for making various food items.

Fresh shoots as food: With their long experience, people of the region have divided shoots of bamboo species into different categories for food. Shoots of some species are suitable for fermentation and whereas shoots of some have good taste as fresh or dried. There are species of bamboo like *Phyllostachys mannii*, *Melocanna baccifera, Bambusa nutans*, *B. tulda*, *Dendroclamus sikkimensis*, *D. giganteus* and *Chimonobambusa callosa* (apical shoots) in the region which are mostly preferred by the people as fresh for food. The shoots of most of these have less cyanogenic glycosides and do not give pungent smell and bitter taste. Young shoots are harvested during the monsoon season and their culm sheaths removed to extract out the soft edible portion (Fig.1). The shoots are then washed in water or sometimes soaked in water for few minutes, and are boiled or fried in oil and eaten as vegetables or mixed with pork and other vegetables. Some people prepare pickles from the fresh shoots of these species of bamboo. Usoi-Ooti of Manipur, Rawtui-bai of Mizoram, Mia-gudhog of Tripura are some of the important recipes prepared from fresh shoots of bamboo (Table 4).

Shoots dried for food: Drying of bamboo shoots for food is another very common practice in the region. The shelf life of bamboo shoot is very short (two to three days only) and due to very fast growth of the shoots the period to get right edible stage of shoots is also very short (just one to two days after the shoots emerge out of soil). To overcome these problems associated with bamboo shoots as food, people of the region started drying bamboo shoots in sun or over fire. These dried shoots could be used round the year as condiments with various vegetables and meat items (Table 4). Drying also reduces the content of cyanogenic glycoside content and shoots become tastier.

Shoots fermented for food: Fermentation is one very important technique which is extensively followed in the North-East region of India to increase the shelf life of bamboo shoots, make it more palatable and easy to store and handle. Fermentation also decrease the level of cyanogenic glycosides in bamboo shoots to the extent of hundred percent and at the same time increases the nutritional and health benefits. Fermentation of young bamboo shoots is very common in the North-East region particularly in states like Manipur, Tripura, Arunachal Pradesh and Meghalaya and there are number of methods of fermentation which are specific to tribe, region or species/variety of bamboo (Table 3). The method of fermentation has been developed locally using local materials and orally passed on from one generation to the next. Some tribes like Khasi, Garo and Jaintia of

Table 3: Traditional fermentation and drying of bamboo shoots in North-East India

Fermented Bamboo Product	**Tribe and State**	**Process of fermentation of bamboo shoots**
Pdam	Khasi, Meghalaya	Fermentation in plastic or glass bottles submerged in water
-	Khasi, Meghalaya	Wrapped in banana leaves fermentation in bamboo basket
Soibum	Meetei, Manipur	Sliced bamboo shoots fermented either in pot (black clay) or bamboo baskets, exudates drained out
Soidon	Meetei, Manipur	Sliced bamboo shoots fermented in earthen pots for 3 to 7 days
Soijin	Meetei, Manipur	Sliced bamboo shoots boiled and fermented in a basket
Hikhu	Apatani, Arunachal Pradesh	Chopped bamboo shoots wrapped in banana leaves fermented within 6 to 8 days
Hiring	Apatani, Arunachal Pradesh	Sliced bamboo shoots fermented in bamboo cylinders within 7days
Hithyi	Apatani, Arunachal Pradesh	Sliced bamboo shoots sundried and stored in baskets
Ekung	Adi, Arunachal Pradesh	Sliced bamboo shoots wrapped in ekkam (*Phrynium pubenerve*) leaves and fermented

