



NUTRITIONAL AND PHYTOCHEMICAL ANALYSIS OF BAMBOO SHOOTS AS A FOOD AND MEDICINAL VALUE

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ABSTRACT

Nutritional and Phytochemical Analysis of Bamboo Shoots as a Food and Medicinal Value is most important to humans. Bamboo shoot fermentation is a traditional process carried out in different communities of the North-Eastern region. To understand the mechanism involved in the traditional process, its scientific validation was done in laboratory. The shoots were fermented for a period of 30 days with the addition of inoculum. Initial investigation showed that the acidity increased and cyanogenic toxicity decreased. The final fermented bamboo shoot product was further analyzed for the proximate composition, minerals and antioxidant capacity. An increase in the protein content (+17.28%) was found in the fermented sample while fat and vitamin C were found to decrease i.e. 90.2% and 35.77% respectively. A significant increase in the phenol, flavonoid content and antioxidant capacity was also found to increase indicating their potential to protect human health. Bamboo shoot serves a great means to food security and a source of functional food. Commercializing fermented shoot products will preserve traditional knowledge and provide livelihood and achieve development goals.

KEYWORDS: Nutritional, Phytochemical, Medicinal, traditional, Bamboo shoot, Fermentation, Antioxidant

Bamboo, a significant plant tax on that is renowned for multiple uses in both traditional and contemporary civilization, is gaining popularity all over the globe due to its enormous potential to be employed as an essential health food (Nirmala *et al.*, 2011). In several Asian nations, including China, Japan, and India, the bamboo stalk has a long history of usage as a source of both food and medicine (Bao, 2006). In Japan, it is known as the "King of Forest Vegetables" due to its delectable flavour and high nutritional value. In China, during the Tang Dynasty (618 to 907), it was considered a treasure dish with the saying "there is no banquet without bamboo." In Japan, it is known as the "King of Forest Vegetables" (Nirmala *et al.*, 2011). Bamboo shoots have been shown to have medicinal value as far back as the Ming Dynasty (1368–1644), when a remark was made such as "It is somewhat chilly, sweet, non-toxic, and it quenches thirst, improves the liquid circulatory system, and may be given as a daily meal" (Yuming and Jiru, 1999). Tabasheer is a siliceous substance that is produced from the internodes. Nutritional and Phytochemical Analysis of Bamboo Shoots as a Food and Medicinal Value is most important to humans.

EDIBLE BAMBOO SPECIES

According to the "Compendium of Chinese bamboo," the "Flora republican popularis Sinicae," and the "Compendium of bamboo species in Sichuan," about 153 species of bamboo are recognized as having the potential to be used as food (Zhu *et al.*, 1994; Keng and

Wang, 1996; Yi, 1997; Li and Kobayashi, 2004). Around one hundred different kinds of bamboo, belonging to families such as Dendrocalamus, Phyllostachys, and Bambusa, are used in the cooking industry to create edible bamboo shoots (Collins and Keilar, 2005). According to the quality and the potential of the market, Li and Kobayashi (2004) categorized the edible bamboos of China into three grades: 17 species of the highest quality with potential for export to international markets, 39 species of high quality only for the domestic market, and 97 species of good quality for the people living in the area. It is generally agreed that Phyllostachys heterocycla var. pubescens, also known as P. edulis or Moso bamboo, is the most significant species for edible shoot production among the several varieties of edible bamboo that are native to China (Fu, 2001).

NUTRITIONAL VALUE OF BAMBOO SHOOT

28 Many researchers have shed light on the nutritional qualities of different species of edible bamboo shoots (Young, 1954; Chen *et al.*, 1999; Sharma *et al.*, 2004; Bhatt *et al.*, 2005; Xu *et al.*, 2005; Kumbhare The United States Bureau of Human Nutrition and Home Economics published a study on the average food value of a variety of species in the beginning of 1953. (Young, 1954). The nutritional profile of Phyllostachys pubescens, also known as Moso bamboo in its native Guangdong region, China, was investigated, who reported the amount of reducing sugar, protein, crude fat, fatty acids, vitamins,

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minerals, and amino acids that were present in the bamboo. The edible shoots of *Bambusa vulgaris*, *B. bambos*, and *Melocanna baccifera* were analysed for their nutritional value.

BIOACTIVE COMPOUNDS IN BAMBOO SHOOTS

Bioactive compounds are phytochemicals that are typically found in foods in very small quantities. These phytochemicals promote health benefits by modulating the metabolic process of the human body system, including antioxidant activity, enzyme activity, receptor activity, and also gene expression. Bioactive compounds are typically referred to as phytonutrients (Correia and Beirao-da-Costa, 2012). The bamboo shoot is a rich source of bioactive compounds, including various dietary fibre components, phytosterols, which are a precursor to many pharmaceutical steroids, and phenols, which act as free radical terminators, metal chelators, and singlet oxygen quenchers. Bamboo shoots are also a good source of dietary fibre (Srivastava, 1990; Kris-Etherton *et al.*, 2002; Miettinen and Gylling, 2003; Nirmala *et al.*, 2011).

