

The Amazing Bamboo: A Review on its Medicinal and Pharmacological Potential

Review Article

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Abstract

Bamboo is a perennial plant found all over the Earth except alkaline soils, desert, and marsh. In recent years, focus on plant research has increased all over the world and evidence show immense potential of Bamboo as a medicinal plant which is used in various traditional systems of medicine like Ayurveda. Bamboo as a herbal drugs have got extreme momentum in global health care systems. The beneficial therapeutic effect of bamboo is seen in their continued use and benefits which are proven scientifically where triterpenes and steroidal glycosides are identified as major phytoconstituents. The ethanomedical and pharmacological studies on bamboo such as anticancer, antioxidant, antimicrobial, antidiabetic, anti ulcer, antifertility properties etc., are critically reassessed in this paper. Though the potential of Bamboo is varied, more research inputs are required for critically assured results.

Keywords: Bamboo; Anti cancer; Anti diabetic; Pharmacological profile; Scientific classification; Common names and distribution in India; Chemical composition; Ethanomedical uses; Anti-Cancer Activity; Proximate analysis; Chemical composition; Phytochemicals present; Cardio protection

Introduction

Bamboo is a perennial, giant, woody grass belonging to the group angiosperms and the order monocotyledon. The grass family *Poaceae* (or *Gramineae*) can be divided into one small subfamily, *Centothecoideae*, and five large subfamilies, *Arundinoideae*, *Pooideae*, *Chloridoideae*, *Panicoideae*, and *Bambusoideae*. In distinction to its name, bamboos are classified under the subfamily *Bambusoideae* [1]. Few examples of bamboo genera are *Bambusa*, *Chusquea*, *Dendrocalamus*, *Phyllostachys*, *Gigantochloa* and *Schizostachyum*. There are about 10 genera and 1450 species [2].

Scientific classification

Kingdom: Plantae
(unranked): Angiosperms
(unranked): Monocots
(unranked): Commelinids
Order: Poales

Family : Poaceae

Subfamily : Bambusoideae

Supertribe : Bambusodae

There are approximately 60 to 70 genera and over 1,200 - 1,500 species of bamboo in the world. About half of these species grow in Asia, most of them within the Indo-Burmese region [3] which includes 136 species under 23 genera which are available only in India [4]. Most of the bamboos grow in a warm climate, abundant moisture, and productive soil, all though some do grow in reasonably cold weather about 20 °C. They grow in plains, hilly and high altitude mountainous regions, and in most kinds of soils, except alkaline soils, desert, and marsh [5]. In recent years, focus on plant research has increased all over the world and evidence show immense potential of Bamboo as a medicinal plant which is used in various traditional systems like Ayurveda, Unani etc., Bamboo as a herbal drugs have got extreme momentum in global health care systems. Many bamboo spp. have been found to have therapeutic potential and are being used since time immemorial. The beneficial therapeutic effect of these

bamboo species is seen in their continued use and benefits which are proven scientifically [6].

Bamboo played a significant role in human civilization since ancient times, and is still contributing to the subsistence of the current world. The leaves of *Bambusa* are used as a folk medicine for the treatment of cough, fever and leprosy. It was reported that the extract of *B. arundinacea* showed anti inflammatory, antiulcer, antifertility, antimicrobial and hypoglycaemic activities. The hypoglycemic properties of extracts of bambusa leaves have also been established. Bamboo leaves have been used in traditional Chinese medicine for treating fever and detoxification for over 1000 years. Flavonoid-rich bamboo leaf extract has multiple biological effects, such as anti-free radical, antioxidation, anti-aging, anti-fatigue, anti-bacterial, anti-viral, and prevention of cardiovascular diseases. Hence bamboo can be used as a pharmaceutical intermediate, dietary supplement, cosmetic ingredient, and food additive [6].

Growth and Morphology

Bamboo is segmented into 2 structures one is the rhizomes and other is the culms. The rhizome is the underground part of the stem. Individual bamboo stems, or culms, emerge from the ground at their full diameter and grow to their full height in a single growing season of three to four month. It is this portion of the bamboo that contains most of the woody material. Most of bamboo culms are cylindrical and hollow, with diameters ranging from 0.25 inch to 12 inches, and height ranging from 1 foot to 120 feet [7].

