

# Nutritional And Qualitative Phytochemical Analysis Of Edible Bamboo Shoots Harvested From Karnataka

**Karthik. M.B<sup>1\*</sup>**

<sup>1\*</sup>Department of Studies and Research in Microbiology, Mangalore University, Post Graduate Centre, Jnana Kaveri campus, Kodagu, Karnataka, India.

**Jayashankar. M<sup>2</sup>**

<sup>2</sup>Department of Studies and Research in Microbiology, Mangalore University, Post Graduate Centre, Jnana Kaveri campus, Kodagu, Karnataka, India.

**\*Corresponding Author's: Karthik. M.B**

<sup>\*</sup>Department of Studies and Research in Microbiology, Mangalore University, Post Graduate Centre, Jnana Kaveri campus, Kodagu, Karnataka, India., **E-mail:** [karthikmbelliappal@gmail.com](mailto:karthikmbelliappal@gmail.com)

## ABSTRACT

Bamboo shoots are nutritious vegetable consumed globally, which are grown in early spring and rainy season. In the month of May to August. In the present study Eight edible bamboo species- *Dendrocalamus asper*, *Dendrocalamus strictus*, *Dendrocalamus hamiltonii*, *Dendrocalamus brandissii*, *Dendrocalamus stocksii*, *Bambusa bambos*, *Bambusa nutans* and *Bambusa tulda* are selected from different regions from Karnataka. Their characteristics are noted. Below experiments are conducted for Nutritional analysis - Moisture, Carbohydrate, Crude Protein, Crude Fiber and Total Ash analysis experiment are performed and Phytochemical analysis : Alkaloids, Flavonoids, Saponins, Tannins, Phenols, Glycosides, Proteins and Amino acids are performed and Results are tabulated for the obtained edible bamboo shoots. The results showed that *Dendrocalamus asper*, *Bambusa bambos* and *Bambusa nutans* are highly nutritious and suitable for edible which provide high nutrients. The phytochemical constituents alkaloids, phenols, proteins and amino acids are present in most of the shoot sample which shows that it has medicinal property.

**Key words-** Bamboo shoot, Phytochemical, Nutrition.

## 1. INTRODUCTION

Bamboo is known as green gold. The shoots of these are a highly nutritious vegetable, considered to be the fastest growing, highest yielding renewable natural resource. Bamboo is not only an ideal economic investment with various uses but also has enormous potential for alleviating many environmental and social problems. Besides its utility in furniture, construction, agriculture, baskets, handicrafts etc., juvenile shoots are used as food in many parts across the globe.

There are more than 1250 bamboo species belongs to 75 genera worldwide. In India its around 148 species in 29 genera of bamboos both wild and cultivated are noted (M.L. and Chongtham, 2015). The young shoots are used as food worldwide it is a popular vegetable in many South East Asian countries (Rana et al., 2022). The juvenile shoots are not only delicious but are rich in nutrient components, mainly proteins, carbohydrates, minerals, and fiber and are low in fat and sugars. (Premlata et al., 2015) In addition, they contain phytosterols and a high amount of fiber. Which are natural medicines that are attracting the attention of health advocates and scientists (Chongtham et al., 2011).

Bamboos incorporates several economic, ecological and social benefits in the day to day life of human beings. It's important to encourage cultivation of bamboo shoot especially in tribal areas in order to harmonize the international food safety, security and nutrition (Choudhury et al., 2012).

Bamboo shoots have industrial importance too. They are used for the production of bioethanol. They are also used as a source of natural products like potassium, dietary fibers, carbohydrates, and vitamins. Bamboo shoots may be used to produce functional xylooligosaccharides which find application in food, biodegradable plastics or nanoparticles, and pharmaceutical industries (Tomar, 2016) Bamboo are widely available, they are fast-growing, versatile, quickly storing and sequestering carbon, growing in degraded lands, and has excellent fuel properties for conventional bioenergy production (Rathour et al., 2022).



*Figure 1- Photographs of edible bamboo shoots collected*

Fresh bamboo shoots have high protein content (amino acids), carbohydrates and several vitamins.

Nutraceuticals are everyday foods with components a specific medical or physiological benefit. They are excellent source of edible fibers (Nayak and Palta, 2022). It has been reported that fresh bamboo shoots contain an anti-nutrient- cyanogenic compound in many bamboo species. They have a peculiar smell due to this cyanogenic compound, which can be minimized by different processing method like boiling, fermentation, washing, drying and canning (Chetia et al., 2022).

