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PHYSICO-CHEMICAL PROPERTIES OF BAMBOO SHOOT POWDER (BSP) FROM SPECIES *BAMBUSA BALCOOA*

[1]**Author** Farhin Rahman

[2]**Co-Author** Ruma Bhattacharyya

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ABSTRACT

This paper analyzed the physiological and chemical composition of the bamboo shoot powder (BSP) from the species *Bambusa balcooa*. Bamboo shoot has attained significance as a functional food due to its health promoting nutrients. Among different species of bamboo shoots, *Bambusa balcooa* was selected for the present study due to their availability as well as higher consumer acceptability and also high nutritional quality. The physicochemical analysis of the bamboo shoot powder was carried out by standard procedures. The functional characteristics of bamboo shoot powder were good in terms of water absorption capacity (70.00g/100g) and oil absorption capacity (62.30g/100g). The present study indicated that bamboo shoot powder was high in protein (21.11g/100g), crude fibre (35.10g/100g), total mineral (2.25 g/100g) as well as low in fat (0.99g/100g) and total carbohydrate (25.46g/100g). The colour of the bamboo shoot powder was measured by the Hunter's Lab colour analyzer and it was found as the highest L-value (Lightness, 85.91) and b-value (Yellowness, 27.88). The result revealed that the bamboo shoot powder reflected the "light yellow" in colour. The present study depicted that bamboo shoot powder could significantly be used as a nutritional additive for fulfilling their therapeutic as well as nutritional needs in various food preparations.

Keywords:

Bamboo Shoot Powder (BSP), Bambusa balcooa, Physico-chemical properties, Colour analysis, Hunter's Lab colour analyzer Nutritional additive, Therapeutic needs.

[1] Corresponding Author : Assistant Professor, Department of Home Science, Lakhimpur Girls' College
Email – rahmanfarhin11@gmail.com , Contact No. 7002051219
[2] Co-Author : Professor, Department of Food Science and Nutrition, Assam Agricultural University
Email – rumab76@gmail.com

INTRODUCTION

In search for new sources of food for humans and animals, many wild plants, which until now have not been adequately utilized by men, are being investigated as a food source. Bamboo is one of such uncommon source of food. It has now achieved the status of an economically most important plant, in India rightly considered as "Green Gold" (Bao et al., 2006). Bamboo as a green gold is sufficiently cheap and plentiful to meet the abundant needs of human populations from the "child's cradle to the dead man's bier." Because of its multifarious utility, both in the traditional way for the rural people as well as in modern society, bamboo is becoming a very important plant worldwide (Madhab, 2003).

Bamboo is a perennial, giant, tall arborescent grass as well as fastest growing plants in the world, belonging to the tribe Bambuseae of the family Poaceae. More than 1250 species, belonging to 75 genera, are being reported worldwide, to which India has contributed more than 125 species belonging to 18 genera (ISFR, 2011). Out of more than 125 species available in India, the most commonly edible bamboo species are Bambusa balcooa, Bambusa pallida, Bambusa tulda, Bambusa polymorpha, Dendrocalamus hamiltonii, Dendrocalamus giganteus and Melocanna bambusoides (Bora et al., 2015).
Bamboo is not merely the poor man's timber but also the rich man's delicacy in terms of young shoots. Bamboo shoots exhibit a great potential as a food resource (Satya et al., 2012). Bamboo shoots are the edible young plant that have just come out from the ground. Bamboo shoots are generally 20-30 cm long, tapering at one end and at the time of harvest normally weighs more than 1kg (Dollo et al., 2009). Depending on the location, depth and nutrition of the soil, watering and drainage conditions, temperature, pH and soil fertility, the shooting period of bamboo shoots vary species to species. The sheaths covering the shoots are black, brown, yellow or purple and in some species are

