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Bamboo Shoots: An Untapped Source of Essential Nutrients and Bioactive Compounds

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ABSTRACT

Food not only provides us with essential nutrients that are vital for normal functioning of the body, but also serves as a source of several active ingredients termed as bioactive compounds which play an active role in prevention and cure of chronic diseases. Emphasis on the utilization of food sources having balanced and optimum proportion of these nutrients and bioactive compounds globally might prove to be the most crucial factor in cutting the exorbitant costs of prevalent health care systems thereby bringing social and economic gains. Bamboo shoots, the young, aerial outgrowths of the bamboo plant, along with being rich repository of essential nutrient, also contain generous quantities of several bioactive compounds such as phytosterols, phenols and dietary fiber. These bioactive compounds have been proven to impart bamboo shoots with several health benefits such as reducing serum cholesterol, anti-inflammatory, anti-bacterial, antimicrobial and antioxidant properties, prevention of diabetes, obesity, metabolic disorders, cardiovascular diseases and even certain types of cancers. Therefore, with a plethora of bioactive compounds and associated health benefits, bamboo shoots represent an ideal functional food resource which if utilized to its full potential can prove to be a major ally in our quest for a healthy future.

Keywords- *Bamboo shoots, food, nutrients, bioactive compounds, health*

1. INTRODUCTION

Food is no longer considered as just a mean to curb the hunger or to satisfy the appetite but has taken totally new dimensions in the light of modern scientific research highlighting the active role played by food in prevention and cure of several chronic diseases such as cardiovascular diseases, cancers, metabolic disorders *etc.* These studies have attributed the positive health impact of foods to their phytochemical constituents or "bioactive compounds" [1].

Bioactive compounds are extra-nutrient, secondary plant metabolites with potent health promoting effects. These phytochemicals, though not essential for fundamental plant physiochemical processes, are found to play some important biological functions such as defense against herbivores, attraction of pollinators and cell signaling. Several groups of bioactive compounds are known to exist naturally in wide variety of plant foods and food products *e.g.* polyphenols, carotenoids, anthocyanins, phytosterols, dietary fibers, alkaloids, glycosides *etc*. and impart specific health benefits upon consumption of such plant foods and food products. Because of all

these associated health benefits, consumption of bioactive compound rich foods, especially fruits and vegetables, have gone upscale in recent times, driven mainly by increased health consciousness among people and is backed by strong scientific evidences [2].

Bamboo shoots, the young, soft and juicy culms of the bamboo plant, have made a distinct niche for themselves in global food markets with their superior nutritional repositories. Along with basic nutrients, shoots also contain significant proportions of most of the essential mineral elements required for the optimum, growth, development and functioning of human body **(Table 1)** [3, 4].

Table 1. Content of various mineral elements in juvenile bamboo shoots (mg/100g) [3].

Minerals	*Bambusa bambos*	*Bambusa Tulda*	*Dendrocalamus asper*	*Dendrocalamus giganteus*	*Dendrocalamus hamiltonii*
Ca	0.36	4.06	5.51	6.80	3.00
Cu	0.28	0.44	0.32	0.56	0.29
Fe	2.99	3.19	3.37	2.43	2.69
Mg	5.38	8.68	10.14	10.10	6.91
Mn	0.47	0.70	0.41	0.34	0.16
K	576.00	408.00	464.00	288.00	416.00
P	30.12	19.31	40.95	15.90	28.12
Se	0.0003	0.0004	0.001	0.0005	0.0008
Na	10.06	12.96	10.14	8.22	9.32
Zn	0.57	0.72	0.85	1.09	0.70

For centuries, local communities in East and Southeast Asia, including the major countries of Japan, China, Korea, Indonesia and India have consumed bamboo shoot as a seasonal vegetable. They are eaten with different local ingredients in different regions. Usage of shoots is not only limited to a food resource, but they also constitute an integral component of the various traditional medicine system across Asia being used for improvement of bowel function and digestion, prevention of metabolic disorders, cardiovascular diseases and certain types of cancers *etc*. Although, their use as a seasonal delicacy and further applications in traditional medicinal systems was already well established, scientific basis of much of these health claims and benefits of bamboo shoot consumption has only been elucidated in the last decade or so correlating them with the presence of bioactive compounds [5]. Bamboo shoots contain several bioactive compounds, more importantly phytosterols, phenols and dietary fibers **(Table 2)**. These bioactive compounds, their respective health benefits and their contents in the shoots of different bamboo species are described below.