Edung	Adi, Arunachal Pradesh	Sliced bamboo shoots fermented in bamboo cylinders
Eup	Nyishing Arunachal Padesh	Shoots fermented within 1-3 months covered with ekkam (*Phrynium pubenerve*) leaves
Ikung	Adi, Arunachal Pradesh	Bamboo shoots cut in small pieces and partially dried in the sun and then bottled for two to three months
Ib	Adi, Arunachal Pradesh	Bamboo shoots cut into small pieces and fully dried in the sun
Mesu	Limboo, Drajeeling, Sikkim	Shoots fermented in green yellow bamboo stems for 7 to 15 days
Rawtuai rep	Mizo, Mizoram	Bamboo shoots (*Phyllostachys mannii*) sun or fire dried
Moiya-Koshak	Debbarma, Tripura Uchoi- Tripura	Bamboo shoots (local variety Warthwi Moiya) a no-bitter variety is chopped and wrapped in banana leaves for fermentation (2-3 days)
Midukye	Chakma, Tripura	Bamboos shoots of non-bitter variety chopped and wrapped in banana leaves for fermentation
Melye-Amiley	Chakma, Tripura	Chopped bamboo shoots first soaked in water in an earthen pot for two days and then allowed to ferment in the same pot by covering the lid
Moiya-Pangsung	Uchoi, Tripura	Big pieces of bamboo shoots fermented in water for two days. Then the fermented shoots shopped in small pieces and used

Meghalaya mainly ferment the chopped bamboo shoots in a container filled with water. Earlier these containers were of either bamboo, wooden or earthen but now replaced mainly with plastics. In this method shoots can be preserved for more than one year. The fermented shoots develop a sour taste at the same time maintain the crunchiness which is relished by the local people. The people of Meghalaya mainly prefer the shoots of *Dendrocalamus hamiltonii* for fermentation by this water method. The Adi tribe of Arunachal Pradesh ferment the bamboo shoots in a bamboo basket covered with ekkam (*Phrynium pubenerve*) leaves (Table 3). In Manipur bamboo shoots are fermented by the Meetei people either in an earthen pot or in bamboo basket. The Meetei call these fermented bamboo shoot products either soibum or soijin. Some of the Naga tribes of Nagaland state ferment bamboo shoots in a conical bamboo basket which bears a hole at the bottom to collect the exudates from fermented shoots. The exudates is used for flavoring various food items round the year. Various tribes (Debbarma, Uchoi, Chakma) of Tripura state also ferment bamboo shoots, mainly in earthen pots (Table 3). The fermented products are called Moiya koshak (Debbarman and Uchoi Tribes), Medukeye (Chakma Tribe) or Melye amiley (Chakma tribe). The fermentation of bamboo shoots by different methods is also associated with unique group of microflora which increases the nutritional

value of the shoots (Jeyaram et al 2009). The fermentation process increases the level of proteins, vitamins, essential amino acids and various bioactive compounds (Sarangthem and Singh 2003a; Nirmala et al 2011).

Traditional recipes of bamboo shoots: In North-East India, **s**hoots are consumed almost round the year either as fresh (nearly for 6 to 7 months) or dried and fermented. People in different regions have different methods of bamboo shoot consumption. Some prefer fresh like Mizo people and some prefer fresh as well as fermented like Meetei people of Manipur and Debbarma, Uchoi and Chakma tribes of Tripura. Meetei people of Manipur prepare tasty Usoi-Kangsu and Usoi-Ooti from fresh bamboo shoots. (Table 4; Fig. 2B). The fresh shoots are sliced soaked in water overnight to remove cyanogenic glycosides mixed with fermented fish or dried fish for making Usoi-Kangsu or boiled with presoaked peas with a pinch of sodium bicarbonate for making Usoi-Ooti (Fig. 2B). Bamboo shoots of *Bambusa nutans* are generally preferred for making these dishes. The shoots of *B. nutans* have less cyanogenic glycosides and taste sweet as raw. Mizo people from Mizoram state also like to have fresh bamboo shoots of *Melocanna baccifera* and *Phyllostachys mannii*. They prepare Rawtuai bawl from fresh shoots of these species. Fresh shoots of *P. mannii* or *M. baccifera* are boiled and mixed with green chilies either with fermented pork or with leaves of a bean, which is available locally in the region. Fresh shoots of *M. baccifera* are also cooked with rice with a pinch of sodium bicarbonate and the recipe is called Rawtui-bai (Table 4; Fig. 2C).

