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## Bamboo: Inherent source of nutrition and medicine

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**Abstract**

Bamboo is a perennial plant found all over the world except alkaline soils, desert, and marsh. Bamboo shoots are considered as one of the useful health foods because of their rich contents of proteins, carbohydrates, vitamins, fibers, and minerals and very low fat. Though bamboo shoots provide lots of health benefits, their consumption is confined mostly to Southeast Asian and East Asian countries. In recent years, evidences show immense therapeutic potential of Bamboo plant, which has been used in various traditional systems of medicine like ayurveda. The leaves of Bamboo are used as a folk medicine for the treatment of cough, fever and leprosy. Recent scientific evidences indicate that the extract of Bamboo possess antioxidant and free radical scavenging property, antimicrobial, anti-aging and cardio-protective property. This review discussed about different nutritional constituents and therapeutic potential

**Keywords:** Bamboo, medicinal plant, therapeutic potential, health benefits

**Introduction**

Most foods are considered functional in terms of providing nutrients and/or energy to sustain basic life. However, in the last decade, consumer demands in the field of food have changed considerably. With the economic development and the improvement of people's living standards, demand for natural foods, especially healthy and organic (natural) food, has greatly increased. Moreover, increasing public awareness of the link between diet and health has boosted the consumption of these foods to unparalleled levels, particularly in countries where the population is aging and health care costs are rising. Scientific evidence and a growing awareness of the correlation between diet and health, coupled with sedentary lifestyles, an aging population, and ever increasing healthcare costs have driven the interest in healthier food products. These products include functional foods and nutraceuticals that confer positive health benefits to consumers.

Bamboo is one of the most valuable plants worldwide, because of its varied industrial and medicinal uses, and also because it's different parts contains abundant nutrients and antioxidants. Every part of the plant - leaves, shoots, culm sheath and culms are used either as food or used for medicine and health benefits. Now it has been observed that leaves, which are generally discarded, are the best source of a number of antioxidants and bioactive compounds. Old culms are used for making bamboo salt enriched with a number of nutrients available in the culms<sup>[1]</sup>.

Worldwide bamboo shoots have become a multibillion dollar business. China, the biggest supplier of bamboo shoots to the world market, earns US\$130 million annually from exports of edible bamboo shoots. About 200 species of bamboo can provide edible and palatable bamboo shoots, though Moso bamboo (*Phyllostachys edulis*) is the most preferred species for shoots in the international market. Day by day bamboo is gaining popularity worldwide as healthy and nutritious food as it is free from residual toxicity, low in fat and rich in edible fiber and mineral elements mainly potassium, calcium, manganese, zinc, chromium, copper, iron and lower amount of phosphorus and selenium. Presence of high quality vitamins such as vitamin A, vitamin B1, vitamin B3, vitamin B6 and vitamin E, carbohydrates, proteins and minerals in bamboo shoots and their easy availability to common man may also help in solving nutritional deficiency of rural poor. Fresh bamboo shoots are delicious, crispy and healthy, with high fiber content. After cooking the shoots are still crisp, because cooking does not destroy their texture. Freshly harvested bamboo shoots need to be processed before cooking to remove cyanogenic glycoside, an anti-nutrient present in fresh bamboo shoots<sup>[2]</sup>.

Recent studies have demonstrated that bamboo shoots both fresh and fermented, are a good source of phenols and phytosterols that are the precursors of many pharmaceutically active

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substances found in plants and act as nutraceuticals. Phenolic compounds, including their subcategory flavonoids, have antioxidant properties. This activity of phenolic compounds is mainly because of their redox properties which allow them to act as reducing agents, hydrogen donors, singlet oxygen quenchers and metal chelators. Phytosterols are very effective therapeutic strategy for lowering LDL cholesterol concentrations. They also inhibit the production of carcinogens, cancer cell growth, invasion and metastasis, and promote apoptosis in cancer cells. However, young bamboo shoots are generally consumed after processing and long term preservation due to presence of high content of cyanogenic glycoside (antinutrient) and very short shelf life of shoots. Processing and preservation is expected to affect content, activity and bioavailability of various nutrient and bioactive compounds including phenols and phytosterols in the bamboo shoots [3].