2. PHYTOSTEROLS

Phytosterols, the structural and functional counterpart of cholesterol in plant kingdom have gained lots of acclaim in the recent times due to their potential implications for human health. Scientific evidences supporting their beneficial action on reducing serum cholesterol and low density lipoprotein (LDL) cholesterol levels, reducing blood cholesterol levels, anti-microbial and anti-cancerous properties as well as their other beneficial health effects have resulted in promotion of phytosterol rich plant based diets [6]. Bamboo shoots are known to contain significant deposits of phytosterols which is supported by several scientific studies. Srivastava [7] estimated the phytosterol content in the fresh shoots of two bamboo species *Bambusa tulda* and *Dendrocalamus giganteus* and it was found to be 0.21% and 0.39% on dry weight basis respectively. He and Lachance [8] and Lachance and He [9] reported three major phytosterols (β-sitosterol, campesterol and stigmasterol from shoots of several bamboo species including *Bambusa oldhami* Nakai, *B. edulis*, *Dendrocalamus latiflorus* Munro, *Phyllostachys edulis*, *P. pubescens*, and *P. makinoi* and they proposed a hypocholesterolemic formulation with potent cholesterol lowering properties and suggested that these phytosterols act by inhibiting or reducing the cholesterol absorption and cholesterol synthesis and by fecal excretion of neutral and acid sterols.

Sarangthem *et al.* [10] estimated the total phytosterol content of 7 different bamboo species *i.e. Arundinaria callosa*, *Bambusa balcooa*, *B. pallida*, *B. khasiana*, *Cephalostachym pergracile*, *Dendrocalamus hamiltonii* and *D. strictus* which ranged from 0.12 to 0.19% with highest being in *B. pallida* and *D. hamiltonii* while lowest was reported from *B. khasiana*. Sarangthem and Singh [11] reported the total phytosterol content of *B. balcooa* and *D. strictus* to be 0.18% and 0.14% on dry weight basis respectively. Lu *et al.* [12] analyzed the effect of genetic variability, parts and seasons on phytosterol content and composition in shoots of four species (*Dendrocalamus latiflorus*, *Phyllostachys praecox, P. pubescens and Pleioblastus amarus*). They found that the total phytosterol content in bamboo shoots ranged from 112.4 to 279.6 mg/100g dry wt. in four species with highest being in *P. pubescens* and lowest being in *D. latiflorus* while the phytosterol composition included β-sitosterol, campesterol, stigmasterol, ergosterol, cholesterol and stigmastanol. Further, they also found out that shoot shells contain much higher phytosterol as compared to shoot body itself (321.8 mg/100g dry wt. in *P pubescens*) and can be more effective in lowering cholesterol levels. Lu *et al.* [13] utilized the supercritical CO2 extraction method to extract bamboo shoot oil (BSO) from the shoots of *Phyllostachys pubescens* and several phytosterols and their derivatives such as β-sitosterol, campesterol, stigmasterol, ergosterol, cholesterol, stigmastanol, stigmasta-3,5-dien-7-one, stigmast-4-en-3-one were identified using GC-MS analysis with maximum concentration being of β-sitosterol (26%).

Further, Lu *et al.* [14] studied the hypolipidemic effect of BSO extracted from *Phyllostachys pubescens* in rats and proved that BSO with its relatively higher phytosterol content compared to other vegetable oil, can be an ideal dietary supplement for lowering serum cholesterol levels. In another study, Lu *et al.* [15] analyzed the effect of this phytosterol rich BSO on non-bacterial prostatitis (NBS) and their result showed that BSO was able to inhibit prostate inflammation by altering the expression pattern of inflammatory cytokines, their receptors, and other genes related to inflammation mechanism and therefore it was proposed that BSO can prove to be a

useful raw ingredient in future medicinal formulations aimed at treating chronic non-bacterial prostatitis. Tanaka *et al.* [16] studied the antimicrobial activity of bamboo shoot skins of *Phyllostachys pubescens* and found that the dichloromethane-soluble methanol extract from the shoot skins was able to inhibit the growth of bacteria *Staphylococcus aureus*. They further isolated the active constituents responsible for antimicrobial activity and were identified as phytosterols namely stigmasterol and dihydrobrassicasterol by NMR and mass spectrometry. Zheng *et al.* [17] reported the total phytosterol content in the fresh bamboo shoot residue to be 523 mg/100g dry weight. These studies therefore support the fact that bamboo shoots contain very high quantities of major phytosterols and have potential health benefits to human populations. Phytosterol content in fresh juvenile shoots of five bamboo species (*Bambusa balcooa, B. nutans, Dendrocalamus giganteus, D. hamiltonii and D. membranaceus*) was presently estimated which ranged from 123.84-176.71 mg/100g dry weight (**Table 2**).

