Nutrient Components in Young Shoots of Edible Bamboos of Manipur, India

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Abstract

Bamboo, a versatile grass, is a multipurpose plant with social, economic and cultural significance. Almost every part of this plant is utilized by human civilizations around the world. Apart from its multifarious utilities, bamboo is also gaining recognition as an edible natural resource. Bamboo shoots, the juvenile culm of bamboo plants, are soft, highly palatable and have been incorporated in several Asian cuisines. They are nutritionally rich in proteins, carbohydrates, amino acids and dietary fibres and low in fat and sugar. Manipur, one of the eight states of North Eastern India, has a good resource of bamboos. Bamboo shoots both in raw as well as fermented forms have been consumed since time immemorial. Almost all the bamboo species found in the state are edible but shoots of some species are popularly consumed because of their good productivity and taste attributes. Nutritive values in shoots of five popularly used edible bamboo species of Manipur viz, *Bambusa nutans, B. tulda, Dendrocalamus giganteus, D. hamiltonii* and *D. sikkimensis* were analysed. The shoots of *B. nutans, D. giganteus* and *D. hamiltonii* have overall high nutrient values and also yield good quantity of edible portion. The shoots are also soft, have sweet flavour, tasty and are mostly preferred by the people. These species could be raised on mass scale for commercial production of fresh, fermented and other processed forms to earn revenue for the state and also for the country.

Keywords: Edible bamboos, Bamboo shoots, Nutrients, Manipur.

Introduction

The North Eastern Region of Indian sub-continent is well known for the rich depository of bamboo. It holds more than two-third of the total growing stock of the country (Tripathi 2008). Manipur, one of the eight states of North-East India falls under the Indo-Myanmar hotspot region (Myers et al. 2000). The state has geographical area of 22,327 sq.km and lies between 92º 59′ to 94º 46′ E longitudes and 23º 50′ to 25º 42′ N latitudes. It mainly comprises of hilly terrain (92%) surrounding a saucer-shaped central valley (8%). The major ethnic community in the state is Meitei and they inhabited in the valley. There are altogether 33 ethnic tribal communities dominated by Nagas and Kukis and they

occupied hilly areas (Naithani et al. 2010). It has tropical to sub tropical to temperate montane forests within its territory (Sharma 1987). By virtue of its climatic conditions, a large number of different bamboo species grows here both in the hills and in the plains of Manipur. Out of 128 bamboo species reported from India (Seethalakshmi and Kumar 1998), 53 species are reported from Manipur (Devi and Sharma 1993) which is 41% of India's total bamboo species. Bamboo occupies a total growing area of 3692 sq.km which is 21.44% of the total forest area of the state. A total growing stock of 11,470 tonnes is obtained from Manipur which is highest among the eight states of North East India (Naithani et al. 2010).

The life of Manipuri people is very much associated with bamboo. It plays a very important role in the socio-economics of the local people as they depend on it for earning their livelihood. The people use bamboo for house construction, food, fuel, fodder, making tools and other household items and use in many religious ceremonies. Bamboos are also widely used in handicraft industry to make attractive items. The need for bamboo exists from childbirth to death and it is a culture to grow bamboo in their homestead. Almost all the households maintain bamboo colonies in their private land. They differentiate particular variety of bamboos according to their different uses; bamboo for construction, bamboo for ritual, bamboo for use in daily life of people and bamboo for food, etc. Bamboo shoots, the young juvenile culm of the bamboo plants that arise from the underground rhizomes, have been used as an important food ingredient in this region and constitute a range of traditional delicacies. Most of the species growing in Manipur are edible and can be used as food. Not only the fresh young shoots but also the fermented forms are largely consumed in this state as vegetables or as additives.

