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GENERAL ARTICLE

Bamboo Species of Odisha, India: Source of Nutraceutical

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Study Area: Bhubaneswar, Odisha, India
Coordinates: 20.27°N; 85.84°E

Key words: Antioxidants, Bamboos, Dietary fibers, Nutritional values, Pharmacological values

Abstract

Bamboos are one of the most important medicinal plant wealth, as they contain a number of bioactive compounds and also have high nutritional values. Bamboos are a source of antioxidants. Bamboo extracts cure several chronic and regenerating diseases. In this study, 18 species of bamboo were studied for their biological importance in their nutritional as well as medicinal properties. Literature data of seven species from the genus *Bambusa*, five species from *Dendrocalamus* genus, three species from *Phyllostachys* genus, two species viz. *Sasa borealis* and *S.senanensis* from genus *Sasa* and one species viz. *Pseudosasa japonica* from *Pseudosasa* genus was collected and organized for their nutritional and medicinal values. The data revealed that juvenile bamboo shoots have a lot of health advantages due to the presence of secondary metabolites such as phenols, minerals, carotenoids, dietary fibres, saponin, phytosterols, vitamin C, vitamin E *etc*. Besides this bamboo shoots and leaves also comprise carbohydrates, eight essential amino acids, a high amount of protein content in fresh shoots and minerals. These minerals may supply defence against many chronic and degenerative diseases and also serve as one of the nutritional resources.

Introduction:

Bamboos, the giant grass in the world, are included in the family Poaceae, subfamily Bambusoideae (Canavan *et al*., 2017). Bamboos are characterized as one of the most essential sustainable, easily gained and beneficial of all forest resources (Buckingham *et al*., 2011). Most of the Bamboo species seemed to be familiar and habituated by human beings since the origin of civilization. Bamboo leaves are utilized as a food packaging material to avoid food adulteration since ancient periods in Asian provinces (Nongdam & Tikendra, 2014). In this zone, the leaves of Bamboos are explained in the customary practice of pharmaceuticals for curing several number of health problems like high blood pressure, coronary artery disease, acute myocardial infarction and certain classes of cancer. These healing properties are mainly health beneficial and mediated due to their antioxidant property (Panee, 2015).

Bamboo: a rich source of secondary metabolites

Juvenile bamboo shoots contain several nutrients and bioactive compounds such as phenols, vitamin-C, flavonoids, vitamin-E, selenium, iron, copper, zinc, manganese *etc*. which provide a number of health benefits and seemed to protect against many incurable and degenerative diseases (Fig.-1) (Tanaka *et al*., 2014).

Phenolic substances: bamboo shoots provide the most abundant phenolic metabolites ferulic acid, chlorogenic acid, rutin and P-coumaric acid. Phenolic compounds are the outputs of the secondary metabolism and are accredited with a large number of health benefits due to their capable applications such as a source of anti-oxidant and anti-microbial (Pourreza, 2013). They exhibit positive beneficial effects like anti-oxidant, anti-inflammatory, anti-microbial, anti-allergic, cardioprotective and vasodilating activities. Phenols are used as anti-oxidants through different procedures such as stroll of free oxidants, extinguishing of ROS, hindrance of the oxidative enzymes *etc*. Anti-oxidant activity is one of the most valuable characteristics measured for boosting food and nourishing feature. (Pourreza, 2013). Flavonoids, phytoestrogens, and phenolic acids are included in phenolic compounds. These have anti-microbial properties against 4 strains of bacteria, such as *Bacillus subtilis*, *Staphylococcus aureus*, Escherichia coli and Pseudomonas aeruginosa and three fungal strains such as *Fusarium oxysporum*, *Aspergillus niger* and *Candida albicans*. The phenolic compound was

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assessed in fresh and synthesized bamboo shoots of four bamboo species, such as *Bambusa tulda, B.balcooa*, *Dendrocalamus hamiltonii* and *D.giganteus*. Anti-oxidant properties were found to be decreased by boiling. So fresh bamboo shoots should be consumed for more benefit (Choudhry *et al*., 2012).

Dietary fibres: these are the edible part of the plants, rich in carbohydrates, and good for digestion and absorption. Dietary fibres are also known as roughage. Bamboo fibre contains zero calories and energy and is a powder-formed white tasteless and is utilized in a large number of food products such as confectionery, meat, yoghurt, liquid refreshment, spices and sauce. Fibre present in bamboo shoots may be categorized as nutrient detergent fibre (NDF), and acid detergent fibre (ADF). PDF include indigestive component plant material such as celluloses, hemicellulose and lignin and ADF contain cellulose and lignin (Fig.-2). The amount of fibres is not decreased after fermentation. These increase food values (Li *et al*., 2016).

