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An Overall Review on Bamboo Shoot and its Role in Food Security

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ABSTRACT: The major burden in uplifting the objective of global food security with this growing population is an indicator to raise the crops production. Presently, very few food crops feed the giant majority of world's population. The major challenge is to feed the growing population by food products with good source of nutrients for nourishment of humans and where it could reach all classes of the society. To liberate the world from this widespread hunger and malnutrition, there is requirement to discover a novel food crops which play a vital role in supplementing the existing food crops for both, nutritional and health security. The classic and resourceful plant, bamboo, is obscurely associated with hominids since from decades. It is one of the fastest growing plants and is assessed to cover 8.96 million ha of the total 63.3 million ha forest area of India. The North-East India anchorages around 43 per cent of the entire bamboo wealth in India. The utilization of immature shoots of bamboo as a health food is limited known fact as compared to its use in industries for construction purpose. The shoots of bamboo having high nutritive and therapeutic values can be determined to make up the nutritional deficiencies in the food and utilized to feed the rapidly increasing human population in the world. Bamboo, which is amongst the highly significant NTFP (non-timber forest produce), can be proved as the biggest ally in our fight against global hunger and food insecurity. Safe to eat bamboo shoots need to be processed and used instantaneously due to their seasonal obtain ability and diminutive shelf life span. The consumer acceptance by not restricting to a specific region is the utmost necessary. Some edible products such as candy, chutney, preserve, nuggets, cracker (papad) and chukhare are analysed for sensory evaluation in one of the studies. The results of which discovered that prepared formulations were nutritionally rich and satisfactory by sensory evaluation scores. It will offer plenty of scope towards engagement of unemployed directly or indirectly through production, value addition and marketing of the bamboo shoot thereby improves the food, economic and ecological security of the world.

Keywords: Bamboo shoot, forest area, food security and global hunger.

INTRODUCTION

Global food security along with energy and water security has been the most prominent issue of the past few decades featuring heavily in majority of the international meets, discussions, conferences on development and other related themes and it has been predicted as a major threat to be faced by societies in 21st century. Ensuring food security by eradicating hunger, malnutrition and poverty constitute one of the eight Millennium Development Goals proposed by the United Nations in 2000. Food and Agriculture Organization of the United Nations (FAO) describes food security as, "a state when all people, at all time, have physical and economic admittance to adequate, safe and nutritious food to encounter their dietary needs and food preferences for dynamic living and healthy life style". Thus, people can be said to be food secure when they have enough nutritious food to avoid health impact of malnutrition and lack any fear of hunger and starvation. But ever growing world population and rapidly shrinking natural resources has hindered the goal of achieving food security for all. As per the recent reports, an estimated 815 million people were still chronically undernourished in 2016 (FAO, 2017) despite all the efforts toward eliminating the global hunger and this number is expected to increase in immediate future with further rise in human population. As per the estimates of United Nations, world population is anticipated to reach more than 8 billion by 2025 and more than 9 billion by 2050, which will further worsen the prevalent food insecurity situation as it will require increasing the existing food production by 60% (UNDESA, 2017). For food security, production, procurement, and distribution are the three pillars. In the world, especially in developing countries, it is estimated that about 1.2 billion people do not have sufficient food to meet their daily requirements and further 2 billion people are lacking in one or more micronutrients (Kotecha, 2008). According to the report of the year 2005 of World Bank, the situation in