Bamboo is a fast growing species, with reported growth rates of 250 cm (98 in) in 24 hours and a high yield renewable resource. Bamboo growth depends on species, but generally all bamboo matures quickly. Bamboo has 40 to 50 stems inches one clump, which adds 10 to 20 culms yearly. Bamboo can reach its maximum height in 4 to 6 months with a daily increment of 15 to 18 cm (5 to 7 inches) Culms take 2 to 6 years to mature, which depends on the species [8].

Common names and distribution in India

Bamboo, common name in English (Bamboo, Bamboo manna, Giant Thorny Bamboo); Hindi (Bans-lochana, Banskapur, Vanoo, Banz); Gujarati (Toncor, Wans, Vanskapur, Vas-numitha); Bengoli (Bans-Kapur, Baans, Baansh, Baroowa Bans); Sanskrit

(Vanshalochana, Venulavanam); Arab (Tabashir); Marthi (Bansa, Baambii, Bansamitha); Tamil(Munga-luppa, Mullumangila, Mulmunkil, Mungil); Telugu (Veduruppu, Mulkas Veduru, Mullu Veduru); Maliyalam (Moleuppa); Kannad (Bidaruppu, Tavakshira) [9].

Bambusa arundinacea is mainly found in Arunachal Pradesh, Karnataka, Orissa, Maharashtra, Himachal Pradesh, Andhra Pradesh and Gujarat. While most other seen species is *Dendrocalamus strictus* found in Andhra Pradesh, Assam, Gujarat, Maharashtra, Himachal Pradesh, Madhya Pradesh, Manipur, Orissa, Karnataka, Uttar Pradesh, Rajasthan. Few other species like *Bambusa balcooa*, *Bambusa pallida*, *Bambusa tulda*, *Bambusa polymorpha*, *Dendrocalamus hamiltonii*, *Dendrocalamus longispathus*, *Melocanna bambusoides*, *Oxytenanthera spp.* are found abundant in North Eastern India [10].

Consumption of Bamboo

Bamboo shoot is a traditional delicacy in many countries including India. As they are low in fat, high in potassium, carbohydrate, dietary fibres, Vitamins and active materials, bamboo shoots are consumed in raw, canned, boiled, marinated, fermented, frozen, liquid and medicinal forms. As the consumption pattern of bamboo shoots in most of the countries is traditional, non-standardized, seasonal and region-specific [11].

Chemical composition

The chemical composition of bamboo is similar to that of wood. The main constituents of bamboo culms are cellulose, hemi-cellulose and lignin, which amount to over 90% of the total mass. The minor constituents of bamboo are resins, tannins, waxes and inorganic salts. Compared with wood, however, bamboo has higher alkaline extractives, ash and silica contents [12]. Bamboo contains other organic components in addition to cellulose and lignin. It contains about 2-6% starch, 2% deoxidized saccharide, 2-4% fat, and 0.8-6% protein [13].

Phytochemicals present

The silicious substance found near the joint inside is white camphor like and crystalline in appearance, slightly sticky to the tongue and sweet in taste. Shoot has active constituents such as oxalic acid, reducing sugars, resins, waxes, HCN, benzoic acid, diferuloyl arabinoxylanhexasaccharide, diferuloyl oligo saccharide, (5,5'-di--(diferul-9, 9'-dioyl)-[α -L-arabino furanosyl-(1 \rightarrow 3)- O- β -D-xylopyranosyl-9 (1 \rightarrow 4) -D-xylopyranose] (taxiphyllin). Seed contain arginine, cysteine, histidine, isoleucine, leucine, lysine, methionine, phenylamine, threonine, valine, tyrosine, niacin, riboflavin, thiamine. Leaves mainly contain proteins like gluteline, lysine, methionine, betain, cholin, proteolytic enzymes like nuclease and urease [13].