### Origin of Bamboo

Bamboo shoots have a long history of being used as a source of both food and medicine in China and Southeast Asia. In Japan, the bamboo shoot is called the “King of Forest Vegetables.” In China, knowing the nutritional value and delicious taste, people considered bamboo shoots a treasure dish in the Tang Dynasty (618 to 907) and there was a saying that “there is no banquet without bamboo.” The properties of bamboo shoots were recorded in the book *Compendium of Materia Medica*, a pharmaceutical text written during the Ming Dynasty (1368 to 1644), with the following words: “It’s slightly cold, sweet, nontoxic, and it quenches thirst, benefits the liquid circulatory system and can be served as a daily dish”. China has the largest bamboo industry producing approximately 1.3 million metric tons of fresh bamboo. Worldwide, more than 2 million tons of bamboo shoots are consumed annually of which about 1.3 million tons are produced in China alone. The popularity of Chinese restaurants worldwide gives an opportunity for people in many countries to taste this bamboo vegetable. In India, however, despite the fact that it is the 2nd largest producer of bamboos after China, not much importance has been given to the use of bamboo shoots as food due to lack of awareness of the edible characteristics of the shoots. Consumption of tender shoots is confined mainly to the Northeastern states of India where they are part of the traditional cuisine. Canned and preserved bamboo shoots currently dominate international trade, but due to increased consumer demand for non-processed food, it is projected that the share of fresh shoots will significantly increase in the near future [3,4].

### Morphology of bamboo plants and its usages

The evergreen bamboo plant consists of aerial stems known as culms, which arise from a network of rhizomes and bear branches and leaves [Fig 1]. A new emerging young culm is known as bamboo shoot or juvenile shoot. It is actually culms that emerges from the ground in full diameter and contains nodes and internodes in a vertically miniaturized form. The young shoots are tightly clasped with overlapping sheaths that have to be removed to extract the edible part. New culms or juvenile shoots in bamboos usually develop with the beginning of the monsoon season during which the young edible shoots are harvested. The typical “shooting season” of a species rarely exceeds 2 months. This period can be extended by modifying the cultivation and management practices. Fresh shoots have a crisp, crunchy taste, and sweet flavor, imparting a unique taste. They are mostly used in

making appetizing soups, delicious snacks, hot curries, spicy stir-fries, attractive salads, pickles, aromatic fried rice, spring rolls, and other stewed and fried dishes. Shoots are also used as an extender, because the tissue takes on the flavor of the ingredients in which it is cooked. The most common preparation involves boiling the shoots in stocks, soups, or salted water for use in assorted dishes. The shoots are not only used as vegetables but are also processed and preserved in many forms such as dried, fermented, salted, pickled, water soaked, and canned. Bamboo shoots are gastronomic treats whether used fresh or in fermented or roasted form. In addition to being delicious, bamboo shoots are rich in some nutrient components, mainly proteins, carbohydrates, and minerals but have a low fat content. Bamboo shoots also contain phytosterols and a high amount of fiber that have cholesterol-lowering and anti-carcinogenic activity and therefore could be called nutraceuticals or natural medicines. The shoots are free from residual toxicity as they grow without the application of hazardous fertilizers or pesticides [1, 4].

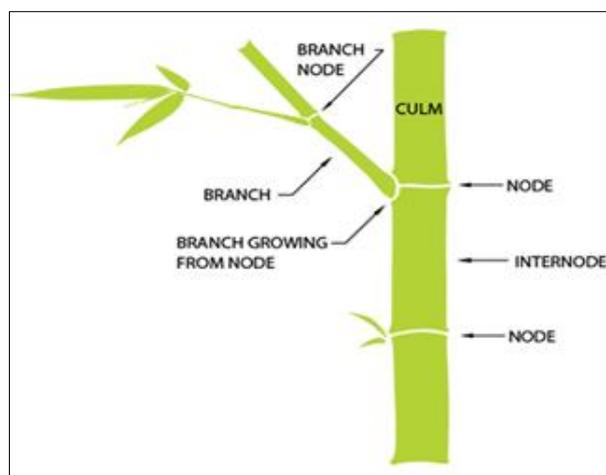


Fig 1: Morphology of Bamboo shoots.