Table 4. Traditional bamboo shoot recipes from North-East India

Bamboo shoot recipe	**Tribe and State**	**Method of preparation**
Rawtuai -Bawl (non veg)	Mizo , Mizoram	Boiled bamboo shoots (*Phyllostachys mannii*) mixed with fermented pork and spices
Rawtuai -Bawl (veg)	Mizo, Mizoram	Bamboo shoots (*Phyllostachys mannii*) boiled and mixed with green chilies and leaves of small beans
Rawtuai -Rep	Mizo, Mizoram	Sun or fire dried bamboo shoots (*Phyllostachys mannii*) soaked in water and then mixed with either fermented pork or green chilies and leaves of small beans
Rawtuai-Kan	Mizo, Mizoram	Boiled bamboo shoots (*Melocanna beccifera*) fried with oil and other spices
Rawtui-bai	Mizo, Mizoram	Fresh shoots of *Melocanna beccifera* chopped soaked in water and boiled with some rice with a pinch of sodium-bicarbonate
Usoi-Ooti	Meetei, Manipur	Sliced bamboo shoots *(Bambusa nutans)* and dried pea soaked in water overnight then boiled with a pinch of sodium bicarbonate
Usoi-kangsu	Meetei, Manipur	Overnight water soaked bamboo slices boiled with potato and mixed with fried fermented fish

		and dried chilies
Soijin-eromba	Meetei, Manipur	Fermented bamboo shoots boiled with potato and mixed with fermented fish and dried chilies
Ngakra-Soijin Thongba	Meetei, Manipur	Fermented bamboo shoot (Soijin) and cat fish (local breed) cooked with oil and spices
Mia-Gudhog	Jamatia, Tripura	Fresh bamboo shoots washed and cooked with various vegetables and fermented fish and smashed. Chilies, onion and garlic used for taste
Mia-Mosho	Jamatia, Tripura	Boiled bamboo shoots used for making chutney with fermented fish and chilies
Mia –Chachiew	Jamatia, Tripura	Boiled bamboo shoots cooked either with rice powder, dried pea or dal (pulses) with a pinch of sodium bicarbonate
Mia-Mweiborog	Jamatia, Tripura	Boiled bamboo shoots with vegetables, fish, chilies and onion
Moiya Koshak-Shidal	Debbarma, Tripura	Fermented bamboo shoots with fermented fish (shidal)
Chakkhoi	Uchoi, Tripura	Fermented bamboo shoots with vegetables
Moya-Chakhoi	Tripura	Shoots of non-bitter bamboo soaked in hot water (5 minutes) dried in sun and consumed with other vegetables
Perok-Ikung	Adi, Arunachal Pradesh	Ikung (fermented) bamboo shoots prepared with fried chicken and spices or boiled with chicken and spices
Yekdin-Ikung	Adi, Arunachal Pradesh	Ikung (fermented) bamboo shoots fried or boiled with pork and other spices
Engo-Ikung	Adi, Arunachal Pradesh	Ikung (fermented) bamboo shoots boiled with fish and spices
Itting-Oying	Adi, Arunachal Pradesh	Fresh bamboo shoots cut into small pieces and boiled and prepared with vegetable or added with chicken or pork
Ib-Oying	Adi-Arunachal Pradesh	Dried bamboo shoots prepared with fish, chicken or pork

There are also a number of recipes of fermented bamboo shoots particularly in Manipur, Nagaland and Arunachal Pradesh. Fermentation of shoots is mainly done for two reasons. One is to make the

bamboo shoots free from the cyanogenic glucoside and make it palatable and secondly, to extend the shelf life of the shoots. Fermentation also makes bland shoots tasty and soft. Except few species like *P.mannii* and apical shoots of *Chimonobambusa callosa,* mostly shoots of all other edible species of bamboo are fermented in the region. Fermented shoots are then used for making various food items either alone or in combination with fish (fermented or fresh) pork, or with different vegetables and spices. The Meetei people of Manipur prepare Soijin-Eromba from partially fermented bamboo shoots. The fermented bamboo shoots are boiled with potatoes and mixed with fermented fish and chilies. Soijin is also cooked with cat fish along with good amount of oil and spices. Khasi-Jaintia people use the fermented bamboo shoots for making pickles or cook along with pork. In the state of Tripura also different tribes like Debberma, Uchoi, Chakma, Jamatia etc. use fermented bamboo shoots for making chutteny and various other items mixed either with fermented fish or other vegetables (Table 4). These fermented bamboo shoots are reported to be enhanced with nutrient and bioactive components which are beneficial for good health (Nirmala et al 2011). Fermented bamboo shoots may also be a source of probiotics bacteria and itself acts as a prebiotic as well.