Edible bamboo species

Out of 128 bamboo species of India, more than thirty species are utilized for their edible shoots. In Manipur, almost all the bamboo species growing here are edible but shoots of some species are very popular and extensively used because of their good productivity and taste attributes. Table 1 represents the list of popular bamboo species whose shoots are consumed by the people of Manipur. Very few species are available in the market but shoots of different species are largely consumed in local areas. Shoots of *Bambusa* and *Dendrocalamus* are the dominant species used for food both in fresh and fermented forms. Most of *Dendrocalamus* species *(D. giganteus, D. sikkimensis, D. hamiltonii)* produce large to medium sized shoots yielding good quantity of edible portions. *B. nutans, B. tulda, D. giganteus* and *D. hamiltonii*, grow luxuriantly throughout Manipur. *D. sikkimensis* are found plentiful in hilly areas. Because of their availability and good taste of shoots, these species are largely used for food as fresh vegetable and also for preparation of fermented products. Shoots of *Chimonobambusa callosa* are available late in the market i.e. from September to November as shoots develop late in autumn. They are small sized apical shoots and are used mostly in fresh form to

prepare delicious traditional dishes. *Cephalostachyum capitatum*, a small sized bamboo, shoots are found mostly in fermented form in the market.

Table 1. List of commonly used edible bamboo species in Manipur and their distribution

Sl. No.	Name of species	Local name	Shoot size	Food form	Distribution
1.	*Bambusa balcooa*	Barua	Medium	Fermented	Jiribam
2.	*B. bambos*	Lam saneibi	Medium	Fresh/Fermented	Ukhrul District
3.	*B. cacharensis*	Moirang-wa	Medium	Fresh/Fermented	Imphal & commonly cultivated in Jiribam
4.	*B. mizorameana*	Khokwa	Small	Fresh	Kangla village, Charoi Tupul, Bishnupur Ngariyan village, Imphal valley
5.	*B. nutans*	Saneibi	Medium	Fresh/Fermented	Throughout valley and adjoining hilly areas
6.	*B.tulda*	Utang	Small	Fermented	Throughout Manipur
7.	*Cephalostachyum capitatum*	Naat	Small	Fermented	Charoi Tupul, Ngariyan village near Bishnupur, Ukhrul
8.	*Chimonobambusa callosa*	Laiwa	Small	Fresh/Fermented	Koubru, Bishnupur, Mao, Siroy hill
9.	*Dendrocalamus giganteus*	Maribob	Large	Fresh/Fermented	Tengnoupal, Ukhrul, Imphal, Taretkhun, Imphal-Kohima road
10.	*D. hamiltonii*	Unap, Wanap	Medium	Fresh/Fermented	Throughout Manipur
11.	*D. hookerii*	Watangkhoi	Medium	Fresh	Throughout plain and low hills
12.	*D. sikkimensis*	Maribob/Warubob	Large	Fresh/Fermented	Charoi Tupul
13.	*D. longispathus*	Uil/ Dojungpai	Medium	Fresh	Laiching near Moreh, Bishnupur, Churchanpur, Khonglon, Saparmeina
14.	*D. manipureanus*	Uii	Medium	Fresh	On the way to Ukhrul, Moreh, Lilong, Thoubal district
15.	*Melocanna baccifera*	Moubi-wa	Small	Fresh/Fermented	Lokchao, Chandel

					district, between Imphal Irang, Kangla village

Bamboo shoot is the young immature culm that arises from underground rhizome of the bamboo plant. Shoots emerge during rainy season and are harvested at the stage when they attain a height of 25-30cm. They are popular in Asiatic countries and form a major component of their traditional cuisines. They are not only delicious but also nutritious and constitute a range of traditional delicacies. Young shoots are taken either fresh at the time of harvesting season or different processed and preserved forms such as dried, fermented, pickled, etc. during offseason. In India, consumption of shoots is confined mainly in North Eastern states which are endowed with rich bamboo resources. In Manipur, bamboo shoots both in raw as well as fermented forms have been consumed since time immemorial. An annual consumption of 2188 tonnes per annum of young bamboo shoot has been reported and rural communities could earn net revenues of 5.69 million rupees per year (Bhatt et al. 2004). The fresh young shoots locally called "Usoi" are used for making different delicacies. Usoi-ooti and Usoi-kangsu are popular traditional dishes made from fresh shoots.