covered with tiny hairs (Upreti et al., 2002). Bamboo shoots have immense potential of being used as important health food as they contain high amounts of proteins in terms of 17 amino acids (eight are essential amino acids) and dietary fibres, carbohydrates, and low in fat (Satya et al., 2009a). Due to such high profile of nutrition, bamboo shoot is considered as an "ideal healthy vegetable" (Xu et al., 2005). Freshly collected bamboo shoot have good amount of vitamin-A, thiamine, niacin, vitamin-B6, vitamin-E (Bora et al., 2015). It is also rich in mineral elements mainly potassium, calcium, manganese, zinc, chromium, copper, iron and lower amount of phosphorous and selenium (Nirmala et al., 2011). Bamboo shoots contain flavonoids, phenols and phenolic acids which are potent antioxidants (Pandey et al., 2011). Bamboo shoots are highly nutritious and therapeutically rich food. Presence of high fibre and phytosterols in bamboo shoot reduces fat and cholesterol levels of blood and making them one of the most important health food among vulnerable age groups (Kalita et al., 2012). The anticancer property of bamboo shoots might be attributed to the presence of phytosterols (Pandey et al., 2011). Most of the biological origin of food and agro-products are heat sensitive. So, it is important to reduce their water activity to increase shelf-life without diminishing their quality parameters. Thus, lots of emphasis is being focused on drying technology of bamboo shoot. The bamboo shoot powder has attained significance as a functional food due to its health promoting nutrients.

REVIEW OF LITERATURE ON PHYSICO-CHEMICAL PROPERTIES OF BAMBOO SHOOT

Physical characteristics of bamboo shoot:

Depending upon various species, bamboo shoots are usually 20–30 cm long and taper to a point. A bamboo shoot at the time of harvest normally weighs more than 1 kg. The size and weight of bamboo shoot depend upon the location, depth, pH and nutrition of

the soil, irrigation and drainage conditions, climate, rainfall, temperature and soil type and fertility (Dollo et al., 2009). The shooting period of a bamboo is different for different species. Generally the temperate climate bamboos are the runners and shoot in the spring but the tropical and sub-tropical species are shooted in the late summer and fall, which are mainly clumpers. Bamboo shoots are tender, soft, crispy, generally ivory yellow in colour. The colour of the sheaths coveringof the shoots are normally black, brown, yellow or purple. The edible tender shoots look like coiled springs and have an astringent flavour. The shoots of some species are known to contain cyanogenic glycosides, called taxiphyllin, [2-(b-D-glucopyranosyloxy)-2-(4-hydroxyphenyl)acetonitrile] which, therefore, develops acrid and bitter taste in bamboo shoot (Anonnymous, 2004). Although bamboo shoots are found during the monsoons, there are normally two types of bamboo shoots available throughout the year; winter shoots and spring shoots depending on the seasons of a year. The spring shoots are normally larger, tougher and more superior compared to the winter shoots (Satya et al., 2010).

Chemical characteristics of bamboo shoot:

(a) Moisture content

Moisture content is an important constituent of shoot vegetables that influence the water activity and stability during storage and indirectly represent the yield and quality of total solids. It is not a fixed constituent and is dependent upon many factors such as cultivar, yield, proportional amount of chemical constituents and environmental factors like temperature, air circulation, relative humidity etc. (Clarke, 1985).

Choudhury et al. (2010) stated that fresh bamboo shoot is a high moisture food, containing about 90 percent of water. The study reported by Bhatt et al. (2003, 2005) that the moisture content of species Bambusa balcooa ranged from 84 to 86.3 percent. The raw form of Bambusa balcooa contained 91.65 percent of moisture content (NMBA,

2009). During drying, moisture content is reduced. Mustafa et al. (2016), evaluated that the dried bamboo shoot powder of Bambusa balcooa had 13.62 percent moisture content.

(b) Crude protein

Protein plays a major role in ensuring health and well-being. Among shoot vegetables, bamboo shoots are rich in proteins and amino acids essential for the human body. If these essential amino acid containing bamboo shoots are consumed in sufficient amount, could meet a better portion of an individual's daily protein requirement to prevent various nutrient deficiency disease (Gupta et al., 1989).

Kumbhare et al. (2007) reported that the crude protein content in raw bamboo shoots of different species ranged from 9.6 to 17.2 percent. The another study reported by Satya et al. (2009) that the crude protein content of Bambusa balcooa was 25.84 percent. The crude protein content decreased after boiling the shoots at increasing temperature. But low temperature heating is effective. The wide variations in the protein content of bamboo shoots may be attributed to differences in species, growing site, climatic factors and as well as method of analysis. Mustafa et al. (2016) who has reported that the powdered form of Bambusa balcooa contained 19.32 g of crude protein. The protein content of Bambusa balcooa was 34.51 g per 100g in dry weight basis (Choudhury et al., 2015).

