

BAMBOO FOREST RESOURCES OF INDIA AND ITS ROLE IN FOOD SECURITY - A REVIEW

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ABSTRACT

Bamboo, the fastest growing plant, is estimated to cover 8.96 million ha of the total 63.3 million ha forest area of India. The plant is intricately associated with humans from times immemorial. Though popularly known for industrial usage, a lesser known fact of bamboos is the utilization of its juvenile shoots as food that can be consumed fresh, fermented, canned or pickled. Bamboo shoots have high nutritive value containing low fats and cholesterol and high amount of carbohydrate, proteins, minerals and dietary fibres. It holds great promise for utilization as health food because of presence of bioactive compounds which is found to have medicinal properties. Being one of the fastest growing plants, its shoots can be utilized for feeding the ever increasing human population and also because of its nutritional and therapeutic values, the shoots can be used to make up for the dietary deficiencies of nutrients in the diet.

Keywords: Bamboo shoots, Forest resources, Nutritional value, Therapeutic values.

India is the seventh largest country in the world covering an area of 328.78 million ha. The forest cover is over an area of 63.3 million ha which is 19.27 per cent of the total geographical area, of which the dense forest cover (i.e. with density over 40%) constitutes only 11.17% (FSI, 1997). India has 16% of world's population and 15% of world's livestock but only 2% of the geographical area and 1% of the forest area. An estimated 8.96 million ha forest area of the country contains bamboo (Rai and Chauhan, 1998). Bamboos, tall arborescent grasses, belonging to the family *Poaceae* (sub family *Bambusoideae*) is the fastest growing woody plant. With good soil and plenty of water, bamboo can grow a foot in a day.

Bamboo falls into two main categories according to growth pattern, (i) sympodial or clump forming and (ii) monopodial or non-clump forming, runner bamboo. In India, clump forming bamboo constitute over 67% of the total growing stock, of which *Dendrocalamus strictus* is 45%, *Bambusa bamboos* 13%, *Dendrocalamus hamiltonii* 7%, *Bambusa tulda* 5% and *Bambusa pallida* 4%. All other species put together are 6%. *Melocanna baccifera*, a non-clump forming bamboo, accounts

for 20% of the growing stock and is found in the north-eastern states (Naithani, 1993). Bamboo generally forms the under-storey in the natural forests. It is found to grow practically all over the country, particularly in the tropical, sub-tropical and temperate regions where the annual rainfall ranges between 1,200mm to 4,000 mm and the temperature varies between 16°C and 38°C. The most suitable conditions for the occurrence of bamboo are found in between 770 - 1,080 meter above sea level. However, two-thirds of the growing stock of bamboo in the country is available in the north-eastern states (Rai and Chauhan, 1998). Worldwide there are more than 1,250 species of bamboo belonging to 75 genera which are unevenly distributed in various parts of the humid tropical, sub-tropical and temperate regions of the earth (Scurlock *et al.* 2000). India is the second richest country in bamboo genetic resources after China, comprising of 124 indigenous and exotic species, under 23 genera, found naturally and/or under cultivation (Naithani 1993). The versatile and evergreen plant is found almost everywhere in the world but the frozen poles.

Since time immemorial bamboos plays a significant role in human civilization and is

contributing to the subsistence of people living in the tropical and subtropical belts in Asia, Latin America and Africa. This natural resource plays a major role in the livelihood of rural peoples and in rural industry. There are more than 1500 different documented traditional uses of bamboo (INBAR 1997; Nirmala *et al.*, 2011). This “*green gold*” is sufficiently cheap and plentiful to meet the vast needs of human populace from the “*child’s cradle to the dead man’s bier*”. That is why sometimes it is known as “*poor man’s timber*”. Bamboo has versatile uses as building material, paper pulp resource, scaffolding, agriculture implements, fishing rods, weaving material, substitute for rattan, plywood, particle board manufacture etc. The leaves have been used as fodder for livestock by the Japanese for hundreds of years. Giant pandas in China survive only on bamboos and can consume on the average 19 kilogram of fresh bamboo leaves per day. Many bamboos are popularly used as ornamental plants to beautify homes and gardens. Due to their characteristic growth habits, particularly its interwoven system of rhizomes and roots that performs the function of cohesion, bamboo have enormous potential for alleviating many environmental conditions such as soil erosion control, water conservation, land rehabilitation, and carbon sequestration (Benzhi *et al.*, 2005). Today, it helps more than 2 billion people meet their basic needs. At present there are 3000 companies around the world engaged in production of various bamboo based products such as panels, flooring, pulp, charcoal, edible shoots, and other daily-use articles (Xuhe, 2003). Though more popularly known for industrial usage, a lesser known fact of bamboos is the utilization of its juvenile shoots as food.