Table 2. Bioactive compounds [Phenols (mg/100g fresh weight); Phytosterols (mg/100g dry weight) and Dietary fiber components {NDF, ADF, Lignin, Cellulose and Hemicellulose} (g/100g fresh weight) in juvenile shoots of some edible bamboo species from India

Bioactive Compounds	*Bambusa balcooa*	*Bambusa nutans*	*Dendrocalamus giganteus*	*Dendrocalamus hamiltonii*	*Dendrocalamus membranaceus*
Phytosterol	123.84	142.23	158.10	176.71	162.57
Phenols	382.23	465.34	609.32	530.65	596.67
NDF	5.25	5.49	6.00	4.82	5.20
ADF	0.51	0.70	0.71	0.60	0.57
Lignin	0.30	0.38	0.44	0.31	0.33
Cellulose	0.21	0.32	0.27	0.29	0.24
Hemicellulose	4.74	4.79	5.29	4.22	4.63

3. PHENOLIC COMPOUNDS

Phenols constitute a large and diverse class of natural secondary metabolites produced mostly via shikimate, phenylpropanoid, flavonoid, anthocyanin, and lignin pathways. Structurally, phenols are simple aromatic hydrocarbons having either one (phenol) or more than one hydroxyl group substitution (polyphenols). Major group of plant phenolic compound includes flavonoids (flavones, flavonols, anthocyanidins, isoflavones *etc*.); tannins; chalcones; coumarins and phenolic acids [18]. Phenolic compounds signify the largest groups of natural antioxidant mainly because of the strong hydrogen-donating properties of their hydroxyl groups. They prevent the oxidative damage of various biomolecules such as DNA, lipids and proteins by scavenging various

reactive species such as superoxide radical, hydroxyl radical, peroxyl radical, hypochlorous acid, and peroxynitrous acid and also by chelating metal ions thus playing an important role in prevention of various chronic diseases such as cardiovascular diseases, gastric ulcers, cancer or hepatic encephalopathy *etc.* Other health benefits of phenol include anti-diabetic, anti-hypertensive anti-inflammatory, anti-allergic, anti-microbial and cardioprotective properties [19, 20, 21].

Bamboo shoots are considered a rich source of phenolic compounds. Kozukue *et al.* [22] studied the changes in phenolic compounds in bamboo shoots during storage at 20^0C. They found that the content of crude phenolic compounds soon after the harvest was 165 and 106 mg/100g fresh weight, in the apical and basal portions of the shoots respectively and these levels decreased during storage. They also identified 25 individual phenolic compounds in the shoots using GC-MS analysis including 5-dihydroshikimic acid, shikimic acid, p-hydroxyphenylethanol, p-hydroxyphenylpropionic acid, ferulic acid, caffeic acid and chlorogenic acid. Akao *et al.* [23] isolated a highly bioactive lignophenol derivative from bamboo lignin, Lig-8 which exhibited a potent neuroprotective activity against hydrogen peroxide (H_2O_2) induced apoptosis in human neuroblastoma cell line SH-SY5Y and thus can be utilized in the treatment of neurodegenerative diseases. Lu and Xu [24] studied the polyphenolic content of the different portions of shoots in case of *Phyllostachys heterocycla* var *pubescens* and found that polyphenol content was maximum in apical region (around 60 mg/g fresh weight) and it decreased toward middle and basal portions. Shen *et al.* [25] studied the total polyphenol content of the *Phyllostachys praecox* shoots which was around 1.6 mg/g of fresh weight. Ito *et al.* [26] also studied the effect of lig-8, a lignophenol derivative from bamboo, on the protection from neurodegenerative disorders. Park and John [27] identified eight different 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 nigra*. They also found that bamboo shoot extract possess potent antioxidant properties which is correlated to their phenolic content. Yang *et al.* [28] while investigating the effect of nitric oxide on browning and lignification of peeled bamboo shoots of *Phyllostachys violascens* determined the total phenols of the shoot sample which was 23.50 mg/g of fresh weight which decreased upon storage. Pandey *et al.* [29] analyzed the total phenol content in the fresh shoots of 4 species *i.e. Bambusa bambos*, *B. tulda*, *Dendrocalamus asper* and *D. strictus* whereas maximum total phenol content was reported in case of *D. strictus* (1.25 g/100g). Liu *et al.* [30] studied the total flavonoid and phenolic acid content of the byproducts of canned bamboo shoot. Pandey and Ojha [31] analyzed the effect of harvesting age on the total phenolic content in shoots of 3 species *i.e. Bambusa tulda*, *Dendrocalaus asper* and *D. strictus* with *D. strictus* having maximum phenol content (2.26%) at optimum harvesting age. Further, they isolated 4 different phenolic acids in the shoots namely gallic acid, vanillic acid, chlorogenic acid and caffeic acid. Pandey and Ojha [32] analyzed the total phenol content in fresh shoots of 4 bamboo species *i.e. Bambusa bambos* (0.36 g/100g), *B. tulda* (0.39 g/100g), *Dendrocalamus asper* (0.58 g/100g) and *D. strictus* (0.63 g/100g).