In this plant, triterpenes and steroidal glycosides are the major phytoconstituents. Stigmast-5, 22- dien-3 β -ol [4], Stigmast-5-en-3 β -ol- β -D gluco pyranoside are isolated in good quantities. 17, 20, 20-tri demethyl-20 α - isopranyl oleanane and eicosanyl dicarboxylic acid, α -amyrin acetate and urs-12-en-3 β -ol- β -D- glucopyranoside have also been isolated [14]. Qualitative phytochemical screening methods detected the presence of particular phytochemical in the ethanolic and water extracts. Natural products belonging to saponins,

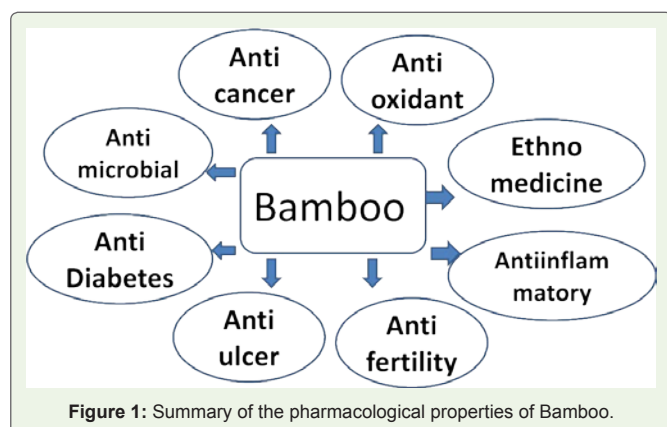


Figure 1: Summary of the pharmacological properties of Bamboo.

diterpenes, triterpenes, phenols, tannins, and flavonoids were shown to be present in both the ethanolic and aqueous extracts of *Philippine Bamboo*, *Schizostachyum lumampao*, Leaves [15]. Qualitative Phytochemical Screening of Ethanolic and Aqueous Extracts of Philippine Bamboo, *Schizostachyum lumampao*, Leaves illustrated the presence of saponins, Diterpenes, Phenols, phytosterols, Tannins and Flavanoids in the ethanolic extract where as phytosterols were absent among these in the water extract [15]. The specifications of antioxidant properties of Bamboo leaves were studied [16]. They reported total flavanoids to be 15.6%, phenolic acids 7.9%, Ash 1.4%, protein 1.24 %, Total heavy metals <0.0003% and moisture 4.9%.

Proximate analysis

The proximate analysis of buho (*Schizostachyum lumampao*) with potential to be used as herbal tea shows a high amount of ash, crude fiber, and crude protein. Qualitative phytochemical screening revealed the presence of saponins, diterpenes, triterpenes, phenols, tannins, and flavonoids in both the ethanolic and aqueous leaf extracts, while phytosterols were only detected in the ethanolic extract [15]. The ash content, which is equivalent to the amount of inorganics in the leaves, is about 30 %. The values for the proximate analysis of the leaves (reported as mean \pm standard deviation, n=3) are as follows: 9.99 ± 0.056 % moisture, 30.49 ± 0.58 % ash, 22.10 ± 1.26 % crude protein, 1.56 ± 0.97 % crude fat, 28.65 ± 0.09 % crude fibre, and 7.21 ± 0.79 % total sugar [17].

A number of studies of bamboo have yielded information about the chemical constituents, but no systematic evaluation has been carried out, so it is difficult to determine which of the identified compounds might be among the primary active constituents. It has been noted that the bamboo plant has unusually high levels of acetylcholine (which acts as a neurotransmitter in animals and humans; its role in plants is as yet unknown), especially in some portions of the plant (e.g., upper part of the bamboo shoot). It is conceivable that compounds of similar chemical structure in bamboo may contribute to the effects of the herb and its extracts on brain function. The bamboo leaves, obtained from the common tall bamboos (species of *Phyllostachys*, rather than the small *Lophatherum*) have recently been utilized as a source of flavonoids (e.g., vitexin and orientin) which are used as antioxidants. The flavonoids may reduce inflammation, promote circulation, and inhibit allergy reactions [18].

Ethanomedical uses

Bamboo sap treats cold, resolves phlegm, fever, or loss of consciousness associated with phlegm-heat; especially used in remedies for children's feverish disorders and epilepsy. The leaves of *Pleioblastus amarus*, a tall bamboo growing in Southern China has slightly bitter, pungent taste is used in treating fever, fidgeting, and lung inflammation [19]. The Kani tribes believe that the seeds of *Bambusa arundinacea* enhance the fertility which has increased the demand of seeds of this species in pharmaceutical industry to manufacture drugs to improve fertility. *Bambusa* leaf juice is given for strengthening the cartilage in osteoarthritis and osteoporosis. It has a vital role in the integrity of the bones, arterial walls, skin, teeth, gums, hair and nails and has been used to alleviate eczema and psoriasis [20].