Bamboo shoot: A bamboo shoot is young, immature, expanding culm that emerges from nodes of the rhizome of plants. The young shoots are tightly clasped with overlapping sheaths that have to be removed to extract the edible part. New culms or juvenile shoots in bamboos usually develop with the beginning of the monsoon season during which the young edible shoots are harvested. All species of bamboo shoots available in the world are not edible. Out of 124 species available in India, the most commonly edible bamboo species are *Bambusa pallida*, *Bambusa tulda*, *Bambusa polymorpha*, *Bambusa balcooa*, *Dendrocalamus hamiltonii*,

Dendrocalamus giganteus and *Melocanna bambusoides* (Sharma, 1980). Depending upon species, bamboo shoots are usually 20-30 cm long and taper to a point. A bamboo shoot at the time of harvest normally weighs more than 1 kg. However, their size and weight depend considerably upon the location, depth, pH and nutrition of the soil, irrigation and drainage conditions, climate, rainfall, temperature and soil type and fertility. The shooting period of a bamboo varies from species to species. In general, the temperate- climate-bamboos are runners, which shoot in the spring, while the tropical and sub-tropical species are clumpers, which shoot in the late summer and fall.

Consumption pattern: A traditional forest vegetable in China for more than 2500 years, bamboo is now gaining popularity worldwide in the utilization of its shoots as healthy and nutritious food (Nirmala *et al.*, 2007). In many parts of the world, bamboo shoots form a part of the conventional cuisine and are consumed in various forms (Bal *et al.*, 2008). They are consumed in different forms such as medicinal, fermented, roasted, boiled, blanched, canned, pickled etc. Fresh shoots have a crisp, crunchy taste, and sweet flavor, imparting a unique taste. They are mostly used in making appetizing soups, delicious snacks, hot curries, spicy stir-fries, attractive salads, pickles, aromatic fried rice, spring rolls, and other stewed and fried dishes. Consumption of bamboo shoots is mainly concentrated in Southeast Asia, where they are a popular ingredient in the local cuisine. Bamboo shoots have a long history of being used as a source of both food and medicine in China and Southeast Asia (Bao, 2006). In Japan, the bamboo shoot is called the “*King of forest vegetables*”. In China, knowing the nutritional value and delicious taste, people considered bamboo shoots a treasure dish in the Tang Dynasty (618 to 907) and there was a saying that “there is no banquet without bamboo.” Presently, though the shoots are consumed more as a vegetable by local people, they are made available to others as a delicacy in up-scale markets and specialty restaurants. Hence, bamboos are no longer considered as “*poor man’s timber*” but they form a “*rich man’s delicacy*”. (Nirmala *et. al.*, 2011).

In international markets, China earns 6,500 million India rupees every year from export of edible bamboo shoots, with import of USA at around 44,00

tonnes accounting for 14.5% of the total world import (Lobovikov, 2003). Every year USA imports 30,000 tonnes of canned bamboo shoots from Taiwan, Thailand, India and China for domestic consumption as food items (Daphne, 1996). The import of Australia is estimated about 8,000 tones per annum (Cahill, 1999). Taiwan consumes about 80,000 tones of bamboo shoots annually constituting a value of 2,500 million Indian rupees, covering 30,000 ha of land of bamboo shoots under cultivation, producing total 380,000 tones of bamboo shoots per year (Tai, 1985). In Japan, the present annual consumption of bamboo shoots is 3 kg per person, compared to 1.2 kg per person in 1950s (Yang *et al.*, 2008). At present, over two million tonnes of edible bamboo shoots are consumed in the world each year (Yang *et al.*, 2008). Statistics shows that about 26.2, 435 and 426.8 tones of bamboo shoots are harvested annually in the north eastern states of India like Sikkim, Meghalaya and Mizoram, respectively, where about 20-30 million tones of bamboo shoots are utilized for production of canned bamboo shoots annually (Bhatt *et al.*, 2004).