Fermented shoots

Fresh shoots are found only during growing season i.e. July to September and so people ferment the shoots by traditional methods for use during offseason. Fermented bamboo shoots are highly prized vegetable items consumed throughout the year and are traditionally prepared by cutting thin slices of bamboo shoots and pressing it tightly either in earthern pots or in bamboo baskets for a minimum period of three months. The two popular fermented forms of Manipur are Soibum and Soidon. These are available in the market throughout the year and used as vegetables or additives for making different delicious dishes. Traditional fermentation of bamboo shoot is done in large scales in Khongkhang, Andro, Noneh, Tengnoupal, Churachandpur and Kotha and these areas supply fermented shoots throughout the state. Fermented shoots of 114.3 tonnes per year are sold in the markets and a net income of 3.8 million rupees per year has been earned by selling fermented bamboo shoots (Bhatt et al., 2005a). Shoots of *B. nutans, B. tulda, D. giganteus, D. hamiltonii, D. sikkimensis, C. capitatum*, etc. are largely used for fermentation.

Physical properties of shoot

Physical parameters to ascertain quality attributes of bamboo shoots include length, girth and weight of the shoots with and without culm sheath. Five shoots each of *B. nutans, B. tulda, D. giganteus, D. hamiltonii* and *D. sikkimensis* were taken at random for all the parameters and average values of these

parameters were considered (Table 2). The average length of the shoot was maximum in *B. nutans* (31cm and 22.86cm with and without culm sheath) and minimum in *B. tulda* (18.35cm and 13.50cm with and without culm sheath). *D. giganteus* attained the largest girth size with 48.15 and 45.75 cm with and without culm sheath and *B. tulda* the smallest (19.35 and 18.95cm with and without culm sheith). Average weight of the shoot without culm sheath ranged from 0.23 to 1.16 kg with the shoots of *D. giganteus* having the maximum and minimum in *B. tulda. D. giganteus* and *D. sikkimensis* produced larged sized shoots; *B. nutans* and *D. hamiltonii* produced medium sized shoots resulting in good yield.

Table 2. Average length, girth and weight of the juvenile shoots of five popular edible bamboos.

Name of the species	Length (cm)		Girth (cm)		Weight (kg)	
	With culm sheath	Without culm sheath	With culm sheath	Without culm sheath	With culm sheath	Without culm sheath
Bambusa nutans	31.00±3.03	22.86±5.87	34.28±2.68	33.90±2.33	1.49±0.33	0.85±0.13
B. tulda	18.35±3.65	13.50±2.70	19.35±2.35	18.95±2.45	0.35±0.05	0.23±0.02
Dendrocalamus giganteus	28.75±0.25	18.35±0.85	48.15±0.15	45.75±0.25	1.85±0.10	1.16±0.01
D. hamiltonii	25.50±2.24	17.80±0.81	21.30±4.41	19.44±2.56	0.53±0.08	0.30±0.03
D. sikkimensis	28.46±4.05	21.50±3.21	37.80±2.11	36.46±2.28	1.71±0.50	1.12±0.13

Result = Mean ± Standard deviation of five replicates

Nutritional composition of shoots

Macronutrients

Bamboo shoot is gaining worldwide popularity because of its nutrient components, high fibre and low fat content. The nutritional value of edible shoots of different bamboo species has been carried out by several workers (Qui 1992; Shi and Yang 1992; Tripathi 1998; Sharma *et al*. 2004; Bhatt *et al.* 2005b; Xu *et al*. 2005; Nirmala et al. 2007, 2008, 2011). The nutritive values of fresh shoots of five popular edible bamboo species of Manipur were analysed (Table 3). The shoots have good amount of proteins, amino acids, carbohydrates, fibres and low amount of fats. Protein content ranged from 1.88 to 3.25 g/100g fresh weight of bamboo shoots. The highest protein was found in *B. nutans* (3.25 g/100g fresh weight) and the lowest in *D. sikkimensis* (1.88 g/100g fresh weight). The highest amount of amino acid was found in *D. hamiltonii* (4.03 g/100g fresh weight) and the lowest in *D. sikkimensis* (1.86 g/100g fresh weight). Carbohydrate content ranged from 2.76 to 4.66 g/100g fresh weight with *D.*