Phenolic compounds in bamboos have multiple biological effects such as antioxidation, anti-ageing, antifatigue, antimicrobial and prevention of cardiovascular diseases. Dietary fibres and phytosterols have a beneficial effect on lipid profile and bowel function and reduce total serum cholesterol and low-density lipoprotein cholesterol level. Bioactive compounds mainly phenols, phytosterols and dietary fibres, which play a potential role in health promotion and providing protection against many chronic and degenerative diseases. by this properties shoots can be utilised as an ingredient in the development of functional foods which also serves as medicine (Nirmala et al., 2014). In the present investigation the nutritional and phytochemical constituents are checked in the fresh bamboo shoots which may be helpful for the production of functional food and pharmaceutical applications.

## **2. MATERIALS AND METHODS**

### **2.1. Study area:**

Bamboo shoot Samples are collected from different region from Karnataka state they are tabulated and characterised depend upon height appearance diameter of culum inter node length



#### **2.4. Nutritional analysis:**

Moisture, carbohydrates, crude protein, crude fat, crude fibre and ash contents of the bamboo shoots were determined using the Official Methods of Analysis of the AOAC International (AOAC, 2005). The average value was obtained from triplicate readings for each assay. (AOAC International, 1995) (“AOAC (2005) Official Methods of Analysis of Association of Official Analytical Chemists. 18th Edition, Washington, DC. - References - Scientific Research Publishing,” n.d.)

##### *Moisture analysis*

The moisture content of the bamboo shoots was determined using oven drying method.

##### *Carbohydrate analysis*

The carbohydrates in the bamboo shoots were estimated using anthrone reagent and the absorbance were read at 630 nm against a standard graph.

##### *Crude Protein analysis*

The crude protein content of the bamboo shoot samples was determined using Bradford assay method. The absorbance were read at 750 nm.

##### *Crude Fiber analysis*

The fiber content was estimated by acid alkali method. The crude fiber content of the sample was calculated from the loss in weight on ignition and expressed as percentage of fresh weight.

##### *Total Ash analysis*

The total ash content of the bamboo shoot samples was determined using muffle furnace.

#### **2.5. Preparation of extracts :**

The shoots are cut into pieces and dried. grinded separately in a grinder and powdered later they are soaked in Ethyl acetate and Methanol solvents separately for 72 hours. The solutions were filtered using muslin cloth, Whatman filter paper No: 40 and then dried in rotary evaporator followed by final drying at 37°C. The dried extract is stored at 4°C in refrigerator for further use.

#### **2.6. Phytochemical analysis :**

All the extracts were tested chemically for detection of various phytochemicals - alkaloids, flavonoids, saponins, tannins, phenols, and glycosides by using standard protocol.

##### *Alkaloids*

Bamboo shoot Extracts were dissolved individually in dilute hydrochloric acid and separated out by filtration. The filtrates were used to test for the presence of alkaloids by Mayer's test. Mayer's test - The amount of 1.36 g of mercuric chloride was dissolved in 60 mL of distilled water and 5 g of Potassium iodide in 10 mL of water. The two solutions were mixed and diluted to 100 mL with distilled water. To 1 mL of acidic aqueous solution of extracts, a few drops of reagent were added. Formation of white or pale precipitate showed the presence of alkaloids.

##### *Flavonoids*

Shinoda Test- In a test tube 200mg of the bamboo shoot extract was dissolved in 2 ml of methanol and heated. Few turnings of magnesium metal were added to the mixture followed by the addition of a few drops of concentrated hydrochloric acid. The appearance of an orange to red colour was indication of the presence of flavonoids.

### Saponins

Froth test- In test tubes, 20 mg extract was suspended in 20 ml of distilled water and boiled for 5 min. 10 ml of the filtrate and 5 ml of distilled water was added and mixed well to develop the froth. The development of emulsion after mixing the froth with olive oil confirmed the existence of saponins.

### Tannins

Ferric chloride test- In a test tube 2 mL of aqueous extract and 1-2 drops of 5% aqueous ferric chloride solution was added. A bluish black colour which disappears on addition of a few mL of sulphuric acid indicated the presence of tannins.

### Phenols

Lead acetate test- In a test tube 50 mg extract was dissolved in 5ml distilled water and added 3 ml of 10% lead acetate solution to this solution. A bulky white precipitate indicates the presence of phenolic compounds.