Phytosterols: alike cholesterol these are the bioactive compounds excluding the substation on the side chain of sterolic compounds. These are cholesterol-lowering agents. These play important role in the regulation of cardiovascular disease and anti-cancer properties. These decrease total serum and LDL cholesterol in rats. These are actively present in fresh bamboo shoots. Bamboo shoots which are harvested in the spring seasons contain the highest amount of phytosterols (Chongtham *et al*., 2011).

Other bioactive compounds: in bamboo shoot extracts other bioactive compounds are carotenoids, saponin, vitamin C, vitamin E etc. These all act as anti-oxidant. These are involved in controlling appetite and treating fever, cough and phlegm. Tricin and Taxifolin from ethyl acetate extract of bamboo shoots act as anti-oxidant. Dendrocin protein from *Dendrocalamus lactiferous* is an anti-fungal protein. Chitin binding proteins act against pathogenic bacteria and fungi. Terpenoid acid-rich bamboo extracts act as anti-fatigue, anti-hyperlipidemic, and anti-hypersensitive (Gong *et al*., 2015).

Bamboo as pharmacological value

Bamboo shoots and leaves are explained in the ancient treatment for treating high strain, arterial sclerosis, skin diseases, cardiovascular disorder and particular forms of cancer (Panee *et al*., 2015, Behera *et al*., 2021).

Anti-oxidant activities: bamboo extracts have mainly anti-oxidant activities. These extracts contain flavonoids, polyphenols, alkaloids, terpenoids, tannins, saponins etc. These have the capacity for healing and regeneration of the skin. Bamboo extracts rich in amino acids and flavonoids protect the skin from oxidative stress (Gong *et al*., 2015). *P.nigra, P.edulis* and *P.bambusoides* have anti-oxidant properties (Shukla *et al*., 2011).

Anti-diabetic properties: *Sasa borealis* leaf extract remarkably downed plasma glucose showing anti-diabetic capacity. The prohibitory result of the leaves of *Pseudosasa japonica* was estimated on a high quantity of fat diet generated fatness and diabetes in mice. Anti-diabetic effect of petroleum extract on the shoot and leaves of *B.vulgaris* was studied in streptozotocin-generated diabetic rats and noticed a remarkable reduction in blood glucose amount. Leaves and shoots of *Sasa borealis*, a species of bamboo were published to reveal anti-hyperglycemic activity (Goyal *et al*., 2017).

Anti-microbial properties: the leaves of bamboo are used as antihelmintic. Antimicrobial effect of sequential extracts of juvenile fresh leaves of bamboo estimated in opposition to both gram-positive and gram-negative bacterial strains by using disc diffusion technique. The bamboo extracts also has anti-viral and anti-fungal capacity (Zhang *et al*., 2017).

Anti-cancer properties: ethanolic extracts of several bamboo species have shown anti-tumour effects against malignant tumours. Besides shoots, clinical studies have also estimated the effective anti-tumour characteristic of other parts of bamboo plants such as leaves and culms. It has been revealed that ethanolic and water extracts developed from tiny branches and leaves of Phyllostachys edulis can reduce or prohibit the development of chemically generated breast cancer as specified by the inhibition of hyperinsulinemia and remarkable reduction in the circulating amount of TNF-ALPHA in a high amount of fat treated mice. *P.nigra* was found to have anti-tumour activity against mouse leukaemia and human lung and gastric adenocarcinoma cell lines (Panee *et al*., 2015). Leaf extracts of *S.senanensis* have also anti-cancer properties (Shukla *et al*., 2011).

Anti-ulcer properties: it has been reported that oral administration of folic extract of bamboo grass significantly reduces water immersion, restrains stress and induced gastric ulcers in rats. Folin suppresses the condition of hyperpigmentation, and reducing of mucopolysaccharides acid in ethanol-raised ulcers and also seemed to clamp down the secretion of histamine from mast cells of rats, stabilize erythrocytes and accelerate their agglutination under acidic conditions (Muniappan & Sundararaj, 2003).