Contemporary food items from bamboo shoots

Change in lifestyle and globalization has greatly brought changes in the food habits as well in the region. Old food habits and cuisines are being replaced or being modified due to reasons like non-availability of traditional food items, change of taste or difficulty in processing. Old and traditional methods of bamboo shoot fermentation and preservation are also being modified and being made hygienic. Out migration of people from the region to big cities and towns for education and job has also changed the food habit and taste of these people at the same time have also learnt various new ways of bamboo shoot consumption. Because of these reasons various methods are being developed for the new cuisines and recipes. Institutes, research organizations and individuals are also working on various aspect of bamboo shoot as food and preparation of new bamboo shoot recipes is one of the important aspects.

Food items with bamboo shoot chunks and shreds: Small pieces and shreds of bamboo shoots are excellent material for making various food items like stir fry with noodles and various vegetables and cooking along with rice and making omelet and egg curry (Table 5). Shredded bamboo shoots also go very well with pulses, sambar and other vegetables like papaya, *Sechium edule* (Table 5). Small pieces of bamboo shoots maintain the crunchiness with *papaya and S. edule*, which become paste while cooking. Shreds and small pieces of bamboo along with ground nuts (peanuts) and fresh/frozen peas are very good with fried rice. Bamboo chunks are also very good for making pakora, finger chips and other items with besan (gram flour). Fresh shoots of bamboo species like *P. mannii*, *B. tulda*, which taste sweet, are suitable for making these food items. Either boiling of bamboo shoots for five to ten minutes or soaking in water is sufficient to remove the traces of cyanogenic glycosides, if present. Shreds and small pieces from the shoots of *D. hamiltonii* are also good for making these food items because of hardness but need boiling for at least half an hour before use.

Table 5. Contemporary use of bamboo shoots as food in India

Food items with bamboo shoot	**Method of preparation**
(a) Food items prepared with paste of bamboo shoots	

Chapatti	25 per cent bamboo paste mixed with 75 per cent wheat flour made dough for preparing chapatti
Parantha	20 per cent bamboo paste mixed with cream (10 per cent) and wheat flour (70 per cent). Soft parantha prepared with the dough
Bamboo Shoot Paste-Egg Curry	Bamboo shoot paste fried along with onion, garlic, ginger paste and then added small pieces of egg white from boiled eggs. The yellow part of the boiled egg is mixed with water first then added to fried mixture
Bamboo shoot paste-Mutton	Bamboo paste is fried with onion, garlic, ginger. Then added mutton and fried for some time. Added water according to requirement and cooked for 15 to 20 minutes
Bhujia	Paste (30 per cent) mixed with gram flour (50 per cent) and potato starch (20 per cent). Prepared thick paste passed through a sieve (1 mm x 1mm) and fried
Cookies	Bamboo paste (10 to 15 per cent) mixed with other ingredients (wheat flour per cent, butter plus oil 25 per cent, sugar 12.5 per cent, coconut powder 12.5 per cent, baking powder 2 to 2.5 per cent) and baked
Bread	Ten to 15 per cent bamboo paste mixed with wheat flour (80 per cent) and baking powder and baked
Paneer	Bamboo paste (25 per cent) boiled with milk (75 per cent) boiled and coagulated by adding lime or vinegar
(b) Food items prepare with chunks and shreds of bamboo shoots	
Pickles	Bamboo shoot chips fermented in water for 6 months and prepared pickle by adding spices and oil
Bamboo shoot rice	Small bamboo chips (10 per cent) cooked with rice (90 per cent)
Bamboo shoot fried rice	Bamboo shoot chips (10 per cent), ground nuts (5 per cent) fried and mixed with precooked rice
Bamboo shoot-Omelet	Fine shreds or pieces of bamboo shoots mixed with egg for preparing omelet. Coriander and chili added for taste
Bamboo shoot-Noodles	Fine shred of bamboo shoots fried with boiled noodles. Other vegetables like pea, bean may also added
Pakora	Bamboo shoot slices (of *Dendrocalamus hamiltonii*) dipped in gram flower paste and fried
Finger chips	Peeled shoots of *Phyllostachys mannii* dipped in gram flour paste and fried

Food items with bamboo shoot paste: Conversion of bamboo shoots into paste is one of the most convenient and easy way of conservation for long term and also is easier in carrying and transporting from one place to another. The bamboo shoot paste can be stored in a glass or plastic bottles and in plastic packets. This paste can be used for making bakery items like biscuits, bread, cookies as well as for making Chapatties and parantha (Fig. 3A-F). The paste is also being used as

spices and thickening of mutton or egg curry. The bamboo paste is also going very well with paneer (cottage cheese). The bamboo shoot paneer is very good for making chapatti and parantha.