### Glycosides

The different extracts were hydrolysed with 5 ml conc. HCl for 2 hours on a water bath and filter. The hydrolysate was subjected to the following tests. Borntrage's test - In a test tube 2 ml of filtered hydrolysate were taken and into it added 3 ml of chloroform and mixed well. A chloroform layer was separated and to it 10% ammonia solution was added. A pink colour indicated the presence of glycosides.

### Proteins and Amino acids

Ninhydrin test - In a test tube 100 mg extract was dissolved in 10 ml of distilled water and filtered through Whatman filter paper No: 1. Take 2 ml of aqueous filtrate in a test tube add 2 drops of ninhydrin solution (10 mg of ninhydrin in 200 ml of acetone) was added. A development of characteristics purple colour indicated the presence of amino acids.

## 3. RESULTS

Bamboo shoots are healthy and nutritious food of globe . The eight bamboo species shoots are collected from the Karnataka region from different places showed in the below Table- 1 the places are identified and spotted in the above map in Figure-2.

**Table 1- Collection of bamboo shoots from different selected Districts of Karnataka**

SI No	District	Habitation	Identified Bamboo shoot Species
1	Kodagu	Madikeri (Mekeri)	<i>Dendrocalamus asper</i>
		Hoskeri	<i>Bambusa nutans</i>
		Mavina halla forest (Chikka aluvara)	<i>Dendrocalamus strictus</i>
		Nisarga dhama	<i>Bambusa bambos</i>
		Thadiyandamol	<i>Dendrocalamus brandisii</i>
2	Dhakshina kannada	Mangalore	<i>Bambusa nutans</i>
		Sullya	<i>Bambusa bambos</i>
		Puthuru	<i>Dendrocalamus strictus</i>
		Subrahmanya	<i>Bambusa bambos</i>
3	Shivamogga	Sharavathivalley	<i>Dendrocalamus asper</i>
		Thirthahali	<i>Dendrocalamus strictus</i>
		Sagara	<i>Bambusa nutans</i>
4	Hassan	Arkalgodu	<i>Bambusa bambos</i>
		Ramanathpura	<i>Bambusa nutans</i>
		Sakaleshpura	<i>Bambusa tulda</i>
5	Bengaluru	Banerghatta	<i>Dendrocalamus Stocksii</i>
		Jigani	<i>Dendrocalamus strictus</i>
		Annekal	<i>Bambusa nutans</i>
6	Mysuru	Hunsuru	<i>Bambusa tulda</i>
		Koppa	<i>Bambusa bambos</i>

		Bandipur	<i>Bambusa nutans</i>
7	Chamarajanagara	B R Hills	<i>Bambusa tulda</i>
		Mallemahadeshwara betta	<i>Bambusa bambos</i>
8	Chikamagaluru	Sringeri	<i>Bambusa nutans</i>
		Kadur	<i>Bambusa tulda</i>
		Mudigere	<i>Dendrocalamus hamiltonii</i>
9	Belagavi	Dandeli	<i>Dendrocalamus strictus</i>
		Shiroli	<i>Bambusa nutans</i>
		Amboli	<i>Dendrocalamus hamiltonii</i>
10	Uttara kannada	Sirsi	<i>Dendrocalamus Strictus</i>
		Karwar	<i>Dendrocalamus hamiltonii</i>
		Honavara	<i>Bambusa nutans</i>

The characteristics of the bamboo species from which shoots are collected are observed in different spot data was taken about the appearance, soil type, habitat, height, Inter node length, Culm Diameter and tabulated in the below mentioned (Table -2) .