Badwaik *et al.* [33] determined the total phenol content and antioxidant activity in the fresh shoots of *Bambusa balcooa*. The total phenol content was 97.50 mg/100g whereas the antioxidant activity was found to be 26.62%

of DPPH radical scavenging activity. Further, Badwaik [34] studied the total phenol content and antioxidant activity in fresh shoots of 4 species *i.e. Bambusa balcooa, B. pallida, B. tulda* and *Dendrocalamus hamiltonii.* Total phenol of 4 species ranged from 79.85 to 101.65 mg/100g and total antioxidant activity ranged from 19.17 to 27.12% of DPPH radical scavenging activity. Nemenyi *et al.* [35] analyzed the total phenol content of fresh shoots of 14 *Phyllostachys* species which ranged from 826.22 to 1321.95 µg GA/ml. Thomas *et al.* [36] studied the total phenol content of shoot extracts of *Bambusa polymorpha* and found it to be 246 mg CAG/100g. They also reported that addition of bamboo shoot extract significantly lowered the levels of lipid oxidation in pork nuggets thus confirming the strong antioxidant property of phenols present in bamboo shoot extract. In the present investigation, total phenol content in juvenile shoots of five bamboo species found to be ranged from 382.23-609.32 mg/100g fresh weight **(Table 2)**.

4. DIETARY FIBER

Dietary fiber is a collective term applied to plant cell components which are either water soluble or insoluble polysaccharides present in the plant foods such as cellulose, hemicellulose, pectin, gums, mucilages and lignin [37]. Consumption of food or food products rich in dietary fiber content has been shown to be beneficial in improving digestive function, reducing serum cholesterol levels, normalizing blood sugar levels, easing constipation, prevention of diabetes, obesity and cardiovascular diseases [38-41]. Bamboo shoots contain significant amount of dietary fiber. Bhatt *et al.* [42] studied the crude fiber content in the shoots of 11 bamboo species *i.e. Bambusa balcooa, B. nutans, B. tulda, Dendrocalamus giganteus, D. hamiltonii, D. hookeri, D. longispathus, D. sikkimensis, Melocanna baccifera, Phyllostachys bambusoides* and *Teinostachyum wightii* and found that crude fiber in various species ranged from 23.1 to 35.5% with highest being in the shoots of *M. baccifera*. Kumbhare and Bhargava [43] while investigating the effect of processing on the nutritional values in the shoots of 4 Central Indian bamboo species *i.e. Bambusa nutans, B. vulgaris, Dendrocalamus asper* and *D. strictus*, found out the crude fiber content in fresh shoots in the range of 0.71 to 0.98%, which was significantly lesser as compared to previous reports on bamboo shoots. Nirmala *et al.* [3] in a study to determine the nutrient changes in emerging juvenile shoots of five commercially important bamboos *i.e. Bambusa bamboos, B tulda, Dendrocalamus asper, D. giganteus* and *D. hamiltonii* found that the crude fiber in freshly emerged shoots ranged from 2.64 to 3.97% whereas in 10 days old shoots, there was an increase in the fiber content which ranged from 8.20 to 13.84%. Nirmala *et al.* [44] determined the content of different components of dietary fiber *i.e.* NDF (2.64 g/100g), ADF (2.150 g/100g), lignin (0.56 g/100g), hemicellulose (0.49 g/100g), and cellulose (1.58 g/100g) in the freshly harvested shoots of *D. giganteus*.