Pharmacological Profile

Anti-Cancer Activity

Among a number of short term evaluation systems for the detection of environmental carcinogens/mutagens, mammalian cell transformation systems are particularly useful since their assay endpoint is neoplastic conversion of target cells. The leaves of *Sasa senanensis* have been used in Eastern Asia as a potential source of natural drug since hundreds of years and alkaline extract prepared from the leaves is popularly known as "Sasa health". The evaluation of carcinogenic/co-carcinogenic activity of Chikusaku-eki, a bamboo charcoal by-product used as a folk remedy in BALB/c 3T3 cells determined the carcinogenic and tumor promoting potential of Chikusaku-eki using BALB/c 3T3 A31-1-1 cell transformation system. The results proved that Chikusaku-eki did not act as a tumor promoter [21]. One of the casual factors of tumor progression is suppression of immune functions. Polysaccharides from mushrooms or microbial cell wall components were shown to be efficient immuno stimulating agents. The extracts of the kumaizasa bamboo leaves are used in traditional Japanese medicine as an anti inflammatory. A study on immuno stimulation-mediated anti-tumor activity of bamboo (*Sasa senanensis*) leaf extracts obtained under 'vigorous condition' carried out which evaluated the antitumor activity and immuno potentiating efficacy of the bamboo extracts. The extracts stimulated both macrophages and Natural killer cells suggesting that it may be the primary immuno potentiating factor in plays an important role in cancer prevention [22].

Bambusae caulis in taeniam (BCT) is widely used as traditional chinese medicine. The effects of BCT on the metastatic potential of malignant cancer cells and the mechanism of anti-metastatic activity has not been explained previously. Thus the group [23] carried out a study on aqueous extract of *Bambusae caulis* which inhibits PMA-induced tumor cell invasion and pulmonary metastasis. Pretreatment with AE-BCT efficiently inhibited cell migration, invasion and adhesion. Therefore the results demonstrated that AE-BCT significantly reduced the metastatic activity of highly malignant cancer cells by suppressing MMP-9 activity via inhibition of ROS-mediated NF- κ B activation. These results conclude that AE-BCT may be a safe natural product for treatment of metastatic cancer [23].

Sarijang is a bamboo salt soy sauce which has been demonstrated to exert anti-inflammatory and antitumor activity. The pro-apoptotic effects of sarijang in vitro was carried out in U937 human leukemia cell model. [24] Conducted an experiment on inducing apoptosis by sarijang in U937 human leukemia cells through the activation of caspases. The apoptosis induced by sarijang was significantly inhibited by z-VED-fmk, a pan-caspase inhibitor, which demonstrated the importance of caspases in the process. These results concluded that sarijang can be a potential chemo therapeutic agent for the use in control of U937 leukemia cells, hence they are required to identify the active compounds [24]. The effect of leaves of *Pseudosasa japonica* on the development of DMBA (7,12-Dimethylbenz[a] Anthracene) to induce breast cancer in Sprague-Dawley rats were studied. It was observed that oral administration of bamboo extract for 3 weeks prior to DMBA injection delayed the onset of breast cancer by one

week as compared to the control. Further the extract also showed the potential of decreasing the incidence of occurrence of tumor by 44% and restricting the growth rate of the tumor by 67% after 11 weeks of DMBA treatment [25].