### Nutrient composition of bamboo

Bamboo shoots have immense potential of being used as important health food as they contain high proteins, amino acids, carbohydrates, many important minerals, and vitamins. Freshly collected bamboo shoots have good amount of thiamine, niacin, vitamin A, vitamin B6, and vitamin E. Also the bamboo shoot based diets are rich source of dietary fibers and phytosterols and less cholesterol contents which make them one of the popular natural health foods [5].

### Amino Acids

Bamboo shoots have rich amount of amino acids. Out of 17 amino acids reported in bamboo shoots, 8 amino acids were essential for human body [6, 7]. The amino acid content of freshly harvested, fermented, and canned shoots of *Dendrocalamus giganteus* was studied. There was decreased amount in amino acid in fermented (2.005 g/100 g fresh weight) and canned shoots (1.980 g/100 g fresh weight) as compared to freshly collected juvenile shoots (3.863 g/100 g fresh weight). Giri and Janmejay [8] reported reduction of individual amino acid content in 300-day-old bamboo shoots of *Bambusa tulda*. It was also observed [9] the presence of tyrosine as the most abundantly free amino acids in young shoots of *Phyllostachys pubescens*.

### Proteins

Bamboo shoots are good source of protein with protein content ranging from 1.49 g/100 g to 4.04 g/100 g fresh weight in fresh bamboo shoots [10]. The lowest amount of protein was detected in canned shoots (1.980 g/100 g fresh weight) as compared to fermented (2.005 g/100 g fresh weight), 10-day-old emerged shoots (2.230 g/100 g fresh weight) and freshly harvested shoots (3.863 g/100 g fresh weight) of *Dendrocalamus giganteus*. However some scientist [33] found enhancement of protein content in fermented shoots from 3.1% to 7.1% and 8.1% on the 3rd and 5th day of fermentation process, respectively [10,11].

### Minerals

Bamboo shoots are endowed with rich quantities of useful minerals such as potassium, phosphorus, sodium, calcium, magnesium, and iron. Minerals are required for the proper functioning of many useful metabolic activities of our body [10]. The highest content of potassium (1400 mg/100 g fresh weight) was identified in *Bambusa arundinaria*. The level of potassium in shoots of *O. Abyssinica*, *Amaranthus spinosus*, *Hibiscus species*, and *Solanum macrocarpon* were higher than the popular vegetables. The daily recommended dose of potassium is 2.0 to 5.5 g/d [9] and it confers protection to human heart by maintaining normal BP and stable heartbeat of an individual. The iron requirement by women at pregnancy and during the nursing of child is very high. Regular consumption of iron rich bamboo shoots will provide the necessary iron requirement of the individual. Scientist also examined [11] changes in mineral content of shoots of *Bambusa bamboos*, *Bambusa tulda*, *Dendrocalamus asper*, and *Dendrocalamus strictus* by subjecting to differential treatment of salt concentration and boiling at different time durations. The minerals, namely, potassium, sodium, phosphorus, calcium, and magnesium present in the fresh bamboo shoot did not show significant change after treatments.

### Carbohydrates

The level of carbohydrates present in bamboo shoots is reported to be high and its content in edible shoots of *Bambusa nutans*, *Bambusa vulgaris*, *Dendrocalamus strictus*, and *Dendrocalamus asper* was found at 3.3%, 3.4%, 0.6%, and 2.9%, respectively [11]. There was significant increase in the amount of carbohydrate in bamboo shoots after subjecting them to boiling process. The rise in carbohydrate may be due to hydrolysis of complex polysaccharides into single monosaccharide sugar units.