*Table 2- Characteristics of edible bamboo collected from Karnataka region.*

Sl. no	Bamboo species	Location of samples collected	Native	Habitat and Soil type	Appearance	Height	Inter node length	Culm Diameter	Life span and Flowering	Uses Other than edible
1	<i>Dendrocalamus asper</i>	Kodagu, Shivamogga	Native To Indonesia	They prefer well drained soil mix with sand and stones.	Non thorny, closely packed clumps with protruding nodes	20-30 meter	20 - 45 cm	08 to 20 cm having a thickness of 1.2 to 2 cm	life span of 70 to 100 years with gregarious and sporadic flowering	Used for construction handicrafts and ladders
2	<i>Dendrocalamus strictus</i>	Kodagu, Dhaksina Kannada, Shivamogga, Bangalore, Belgavi and Uttara Kannada	Native to India	They prefer dry Alluvial soil beside river streams and in open Deciduous forest.	Non thorny, very densely packed clumps with prominent nodes	13-16 meter	13 -16 cm	08 to 10 cm having a thickness of 1.5 to 3 cm	life span of 25to30 years with gregarious flowering	Used as building material, furniture, artworks baskets mats and decorative items
3	<i>Dendrocalamus hamiltonii</i>	Chikamagaluru Belgavi Uttara Kannada	Native of South Asian countries	They prefer open forest areas, hillsides light (sandy), medium (loamy) and heavy (clay) soils and prefers well-drained soil	Non thorny Closely growing culms zig zag branching	15-18 meter	30-40 cm	05 to 15 cm having a thickness of 1.5 to 3 cm	life span of 30-50 year with gregarious and sporadic flowering	wood substitute, Building material, Crafts and ladders
4	<i>Dendrocalamus brandisii</i>	Kodagu	Southeast Asia	They prefer wet evergreen tropical forests well-drained loamy soil Calcareous rocks in altitude ranging from 0 to 1300 m	Non thorny Closely packed culms	20-25 meter	30 - 60 cm	10 to 20 cm having a thickness of 1.8 to 3 cm	life span of 40 to 45years with gregarious and sporadic flowering	Construction, Building material, Crafts, supporting material, baskets and Furniture's.
5	<i>Dendrocalamus stocksii</i>	Bangalore	Endemic to Penninsular India	Found in banks of streams and Valley prefer well drained and deep Loamy soil.	Non thorny, loosely packed culms,	15-18 meter	15 - 30 cm	2.5 to 4.0 cm having a thickness of 1 to 1.5 cm	Life span of 70 years only sporadic flowering	Ladders agriculture implements furniture's building material and construction purpose

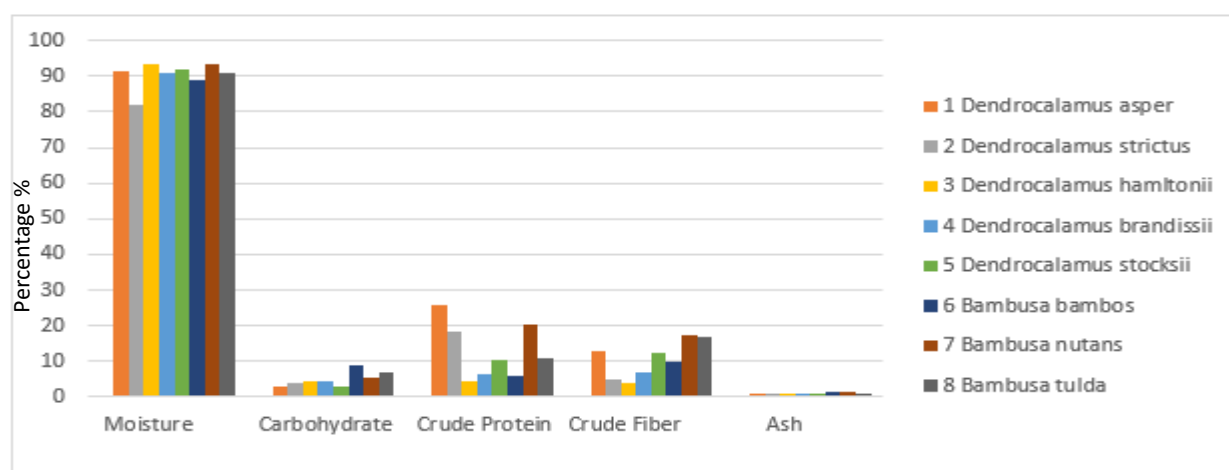
6	<i>Bambusa bambos</i>	Kodagu Dhaksina Kannada Hassan Mysore Chamarajana gara	Native to India	Grow in altitude up to thousand meter gross Karo near perineal Rivers and preference Rich and moist soil	Thorny densely packed culms with slightly Swollen Nodes	20-25 meter	30 - 45 cm	15 to 18 cm diameter thickness of 1.5 to 2.5 cm	Life span of 40-60 years with gregarious flowering occasionally sporadic flowering	Raw material for pulp and paper industries used for handicrafts and for roofing material.
7	<i>Bambusa nutans</i>	Kodagu Dhaksina Kannada Shivamogga Hassan Bangalore Mysore Chikamagaluru Belgavi Uttara Kannada	Native to Himalaya to Indo-China.	Preference moist hill slopes and flat up lands with well drained sandy loam and clayey soil's	Non thorny Loosely cramped, straight and smooth clubs	20-30 meter	25 - 45 cm	05 to 10 cm diameter thickness of 0.3 to 2.5 cm	Life span of 35 years with gregarious or sporadic flowering	Used for building materials house constructions and crafts and basketry.
8	<i>Bambusa tulda</i>	Hassan Mysore Chamarajana gara Chikamagaluru	Native to the Indian subcontinent, Indochina, Tibet, and Yunnan,	Prefers good rainfall with moist Aluvara M Syal Attend altitude 1500 m	Non thorny Closely packed clubs	20-25 meter	40 -70 cm	05 to 10 cm diameter thickness of 0.8 to 1.5 cm	Life span of 30-60 years with gregarious flowering	Weaving applications, basketry and handicrafts