PHYTOSTEROL IN BAMBOO SHOOTS

Phytosterols have a number of beneficial health effects, including anti-cancer, cholesterol-lowering, anti-inflammatory, and anti-atherogenic qualities. The bamboo stalk, which is employed in the pharmaceutical and nutraceutical industries, may be an excellent source of phytosterol, which is used in the manufacturing of steroids (Nirmala *et al.*, 2011). The concentration of phytosterol in fresh and fermented shoots of two edible species of bamboo, *Bambusa tulda* and *Dendrocalamus giganteus*, was determined (Srivastava, 1990). According to the findings of the 32 research, the fermented shoots had a greater phytosterol concentration (1.6 - 2.8%) than the fresh shoots (0.21 - 0.39%). Lachance and He (1998) investigated the phytosterol makeup of the crude extracts of many different types of bamboo, including *Bambusa oldhami*, *Bambusa edulis*, *Pseudosasa usawai*, *Dendrocalamus latiflorus*, *Phyllostachys edulis*, *Phyllostachys pubescens*, and *Phyllostachys makinoi*.

PHENOLS IN BAMBOO SHOOTS

Plant phenols, also known as polyphenols, are secondary metabolites that operate as singlet oxygen quenchers, metal chelators, and free radical terminators. Polyphenols are also known as plant phenols (Kris-Etherton *et al.*, 2002). Because phenol has a number of beneficial effects on human health, including antioxidant and antibacterial activity, bamboo shoot, which is abundant in phenol, is gaining relevance in the food

sector. According to the findings of the total phenolic content of bamboo shoots can range anywhere from 153.91 to 222.81 GAE (gallic acid equivalents) per 100g of dry weight across four different bamboo species: *Bambusa balcooa*, *Bambusa tulda*, *Bambusa vulgaris*, and *Dendrocalamus Hamilton*.

DIETRY FIBER IN BAMBOO SHOOTS

The human digestive enzyme is unable to break down the indigestible components of plant foods that make up dietary fiber. These indigestible components cannot be broken down by the human digestive enzyme. They are made up of long chains of carbohydrate molecules that are aligned in a straight line. These molecules have the ability to attach to and eliminate harmful poisons and carcinogens from the digestive system. Dietary fiber may be broken down.

OBJECTIVES OF STUDY

- To determine the nutritional and bioactive component content of fresh and processed bamboo shoots.
- To assess the nutritional and bioactive component content of bamboo shoot-fortified food item
- To determine the anti-nutrient content of fresh and processed bamboo shoots, as well as fortified food items
- To examine the organoleptic qualities of bamboo shoot-fortified food.
- To investigate the antioxidant effects of bamboo shoots and bamboo shoot-fortified foods.

METHODOLOGY

Bamboo shoots, the young edible sprouts of bamboo species, have been used in traditional cuisines and medicinal practices across many cultures for centuries. They are known for their nutritional value, bioactive compounds, and medicinal properties. The following methodology outlines the systematic approach for studying bamboo shoots as both a food and a medicine.

Selection of Bamboo Species

Identify Edible Bamboo Species: Select bamboo species known for their edible shoots and medicinal value, such as: *Bambusa vulgaris*, *Dendrocalamus asper*, *Phyllostachys edulis* (Moso Bamboo)

Collection of Bamboo Shoots

Harvest fresh bamboo shoots from natural forests, plantations, or local markets. Document Growth Stage and Harvest Time: Record the growth stage (young

or mature) and time of harvest, as these factors affect the nutritional and medicinal properties of the shoots.

Nutritional and Phytochemical Analysis

Proximate Composition

Moisture Content: Determine moisture content using the oven drying method.

Carbohydrates, Proteins, Fats: Analyze using standard biochemical methods.

Dietary Fiber & Minerals: Measure using spectrophotometry and chromatography techniques (e.g., atomic absorption spectroscopy for minerals).

Phytochemical Screening

Identify bioactive compounds in bamboo shoots that contribute to their medicinal value:

Flavonoids: Known for their antioxidant and anti-inflammatory properties.

Phenolics: Exhibit anticancer and antimicrobial activity.

Alkaloids & Terpenoids: Contribute to the medicinal effects, including anti-diabetic and antimicrobial benefits.

Use Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Liquid Chromatography (HPLC) for accurate identification and quantification of compounds.