Health benefits and Nutritional aspects of bamboo shoots

Bamboo shoots have always been considered nutritious and healthy and have long history of its consumption in India, Southeast Asia, China and Japan as food for good health. Shoots promote motion and peristalsis of the intestine, help in digestion and preventing and curing of cardiovascular diseases and cancer. Bamboo shoots are believed to relieve hypertension, sweating, paralysis (Shi and Yang 1992; Bao 2006). Bamboo shoot is cheap and excellent source of dietary fiber which ranges from 2.23 to 4.49 g/100 g fresh weight of shoots and increase with the age (Nirmala et al 2014). The fiber content in bamboo shoot is reported to be higher than most of the commonly consumed vegetables (Nirmala et al 2011). The fiber in bamboo shoots consists of hemicelluloses, cellulose and lignin and classified in nutrient detergent fiber (NDF) and acid detergent fiber (ADF). The fiber is inert, has zero calories and now also available in powder form commercially. Dietary fibers reported to reduce risk of cardiovascular diseases, hypertension, diabetes, obesity, cancer and various gastrointestinal problems (Anderson et al 2009; Lattimer and Haub 2010; Brennan et al 2012). Dietary fiber of bamboo shoots has the beneficial effect on lipid profile and bowel function (Park and Jhon 2009). The hemicellulosic fractions from *Phyllostachys pubescens* reported to have potential to be used in the food industry (Peng et al 2012). The shoots of several bamboo species from North East India have also been worked out for their nutrient components and phytochemicals (Table 6).

Table 6: Macro-nutrients, vitamins, minerals and bioactive compounds in the shoots of bamboo species from North-East India (Nirmala et al 2011, Nirmala et al 2014)

Nutrient elements	Quantity (range)
Macro-nutrients	
Amino acids	3.01-3.98 g/100 g fresh weight
Proteins	2.31-3.69 g/100 fresh weight
Carbohydrates	4.32-6.92 g/100 g fresh weight
Starch	0.21-0.59 g/100 g fresh weight
Fat	0.33-0.56 g /100 g fresh weight
Vitamins	
Vitamin C	1.00-4.48 mg/100 g fresh weight
Vitamin E	0.42-0.91 mg/100 g fresh weight
Minerals	
Calcium	0116-0.640 mg/100 g fresh weight
Copper	0.16-1.08 mg/100 g fresh weight

Iron	2.234-3.917 mg/100 g fresh weight
Magnesium	3.486-10.14 mg/100 g fresh weight
Manganese	0.16-0.878 mg/100 g fresh weight
Potassium	232-576 mg/100 g fresh weight
Selenium	0.0001-001 mg/100 g fresh weight
Sodium	8-15.6 mg/100 g fresh weight
Zinc	0.574-1.086 mg/100 g fresh weight
Bio-active compounds	
Dietary fibers	2.26-6.75 g/100 g fresh weight
Phenols	191.3-443.97 mg /100 g fresh weight
Phytosterols	0.13-0.19 g/100 g fresh weight

Similarly other bioactive compounds present in the bamboo shoots like phenols and phytosterols have various health benefits. Phytosterols are reported in fresh as well as fermented bamboo shoots. Total sterols in fresh bamboo shoots ranges from 112 to 620 g/100 g fresh weight (Sarangthem and Singh 2003a & b) and by fermentation of shoots the level of sterols increase to many folds (Sarangthem and Singh 2003a). Bamboo shoots have bita-sitosterol, campesterol, stigmasterol, cholesterol, ergosterol and stigmasterol-type sterols (Nirmala et al 2014). The presence of phytosterols in a diet has various benefits like lowering of cholesterol level, help in cardiovascular diseases and cancer (Jones and AbuMweis 2009; Woyengo et al 2009). Phenol is another bioactive compound which is abundantly available in the bamboo shoots. The quantity of phenols in fresh bamboo shoots ranges from 191 mg/ 100 g in *Bambusa balcooa* to 443.97 mg/100 g in *B. tulda* (Nirmala et al 2014). Phenols are reported to have various positive health benefits such as antioxidant, anti-inflammatory, anti-allergic, antimicrobial, cardioprotective and vasodilations (Nirmala et al 2014). It has been reported that various preservation methods and processing methods have negative impacts on the level of phenols in bamboo shoots.