### Fat

Bamboos shoots are known to have very less amount of fats and its low content makes them an ideal candidate for providing healthy nutrition to people with diabetic and cardio thoracic diseases. Research [11] reported very low amount of fat (0.1 g/100 g fresh weight) in shoots of *Dendrocalamus strictus*. It was [11] also revealed lowest fat content in non-salted canned shoots (0.250 g/100 g fresh weight) as compared to fermented (0.315 g/100 g fresh weight) and freshly harvested shoots (0.387 g/100 g fresh weight) of *Dendrocalamus giganteus*. The level of fat was significantly increased almost 3- to 4-fold in older shoots of 10 days as compared to juvenile shoots of *Bambusa bamboos*, *Bambusa tulda*, *Dendrocalamus asper*, *Dendrocalamus giganteus*, and *Dendrocalamus hamiltonii* [12].

### Fiber

The dietary fibers possess number of health benefits as they control blood pressure, hypertension, and obesity and also protect body from coronary diseases and potential carcinogens. The consumption of fiber-rich diets helps in reducing the unwanted bad cholesterols (low density lipoprotein and very low density lipoprotein) in the blood, lowering insulin demand, keeping the digestive track healthy, and improving laxative property [7]. The intake bamboo shoot on regular basis improves the lipid profile and bowel movement in young healthy women [10, 11]. Maximum presence of crude fibre (35.5%) was reported in *Melocanna baccifera*, the amount of dietary fiber increased by around 2 fold in 10-day old shoots as compared to fresh shoots of *Bambusa bamboos*, *Bambusa tulda*, *Dendrocalamus asper*, *Dendrocalamus giganteus*, and *Dendrocalamus hamiltonii*. The fibre content in bamboo shoot after boiling was not decreased significantly. However dietary fiber components such as NDF, ADF, lignin, hemicellulose, and cellulose increased in fermented shoots of *Dendrocalamus giganteus* when compared to freshly harvested shoots [10, 11].

### Phytosterol

Phytosterols with its structure similar to cholesterol are extensively found in plants and their presence in fresh or fermented bamboo shoots is very prominent. The importance of phytosterol in maintaining quality life is well documented by several workers [13]. Evaluation phytosterol content in bamboo shoots of *Pleioblastus amarus*, *Pleioblastus pubescens*, *Dendrocalamus latiflorus*, and *Pleioblastus praecox* were performed using ultra performance liquid chromatography. They detected presence of higher level of  $\alpha$ -sitosterol as compared to other sterols like campesterol and stigmasterol. Phytosterol-rich diets help in reduction of colon, breast, and prostate cancer the progression of tumor growth is inhibited by interfering the cell cycle, apoptosis and tumour metastasis. The cholesterol level in blood is reduced as presence of phytosterol inhibits the absorption of dietary cholesterol and cholesterol esterification in intestinal mucosa [13, 14].

### Phenols

Phenolic compounds present in plants are important bioactive compounds as they exhibit strong natural anti-oxidative and anti-inflammatory properties and sometimes antimicrobial activities as well. Bamboo leaves possess antioxidant capacity because of high presence of phenolic compounds [15]. Eight phenolic acids were identified in bamboo shoots of *Phyllostachys pubescence* of which protocatechuic acid, hydroxybenzoic acid, and syringic acid were found to be most abundant. The extracts of stems and leaves of *Phyllostachys* spp. exhibited strong antibacterial activities. The correlation between the antioxidant property of the plant and phenolic compound content was also found statistically significant. Changes in amount of phenolic compounds were also studied when fresh bamboo shoots were boiled, steamed, and stir fried. The total phenolic content in both boiled and stir fried samples reduced slightly compared to fresh shoots. But there was increase in the level of phenolic compounds in steamed bamboo shoot. The decrease in amount of phenolic compounds in boiled or stir fried shoot samples may be due to decomposition of phenolic compounds during the heat treatment [15,16].

Studies also conducted on bamboo leaf have shown that leaf is highly nutritive and contains important raw materials like

crude protein, crude fiber, ash and other minerals. Leaves were found to be rich in calcium, magnesium, copper, and manganese; moderate in zinc, while poor in phosphorous, potassium and sodium [3, 9].