(c) Crude fat

Fat is an essential nutrient for performing different functions of the body. Essential fatty acids are derived from fats which are not produced by the body and they are supplied through food into the body. The essential fatty acids are linoleic and linolenic acid. Essential fatty acids are required for controlling inflammation, blood clotting, and brain development. Satya et al. (2012) stated that bamboo shoots are known for their low fat

content and contain major aessential fatty acids.

Kumbhare et al. (2007) stated that bamboo shoots are low in fat and calories. Gopalan et al. (2004) reported that 0.5 percent fat present in raw edible bamboo shoots. Bhatt et al. (2003, 2005) reported that the crude fat content of fresh and raw bamboo shoot species Bambusa balcooa ranged from 0.6 to 1.0g per 100g. During boiling and drying of bamboo shoots, the crude fat content is slightly reduced and thus making it more beneficial for patient requiring fat free food. Bora et al. (2015) reported that the dried bamboo shoot powder of species Bambusa balcooa had 0.28 percent fat content.

(d) Total mineral (Ash content)

The ash content of any food stuff represents the total amount of minerals present in the food. Higher the ash content reflects the more amounts of minerals present in the foods. Kumbhare et al. (2007) reported that ash content of bamboo shoots ranged from 0.8 to 0.9 percent. The data reported by Gopalan et al. (2004) that 1.1g per 100 g of ash present in raw bamboo shoots. The total mineral content of Bambusa balcooa had 3.1 percent (Satya et al., 2009)

Bhatt et al. (2005) stated that ash content in different species of raw edible bamboo shoots varies from 2.1 to 3.7 percent in North Eastern Himalaya region in India. A study showed that Bambusa balcooa contained 0.88 percent of ash content (Bora et al., 2015). The species Bambusa balcooa in the powdered form contained 4.16 percent ash content (Mustafa et al., 2016).

(e) Crude fibre

Crude fibre is the additional portion of the total carbohydrate of a food which is resistant to the acid and alkali treatment. The possible beneficial effect of crude fibre from vegetable to human beings are well established for alleviating the incidences of diabetes

mellitus, obesity, coronary arteries diseases and colon cancer etc.(Myers, 2007).

Kumbhare et al. (2007) stated that crude fibre content in raw bamboo shoots ranged from 0.71 to 0.98 percent. Bhatt et al. (2005) reported a great variation in crude fibre content of bamboo shoots of different species from different regions of the North-Eastern Himalaya (India) and it ranged from 23.1 to 35.5 percent. The study reported by Satya et al. (2009) that the bamboo shoot species Bambusa balcooa contained 26.40 g of crude fibre content in per 100 g.

Mustafa et al. (2016) and Choudhury et al. (2015) stated that in case of dried bamboo shoot powder of species Bambusa balcooa contained 24.44 g and 34.41 g of crude fibre content respectively in per 100 g.

(f) Total carbohydrate

Generally the shoot vegetables are not considered as an important source of carbohydrate (and hence energy). Due to high fibre content, the bamboo shoot contain complex carbohydrate, namely those derived from plant source have a relatively low glycaemic index as compared to sugar and jaggery. Population subsisting on diet high in complex carbohydrates no doubt lowers the levels of total and LDL cholesterol in the system. As a result complex carbohydrate diets lower the risk of cardiovascular diseases (Bamji et al., 2003). The polysaccharides may be hydrolyzed into simple sugars resulting in the formation of monosaccharides during processing of bamboo shoots. The oligosaccharides which cause flatulence can be converted to monosaccharides and thus the cooking of bamboo shoots could be beneficial for health (Kumbhare et al., 2007).

Wen et al. (2000) stated that carbohydrates from a major part of food and help a great deal in building body strength, by generating energy. Gopalan et al. (2004) quoted 5.7 percent of carbohydrate present in edible bamboo shoots. Similarly, Bhatt et al. (2005)

also reported a wide range of carbohydrate in different species of raw bamboo shoots from different regions of North Eastern Himalaya (India) and the range was 4.5 to 5.2 percent. NMBA (2009) reported that the carbohydrate content of bamboo shoot species Bambusa balcooa was 3.90 percent. The carbohydrate content of fresh shoots of 14 bamboo species as reported by Nirmala et al., (2011) ranged from 4.32 to 6.92 g/100 g on fresh weight basis.

(g) Energy

Gopalan et al. (2004) reported that energy value of raw bamboo shoots to be 43 kcal per 100 g. Bhatt et al. (2005) reported energy value as 14.6-16.9 MJ/Kg in different species of raw bamboo shoots from different regions of North Eastern Himalaya (India).