giganteus (4.66 g/100g fresh weight) having the highest and the lowest in *B. nutans* (2.76 g/100g fresh weight). The highest amount of fat content was found in *D. sikkimensis* (0.60 g/100g fresh weight) and the lowest in *B. nutans* (0.31 g/100g fresh weight). Fibre content varied from (5.20 to 15.47 g/100g fresh weight) with the shoots of *B. tulda* having the highest and the lowest in *D. sikkimensis*. The ash content ranged from 0.76 to 0.93% with maximum in *D. giganteus* (0.93%) and the moisture content from 83.60 to 91.26%. In these five species, the highest protein, amino acid, carbohydrate and fibre content were reported in *B. nutans, D. hamiltonii, D. giganteus* and *B. tulda* respectively.

Table 3. Protein, amino acid, carbohydrate, starch, fat, fibre, moisture and ash content (g/100g fresh weight) in the juvenile shoots of five edible bamboo species.

Species / Nutrients	*Bambusa nutans*	*B. tulda*	*Dendrocalamus giganteus*	*D. hamiltonii*	*D. sikkimensis*
Protein	3.25± 0.004	2.88±0.003	2.63±0.003	2.93±0.003	1.88±0.005
Amino acid	2.21±0.012	2.99±0.014	3.59±0.055	4.03±0.044	1.86±0.014
Carbohydrate	2.76±0.040	4.43±0.015	4.66±0.048	3.44±0.036	2.99±0.022
Starch	1.37±0.006	0.48±0.007	0.56±0.008	0.40±0.006	1.31±0.008
Fat	0.31±0.022	0.40±0.012	0.32±0.020	0.37±0.012	0.60±0.014
Fibre	9.89±0.080	15.47±0.122	6.68±0.040	6.14±0.091	5.20±0.042
Moisture	91.26±0.120	88.17±0.176	89.50±0.173	83.60±0.153	91.24±0.142
Ash	0.82±0.001	0.89±0.004	0.93±0.001	0.91±0.003	0.76±0.003

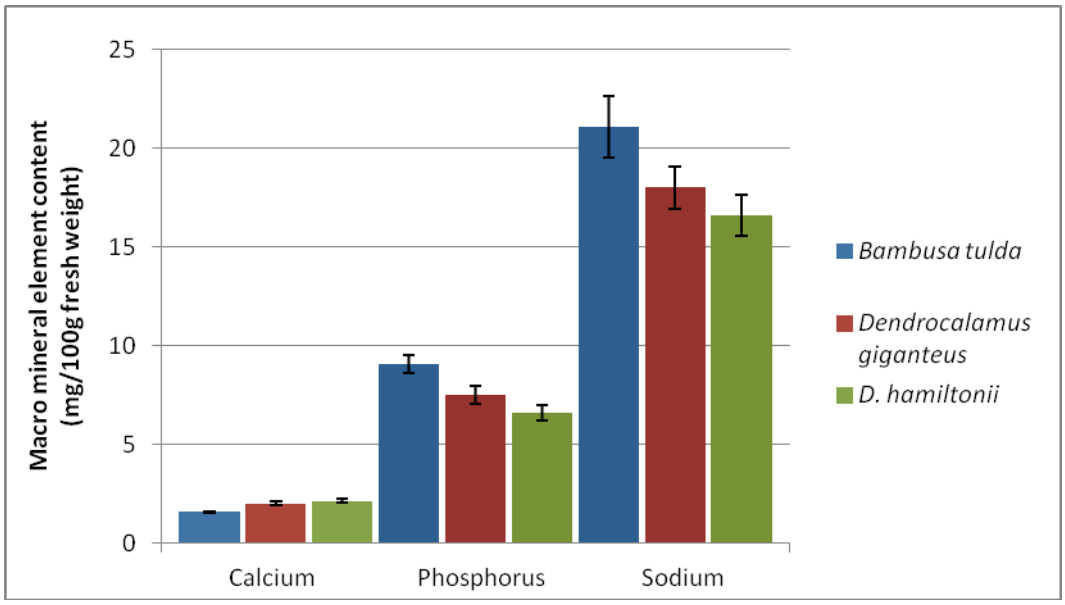
Result = Mean ± Standard deviation of three replicates