Anti-Oxidant Activity

Bamboo shoots are the most popular traditional food delicacies which are generally consumed as fresh, fermented, or canned products in many South-East Asian countries. [26] performed an experiment on Grappling the High Altitude for Safe Edible Bamboo Shoots with Rich Nutritional Attributes and Escaping Cyanogenic Toxicity. Consumption of bamboo species with high level of total cyanogenic content (TCC) in Asia was observed, which resulted in high level of food poisoning. The study indicated that morphologically and genetically evolved edible bamboo species having large and robust bamboo-shoot texture and growing at low altitude contained high level of TCC, low antioxidant properties, and low levels of beneficial macronutrients and micronutrients. Importantly, *Dendrocalamus* species are shown to be rich in TCC irrespective of the growing altitude while *Bambusa* species in comparison are found to have moderate level of TCC. The findings clearly demonstrated that *Chimonobambusa callosa* growing at high altitude represents safe edible bamboo species with nutritious attributes [26]. A previous research study revealed that the medicinal effects of bamboo leaf extracts can be attributed to its antioxidant phytochemicals, such as phenolic compounds [27]. The antioxidant activity studies on "Moso" (*Phyllostachys edulis*), which is harvested in China, showed significant inhibitory effects on superoxide radical, hydroxyl radical, DPPH radical, and ferrous metal-chelating capacities [28].

P. pubescens and *P. Nigra* which are bamboo species found in Korea illustrated antioxidant activity in addition to inhibition of angiotensin converting enzyme which is a potential indicator of its antihypertensive properties [29]. The leaves of *Phyllostachys nigra* var. *henonis* bamboo from China, is utilized as a source of phenolics and flavonoids that exhibit antioxidant activity [30]. Bamboo breed of *Sasa argenteastriatus*, has abundant active compounds and high antioxidant activity in leaves, and is a new leafy bamboo grove suitable for exploitation. The Seasonal Variations of the Antioxidant Composition in Ground Bamboo *Sasa argenteastriatus* Leaves were also reported. It was found that chlorogenic acid, isoorientin and vitexin are the main compounds in *Sasa argenteastriatus* leaves and the content of isovitexin and chlorogenic acid showed a similar seasonal variation [31].

Chemokines are a class of superfamily of small cytokines that regulate trafficking of various types of leukocytes. Chemokines are generally divided into four subgroups as: CC, C, CXC, and CX3C. *Bambusae caulis* in Liguamen (BCL), is a traditional herbal medicine used in East Asia, also known to have antioxidative and immune-regulating properties. [31] worked on *Bambusae caulis* in Liguamen that can Suppresses the expression of Thymus and Activation Regulated Chemokine and Macrophage Derived Chemokine. These authors hypothesized that the potential antioxidant effects of BCL might suppress the production of thymus and activation regulated chemokine (TARC) and macrophage derived chemokine (MDC) in

human keratinocytes (HaCaT cell). The immune regulating effect of BCL was demonstrated by antioxidant capacity using via DPPH and DCFH-DA assays. They found that BCL had strong ROS scavenging effect in HaCaT cell. Collectively, the results suggested that BCL may have a therapeutic potential on skin disease such as atopic dermatitis by inhibiting Th2 [32].

Anti-Microbial Activity

Bamboos are used as bioactive agents for a variety of applications, including bamboo charcoal (bintochan), bamboo vinegar, bamboo juice, bamboo beer, bamboo salt, and tender shoots that used in Chinese cuisine. There are also many traditional drugs associated with bamboos for treating fever and detoxification which have been used in Indian Ayurvedic medicine and Chinese herbal medicine since ancient times. *Moso bamboo*, a member of *Bambusoideae* (Poaceae), is one typical vegetative, monopodial bamboo species, found in subtropics of China. Bamboos, acting as therapeutic agents in ethnomedicine, are used to inhibit inflammation and enhance natural immunity for a long time and there are many bamboo associated fungi with medical and edible value. [33] worked on Diversity and Antimicrobial Activity of Culturable Endophytic Fungi Isolated from *Moso Bamboo* Seeds. The crude extracts of isolates named B09, B34, B35, B38 and zzz816 under submerged fermentation, also demonstrated various levels of bioactivities against bambusicolous pathogenic fungi. This study first reported on the antimicrobial activity of endophytic fungi associated with *Moso bamboo* seeds, and the results showed that they could be exploited as a potential source of bioactive compounds and plant defense activators. They also concluded that strains of *Shiraia sp.* that was isolated and cultured from moso bamboo seeds, could produce hypocrellin A at high yield, which is significantly different from the other strains published [33].