### 3.1. Nutritional composition analysis :

The nutritional composition was analysed for the obtained bamboo shoots from different region according to the species, average is taken and results are tabulated in the below (Table- 3). Graphical representation of data obtained is shown in below (Figure- 4).

**Table 3- Nutritional composition of edible bamboo shoot.**

SL NO	Species	Moisture (%)	Carbohydrate (%)	Crude Protein (%)	Crude Fiber (%)	Ash (%)
1	<i>Dendrocalamus asper</i>	91.5	02.90	25.80	12.71	0.90
2	<i>Dendrocalamus strictus</i>	82.1	04.10	18.29	05.10	0.78
3	<i>Dendrocalamus hamiltonii</i>	93.4	04.35	04.52	03.80	0.92
4	<i>Dendrocalamus brandissii</i>	90.9	04.41	06.59	06.80	1.20
5	<i>Dendrocalamus stocksii</i>	91.8	03.20	10.60	12.34	0.95
6	<i>Bambusa bambos</i>	88.8	08.72	05.88	09.84	1.22
7	<i>Bambusa nutans</i>	93.5	05.50	20.12	17.20	1.50



**Figure 4-** Graphical representation of nutritional composition of edible bamboo shoot.

The nutritional analysis was performed for the fresh bamboo shoots obtained from Karnataka region. The moisture content was high in the *Bambusa nutans* and *Dendrocalamus hamiltonii*. The average of 90% moisture content is present in all the shoots. *Bambusa bambos* are rich in carbohydrate that is 8.72% and *Dendrocalamus asper* is having 2.90% which is less compare to other shoot species. Crude protein is higher in *Dendrocalamus asper* which is 25.8% compare to other shoot samples and very less in *Dendrocalamus hamiltonii* 4.52% crude fiber is also present in higher amount in all species where *Bambusa nutans* having larger amount around 17.20 % and less in *Dendrocalamus hamiltonii* 3.80% compare to other shoot samples.

### 3.2. Phytochemical analysis :

Phytochemical constituents are analysed for the bamboo shoot obtained phytochemical components are extracted by solvent extraction method here we used methanol and ethyl acetate as two different solvents the extract obtained from the shoot samples are further analysed for presence of Alkaloids, Flavonoids, Saponins, Tannins, Phenols, Glycosides, Proteins and Amino acids. The results are tabulated in the below (Table- 4).

**Table 4-** Phytochemical constituents of edible bamboo shoot.

Sl no	Species	Solvent used	Alkaloids	Flavonoids	Saponins	Tannins	Phenols	Glycosides	Proteins & amino acids
1	<i>Dendrocalamus asper</i>	ME	+	-	+	+	++	+	++
		EA	-	+	-	-	+	-	+
2	<i>Dendrocalamus strictus</i>	ME	++	-	-	+	++	+	++
		EA	+	+	-	-	+	+	+
3	<i>Dendrocalamus hamiltonii</i>	ME	+	+	+	+	+	+	+
		EA	-	-	-	+	-	+	-
4	<i>Dendrocalamus brandissii</i>	ME	+	+	+	-	+	+	+
		EA	-	-	-	+	+	+	+
5	<i>Dendrocalamus stocksii</i>	ME	++	-	+	+	++	+	+
		EA	-	-	+	-	+	-	+
6	<i>Bambusa bambos</i>	ME	+	+	-	+	+	+	+
		EA	-	+	+	+	+	-	+
7	<i>Bambusa nutans</i>	ME	+	-	+	+	+	+	+
		EA	-	+	+	-	-	-	+
8	<i>Bambusa tulda</i>	ME	+	-	-	+	++	+	++
		EA	+	+	+	-	+	-	+

Legend- ME: Methanol Extract, EA: Ethyl acetate Extract, + : present, ++: highly present; - : not present.

