Theme: 3.2. Food and Pharmaceuticals

Bamboo shoot fortified cookies as a healthy snack

Oinam Santosh[a], Harjit Kaur Bajwa[a], Madho Singh Bisht[b], