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Nutritional Values of the Gelatinous Substance in Bamboo Internodes

Chaiyong Rujjanawate, Ph.D.[1], Shisanupong Anukanon, Pharm.D.[1]
[1] School of Medicine, Mae Fah Luang University, Chiang Rai 57100, Thailand

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Abstract:

Background: During the rainy and cool seasons, internodes of bamboo *(Dendrocalamus strictus)* contain a clear light brown gelatinous substance with a pale bamboo odor. This gelatinous substance is traditionally called "Piang" and has long been used as a food by northern Thai people. However, there have been no reports regarding nutritional values to support the promotion of this local wisdom usage.

Objective: Thus study aimed to evaluate the nutritional values and anti-oxidant properties of this gelatinous substance.

Methods: Bamboo gelatinous substance was collected from local markets in Chiang Rai, freeze dried and subjected to nutritional analysis and anti-oxidant assay.

Results: The results showed that 1.0 gram of dried gelatinous substance contains 0.79 g of insoluble dietary fiber and 0.11 g of soluble dietary fiber. There was 0.16 g of protein in 100 grams of fresh gelatinous substance and no fats or sugars were detected. Silicon was the most predominant mineral found in the bamboo gelatinous substance. Its content was 20 mg/100 g fresh gelatinous weight. Other minerals found in 100 g fresh gelatinous substance were potassium (104 mg), sodium (2 mg), magnesium (1.78 mg), calcium (4 mg), phosphorus (8 mg), iron (0.14 mg), zinc (0.04 mg) and chloride (4.40 mg). Total polyphenols at small concentrations were found but no anti-oxidant properties were detected.

Conclusion: All of these findings suggested that bamboo gelatinous substance contains almost zero calories but is rich in dietary fibre and silicon, both of which are beneficial to health. This natural product could be developed as a potential dietary supplement.

Keywords: Gelatinous substance, *Dendrocalamus strictus,* Nutritional values

Corresponding author: Chaiyong Rujjanawate, Ph.D.
School of Medicine, Mae Fah Luang University, Chiang Rai 57100, Thailand
E-mail: chaiyong@mfu.ac.th
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Introduction

Bamboos are evergreen perennial flowering plants that are part of the true grass family Poaceae. Most bamboo species are found in tropical, subtropical and mild temperate climates, particularly in the Indian subcontinent, East and Southeast Asia and islands of the Indian and Pacific oceans. Bamboo is considered a multipurpose plant since all of its parts can be used. People in the countryside of the Greater Mekong Subregion (GMS) have their houses built from bamboo wood and bamboo shoots are still a mainstay delicacy of their diet in the rainy season. Bamboo shoots contain amino acids, carbohydrates, minerals, vitamins and nutrient fibers but virtually no fat. It has been demonstrated that there are 6-8 grams of nutrient fibers per 100 grams of fresh weight of bamboo shoot[1]. Nutrient fibers are known to possess cholesterol lowering effects and delay sugar absorption, both which are good for diabetes treatment and weight management[2, 3].

In Thailand, there are 13 genera and 60 species of bamboos recorded[4]. Bamboo shoots from all species are edible. However, bamboo shoot is not the sole source of food material from bamboo. During the late rainy and early cool seasons. another edible material can be collected from the bamboo of a certain species *(Dendrocalamus strictus)*. On the inside of some internodes of some bamboo branches there is found a clear light brown gelatinous substance, with a pale bamboo odor. The internodes in which the gelatinous substance is found are shorter than others in the same clump. The gelatinous substance collected from 3-4 internodes is enough for 1-2 servings. Vendors selling bamboo gelatinous substance are commonly seen in the local markets of Chiang Rai, Thailand, particularly during the months of September to December.

The bamboo gelatinous substance is likely an exudate from bamboo but its origin is still in question. Indigenous people call it “Piang” and it has long been eaten it as a food. This gelatinous substance is usually eaten raw by mixing it with salt, chili, coriander and onion chive. Approximately one serving consists of at least 100 grams of the gelatinous substance. It can also be cooked, making a clear soup with the addition of meat and vegetables. Despite the long known culinary uses of the bamboo gelatinous substance, there have been no reports regarding its nutritional value and no one knows whether consuming this food is beneficial to health.