In a further study, Nirmala *et al.* [4] analyzed the dietary fiber content in fresh shoots of 14 edible bamboo species *i.e. Bambusa bambos, B. kingiana, B. nutans, B. polymorpha, B. tulda, B. vulgaris, Dendrocaalamus asper, D. brandisii, D. giganteus, D. hamiltonii, D. membranaceus, D. strictus, Gigantochloa albociliata* and *G. rostrata* which ranged from 2.26 to 4.49 g/100g on fresh weight basis with maximum being in *B. kingiana*. Pandey *et al.* [29] determined the crude fiber content in the fresh shoot samples of 4 species *i.e. Bambusa*

bambos (0.82 g/100g), *B. tulda* (0.75 g/100g), *Dendrocalamus asper* (0.76 g/100g) and *D. strictus* (0.96 g/100g). Pandey and Ojha [31] studied the effect of harvesting age on the dietary fiber content in the shoots of *Bambusa tulda*, *Dendrocalamus asper*, and *D. strictus* and reported that dietary fiber content of the shoots increased with the harvesting age with optimum age of harvesting for the extraction of dietary fiber in case of *B. tulda* was 20 days (5.20%), for *D. asper* it was 18 days (3.86%) and for *D. strictus* it was 16 days (5.46%). Sood *et al.* [45] analyzed the dietary fiber content in the shoots of *Dendrocalamus hamiltonii* and their results showed crude fiber at 1.50%, NDF at 2.54%, ADF at 2.08% and lignin at 0.49%. Awol [46] while investigating the nutrient, mineral and bioactive constituents of bamboo shoots grown in Masha area of Ethiopia, reported the crude fiber content of fresh shoots to be 18.81%. Badwaik [34] studied the crude fiber content in fresh shoots of 4 bamboo species *i.e. Bambusa balcooa, B. pallida, B. tulda* and *Dendrocalamus hamiltonii* which ranged from 3.16 to 3.92 g/100g. Thomas *et al.* [36] studied the crude fiber content of shoot extracts of *Bambusa polymorpha* which was 5.8%.

Health benefits of dietary fiber from bamboo shoot have been studied intensively. Naito *et al.* [47] patented a methodology to make bamboo shoot powder under pressure and heat from the shoots of *Phyllostachys* species and their study confirmed the therapeutic effect of bamboo shoot powder administration against the acquired intestinal diverticulum mainly because of the high water-swellable fibrous material of the bamboo shoot. Hence they suggested the use of bamboo shoot powder as a food additive for the prevention of intestinal diverticulum and hyperlipemia. Shi and Yang [48] proposed that high cellulose content of bamboo shoots may be helpful in improving gut microbial flora, reduces the fat products and improves the peristalsis of intestine which could prevent intestine cancers. Shimizu *et al.* [49] investigated the effect of bamboo shoot dietary fiber on the fecal steroidal profiles of rats and found an increase in fecal wet weight suggesting improvement in bowel movement. Anping [50] investigated the role of bamboo shoot dietary fiber in regulating intestinal microbial flora in mice model and concluded that bamboo shoot dietary fiber can help in relieving constipation. Park and Jhon [51] studied the effect of bamboo shoot consumption on the lipid profile and bowel function of healthy young women aged 21-23. They correlated the fiber content of bamboo shoots with reduction in serum total cholesterol, low density lipoprotein cholesterol, hepatic lipase, lipoprotein lipase and atherogenic index with an improvement in fecal volume and bowel movement frequency and higher excretion of cholesterol with feces. Bamboo shoots as a dietary fiber source thus have direct beneficial effects on lipid profiles and bowel functions with positive implication on cardiovascular health of the consumers. Different components of dietary fiber (NDF, ADF, lignin, cellulose and hemicellulose) were estimated in juvenile shoots of five bamboo species and their respective values are given in **Table 2**.