India is worst. The prevalence of underweight children in India is the highest amongst the world and is almost twofold than that of sub-Saharan Africa. North-Eastern region is ample in nutritious crops such as bamboo shoots, local rice, buckwheat, flax and many more wild pulses. Traditionally, underutilized crops are being used by the local households to meet their needs. Usually, the diet and nutritional insecurity and scarcity to both rural and urban communities are due to farmer's dependence on few highly selective crop & loss of agro-biodiversity resulting in narrow food baskets. Therefore, bamboo shoot, the neglected product resource, if utilized properly, can help to encounter the growing demand for food and nourishment, energy, medicine and business needs (Devi, 2013). Though it is popularly known for its industrial usage, the utilization of immature bamboo shoots as food which can be consumed canned, fresh, fermented or pickled is relatively a lesser known fact. Shoots refers to the young, edible bamboo plant that have newly appeared from the ground. They are usually 20-30 cm long with tapering at one end and weigh approximately a pound with a sheath covering the shoots (Farelly, 1984). Considerably their weight is dependent upon location, rainfall, watering and drainage conditions, soil fertility, penetration and nutrition of the soil, temperature and pH (Choudhury *et al.,* 2011). They are rich in carbohydrate, proteins, minerals and moisture. Comparatively, the content of cholesterol and fat is found less. Fresh shoots of species like D. giganteus are far more nutritionally rich and healthier with better sensory qualities (Choudhury *et al.,* 2012). The matchless taste and flavour makes the edible bamboo shoot a rare of its kind in case of cuisines (Pande and Pandey, 2008). Apart from India, there are many countries where bamboo shoots forms a traditional delicacy among which few are Japan, US, Thailand, Nepal, Australia, Bhutan, New Zealand, Korea, Malaysia and Indonesia. Ethnic people from Nepal and Bhutan consume it as a pickle or chutney, while in Indonesia, the shoot is added with thick coconut milk and spice to make guleirebung etc. and Sikkimese prefer to consume it as non-fermented curry called tama (Choudhury *et al.,* 2011; Tamang, 1997). Thus, for feeding ever increasing human population, bamboo shoots can positively be utilized. Also due to the therapeutic and nutritional values, it will prove beneficial to make up the dietary deficiencies of micronutrients in the diet resulting in the global food security, safety and nutrition. Bamboos have a extensive history of being multipurpose and a widely used biological resource. Bamboos have its origin to the tribe Bambuseae of the family Poaceae. An over-all of about 128 species belonging to 18 genera are reported to grow in India and cover an estimated 13.96 million hectares of area (ISFR, 2011) and with the government emphasis on rising and making use of bamboos, the areas covered by bamboos is on the upsurge. Bamboos are also utilized for table needs in many countries, but India holds up behind for its usage as a food. Bamboo is one kind of ideal vegetable for it being pollution free, has low fat content, more of edible fibres and rich in minerals mostly like potassium, calcium, manganese, zinc, chromium, copper, iron and minor amount of phosphorus and selenium (Nirmala *et al.,* 2007; Shi and Yang, 1992) but having a substantial fraction of poly unsaturated fatty acids, thus, representing its potential as a source of great healing value. Presence of high quality vitamins such as vitamin A, vitamin B1, vitamin B3, vitamin B6 and vitamin E (Visuphaka, 1985; Shi and Yang, 1992) carbohydrates, proteins and minerals in bamboo shoots and their easy availability to common man may also help in resolving nutritional deficiency of rural poor. Bamboos are low in calories and high in fibre which aids in prevention of colon cancer and in controlling cholesterol level in blood. It is also an upright source of potassium which is a heart healthy mineral. Bamboo shoots also encompass various flavonoids, phenols and phenolic acids (phytochemicals) which are potent anti-oxidants and may have anti-cancer, antibacterial, anti-viral and anti-fungal properties (Pandey *et al.,* 2011; Gupta *et al.,* 2010). Therefore, it is essential to generate more options in bamboo shoot processing. Unfortunately, the common man is not conscious of their qualities as a food supplement and bamboos are chiefly used for the purpose of pulping for paper, fuel and fodder. There is acrucial need to adventure the intrinsic values of bamboos which are rich in all the goodness of natural surroundings to be endorsed as health foods.