### Bamboo and therapeutic potential

Bamboo played a significant role in human civilization since ancient times. 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* possess anti-inflammatory, antiulcer, antifertility, antimicrobial and hypoglycaemic activities. The hypoglycemic properties of extracts of bamboo leaves have also been established. Bamboo leaves have been used in traditional Chinese medicine for treating fever and detoxification for over 1000 years. In recent years numbers of studies on bamboo revealed that bamboo leaf extract has multiple biological effects, such as antioxidant and free radical scavenging property, antimicrobial, anti-aging and cardio-protective property.

### Antimicrobial activity of bamboo

Plants are rich sources of various phytochemicals which possess different medicinal properties against different microbes and bamboo is no exception. In 2010, the antimicrobial activity of the aqueous and ethanolic leaf extracts of *Bamboosa arundinaceae* was studied against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aureginosa* and *Bacillus* sp [17]. The ethanolic extract was found to be more effective in inhibiting the microbes compared to aqueous extract against the standard penicillin. Later, Tanaka and his co-researchers [18] studied the antibacterial activity of *Phyllostachys pubescens* shoot skin (untreated and dichloromethane extract) against *Staphylococcus aureus*. They found that both the extracts could inhibit the growth of *S. aureus* and thus possess antibacterial activity. In 2012, [19] the antibacterial activity of *Dendrocalamus asper* was studied against *E. coli* and found that of the three different extract types (ethanolic, methanolic and methanol-ethanolic) ethanolic and methanol-ethanolic proved to be potential source of antimicrobial drugs. In recent year [20] antibacterial activity of *Gigantochloa apus* was studied against the diarrheagenic *E. coli* and result showed that *E. coli* was sensitive to both the ethanolic and methanolic extracts but in a concentration dependant manner.

### Antioxidant potential of bamboo

A paradox in metabolism is that, while the vast majority of complex life on Earth requires oxygen for its existence, oxygen is a highly reactive molecule that damages living organisms by producing reactive oxygen species. Consequently, organisms contain a complex network of antioxidant metabolites and enzymes that work together to prevent oxidative damage to cellular components such as DNA, proteins and lipids. In general, antioxidant systems either prevent these reactive species from being formed, or remove them before they can damage vital components of the cell. Although certain levels of antioxidant vitamins in the diet are required for good health, there is still considerable debate on whether antioxidant-rich foods or supplements have anti-disease activity. Moreover, if they are actually beneficial, it is unknown which antioxidants are health-promoting in the diet and in what amounts beyond typical dietary intake.

The bamboo leaf extract (BLE) is thought to be good source of natural antioxidants and also have great pharmaceutical potential. BLE is mainly composed of flavonoids, lactones

and phenolic acid. The flavonoids are represented mainly by the flavones C- glycosides which include homoorientin, isovitexin, orientin and vitexin. Apart from this quercetin, luteolin, rutin, caffeic acid, *p*-coumaric acid, chlorogenic acid and triclin are also present. The flavonoid content was recorded to be 3.44% in different bamboo leaves species [21].

*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. The leaves of *Phyllostachys nigra* var. *henonis* bamboo from China, is utilized as a source of phenolics and flavonoids that exhibit antioxidant activity [22]. Bamboo breed of *Sasa argenteostriatus*, 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 argenteostriatus* Leaves were also reported., It was found that chlorogenic acid, isoorientin and vitexin are the main compounds in *Sasa argenteostriatus* leaves and the content of isovitexin and chlorogenic acid showed a similar seasonal variation [21,22].

### Cardio-protective property of bamboo

Cardiovascular disease (CVD) is a general term for conditions affecting the heart or blood vessel. It is usually associated with a buildup of fatty deposits inside the arteries (atherosclerosis) and an increased risk of blood clot. It can also be associated with damage to arteries in organ such as brain, heart, kidney and eyes. CVD is one of the main cause of death and disability in the world, but it can often largely be prevented by leading a healthy lifestyle.