5. OTHER BIOACTIVE COMPOUNDS FROM BAMBOO SHOOTS AND THEIR HEALTH BENEFITS

Katsuzaki *et al.* [52] isolated and identified two strong antioxidant compounds Tricin and Taxifolin from the ethyl acetate extracts of bamboo shoot sheaths. Wang and Ng [53] isolated a potent antifungal protein dendrocin from the bamboo *Dendrocalamus latiflorus*. Fujimura *et al.* [54] purified two novel chitin binding peptides, Pp-

AMP-1 and Pp-AMP-2 which had potent antimicrobial activity against pathogenic bacteria and fungi. Zhang *et al.* [55] isolated a triterpenoid-rich extract from bamboo shavings which had superior anti-fatigue, anti-hyperlipidemic, and anti-hypertensive activities. Park and John [36] evaluated the angiotensin converting enzyme (ACE) inhibition activity of shoot extracts of two Korean species *i.e. Phyllostachys pubescens* and *P. nigra*. Zhang *et al.* [56] isolated a group of hetero polysaccharides from the shoots of *Phyllostachys edulis* which were successfully tested for their potent antioxidant property against superoxide radical and hydroxyl radical. Tanaka *et al.* [16, 57] studied the antibacterial activity of moso bamboo shoot skin (*Phyllostachys pubescens*) against the *Staphylococcus aureus* strain.

Singh *et al.* [58] carried out a therapeutic screening of solvent extracts of fermented *Bambusa balcooa* shoots and confirmed its anti-microbial action against 4 bacterial strains *viz.*, *Staphylococcus aureus*, *Baccilus subtillis*, *Pseudomonas aeruginosa* and *Escherichia coli* and 3 fungal strains, *viz.*, *Aspergillus niger*, *Candida albicans* and *Fusarium oxyporum*. Azmi *et al.* [59] extracted a polysachharide from the shoots of *Gigantochloa levis i.e.* Bamboo Shoot Crude Polysaccharide (BSCP) and tested it for its probiotic properties. When used as carbon source, BSCP showed significant increase in the growth of *Bifidobacterium animalis* ATCC 1053, *Bifidobacterium longum* BB 536 and *Lactobacillus acidophilus* ATCC 4356 which shows that bamboo shoots represent a potential source for natural prebiotics. Hsu *et al.* [60] isolated and purified two chitosanase isoforms from the shoot sheaths of *Bambusa oldhamii* which have several biological activities including antifungal, antibacterial, antitumor and immune-enhancing activities [61].

Liu *et al.* [62] studied the antihypertensive and anti-hyperlipidemic effects of bamboo shoot ACE inhibitory peptide (BSP) extracted from the shoots of *Phyllostachys pubescens.* Further, Liu *et al.* [48] studied antioxidant and ACE inhibition potential of BSP from the byproducts of canned bamboo shoots. 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. Bamboo extracts have been used as functional ingredients for capsules, tablets and in powder form and are consumed to improve not only digestive health but weight management, cardiovascular health and general wellness **(Table 3)**.

Table 3. Medicinal properties of bamboo shoots

S. No.	Potential Benefit	Bamboo Species	References
1	Antioxidant	*Phyllostachys pubescens, P. nigra*	[46, 63]
2	Anti-hypertension	*Phyllostachys pubescens*	[62]
3	Anti-hyperlipidemic	*Phyllostachys pubescens*	[14, 62]
4	Anti-fungal	*Dendrocalamus latiflorus*	[53]
5	Anti-microbial	*Phyllostachys pubescens*	[54]

6	Cholesterol lowering	*Bambusa oldhami, D. latiflorus Phyllostachys pubescens, P. nigra, P. edulis*	[9, 36]
7	Anti-cancerous	*Phyllostachys pubescens*, *P. nigra* var. *henonis*. *P. bambusoides, Pseudosasa japonica, Pleioblastus simonii*, and *Gigantochloa apus*	[64]

6. CONCLUSION

Bioactive compounds obtained from natural plant resources have now gained prominence for their use as prophylactic agents in prevention and treatment of several chronic human diseases. These secondary metabolites or phytochemicals have been shown to exert a wide range of biological activities. In general, these bioactive compounds have low potency in comparison to pharmaceutical drugs, but since they are ingested regularly and in significant amounts as part of the diet, they may have a noticeable long-term physiological effect. Bamboo represents a hugely versatile natural resource which possesses tremendous potential toward fighting global food insecurity. Bamboo shoots are not only rich in basic nutrient components but also contain an array of infused bioactive compounds bestowing them with several health benefits. This natural resource still remain largely untapped in terms of extraction and utilisation of bioactive compounds but with the backing of sound scientific evidences, establishment of bamboo shoots as one of the most sought after ingredient for the functional food industry is inevitable thus making them one of the prominent contributors toward securing a healthy future for the mankind.

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