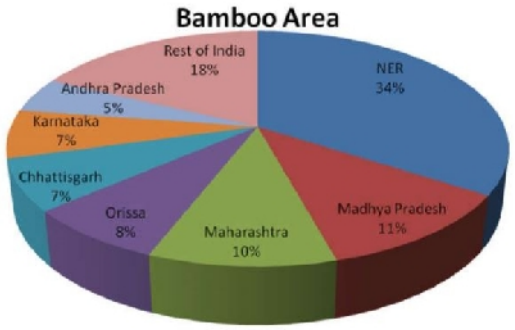

Fig. 1. Bamboo resources found in regions of India (Sharma *et al.,* 2018).

Bamboo as a food: Apart from its many-sided industrial and non-industrial uses, bamboos have an added usage in the utilization of its immature shoots as food. Bamboo shoot is an immature, actively growing, tender culm growing from the buds of subversive rhizome of bamboo plants. The soft, suitable for eating portion of the shoots is covered with defensive non-edible, overlapping leaf sheaths or culm sheaths which need to be removed to obtain edible portion (Pandey *et al.,* 2012). The shooting period of bamboo varies from species to species; their size and weight depending manifestly on locomotion, depth and nutrition of the soil, watering and drainage conditions, temperature, pH and soil fertility (Chaudary *et al.,* 2012) and are normally harvested after completing a growth period of two weeks. For centuries, local communities in East and Southeast Asia, together with the major countries of Japan, China, Korea and Indonesia, have consumed bamboo shoot as a vegetable. They are eaten with

different local ingredients in different regions. Most of the bamboo species fabricate edible shoots but less than 100 species are commonly grown or utilized for their edible shoots (Midmore, 1998).

Rapid lignifications of bamboo shoots start within 2-3 days after harvesting (Lue *et al.,* 2012). For these reasons, bamboo shoots are not only used as fresh but are also processed and preserved in many forms such as dried, pickled, fermented, salted, water soaked and canned. In China, where the use of bamboo shoots as a vegetable dates back to Han Dynasty (202BC- 220AD) (Knechtges, 1986) shoots are used in dumplings, soups, salads, noodles and gravies (Liu, 2009). In Indonesia, bamboo shoots are thinly sliced and then cooked with vegetables, spices and coconut milk (Chaudary *et al.,* 2012). In India, bamboo shoot consumption is restricted mostly to the North East regions and to some extent in Western Ghats and are eaten either fresh or in various processed forms like boiled, soaked, fermented, dried and pickled. Bamboo shoots along with being delicious and highly palatable are also extremely nutritious with rich repositories of various nutrients like amino acids, proteins, carbohydrates, vitamins and dietary fibres (Chongtham *et al.,* 2011). This rich nutrient profile enhances the food value of bamboo shoots and makes them an ideal source for combating prevailing food insecurity especially in the areas of their natural abundance. Further, as the shoots also contain significant quantities of micronutrients like minerals and vitamins thus their consumption can also help in achieving the targets of curtailing "hidden hunger" or micronutrient deficiency. Bamboo shoots consist of significantly higher amount of minerals like potassium (408 mg/100g), phosphorous (19.31 mg/100g), sodium (12.96 mg/100g) and magnesium (8.68 mg/100g) while calcium, copper, iron, manganese and zinc are also present in moderate amounts. The "miracle life element" i.e. selenium is also present in shoots in higher amount than in other common vegetables (Chongtham *et al.,* 2011).

Shi and Yang (1992) while studying the connection amid nutrients in bamboo shoots and human wellbeing, reported that shoots of bamboo are short in calories, high in dietary fibre and rich in various nutrients such as minerals, mostly like potassium, calcium, manganese, zinc, chromium, copper, iron and vitamins namely vitamin A, vitamin B1, vitamin B3, vitamin B6, and vitamin E. Yang and Huang (2009) worked on fresh bamboo shoots of three species of Pleioblastus for ash, moisture, fat, protein, reducing sugar, fibre and vitamin C content, and also reported presence of minerals potassium, calcium, magnesium, chromium, iron and zinc (Table 1).