AIMS OF THE STUDY

The aim of this study was the analysis of physico-chemical properties of bamboo shoot powder from the species Bambusa bacooa.

MATERIALS AND METHODS

Selection and procurement of raw materials:

The edible shoots of Bambusa balcooa (Local name: Bhaluka) was selected for the present study due to their easy availability, accessibility and high therapeutic value and collected from villages of Potia Gaon and Bahona in Jorhat District, Assam.

Processing of bamboo shoot powder (BSP):

Bamboo shoot is covered with thick sheath so processing of bamboo shoots is must. Bamboo shoots were washed after procuring it from the field for removal of dust and dirt. The tip was cut, thick outer sheath was peeled off, inedible base shoot was cut and finally bamboo shoots were sliced (2mm thickness) to get the edible portion of bamboo shoots. The cut shoots were blanched for 30 minutes by changing the water after every 10 min. Then it was dried in tray dryer at 60°C for 4-5 hrs. The dried pieces of bamboo shoots were ground to make powder. Then the powder was sieved by using sieve of 100

mesh sized and stored in the air tight container.

Physico-chemical analysis of bamboo shoot powder:

Water absorption capacity (WAC)

Water absorption capacity was determined by using the method of (Onwuka, 2005). A measured quantity (1 g) of the sample was dispersed in 10 ml of distilled water in a conical graduated centrifuge tube. The sample was thoroughly mixed for 30 second and allowed to stand at room temperature for 30 minutes before being centrifuged at 5000 rpm for another 30 minutes. The volume of the supernatant was measured directly from the graduated centrifuged tube. The amount of the absorbed water was multiplied by the density of water (1g/ ml) and results were expressed as g/100g.

Oil absorption capacity (OAC)

Oil absorption capacity was determined by using the method of Onwuka (2005). The whole process was same but in place of distilled water fat or oil is used in this method.

Colour analysis of BSP

The colour of the bamboo shoot powder was measured by the Hunter's Lab colour analyzer (Hunter Lab scan XE, Reston VA, USA). The colour was measured in terms of L^*, a^* and b^* values, where L^* is the lightness (0=Black, 100=White), a^* for the red-purple (positive value) to the bluish green (negative value) and b^* indicates the yellowness (positive value) and blueness (negative values).

Moisture content

Moisture content of the sample was determined by using the A.O.A.C. method, 2000.

Crude protein content

Crude protein content of the sample was determined with modifications of the A.O.A.C. (2000) method.

Crude fat content

Crude fat was determined with modification of the A.O.A.C. (2000) procedure.

Total mineral content (Ash content)

$$\text{Ash percentage} = \frac{\text{Weight of the ash(g)}}{\text{Weight of the sample(g)}} \times 100$$

Crude fibre content

Crude fibre was determined using the method of A.O.A.C. (2000).

Total carbohydrate content

The carbohydrate content was determined by difference, i.e. by subtracting the sum of the values (per 100g) for moisture, crude fat, crude protein and crude fibre from 100. (Gopalan et al., 2000)

Determination of energy content

The energy was determined by multiplying the percentage of crude protein, crude fat and carbohydrate by the calorific value of these three i.e. by the factor 4, 9, and 4 respectively and the estimation was recorded as Kcal per 100g. (Gopalan et al., 2004)

Statistical Analysis:

Three independent experimental trials of the present study were conducted. Mean values for various parameters were calculated and were analyzed by one-way ANOVA using the SPSS software for windows (version 20).The values were presented as mean along with standard error (Mean ± Standard error).

RESULTS AND DISCUSSION

A. Physico-chemical analysis of Bamboo Shoot Powder (Bambusa balcooa)

The quality evaluation of bamboo shoot powder was affirmed in terms of physico-chemical analysis of composition such as percent water absorption capacity, oil absorption capacity, colour measurement, moisture, protein, crude fat, mineral, crude fibre, total carbohydrate, energy content. In Table 1 and Table 2 the values for physico-chemical properties of BSP are shown. The present study revealed that the water absorption capacity of the bamboo shoot powder was 70.00g/100g. The bamboo shoot powder contains more amount of fibre. Due to more water retaining capacity of the fibres, more amount of water is absorbed by the bamboo shoot powder. Peymanpour et al. (2012) reported that fibre rich source like oat flour had high water absorption capacity. The oil absorption capacity of the bamboo shoot powder was 62.30g/100g. The bamboo shoot powder absorbed more oil due to higher amount of fibre and protein present in it. Ojukwu (2012) also reported that due to hydrophobic nature of protein, can interact with oil in foods and increase their retention capacity.