In India, consumption of bamboo shoots is confined mainly to the Northeastern states where it is a very popular food item amongst the north eastern people. Different communities consume fresh or fermented bamboo shoot. Fermentation is by using different indigenous fermentation techniques practiced by different tribes and communities, the knowledge of the technique being handed over from generation to generation. Fermented bamboo shoot is consumed as *Mesu* in Sikkim, *Soidon*, *Soibum* and *Soijin* in Manipur, *Ekung*, *Eup* and *Hirring* in Arunachal Pradesh, *Lung-siej* or *Syrwa* in Meghalaya. Kandha tribe of Kalahandi, Orissa consume fresh bamboo shoot slices named as *Kardi*. Sometimes it is pounded in pestle and mortar and sundried which is called as *Handua* (Panda and Padhy, 2007).

Nutritional value: Bamboo shoots are low in calories, high in dietary fiber and rich in various nutrients like protein, carbohydrates, amino acids, minerals, fat, sugar, fiber and inorganic salts. It is also found to contain 17 different types of enzymes and over 10 mineral elements consisting mainly of potassium, calcium, manganese, zinc, chromium,

copper, iron, plus lower amounts of phosphorus and selenium (Shi and Yang, 1992; Nirmala *et al.*, 2007). Fresh shoots are a good source of thiamine, niacin, vitamin A, vitamin B₆ and vitamin E (Shi and Yang, 1992). They are rich in protein containing between 1.49 and 4.04 (average 2.65g) per 100 g of fresh bamboo shoots. Amino acid content in bamboo shoot is found to be much higher than in other vegetables such as cabbage, carrot, onion and pumpkin (Nirmala *et al.*, 2011). They are also found to contain 17 amino acids, 8 of which are essential for the human body (Ferreira *et al.*, 1995). Tyrosine amounts to 57% to 67% of the total amino acid content (Kozukue *et al.*, 1999). Fat content is comparatively low (0.26% to 0.94%) and the shoots contain important essential fatty acids. The water content is 88% or more. In view of these essential characteristics *i.e.* low in fats, rich in vitamins, presence of essential amino acids, minerals, dietary fibres *etc.*, bamboo shoot is considered as an ideal vegetable for healthy diet and is now being projected as a new health food (RFRI, 2008).

Medicinal value: Bamboo shoots have been regarded as a traditional Chinese medicinal material for more than 2000 years. In the traditional system of Indian medicine, the silicious concretions found in the shoots are called '*banslochana*' and in the Indo-Persian and Tibetan system of medicine, it is called '*tabashir*' or '*tawashir*' and commonly called as '*bamboo manna*' in English (Nirmala *et al.*, 2011). Modern research has revealed that bamboo shoots have a number of health benefits, from cancer prevention and weight loss to lowering cholesterol level, improving appetite and digestion *etc.* (Debangana *et al.*, 2010).

Because of its high content of potassium, bamboo helps to maintain normal blood pressure and is labeled as a heart-protective vegetable. Its relatively high content of up to 4% cellulose increases the peristaltic movement of the intestines and helps digestion. It also prevents constipation and decreases body fat. Due to high content of dietary fibres and presence of phytosterols, bamboo shoots are known to lower cholesterol level. Shoots of *B. arundinacia* / *B. bamboos* contain choline, betain, nuclease, urease, cyanogens, glucosides and are used in the treatment of diarrhoea, thread worm and cough. Shoots and dried pith of *D. strictus* contain silicious