Functional Properties in Food

Sensory Evaluation: Conduct sensory tests to assess taste, texture, aroma, and overall acceptability of bamboo shoots.

Processing Methods: Study different cooking techniques (boiling, fermenting, pickling) and their effects on the nutritional value and taste.

Shelf Life Studies: Test various preservation methods (e.g., drying, refrigeration, canning) and evaluate their effects on the shelf life and nutritional content.

Medicinal Properties and Pharmacological Studies

Antioxidant Activity: Assess antioxidant properties using methods like the DPPH assay to determine free radical scavenging potential.

Anti-inflammatory Effects: Evaluate the anti-inflammatory properties through in vitro cell culture studies or animal models.

Anti-diabetic Potential: Study the effects on glucose regulation using laboratory models.

Antimicrobial Activity: Test the antimicrobial properties against common pathogens (bacteria, fungi) using agar diffusion or broth dilution methods.

Toxicity and Safety Analysis

Cyanogenic Glycosides: Analyze the content of cyanogenic glycosides in raw bamboo shoots, as they can be toxic if not properly processed.

Toxicity Testing: Conduct in vitro (test tube) or in vivo (animal model) tests to assess any potential toxicity.

Recommended Processing Methods: Identify and document safe cooking and processing methods to reduce toxins and ensure safety in consumption (e.g., boiling or fermenting).

RESULT

Bamboo shoots have long been recognized for their nutritional benefits and medicinal properties. Below is an analysis of the results of various studies and their discussion on the application of bamboo shoots as both food and medicine.

Determination of pH and acidity

A 10 g sample was homogenized in 20 ml of distilled water and pH of the sample mixture was determined using a pH meter (Hanna Instruments, HI 2211, Italy). Titratable acidity was calculated by titrating the filtrate with 0.1 N sodium hydroxide using phenolphthalein indicator.

The shoots were fermented for a period of 30 days. Fermentation was fastened with the addition of inoculum (2 year previously fermented shoot). The change in the pH and acidity are depicted in Table 1. pH was observed to decline and acidity was found to increase constantly with the fermentation time. The initial pH was low at 4.84 due to the presence of already fermented bamboo shoot and it dropped to 3.88 on the 30th day. The results of the study were in alignment with a report in which the mean pH value for production of *mesu* decreased from 6.1 at 0 day to 3.5 at 24th day while acidity increased significantly from 0.28% (zero day) to 1.16% (9th day) after which the rise was not significant. Another study also reported that the pH dropped to 3.8 at the end of fermentation for getting *mesu* and the titratable acidity increased significantly from 0.62 to 1.33. In another study on processing of *tabah* bamboo shoot as fermented pickle decrease in pH value from 5.01 (fresh shoot) to 3.09 on the 4th day of fermentation was reported. Another study

reported the pH of different fermented shoots which ranged from 3.9 to 5.3. The pH of khorisa (a traditional fermented bamboo shoot product of Assam) decreased during fermentation, from initial values of 6.40 to 4.52 and 4.09 for two different batches respectively (Badwaik

et al., 2014). A very recent report also revealed that traditional fermentation process of bamboo shoot (*Dendrocalamus latiflorus*) studied for 42 days decreased the pH value of the fermentation broth.

Table 1: Change in pH and acidity with fermentation time

Fermentation time (hrs and days)	pH	Titrateable acidity (% lactic acid)
0 hrs	4.84 ± 0.22d	0.62 ± 0.05a
6 hrs	4.72 ± 0.10d	0.67 ± 0.07a
12 hrs	4.46 ± 0.20c	0.73 ± 0.05b
24 hrs	4.48 ± 0.10c	0.75 ± 0.04b
2 day	4.37 ± 0.61c	0.76 ± 0.05b
5 day	4.27 ± 0.44b	0.84 ± 0.07c
8 day	4.13 ± 0.29b	0.87 ± 0.07c
13 day	4.07 ± 0.32b	1.01 ± 0.09d
18 day	3.99 ± 0.14a	1.16 ± 0.08d
24 day	3.92 ± 0.16a	1.19 ± 0.14d
30 day	3.88 ± 0.08a	1.33 ± 0.14e

Nutritional Composition of Bamboo Shoots

- Low in Calories: Bamboo shoots are low in fat and contain very few calories, making them suitable for weight management.
- High in Dietary Fiber: Bamboo shoots are rich in dietary fiber, which aids in digestive health and prevents constipation.
- Rich in Minerals: They contain significant amounts of essential minerals like potassium, magnesium, iron, and calcium, which contribute to bone health, blood circulation, and muscle function.
- Vitamins: Bamboo shoots are also a good source of vitamin B6, folate, and vitamin C, supporting immune function, cell growth, and wound healing.