Experiments showed that when the high cholesterol mice were treated with different concentrations of BLE, there was great reduction in the serum cholesterol [23]. Experiments conducted on rats showed that flavonoids rich bamboo beer could significantly lower the blood triglycerides and cholesterol. Apart from this the beer could elevate HDL-cholesterol and reduce LDL- cholesterol in a dose dependant manner [24]. The cardio protective potential of flavone C- glucosides i.e. orientin obtained from the leaves of *Phyllostachys nigra* has been proved by Fu and his coworkers [23]. They also stated that it could also inhibit apoptosis by blocking the mitochondrial apoptotic pathway.

To elucidate the anti-hyperlipidemic effect of Moso bamboo leaves (MBL), mice were fed with high fat food to induce hyperlipidemia and then treated with MBL in a dose dependant manner. The result revealed significant decrease in total cholesterol, tri-glyceride and low- density lipoprotein in serum together with decrease in crude fat in liver [25].

### Anti-diabetic effect

Diabetes Mellitus (DM) is prevalent among almost 200 million people worldwide, which is thought to increase exponentially to 300 million in the next two decades. A study was conducted with moso bamboo leaves (MBL) on 50 diabetic rats and found that different doses of MBL extract possess good hypoglycemic effect [25]. Experiment with *Sasa borealis* leaf extract found that when substituted for meat in patty the leaf extract significantly lowered plasma glucose indicating anti-diabetic activity of sasa leaves. In 2011, an attempt was made to prove scientifically the anti-diabetic activity of the petroleum extract of the leaf of *Bambusa vulgaris* in streptozotocin induced diabetic rats and found that oral administration of the extract for a period of 15 days

significantly reduced the blood glucose level in a dose dependant manner when compared to the standard drug glibenclamide [26]. In 2013, scientists established the exact mechanism by which the leaves of *Sasa borealis* exhibit the anti-diabetic activity. In their experiment they found administration of *S. borealis* extract in STZ-induced diabetic mice increased insulin signaling by increasing phosphorylation of AMP-activated protein kinase (AMPK) in HepG2 cells. In addition to this the extract also increased glucose uptake and suppressed the expression of gluconeogenic genes. From this observation it can be concluded that *S. borealis* extract exerted the anti-diabetic effect through the activation of AMPK and improvement of insulin signaling [27].

#### Anti-cancerous effect

Cancers are a large family of diseases that involve abnormal cell growth with the potential to invade or spread to other parts of the body. They form a subset of neoplasm. A neoplasm or tumor is a group of cells that have undergone unregulated growth and will often form a mass or lump, but may be distributed diffusely

In 2015, about 90.5 million people had cancer. About 14.1 million new cases occur a year (not including skin cancer other than melanoma). It caused about 8.8 million deaths (15.7% of deaths). The most common types of cancer in males are lung cancer, prostate cancer, colorectal cancer and stomach cancer. In females, the most common types are breast cancer, colorectal cancer, lung cancer and cervical cancer.

The leaves of *Sasa senanensis* (popularly known as Kumaizasa) have been used in Eastern Asia as a potential source of natural drug since hundreds of years. The alkaline extract prepared from the leaves (in hot water at 100°C) of *S. senanensis* is popularly known as "Sasa health". Tsunoda *et al.* in 1998 showed that oral administration of Sasa health for 12 days on the mammary tumor induced mice significantly inhibit both the development and growth of mammary tumor in experimental models [28]. In 2008, Seki and his team also made an attempt to prove the anti-tumor activity of Sasa health. They used three different temperatures (100°C, 121°C and 196°C) to prepare the Sasa health to evaluate the anti-tumor potential in three mouse tumor models (S-180, C38 and Meth-A). Oral administration of the extract a concentration of 0.05% or more was found to be effective in suppressing tumor growth in mouse models S-180 and C38. Not only that the extract also posses immunostimulating activity, which in turn activated the macrophages and human natural killer (NK) cells in tumor models and thus suppress the tumor [29]. Experiments were also conducted to test the effect of leaves of *Pseudosasa japonica* on the development of DMBA (7,12-Dimethylbenz [a] anthracene) induce breast cancer in SD (Sprague-Dawley) rats. He found that oral administration of bamboo extract for 3 weeks prior to DMBA injection could delay the onset of breast cancer by one week as compared to the control. Moreover, the bamboo 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. In recent years anti-cancer/tumor activity of *Kumaizasa* bamboo, *Sasa senanensis* and *Caulis bambusae* were also studied [30]. In their study, Seki and Maeda [29] tested the cancer preventive effect of aqueous extract of *Kumaizasa* bamboo both prior to tumor implantation and also after inducing of carcinogenesis using DMBA in experimental mouse. They found that the