To shed light on this matter, this study aimed to evaluate the nutritional values and anti-oxidant properties of bamboo gelatinous substance. The findings may also reveal the potential of this material to be developed as a food supplement.

Materials and Methods

Collection of bamboo gelatinous substance

Bamboo gelatinous substance was collected from local markets in Mae Chan, Mae Fah Luang, Chiang Khong and Chiang Saen districts in Chiang Rai province during November - December 2018. Approximately 60 kg of the Bamboo gelatinous substance was obtained.

Sample preparation

Fresh gelatinous substance was weighed and lyophilized and ground for further analysis. From 53.5 kg of fresh gelatinous substance, 1.070 kg of dried gelatinous substance was obtained. Therefore one 100 grams serving of the fresh gelatinous substance is equivalent to 2 grams of dried powder.

Analyses of nutrient contents and antioxidant activities

The test sample for nutrient and mineral content analysis was prepared by mixing 1.0 g of dried gelatinous substance with 100 ml of deionized water. Analyses of Protein, Fat/Total lipid, Ash, Insoluble dietary fiber, Soluble dietary fiber, Total sugar, Calcium, Phosphorus, Sodium, Potassium, Chloride, Magnesium, Iron, Zinc, Copper, Silicon and total polyphenols was performed. Antioxidant activities were assayed using the ferric reducing ability of plasma (FRAP) and α, α-diphenyl-β-picrylhydrazyl (DPPH), this analysis was carried out at the Food and Nutrition Laboratory, Institute of Nutrition, Mahidol University, certified according to ISO/IEC 17025: 2005. All of the assays except phosphorus, total polyphenol and antioxidant activities were performed according to the official methods of analysis[5]. Phosphorus content was determined by spectrophotometric method[6]. Total polyphenol content was determined according to the Folin-Ciocalteu spectrophotometric method[7]. FRAP was estimated spectrophotometrically following the procedure of Benzie and Strain[8] and DPPH radical scavenging activity was determined according to the method of Katsube et al.[9] Silicon content was measured by β-Silicomolybdenum blue method using the test kit visocolor® *HE* Silicon

Polysaccharide extraction.

The crude polysaccharide fraction was obtained using a hot-water extraction method[10]. Five grams of dried gelatinous substance was mixed with 300 ml hot deionized water. The resulting solution was mixed with four times its volume of anhydrous ethanol for precipitation for 24 h at 4°C. The extraction solutions were separated by centrifugation at 10,000 g for 20 min[11]. After the water supernatant was poured away, the precipitate was washed repeatedly with acetone. The crude polysaccharides were then lyophilized and weighed. The yield (%) of the polysaccharides was calculated as follows:

$$\text{Extraction yield (\%)} = (PS/GS) \times 100$$

Where PS is the dried crude polysaccharide weight and GS is the dried gelatinous substance weight.

Results and Discussion

Macronutrient and mineral content of the bamboo gelatinous substance

Macronutrient and mineral content were expressed in terms of weight per 100 g of fresh bamboo gelatinous substance and reported in Table 1. The amounts of protein, total fat, calcium, phosphorus, sodium, potassium, magnesium, iron, zinc, copper and chloride in

one serving (100 g fresh weight) were far lower than the daily requirements recommended for Thai people[12]. Potassium was the most predominant mineral. Its content in 100 g fresh gelatinous substance was 104 mg. However, in comparison with the level of potassium intake suggested by WHO, at least 3510 mg/day for adult[13], this is still more than thirty times less than the recommended daily intake.

Of all the mineral contents reported here, the most notable value was that of silicon. Silicon content was 20 mg/100 g fresh gelatinous substance. There has been no recommended daily dose of silicon intake for Thais but it was reported that dietary intake of silicon for most Western populations is between 20-50 mg /day[14-16]. Plants in the grass family, including bamboo, are termed "silicon accumulators" because they take up and accumulate silicon from soil to make up a structural component conferring strength and rigidity to stalks[17]. Studies in experimental animals suggested that silicon may be essential for the formation of bone and connective tissues in higher animals and humans[18-20]. Findings from both animal and human experiments suggested that an intake of silicon of near 25 mg/d would ensure nutritional benefits[21].