Bamboo shoots are also endowed with various macro and micro-nutrients, vitamins and mineral elements (Nirmala et al 2014). By regular intake of bamboo shoots people of North-East India can easily meet their recommended dietary allowance (Table 7). Bamboo shoots are a rich source of

Table 6: Comparison of Recommended Daily Allowance (RDA) with nutrients in bamboo shoots.

Recommended Daily Allowance (RDA) for Indians		**Nutritional Components in Bamboo Shoots**	
Components	Amount	Components	Amount in 100 g fresh weight

Protein	60 g/day	Protein	3.69 g
Fat	30 g/day	Fat	0.56 g
Calcium	600 mg /day	Calcium	4.06 mg
Iron	17 mg/day	Iron	3.19 mg
Vitamin C	40 mg/day	Vitamin C	4.80 mg
Zinc	12 mg/day	Zinc	0.72 mg
Magnesium	340 mg/day	Manganese	0.70 mg
Vitamin E	8-10 mg/day	Vitamin	0.91 mg
Selenium	40 µg/day	Selenium 0.8 µg	0.8 µg
Sodium	2500 mg/day	Sodium	12.96 mg
Potassium	2500 mg/day	Potassium	416 mg
Fiber	40 g/day	Dietary Fiber	4.5 g
Amino acids	12.8 g/day	Amino acids	3.98 g
Carbohydrates	300 g/day	Carbohydrates	6.92 g
Starch	189 g/day	Starch	0.59 g
Copper	2 g/day	Copper	0.44mg
Magnesium	400g/day	Magnesium	8.68 mg
Phosphorus	700g/day	Phosphorus	28.21 mg

potassium which is essential for a healthy heart. Other important minerals present in bamboo shoots are calcium, manganese, zinc, chromium, copper, iron, selenium, phosphorus, etc. Fresh shoots are reported to be good source of thiamine, niacin, vitamin A, vitamin B6 and vitamin E. Bamboo shoots appear to be a complete food and perhaps this is the reason bamboo shoots are always there in the local cuisine of the people of north-East India.

Conclusions

Bamboo, the invaluable gift of nature to the people of North-East India, is very deeply involved with the life and culture of people in the region. The cradle to coffin plant is used in the region for everything right from using it as surgical blade for cutting umbilical cord of a new born baby to food medicine, entertainment and finally as bier or coffin. Use of young juvenile shoots (rhizomatous and apical) for food is one of the very important and well developed aspects in the region. Bamboo shoots are consumed as fresh, dried and fermented in various ways like pickle, boiled, mixed with various vegetables, pork, fish, beef, etc. Shoots of almost all the species are consumed as food but some of

the species are preferred by particular tribe or region. With changing time, consumption of bamboo shoots are also accordingly changing. Bamboo shoots in paste and shredded are being preferred the most. Fermenting shoots are also being preferred due to increase in nutritional value after fermentation and increase in the shelf life of the shoots which is otherwise very short (two to three days only). Bamboo as a whole and shoots in particular has great promise for the socio-economic development of the region as it is abundantly available and there is negligible cultivation cost. It grows in the region without disturbing the ecosystem and has much more ecological benefits than many exotic crops introduced in the region. A proper organized system of making new products and marketing them has to be developed to help income generation for the local people.

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Fig. A – D. Edible portions of young shoots after removal of culm sheaths

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Fig. 2. A-D. Traditional dishes of the North –East India. A. Shetkylla (Khasi Recipe, Meghalaya) , B. Ooti (Meetei Recipe, Manipur), C. Rawtui-bai (Mizo Recipe, Mizoram), D. Iromba (Meetei Recipe, Manipur)

Theme: Food and Pharmaceuticals

Fig.3. A-F. Contemporary food items from bamboo shoots. A. Cookies B. Bhujia C. Pakora D. Parantha E. Chapatti F. Omelet