Bhatt et al. (2005b) reported the nutritional values of eleven commercial edible bamboo species in which *D. hamiltonii* showed the highest protein content (3.9 g/100g fresh weight) whereas Tripathi (1998) reported 3.90% protein content in *B. bambos*. Giri and Janmejoy (1992) reported amino acid content of *B. tulda* and *D. giganteus* to be 296 and 215 mg/100g fresh weight which is less compared to our results. Tripathi (1998) reported 3.30% carbohydrate content in *B. nutans* whereas Bhatt (2005b) reported 4.70, 5.70, 4.90, 4.70% carbohydrate content in *B.tulda, D. hamiltonii, D. giganteus* and *D. sikkimensis* respectively. Fat content was reported between 0.6 to 1.0% in eleven species (Bhatt et al., 2005b) which is higher than the present result. Kumbhare & Bhargava (2007) reported 0.76% crude fibre in *B. nutans* which is very less as compared to our results. Moisture content (78.60-94.70%) and ash content (2.1-3.7%) have also been reported in eleven species (Bhatt et al.

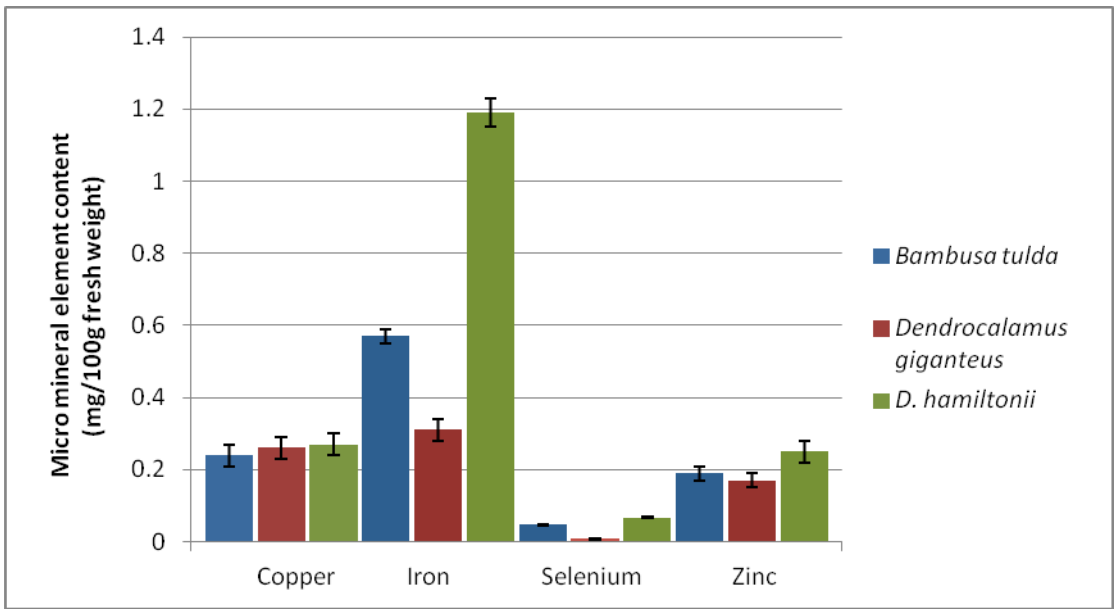
2005b). This variation could be due to difference in genotypes, the growth stage of shoots taken and environmental conditions.