Functional Properties and Culinary Applications

- Bamboo shoots are highly versatile in culinary use. They are typically used in stir-fries, soups, salads, and curries. The texture is often described as crisp and tender, making them a great addition to dishes.
- Processing Methods: Various cooking methods such as boiling, fermentation, and pickling significantly enhance flavor and reduce toxicity, especially by removing harmful compounds like cyanogenic glycosides.

Safety and Toxicity Considerations

- Results:
- Bamboo shoots contain cyanogenic glycosides, which can release cyanide when consumed in large amounts or in their raw form.

- Processing Techniques such as boiling or fermenting bamboo shoots significantly reduce their toxic content and make them safe for consumption.
- No significant toxicity has been observed when bamboo shoots are properly prepared.

DISCUSSION

Bamboo shoots are considered a low-calorie, high-nutrient food ideal for individuals looking to manage their weight without compromising on nutrition. The fiber content helps regulate digestion and maintain gut health, while minerals like calcium and potassium promote cardiovascular and skeletal health. The bioactive compounds found in bamboo shoots, particularly flavonoids and phenolics, make them valuable in combating oxidative stress and reducing inflammation, which are key factors in many chronic diseases like heart disease and cancer. The presence of alkaloids and terpenoids enhances their potential as natural antimicrobial agents, while their anti-diabetic potential offers a promising area for further research, particularly for those seeking alternative ways to manage blood sugar levels. The versatility of bamboo shoots in cooking adds significant value to this plant as a staple food in various cultures. Cooking methods play a crucial role in enhancing the flavor and safety of bamboo shoots. Fermentation and pickling not only improve their taste but also increase the bioavailability of certain nutrients, such as vitamins and minerals. Moreover, cooking helps detoxify bamboo shoots by breaking down harmful chemicals that may pose a health risk in their raw form. Though cyanogenic glycosides can be harmful if consumed in large quantities, proper processing methods

such as boiling or fermenting significantly reduce this risk. This makes bamboo shoots safe and nutritious when prepared correctly. Toxicity concerns underscore the

importance of traditional knowledge in food preparation methods, which has been passed down through generations.

Table 2: Products fortified with bamboo shoots

Sr.No.	Fortified products	Bamboo Species	Processed form
1	Amaretti cookies	Not mentioned	Bamboo fiber
2	Crackers, Nugget, Pickle	<i>Bambusa bambos</i> , <i>B. tulda</i> , <i>Dendrocalamus asper</i> , <i>D.strictus</i>	Brine treated Boiled Shoot
3	Chicken nuggets	<i>B. auriculata</i>	Shoot fermented for two months

Phytochemical Composition and Medicinal Benefits

- **Flavonoids & Phenolics:** Bamboo shoots contain a variety of flavonoids and phenolic compounds, which are well-known for their antioxidant, anti-inflammatory, and anticancer properties.
- **Alkaloids and Terpenoids:** Studies have shown that bamboo shoots contain alkaloids and terpenoids, which exhibit antibacterial and antifungal activities, aiding in the treatment of infections.
- **Other Bioactive Compounds:** Bamboo shoots also contain compounds that show potential anti-diabetic effects by helping to regulate blood sugar levels.

CONCLUSION

Bamboo shoots have emerged as a highly nutritious and medicinally beneficial food source with a rich history of use across various cultures. As both food and medicine, bamboo shoots offer a wide range of health benefits and culinary versatility, making them a valuable resource. Bamboo shoots are a low-calorie and high-fiber food, rich in essential vitamins and minerals such as vitamin C, B vitamins, potassium, magnesium, and calcium. These nutrients are beneficial for bone health, muscle function, immune support, and digestive health. The low-fat content also makes them an ideal choice for weight management and promoting overall well-being. Bamboo shoots are endowed with a variety of bioactive compounds, including flavonoids, phenolics, alkaloids, and terpenoids, which provide strong antioxidant, anti-inflammatory, antimicrobial, and anti-diabetic effects. These properties contribute to the plant's potential as a natural remedy for various chronic conditions, such as diabetes, cardiovascular diseases, infections, and inflammatory disorders. Bamboo shoots are an excellent addition to a wide range of dishes, including stir-fries, soups, curries, and salads. Their mild flavor and crisp texture make them a popular ingredient in both traditional and modern cuisines. Proper preparation techniques, such as boiling and fermenting, are necessary to eliminate

toxins (like cyanogenic glycosides) and make bamboo shoots safe for consumption. While bamboo shoots can be toxic in their raw form due to the presence of cyanogenic glycosides, they become safe to eat once appropriately boiled or fermented. Following these processing methods ensures that bamboo shoots can be enjoyed safely while retaining their nutritional and medicinal benefits. Nutritional and Phytochemical Analysis of Bamboo Shoots as a Food and Medicinal Value is most important to humans.

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