The result of phytochemical analysis showed that Alkaloids are present in all the shoot species in lesser quantity and highly present in *Dendrocalamus asper* and *Dendrocalamus stocksii*. Flavonoids are present in all the shoot samples except *Dendrocalamus stocksii*. Saponins are present in *Dendrocalamus asper*, *D. hamiltonii*, *D. brandissii* and all *Bambusa* species. Tannins are present in



minute quantity in all the shoot samples. Phenols are present abundantly in all shoot samples highly present in *Dendrocalamus asper*, *Dendrocalamus strictus*, *Dendrocalamus stocksii* and *Bambusa tulda*. Glycosides Proteins and amino acids are also present in all the shoots Proteins and amino acids are rich in *Dendrocalamus asper*, *Dendrocalamus strictus* and *Bambusa tulda*.

#### 4. DISCUSSION

Bamboo shoots are proven as a nutritional food which is now globally available which as a high dietary fiber content. Using the traditional knowledge, pharmaceutical preparations of bamboo shoots like bamboo salt, bamboo vinegar, bamboo extracts for diabetes and cholesterol control (Singhal et al., 2013). Phytochemicals obtained from natural plant resources have now gained prominence for their use as prophylactic agents in prevention and treatment of several chronic human diseases. Bamboo shoots have been scientifically proven to contain several with significant anti-cancerous properties. Freshly emerging juvenile shoots are nutritionally superior to the older emerged shoots (Nirmala et al., 2007). Shoots contain high quantities of phenolic compounds which possess potent radical scavenging activity and exert anti-carcinogenic effects by regulating ROS levels, signal transduction cascades, angiogenesis and cell proliferations.

Shoots are also a good source of natural phytosterols such as stigmasterol,  $\beta$ sitosterol and campesterol which provide anti-cancerous effects by inhibition of metastasis, slowing down of cell cycle progression, inhibition of angiogenesis, invasion and adhesion of cancer cells and inducing apoptosis. Bamboo shoots also contain several other anti-carcinogenic agents such as glucosinolates and saponins and efficacy of bamboo shoots phytochemicals for their antitumor potential has already been clinically proven (Sharma and Chongtham, 2018).

Bamboo shoots contain diverse arrays of phytochemicals which are highly effective in preventing as well as treating incidences of several types of cancer diseases. Therefore, bamboo, with its vast worldwide coverage, represent a significant natural resource which has tremendous potential in proving to be one of the best ally in our continued quest to tame cancer. Hence, bamboo shoots should be promoted as a highly efficient functional food and efforts should be made for its inclusion towards any future cancer prevention dietary regimes (Anil Singh et al., 2012). Bamboo shoot extract showed reduced hypertension in rat (Sunarti and Octaviani, 2020). Bamboo shoots have a huge source of bioactive compounds related to human health and the 2,4-di-tert-butylphenol in bamboo shoots is a candidate compound for anti-diabetes-related enzymes (Sansenya et al., 2023)

The bamboo leaves-mediated Ag NPs synthesized Ag NPs signified strong antibacterial, antioxidant, and anticancer activity so it can be used in various biomedical applications and face mask coating to prevent the coronavirus (Jayarambabu et al., 2022) Fermented bamboo shoots are a storehouse of microorganisms also many of them being probiotics in nature. When they are consumed they produce a lot of health benefits, such as anti-oxidant, anti-cancer, reduces blood pressure, prevents cardiovascular diseases, weight loss, to name a few. Besides these, they can also be applied in the industries, especially in the food, pharmaceutical, and biofuel industries (Behera and Balaji, 2021).

#### 5. CONCLUSION

Bamboos are known as poor man's timber which is also known as green gold its every part is used for different purposes for furniture's building material paper industry and many more. Bamboo shoots are highly nutritious contains high fibre it's a seasonal vegetable which should be processed and cooked well. In the present scenario it is used as vegetable which is having high nutritious value which is a source for organic modular food which contains dietary proteins fibers minerals carbohydrates fats vitamins and it have the phytochemicals phenols alkaloids flavonoids which have a medicinal property it's important to explore these properties and find out the benefits of its products to the society for overcome malnutrition, diabetics, diseases and to add in our daily diet as a common vegetable in form of fermented processed pickled etc it is a healthy diet. Which can be used as a functional food which also have a medicinal property.

## 6. CONFLICT OF INTEREST

There is no conflict of interest

## 7. ACKNOWLEDGEMENT

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