Mineral content

Young edible bamboo shoots are rich in various mineral elements such as calcium, potassium, sodium, iron, selenium, etc. Mineral elements present in the fresh juvenile shoots of *B. tulda, D. giganteus* and *D. hamiltonii* are given in Figure 1 (a) and (b). Minerals are required for the proper functioning of many useful metabolic activities of our body. Ca is important in building bones and maintaining normal blood pressure and its content was maximum in *D. hamiltonii* (2.16 mg/100g fresh weight). Fe is important for children and pregnant women and highest amount was found in *D. hamiltonii* (1.19 mg/100g fresh weight). Shoots are labelled as a heart protective vegetable because of its high content of potassium, that helps to maintain normal blood pressure and a steady heart beat. Among the three species, *B. tulda* showed the highest potassium content (388 mg/100g fresh weight). Bhargava et al. (1996) identified the highest content of potassium (1400 mg/100 g fresh weight) in *Bambusa arundinaria* while the least amount (20 mg/100 g fresh weight) was detected in *Melocanna baccifera.* Sodium regulates plasma volume and acid-base balance, involves in the maintenance of osmotic pressure of the body fluids, preserves cell permeability and activates nerve and muscle function. Sodium content among the three species was maximum in *B. tulda* (21.11 mg/100g fresh weight). Selenium commonly known as "Miracle life element" is present in shoots ranging from 0.008 to 0.067 mg/100g fresh weight. This element is required for proper functioning of the thyroid gland and may protect against free radical damage and cancer. Selenium is needed for the proper functioning of the immune system, and appears to be a key nutrient in counteracting the development of virulence and inhibiting HIV progression to AIDS. 100 g of the bamboo shoots can supply 28-75% of potassium, 1-4% of sodium, 10-22% of phosphorous and 22-56% of magnesium for females and 16-43% for adults, respectively and 26-96% RDA (Recommended Dietary Allowance) for pregnant women. Equally, 100 g of the bamboo shoots also contained 28-136% of zinc and 2-7% of copper required as per RDA (Institute of Medicine).



(a)



(b)

Figure 1. Macro (a) and micro (b) mineral element content in fresh shoots of three bamboo species.

The shoots of *B. nutans, B. tulda, D. giganteus* and *D. hamiltonii* have overall high nutritional values. *D. giganteus* and *D. sikkimensis* produce large sized shoots yielding large quantity of edible portions. The shoots of *B. nutans, D. giganteus* and *D. hamiltonii* are also soft, have sweet flavour, tasty and are mostly preferred by the people. From the study, it is revealed that these species are very promising

and could be raised on mass scale for commercial production of fresh, fermented and other processed forms.

Conclusion

Considering the rising global importance of bamboo shoots both for food and health, Manipur has great prospects for utilizing its natural resource for earning income especially for the people in the rural areas. But as of now, there is no viable bamboo shoot based industry in the state and local people cultivate bamboo shoots only for home consumption and very little amount reach upscale markets. Further, albeit shoots are revered for being highly nutritious traditionally, a proper scientific validation of the various nutritional attributes of edible species from Manipur is lacking at large. Therefore, the present study was focused on the detailed nutritional analysis of the shoots of most commonly available and popularly consumed species of Manipur. *Bambusa nutans, B. tulda, Dendrocalamus giganteus, D. hamiltonii and D sikkimensis* are promising species as they are delicious, rich in nutrients and have higher yield values. Efforts have to be made to develop proper processing and packaging techniques for long storage and transport of the finished products. Of great importance is cultivation of the promising genotypes on mass scale for commercial production to provide large amount of shoots to develop a shoot based industry. This shall enable not only the usage of the vast natural resources, but also earn revenue for the state and also for the country.

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