Harmful compounds like paraben are still used as preservatives in foods, cosmetics, and medical products. Continually, consumer demand for the safety of additive agents is increasing year on year, leading to popular movements to reduce the addition of synthetic chemical compounds to foods and cosmetics. The emergence of materials, preferably natural products, having less harmful effects would be highly desirable if their safety could be guaranteed. [34] experimented on Antibacterial activity of *Moso bamboo* shoot skin (*Phyllostachys pubescens*) against *Staphylococcus aureus* which is a major food pathogen. Their study examined the antibacterial activity of *Moso bamboo* shoot skin (*Phyllostachys pubescens*) and its dichloromethane extract had antibacterial activity against *Staphylococcus aureus*. Results suggested that the possibility of effective utilization of anti-bacterial materials from bamboo shoot skins were mainly discarded at present [34].

Anti-Diabetic Activity

Type 2 diabetes is caused due to decreased secretion of insulin by the pancreas and resistance to the action of insulin in various tissues such as muscle, liver, and adipose, leading to impaired glucose uptake. One of the primary risk factors for type 2 diabetes has tracked with similar increases in the prevalence of obesity. Type 2 diabetes management usually includes change of diet and exercise, and most patients ultimately require pharmacotherapy such as an

oral antidiabetic drug (OAD) [35]. Moso bamboo leaves extract were studied in 50 diabetic rats which illustrated hypoglycemic effect [36]. *Sasa borealis* leaf extract was substituted for meat in patty which significantly lowered plasma glucose indicating anti diabetic activity of this extract [37]. The inhibitory effect of the leaves of *Pseudosasa japonica* was evaluated on high fat diet induced obesity and diabetes in C57BL/6J mice. Though the food intake of mice assigned to bamboo extract was found to be slightly higher than the control, but the weight gain was however restricted in mice on bamboo extract compared to control [37]. The anti-diabetic activity of the petroleum extract of the leaf of *Bambusa vulgaris* in streptozotocin induced diabetic rats were studied and it was found that oral administration of the extract for a period of 15 days was effective in significantly reducing the blood glucose level in a dose dependant manner when compared to the standard drug glibenclamide [38].

Leaves of *Sasa borealis*, a species of bamboo, was reported to exhibit antihyperglycemic effect. However, its antidiabetic mechanism was not fully understood. Studies on *Sasa borealis* extract, its antidiabetic effect via activation of the AMP-activated protein kinase were also studied [39]. Treatment with the *S. borealis* extract showed increase in insulin signaling and phosphorylation of AMP which stimulated the expression of its downstream targets, including PPAR α , ACO, and CPT-1. However, inhibition of AMPK activation attenuates the insulin signaling and prevents the stimulation of AMPK target genes. The *S. borealis* extract demonstrated increased glucose uptake in C2C12 cells. The extract significantly reduced blood glucose and triglyceride levels in STZ-induced diabetic mice. The extract enhanced AMPK phosphorylation and increased Glut-4 expression in the skeletal muscle of the mice. These findings demonstrated that the *S. borealis* extract exerts its anti-hyperglycemic effect through activation of AMPK and enhancement of insulin signaling [39].

Anti-Ulcer Activity

Oral administration of a hot-water extract (Folin) of bamboo grass (*Sasa albomarginata*) significantly reduced the incidence of water immersion and restrained stress, ethanol induced and indomethacin induced gastric ulcers in rats [40]. These researchers evaluated the antiulcer effect of bamboo grass in rats by Histological examination of the Folin treated gastric mucosa of the rats which showed that the microscopic blood clots overlaid the superficial epithelium, which also maintained the cellular integrity of gastric mucosa, especially against stress ulcer. Folin suppressed the incidence of hyperaemia and a decline of acid mucopolysaccharides in the ethanol induced ulcer and was seen to suppress the release of histamine from rat mast cells, and stabilize erythrocytes and accelerate their agglutination under acidic conditions. Their results suggested that a microscopic haemostatic effect of Folin reinforced by a membrane-stabilizing effect can be responsible for the prevention of the gastric lesions [41].