The results of this present study revealed that the moisture content of the bamboo shoot powder of Bambusa balcooa was 13.36g per 100g. The moisture content in the present study is consistent with the findings of Mustafa et al. (2016) who reported that the dried bamboo shoot powder of Bambusa balcooa contained 13.62 percent of moisture content. The protein content of bamboo shoot powder of species Bambusa balcooa was found 21.11g per 100g. The findings of the present study are in accordance with the values reported by Mustafa et al. (2016) and Satya et al. (2009) that the crude protein content of the Bambusa balcooa powder ranged between 18.22 g/100g to 25.84 g/100g. The crude fat content of this present study was 0.99 g per 100g. Das et al. (2007) stated that bamboo shoots are low in fat. The findings of the present study were in accordance with the range between 0.28 g/100g to 1.46 g/100g reported by Bora et al. (2015) and Mustafa et al. (2016). The total mineral content of Bambusa balcooa powder was 2.25g per 100g. Mustafa et al. (2016) reported that the bamboo shoot powder of Bambusa balcooa contained 4.16g per 100g of mineral content. The results of Bambusa balcooa

powder in case of total crude fibre content was found 35.10g per 100g. Mustafa et al. (2016) reported that the crude fibre content of bamboo shoot powder of species Bambusa balcooa was 24.44 g per 100g. Similar data reported by Choudhury et al. (2015) that Bambusa balcooa contained 34.41g of crude fibre which is much similar with the present study. The total carbohydrate content of Bambusa balcooa powder was 25.46 g per 100g. As the total carbohydrate was calculated by difference method therefore, it is dependent on other nutrients i.e. moisture, crude protein, crude fat, total mineral and crude fibre. Along with all other nutrients the energy content of bamboo shoot powder of species Bambusa balcooa for this study was found 210.62 Kcal per 100g. From the physico-chemical properties of this present study depicted that Bambusa balcooa powder has highest fibre and total mineral content with low fat content. On the basis of these nutritional values, bamboo shoot powder is used as a food supplement in different food products to enhance their nutritive as well as medicinal value.

B. Colour measurement by the Hunter's Lab colour analyzer

The L-value of the bamboo shoot powder found that 85.91, i.e. it was towards "lightness". The a-value of the powder was -0.80 which indicates that the colour of bamboo shoot powder slightly turns to greenish-yellow. The b-value of the bamboo shoot powder was 27.88 which indicate the "yellowness". This result depicted that the bamboo shoot powder was towards the yellow-axis in the colour wheel. As well as the hue and chroma of bamboo shoot powder was observed as -88.36 and 27.89 respectively. Bora et al. (2015) evaluated that the L, a and b-value of the bamboo shoot powder of Bambusa balcooa was 64.62, -7.50 and 23.50 respectively.

Table 1: Physical characteristics of bamboo shoot powder

Sl. No.	Parameters	Value (g/100g)
1.	Water absorption capacity	70.00 ± 0.02
2.	Oil absorption capacity	62.30 ± 0.01

Values are the mean ± SD of three replicates.

Table 2: Chemical characteristics of bamboo shoot powder

Sl. No.	Parameters	Value (g/ 100 g)
1.	Moisture	13.36 ± 0.32
2.	Crude protein	21.11 ± 0.13
3.	Crude fat	0.99 ± 0.01
4.	Total mineral (Ash)	2.25 ± 0.08
5.	Crude fibre	35.10 ± 0.12
6.	Total carbohydrate	25.46 ± 0.24
7.	Energy	210.62 ± 0.89

Values are the mean ± SD of three replicates

CONCLUSION

The results of the present study depicted that the bamboo shoot powder (BSP) from species Bambusa balcooa is a rich source of protein, crude fibre, total mineral as well as low in fat and total carbohydrate. It has reflected a light yellow colour that could be used as food additive to other food products for enhancement of colour. The high nutritional quality along with good sources of crude fibre, total mineral and low fat content of fresh bamboo shoots need to be explored for their potential of edible purposes. In future, bamboo shoots are becoming more popular as nutritionally and therapeutically supplemented foods. As a healthy and nutritional additive, bamboo shoot powder could significantly be incorporated in different food products for fulfilling their therapeutic as

well as nutritional needs in various food preparations.

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