matter and have tonic and astringent action. The juice of pressed bamboo shoots possesses protease activity that helps in digestion of proteins. Boiled bamboo shoots are used as appetizers and the decoction of shoots are used for cleaning wounds and maggot infected sores, ulcers *etc.* Boiled bamboo shoots mixed with palm-jaggery, is known to induce parturition and abortion. In Java, sap from inside the shoots of *B. vulgaris* is used for curing jaundice. With different flavones and glycosides, bamboo shoots have excellent anti-microbial qualities and its shoots are used in preparation of steroidal drugs. Fermented *Dendocalamus hamiltonii* was accompanied with production of sitosterol-a phytosterol which is the precursor of many pharmaceutically important steroidal drugs (Sarangthem and Singh, 2003). An antifungal protein called "Dendrocinn" with a molecular weight of 20kDa which exhibited inhibitory effect on mycelial growth of *Fusarium oxysporum*, *Botrytis cinerea* and *Mycosphaerella arachidicola* was isolated from fresh bamboo shoots ((Nirmala *et al.*, 2011). The shoots were also found to have antioxidant activities. An anti oxidative compound identified as *tricin* and *taxifolin* were isolated from bamboo shoot. The shoots also contain anti- carcinogenic agents and making them a regular part of diet effectively reduces the free radicals that can produce harmful carcinogens (Nirmala *et al.*, 2011).

Anti-nutritional factor: Bamboos are found to contain cyanogenic glycoside, a natural plant toxin. Cyanide contents were found to be different in different species of bamboos (0.1 to 0.8%) and also among the base, middle and tip portions of the shoot (Satya *et al.*, 2010). The highest concentration was found at the tip, followed by the middle portion and lowest at the base portion (Hague and Bradbury, 2002). Cyanogenic glycosides are nitrogenous phytoanticipins and are used by various plants as effective defensive mechanism against predators (Zagrobelyny *et al.*, 2004). Cyanogenic glycoside is not toxic on its own. However, when cell structures of a plant are disrupted, cyanogenic glycoside will be brought together with the corresponding α -glucosidase enzyme. It will be subsequently broken down to sugar and a cyanohydrin which rapidly decomposes to an aldehyde or a ketone and releases the toxic hydrogen cyanide (Moller and Seigler, 1999). This process takes place in the presence of

water. It happens when the plant is chewed releasing the toxic cyanide to the predator. In the same way, toxic cyanide is released when the plant is cut into small pieces during food preparation but the resulting hydrogen cyanide is easily removed by cooking in water since it is volatile.

The cyanogen in bamboo is identified as taxiphyllin which is a p-hydroxylated mandelo-nitrile triglochinin, one of the few cyanogenic compounds that decompose quickly when placed in boiling water. Bamboo becomes edible because of this instability (Nahrstedt, 1993). It is found that boiling bamboo shoots for 20 minutes at 98 C removed nearly 97% of the HCN. Even the highest quoted figure (800 mg/100g) would be de-toxified by cooking for two hours (Ferreira *et al.*, 1995). Cyanide content is reported to decrease substantially following harvesting. Processing techniques like slicing, soaking, steaming, boiling, drying, fermentation *etc.* eliminates the toxic compound to a great extent (Satya *et al.*, 2010). Different indigenous methods of reducing cyanide include chopping of shoots into small pieces, partial drying of fresh shoots, boiling in water/salt water and draining, changing water several times or by pre-soaking for a long time by subsequent changing 2% salt solution, *etc.* (Ferreira *et al.*, 1995; Bhargava *et al.*, 1996; Tripathi, 1998; Wongsakpairod, 2000; Satya *et al.*, 2010)

CONCLUSION

Bamboo shoot is one of the common food items in many countries and its popularity is growing day-by-day, as main or supplementary foodstuff. Being one of the fastest growing plants, bamboo shoots can be utilized for feeding the ever increasing human population without depletion of the bamboo forest resource. Even though bamboo shoots are found to contain cyanogenic compounds, it is documented that this anti nutritional factor can be easily removed by simple procedures. By using proper processing techniques, the bamboo shoot based food items are safe for human consumption. Due to its nutritional and therapeutic value, the shoots can be used to make up for the dietary deficiencies of key nutrients in the diet. Dried bamboo shoots and its dried fermented form can be preserved and stored for several months without refrigeration. It can be consumed during monsoon when fresh vegetables are scarce especially in the

Himalayan region where majority of rural/tribal people cannot afford cold storage. Bamboo shoot has immense scope given its health and nutritional aspects, its organic sources and its potential to create livelihood opportunities in rural areas. Large scale popularization and technological applications for commercial production of bamboo shoots can contribute enormously to rural economies and boost export earnings. However a strong focus and well meaning strategy is required to create awareness and consumer based marketing linkages and processing infrastructure so that bamboo shoot based food products can be used as powerful tool for poverty alleviation and for food and nutritional security.

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