Other medicinal properties: bamboo extracts are sweet, cooling, diuretic, febrifuge, and expectorant. It is known to control vomiting, stems white-scripting are seemed to be utilised for bacterial infections. It has also been used to treat lung inflammations and phlegm. Bamboo extracts are utilized for convulsions caused by phlegm and heat, spasms, strokes with phlegm abstracting breathing paths and childhood convulsions. The leaf is included as an antidiuretic antipyretic and has continuously been used for chest and head colds, pharyngeal disorder and stomatitis along with urinal flow and suppression of fever. The white

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bleeding of the stem has been practised for bronchial and cerebral infections. The root extracts check blood flow rate and inhibit the release of body fluid, also used in decoction form for anxiety, sleeping problems and general restlessness. The roots have also been used for rabies (Rosario *et al.*, 2015). *Bamboo manna*, the siliceous material found in the hollow internodes of *Bambusa aurindinacea* (Retz.) Wild is used as an antipyretic, antidote to a snake bite, used in cough and as the cardiac drug was standardised to authenticate the siliceous concretion (Prida *et al.*, 2014). *P.nigra, P.bambusoides* and *P.edulis* have anti-inflammatory properties. *P.nigra* has also a cardio-protective effect. Leaf and stem extracts of *B.vulgaris* can induce abortion (Shukla *et al.*, 2011).

Bamboo as nutritional value

Bamboos are used as the most valuable health-beneficial foods as they are having a high content of proteins, amino acids, carbohydrates, minerals and vitamins (Basumatary *et al.*, 2017). Newly collected bamboo shoots have a good level of thymine, niacin, vitamin A, vitamin B6 and vitamin E. Also bamboo shoots are rich in dietary fibres, phytosterols, and fewer cholesterols (Fig.-3) (Nongdam & Tikendra, 2014).

Amino acids: bamboo shoots are abundant in amino acids. Out of 20 amino acids 8 essential amino acids are found in bamboo shoots essential for human bodies. After fermentation, the amounts of amino acids are decreased. Tyrosine, are more abundant in young shoots than in mature ones. There was a significant decrease in amino acids in matured shoots of *B.bambos, B.tulda, D.giganteus* and *D.hamiltonii* compared to instantly harvested shoots (Nongdam & Tikendra, 2014).

Proteins: bamboo shoots contain a high level of protein. It was reported that, a reduction in protein amount of fresh bamboo shoots of *B.bambos* when shoots are subjected to heat treatment in increases salt concentration. The protein content is found more amount in freshly harvested shoots than in matured shoots (Basumatary *et al.*, 2017).

Minerals: bamboo shoots have plenty of utilizable minerals such as potassium, phosphorous, sodium, calcium, magnesium and iron. Minerals are used for the many useful metabolic activities of our body. Freshly harvested bamboo shoots have more content minerals than in matured shoots. The amounts of minerals are reduced with boiling or heat treatment (Singhal *et al.*, 2013).

Carbohydrates: bamboo shoots have a high amount of carbohydrates and there is a remarkable growth in the level of carbohydrates in bamboo shoots after incorporating them into the boiling process. The rise in carbohydrates may be due to the hydrolysis of complex polysaccharides into single monosaccharide sugar units. The carbohydrate content decreased when bamboo shoots from *B.bambos, B.tulda, B.stricus*, and *D.asper* were boiled in a solution with different salt concentrations. There is an increase in carbohydrate content in bamboo shoots along with an increase in age (Pandey *et al.*, 2013).

Table-1: Nutritional and pharmacological importance of *Bambusa* sps.

#	English name	*Bamboo species*	Phytochemicals present Pharmacological importance (P.I.)
1	Thorny Bamboo	*B.arundinacea*	Leaf & shoot extract P.I.-Anti-inflammatory, anti-diarrheal, anti-diabetic, antidote to snake bite, anti-ulcer, anti-microbial, promoting urination, decrease in male fertility and thyroid function, treatment of cough, digestive disorder, nausea, gynecological disorder and fever.
2	Common bamboo	*B.vulgaris*	Chloroform extracts from leaves and Tabasheer from culm P.I.-Treat infantile epilepsy, fever , haematuria and kidney troubles, stimulates menstrual flow, induce abortion, anti-microbial
3	Nodding*	*B.nutans*	Leaf extracts P.I.-Anti-inflammatory, antioxidant, anti-diabetic, anti-microbial property against genital herpes and Viricella Zoster virus, wound healing
4	Bengal*	*B.tulda*	Leaf and shoot extracts P.I.-Antifatigue, antioxidant and antimicrobial agents
5	Giant thorny or male*	*B.bambos*	Leaf extracts P.I.-Leucodendroma, blood purification, bronchitis, fever and gonorrhea, anti-arthritic, anti-obesity, laxative, antispasmodic
6	Guadua or female*	*B.balcooa*	Leaf and stem extracts P.I.-Antioxidant and anti-microbial agents, treatment of peptic ulcer
7	Punting pole*	*B.tuldoides*	Shavings of culm cortex P.I.-Febrile diseases, haematuria, epitaxis & infertile epilepsy
8	Rough giant*	*Dendrocalamus asper*	Leaf extract P.I.-Reduce hyper tension, anti-bacterial activity
9	Solid / Calcutta*	*D.strictus*	Siliceous parts of leaves and nodes P.I.-Antipyretic and carminative,
10	Dragon*	*D. giganteus*	Siliceous secr. of culm Antioxidant, antimicrobial agents, aphrodiasiac tonic
11	_	*D.lactiferous*	Leaf extracts P.I.-Antifungal
12	Tama*	*D.hamiltonii*	Shoot extract P.I.-Antioxidant and anti-microbial
13		*Phyllostachys bambusoides*	P.I.-Antioxidant, anti-inflammatory , lipid lowering
14	Moso/tortoise -shell*	*P. edulis*	Sheaths of stem P.I.-Antioxidant, anti-cancer, anti-inflammatory, lipid lowering, nausea and sour stomach
15	Black*	*P. nigra* `	Sap of young stems, epidermis of bark and leaf extracts P.I.-Antioxidant, anti-inflammatory, cardio protective, lipid lowering, treatment of fever, vomiting and