The results indicate that consuming fresh gelatinous substance from bamboo is safe, even when consumed several times a day and may well have beneficial effects, particularly related to skeletal health.

Phenolic compounds and antioxidant activities

The total polyphenol content of the bamboo gelatinous substance, as measured with Folin-Ciocalteu reagent, was 4.6 mg eq GA/ 100 g fresh weight gelatinous substance while

Table 1 Macronutrient and mineral content of the bamboo gelatinous substance

Components		Reference methods
Protein (g)	0.16	AOAC (2016) 992.23
Total fat (g)	0	AOAC (2016) 948.15, 945.16
Total sugar	ND	AOAC (2016) 982.14
Calcium (mg)	4	AOAC (2016) 985.35
Phosphorus (mg)	8	Kolthoff et al. 1969
Sodium (mg)	2	AOAC (2016) 985.35
Potassium (mg)	104	AOAC (2016) 985.35
Magnesium (mg)	1.78	AOAC (2016) 984.27
Iron (mg)	0.14	AOAC (2016) 984.27
Zinc (mg)	0.04	AOAC (2016) 984.27
Copper	ND	AOAC (2016) 984.27
Chloride (mg)	4.4	AOAC (2016) 971.27
Dietary fibre (g)	1.8	AOAC (2016) 991.42
Si concentration (mg)	20	Test kit visocolor® HE Silicon

Values were expressed in terms of weight per 100 grams of fresh bamboo gelatinous substance, ND = not detected

its total antioxidant properties, as measured with ferric reducing ability of plasma (FRAP) and α, α-diphenyl-β-picrylhydrazyl (DPPH) methods, were undetectable. Since different phenolic compounds made considerable different contributions to different antioxidant activity assays[7], this finding suggested that phenolic compounds in the bamboo gelatinous substance have no anti-oxidant activity.

Polysaccharide and dietary fibre analysis

It was found that 1.0 grams of dried gelatinous substance yielded 0.98 grams of crude polysaccharide. The percentage of crude polysaccharide, soluble dietary fibre and insoluble dietary fibre in dried gelatinous substance were 98, 11 and 79 respectively as shown in Table 2. Therefore, one serving of the fresh gelatinous substance (2 grams of dried powders) should contain nearly 2 grams of dietary fibre. It is noteworthy that the recommended daily intake of dietary for Thais is 25-38 grams[12].

Table 2 Polysaccharide and dietary fiber content of the bamboo gelatinous substance (values were expressed in terms of weight per 1.0 gram of dried bamboo gelatinous substance)

Polysaccharide	Content (g)	%	Reference methods
Crude polysaccharide	0.98	98	Lai and Yang, 2007
Soluble dietary fiber	0.11	11	AOAC (2016) 991.42, 991.43
Insoluble dietary fiber	0.79	79	AOAC (2016) 991.42

Polysaccharides are polymers made up of sugar subunits and can be classified nutritionally into starches and non-starch polysaccharides[22]. The non-starch polysaccharides are included in dietary fibre and not digested by human digestive enzymes[23]. Degradation of these polysaccharides in the human gastrointestinal tract results from the action of enzymes secreted by the intestinal microflora[24].

Dietary fibre is not a nutrient but still plays an important role in maintaining good health[3]. Diets rich in dietary fibre have been associated with beneficial effects on human health and are sometimes considered to be useful for the prevention of obesity[25]. On the basis of solubility, dietary fibre can be classified into two major components. Insoluble fiber adds bulk to the stools and speeds up the passage of stools through the colon while soluble fiber helps in keeping blood sugar levels stable, and creates a feel of satiety and prevents overeating[3].

Conclusion

Gelatinous substance from bamboo contains dietary fibre and minerals that are beneficial to health. The most predominant mineral found in the Gelatinous substance was silicon which has an important role to play in the formation of healthy bone and connective tissues.

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Conflict of Interest

The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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