Table 1: Nutritional composition of different bamboo species (Chongtham *et al.,* 2011).

Name of species	Amino acids (g/100g)	Proteins (g/100g)	Carbohydrates (g/100g)	Starch (g/100g)	Vitamin C (mg/100g)	Vitamin E (mg/100g)	Dietary fiber (g/100g)
Bambusa bambos	3.98	3.57	5.42	0.25	1.90	0.61	3.54
B. kingiana	3.70	3.57	5.45	0.34	2.10	0.50	4.49
B. nutans	3.89	2.84	5.47	0.21	1.19	0.47	2.28
B. polymorpha	3.42	3.64	5.44	0.38	2.60	0.49	3.81
B. tulda	3.65	3.69	6.92	0.59	1.42	0.61	3.97
B. vulgaris	3.57	3.64	6.51	0.27	4.80	0.52	4.24
Dendrocalamusasper	3.12	3.59	4.90	0.36	3.20	0.91	3.54
D. brandisii	3.01	2.31	4.90	0.49	1.59	0.42	4.03
D. giganteus	3.86	3.11	5.10	0.51	3.28	0.69	2.65
D. hamiltonii	3.18	3.72	5.50	0.47	2.45	0.71	3.90
D. membranaceus	3.46	3.38	5.40	0.23	1.58	0.65	2.91
D. strictus	3.07	2.60	6.17	0.31	2.43	0.58	2.26
Gigantohcloa albociliata	3.52	3.05	4.59	0.31	1.00	0.60	4.15
G. rostrata	3.17	3.56	4.32	0.22	3.20	0.49	4.20

Qiu, (1992) studied the nutritive components in 10 species of bamboos in China and reported the presence of 17 amino acids; out of which 8 are important for human body. Six essential amino acids viz, valine, methionine, isoleucine, leucine and lysine along with six nonessential amino acids namely, a spartate, glutamine, glycine, alanine, tyrosine and histidine were reported in bamboo shoots (Qiu, 1992). Tyrosine comprises of 57 to 67 per cent of the total amino acid content of bamboo shoots (Kozukue *et al*., 1999), which is a major constituent of adrenaline and also affects thyroid and pituitary glands of our body. Bamboo shoots are not only used as source of food and nutrition but also have a protracted history of being utilized as a source of medicine in China and Southeast Asia (Bao, 2006) and were said to be useful to the human well-being, particularly by encouraging the peristalsis of the stomach and the intestine, facilitating digestion and avoiding and curing cardiovascular diseases and certain types of cancers. Modern researches have linked most of the health promoting benefits of bamboo shoots with the presence of bioactive compounds like phenols, dietary fibers and phytosterols (Nirmala *et al.,* 2014). These bioactive compounds have been reported to provide specific health benefits upon consumption. Lachance and He (1998) reported that bamboo shoots are also good source of many phytosterols which exhibit cholesterol lowering activity. They proposed an effective formulation prepared from bamboo shoot extract to lower the LDL and serum cholesterol levels and recommended that these phytosterols act by impeding or dropping the cholesterol absorption and cholesterol synthesis and/or by faecal excretion of acid and neutral sterols. Liu, (2009) studied the phytosterol content and composition of four species *Pleioblastus amarus*,