Anti-Inflammatory Activity

The extracts of *Bambusa arundinacea* have been used in Indian folk medicine to treat various inflammatory conditions. It is thought the property of anti inflammatory in the same extract are very much useful in the treatment of inflammatory conditions. [42] worked on understanding the Anti inflammatory and antiulcer

activities of *Bambusa arundinacea*. A well known fact is that the most of the available anti inflammatory drugs are ulcerogenic. The antiinflammatory effect of the methanol extract of the leaves of *Bambusa arundinacea* against carcinogen induced as well as immunologically induced paw oedema and also its antiulcer activity in albino rats have been studied and found to be significant when compared to the standard drugs. The combination of methanol extract and phenylbutazone (Non-Steroidal Anti inflammatory Agent, NSAIA) was studied and found to be the most potent anti inflammatory activity experiment with least toxic (no ulcerogenic) activity. Thus, the combination of herbal product (methanol extract of *Bambusa arundinacea*) with modern medicine (NSAIs) was seen to produce the best antiinflammatory drug and can be useful for long term treatment of chronic inflammatory conditions like rheumatoid arthritis with peptic ulcer, which are commonly observed. Bamboo Extract Reduces Interleukin 6 (IL-6) Overproduction under Lipotoxic conditions through Inhibiting the activation of NF- κ B and AP-1 Pathways implicating a potential application of this natural product as a cost-effective antiinflammation Nutraceutical [43]. Bamboo Vinegar which is a natural liquid derived from the condensed vapor produced during bamboo charcoal production. Depicted a decrease in inflammatory mediator expression and NLRP3 inflammasome activation by inhibiting Reactive Oxygen Species generation and Protein Kinase C- α/β activation [43].

Cardio protection

Chronic heart diseases such as cardiovascular disease has surpassed the death and disability due to nutritional deficiencies and infectious diseases. When the high cholesterol mice were treated with different concentrations of bamboo leaf extract, there was great reduction in the serum cholesterol. *Phyllostachys pubescens* leaves were observed to be protective against palmitic acid induced lipo apoptosis [44]. The flavanoids rich bamboo significantly lower the blood triglycerides and cholesterol and elevated HDL cholesterol and reduced LDL- cholesterol in a dose dependant manner [45]. The flavone Cglucosides (Orientin) from the leaves of *Phyllostachys nigra* was proved to be cardioprotective and inhibited apoptosis by blocking the mitochondrial apoptotic pathway [46].

Antifertility Activity

Ethanol extract of *Bambusa arundinacea* caused a reduction in fertility of male rats. BASE administration for 7 days decreased fertility. Complete recovery of mating behavior was evident only 8 days after BASE withdrawal. The number of spermatozoa in the caput and cauda epididymis were decreased. A concomitant decrease in the motility of spermatozoa collected from the cauda epididymis of experimental animals were also observed [20]. Bamboo leaves has been widely used as animal feed and certain compounds in bamboo leaves which was consumed by pregnant animals had caused miscarriage [47] showed that teratogenic active compounds like alkaloids, flavonoids, triterpenoids can cause death of fetus in uterus followed by spontaneous abortion or resorption. Whereas in male animals, it was observed that consumption of bamboo leaves which contain antifertility compounds lowered the sperm motility. The addition of bamboo leaf infusion on spermatozoa of cows were able to lower the sperm motility and higher concentration resulted in

higher rate of decline in sperm motility. Hence the feed intake in the form of bamboo leaves should be avoided for animals which are kept for specific purposes such as to get an offspring and as a study for natural mating or as source of semen [47].

Antihypertensive Activity

Bamboo shoots contain various proteins, carbohydrates, amino acids, minerals, fat, sugar, fiber and inorganic salts. Bamboo shoots which are consumed as freshly harvested shoots have high content of cyanogenic glycosides, which might cause serious problems. Tyrosine amounts to about 57-67% of the total amino acid content. Bamboo shoots from aqueous extract contains angiotensin converting enzyme inhibitory peptide (bamboo shoot peptide [BSP]) fractions. The fraction was identified which showed that Asp-Tyr was the key compound and it reduces systolic blood pressure as the phenolic compound which was present in BSP has vasodilatory effect, which decreases hypertension [48].

Conclusions

In conclusion Bamboo is a less explored plant with high therapeutic potential. There is a need for extensive studies in bamboo apart from its use in food and craft making. The ethnopharmacological uses of bamboo need to be substantiated with strong scientific studies for its extensive usage in various therapies.

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