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			nosebleeds, antipyretic, anti-diuretic and treatment of lung infections with cough and phlegm
16	Arrow*	*Pseudosasa japonica*	Leaf extracts P.I.- Antihelmintic, antivinous, tonic, abortifacient, stimulant, aphrodisiac, treat asthma, coughs, and gallbladder disorders.
17	Northern*	*Sasa borealis*	Leaf extracts P.I.-Anti-inflammatory, antipyretic, antidiuretic, antihyperglycemic, anti-diabetic, anti-oxidant and obesity reducing
18	Broad leaf*	*S.senanensis*	Leaf extracts P.I.-Cancer inhibitor

*Bamboo

Fibre: bamboo shoots are rich in dietary fibres. Dietary fibres possess a number of health benefits as they control blood pressure, and hypertension, increase body fat, coronary diseases and potential carcinogens. The consumption of fibre-rich diets helps in decreasing undesired cholesterols, lowering insulin demand, keeping the digestive tract healthy, and improving laxative capacity, and bowel movement in young healthy women (Pandey *et al.*, 2013).

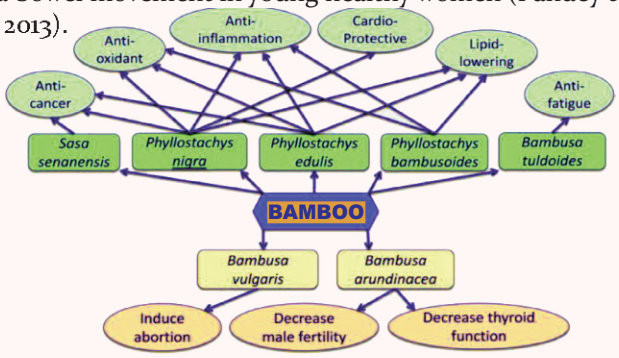

Figure-1: Phytochemical activity of Bamboo species

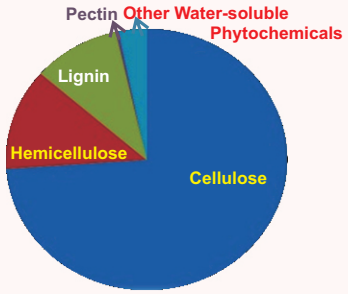

Figure-2: Chemical composition of bamboo shoots

Growth potentials of fermented bamboo shoots in food industries

-->Healthy food (pickles, dietry fibres)
-->Medicines
-->Production of Ethanol/methanol
-->Source of bioactive compounds
-->Preservatives in meat and its products
-->Niche for Lactic acid bacteria

Figure-3: Growth potential of fermented bamboo shoots.

Finally, phytochemicals extracted from bamboo extracts are used as prophylactic substances in the inhibition of several resisting human diseases including cancer, diabetes, ulcer, inflammation etc. Drugs produced from bamboo plant extracts have anti-helminthic, anti-viral, anti-bacterial and anti-fungal activity. Besides that, bamboo extracts have several medicinal uses for several diseases such as bronchitis, cerebral infections, cough, cold, phlegm, heart and lung disease menorrhoea *etc*.

References:

Basumatary, A., Middha, S., Usha, T., Brahma, B. & Goyal, A. (2017): Bamboo shoots as a nutritive boon for Northeast India: an overview. *3 Biotech*., 7(3):169.