Phyllostachys pubescens, *P. praecox* and *Dendrocalamus latiflorus* and isolated 6 different phytosterols namely β- sitosterol, campesterol, stigmasterol, cholesterol, ergosterol and stigmastanol. Further, (Lu *et al.,* 2010) studied the hypolipidemic effects of the bamboo shoot oil on rats, which has a total phytosterol content of about 28 per cent and showed significant effects on lowering serum total cholesterol and LDL-Cholesterol levels. Park and Jhon, (2009) confirmed the beneficial effects of consuming bamboo shoots in lowering cholesterol levels and improving bowel functions in healthy young women, which is attributed to its high levels of dietary fibre. Park and Jhon (2010) later identified eight phenolic compounds namely- protocatechuic acid, p-hydroxybenzoic acid, catechin, caffeic acid, chlorogenic acid, syringic acid, p-coumaric acid, and ferulic acid from shoot extracts of *Phyllostachys pubesens* and *P. nigra*. They reported a significant relationship between these phenolic compounds and anti-oxidant capacities of bamboo shoot extract and thus proposed that bamboo shoots can be a good dietary source of natural phenolic antioxidants. Apart from these health benefits related to their consumption in food form, shoots are also gaining fame in medicinal and nutraceutical market as several commercial health formulations are currently being sold in market (Table 2). Therefore, it can be said that bamboo represents a hugely versatile natural resource which possess tremendous potential towards fighting global food insecurity and providing health benefits too.

Table 2: Bamboo shoot based nutraceutical products (Nirmala *et al.*, 2014).

Product	Category	Content	Manufacturer
Bamboo-nutra®	Anti-aging, probiotic, weight control	Bamboo fiber, bamboo protein	Bamboo Nutra LLC. USA
Nutristart®	Anti-aging, build healthy bones, nails and teeth	Bamboo silica	Nutri Start Naturally, Canada
Bamboo silica®	Dietary supplement, prevents premature aging and preserves skin youthfulness	Bamboo silica	World Organic, Victoria Health's pharmacist, UK
Bamboo juice®	Dietary supplement, nourishes blood and improve eye sight	Essential aminoacids and flavonoids	Zhaoqing Tiankang Green Bamboo Biological Products Co., Ltd. China
Bamboo Shoot Extract Powder	Dietary supplement, treatment for cough, reduce fever and dissipate phlegm	Dietary fiber	Nutra Green, UK and Changsha Winner BioTech Co. Ltd, China
Just Fiber®	Bakery products, reduces fats and calories	Dietary fiber	International Fiber Corporation, USA
Sanacel®	Dietary supplement, improve digestion	Dietary fiber	CFF Gmb Hand Co.KG, Germany

Sensory evaluation of the Bamboo products: Sensory assessment was conducted for six products of bamboo shoot namely preserve, candy, chutney, chukh, nuggets and crackers on ahedonic scale of nine point to assess the overall acceptability of prepared products (Table 3). Color, flavor, taste, texture, and overall quality of the developed products are included as the sensory characteristics (Sood *et al.,* 2013). Sensory analysis was done by 20 semi-trained judges of the age group 20 to 50 years comprising of students, consumers and professionals. The product samples were presented in random order and panellists were asked to rate their analysis on a 1 to 9 point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much and 1 = dislike extremely).

Table 3: Sensory evaluation of bamboo shoot products (Sood *et al.*, 2013).

Parameters	Preserve	Candy	Chutney	Chukh	Nuggets	Crackers
Colour	7.00	7.50	6.50	8.00	7.50	7.85
Flavour	7.50	7.00	6.83	7.50	7.50	8.00
Taste	7.50	8.00	7.00	7.83	8.00	7.50
Texture	8.00	7.83	7.50	8.00	7.85	8.00
Overall acceptability	7.50	7.83	6.95	7.83	7.50	8.00

CONCLUSION

Bamboo, the most versatile renewable resource, coincidently has utmost natural abundance in the areas which are most horribly affected from hunger and undernourishment. The products made were very good in taste as well as from the nutritional point of view. Bamboo shoots are available for a limited period; more number of different edible products can be standardized and formulated in future. Value addition of bamboo shoot and in food market having bamboo component increases their marketability potential of these kinds of novel products the growing global population in near future.

FUTURE SCOPE

There is a need for wide spread knowledge on cultivation, processing and value addition of bamboo shoot. As discussed it has high medicinal values and nutritive value it imprints as the golden standard to combat nutrient deficiencies and to fight global hunger. Further research has to be carried on more processing suitable varieties of bamboo and unique valued added products out of it.

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