*Kumaizasa* bamboo was effective against both the cases and could significantly suppress the incidence of tumor growth and enhanced survival rate on one hand and the extract at the rate of 0.03% fed for two weeks could significantly suppress the cancer. In the same year, the anti-tumor activity of *Sasa senanensis* leaf extract was experimented using three different mouse tumor models *viz.* S-180, C38 and Meth-A. Oral administration of the extract at a concentration of 0.05% or more was found to significantly reduce the tumor growth in mouse models and also prolonged the survival rate compared to the control. Lu and his co-researchers [30] studied the anticancer activity of *Caulis bambusae* on the growth of cancer cell lines (P388 and A549) and found strong inhibitory activity. Apart from this they also isolated a compound named friedelin and proved its efficacy as anti-tumor compound against cancer lines, A375, L929, Hela and THP-1. Recently in 2013, the ethanolic leaf extract of *Sasa quelpaertensis* has also been reported to exert potent cytotoxicity activity against human colon cancer HCT116 cells [31].

#### Anti-obesity effect

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have a negative effect on health

The effect of *Sasa borealis* leaf extract (SBE) was studied on inflammatory cytokines and insulin resistance in high fat diet (HFD) induced obese mice and was found that the *S. borealis* leaf extract was effective at just 5% when administered for 12 weeks. After 12 weeks treatment they recorded that the body weight and the adipose tissue deposition were decreased significantly compared to untreated HFD mice. Result also showed that SBE decreased glucose, insulin, TNF- $\alpha$ , IL-6 and leptin levels. These results justified that SBE contains anti-obesity compounds [32]. It was in 2012 that Kang and his researchers made an attempt to explore the anti-obesity effect of *Sasa quelpaertensis* leaf extract (SQE) in high fat diet (HFD) induced obese mice and mature adipocytes. They noted that the administration of SQE for 70 days to HFD mice not only decreased the body weight, adipose tissue weight, serum cholesterol and triglycerides but also reduced the serum levels of several enzymes along with deposition of lipid droplets in the liver when compared to untreated mice. They finally concluded that the anti-obesity effect of SQE is mediated by the activation of AMPK in adipose tissue [33].

#### Conclusions and Future Perspective

Bamboo shoots have immense potential of being used as important health food as they have high content of useful proteins, amino acids, carbohydrates, and many important Minerals and vitamins and very low fat. Bamboo shoots are consumed predominantly in Asiatic countries where they form integral part of several traditional cuisines of the region. The usefulness of bamboo shoots as health food is not largely known by general public due to ignorance of their high nutritional values. There is a greater necessity to create awareness among the people about their nutritional health benefits so that they are widely accepted. Bamboos occupy a very significant position in everyday life of indigenous people of Northeast India due to their enormous utility as traditional food, house construction materials, and raw materials for production of useful domestic and other handicraft items. The fresh or fermented bamboo shoots for man indispensable part of number of ethnic dishes. But shoots should be properly processed as they contain high level of toxic cyanogenic glycosides. The region being the largest producer of bamboos

in India has a bright prospect for bamboo industry but presently bamboo shoot production is predominantly for fulfilling the local needs. There is a need to increase bamboo processing and packaging units as very few operate actively in the region. Effective marketing strategies should also be formulated to extract maximum profits by making bamboo shoot products available to as many potential and prospective customers inside and outside the country. Intervention of modern micro-propagation techniques is also essential to control the falling population of bamboos. The local bamboo shoot industry if properly established will not only help in socioeconomic enlistment of the region but also generate huge income for the country. Not only as a food, bamboo specially leafs have strong therapeutic property. Further pharmaceutical research can help to develop lifesaving drugs from the bamboo and can save many life.

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