Behera, K., Mandal, U., Panda, M., Mohapatra, M., Mallick, S.K., Routray, S., Parida, S. & Mahalik, G. (2021): Ethnobotany and folk medicines used by the local healers of Bhadrak, Odisha, India. *Egyp. J. Bot*., 61(2):375-389.

Buckingham, K., Jepson, P., Liangru, W., Rao, R., Jiang, S., Liese., W., Lou, Y. & Maoyi, F. (2011): The potential of Bamboo is constrained by outmoded policy frames. *Ambio*., 40(5):544-548.

Canavan, S., Richardson, D., Visser, V., Roux, J. & Wilson, J. (2017): The global distribution of bamboo: assessing correlates of introduction and invasion. *AoB Plants,* 9(1):plw078.

Chongtham, N., Singh, M. & Haorongbam, S. (2011): Nutritional properties of Bamboo shoots: Potential prospects for utilization as a Health food. *Food Sci. Food Safe*., 10:3.

Choudhry, D., Sahu, J. & Sharma, D. (2012): Value addition to bamboo shoots: a review. *J. Food Sci Technol*., 49(4):407-414.

Gong, J., Xia, D., Huang, J., Ge, Q., Mao, J., Liu, S. & Zhang, Y. (2015): Functional components of Bamboo shavings and Bamboo leaf extracts and their antioxidant activities in vitro. *J. Med. Food.,* 18(4): 453-459.

Goyal, A., Middha, S., Usha, T. & Sen, A. (2017): Analysis of the toxic, anti-diabetic and antioxidant potential of *Bambusa balcooa* leaf extracts in alloxan-induced diabetic rats. *3 Biotech.,* 7(2):120.

Li, X., Guo, J., Ji, K, Zhang P. (2016): Bamboo shoot fiber prevents obesity in mice by modulating the gut microbiota. *Sci. Rep*., 6:32953.

Muniappan, A. & Sundararaj, T. (2003): Anti-inflammatory antiulcer activitie of B. arundinacea. *J. Ethnopharmacol*., 88(2-3):161-167.

Nongdam, P. & Tikendra, L . (2014): The nutritional facts of bamboo shoots and their usages as important traditional food of Northeast India. *Int. Schol. Res. Not.*, Article ID 679073

Pandey, A., Ojha, V. & Coubey, S. (2013): Development and self-life evaluation of value added edible products from Bamboo shoots. *Am. J. Food Technol*., 7:363-371.

Panee, J. (2015): Potential medicinal application and cytotoxicity evaluation of extracts from Bamboo plants. *J. Med. Plant Res*., 9(23):681-692.

Panee, J., Liu, W. & Berry, M. (2015): A novel function of Bamboo extract in relieving lipotoxicity. *Phytothor. Res.,* 22(5):675-680.

Parida, S., Rout, K.K. & Mishra, S.K. (2014): Method of

identification and Standardisation of "Vamsalochana" (Bamboo Manna). *Indian Drugs,* 51(01):55-58.

Pourreza, N. (2013): Phenolic compound as potential antioxidant. *Jundishapur J. Nat. Pharmaceut. Pro*., 8(4):149-150.

Rosario, A., Dermott, M. & Panee, J. (2015): Effect of high-fat diet and bamboo extract supplement on anxiety and depression like neurobehaviours in mice. *Br. J. Nutr*., 108(7):1143-1149.

Shukla, R., Sumit, G., Sajal, S., Dwivedi, P.K. & Mishra, A. (2011): Medicinal importance of Bamboo. *Int. J. Biopharm. Phytochem. Res.*, 1(1):9-15.

Singhal, P., Bal, L., Satya, S., Sudhakar, P. & Naik, S. (2013): Bamboo shoots: a novel source of nutrition and medicine. *US Nat. Lib. Med*., 53(5):517-534.

Tanaka, A., Zhu, Q., Tan, H., Horiba, H., Ochnuki, K., Mori, Y., Yamauchi, R., Ishikawa, H., Iwamoto, A., Kawahara, H. & Shimizu, K. (2014): Biological activities and phytochemical profiles of extracts from different parts of a Bamboo (*Phyllostachys pubescens*). *Molecules,* 19(6):8238-8260.

Zhang, J., Zhang, B., Chen, X., Mi, B., Wei, P., Fei, B. & Mu, X. (2017): Anti-microbial Bamboo materials functionalized with ZnO and Graphane Oxide nanocomposites. *Materials* (Basel). 10(3):239.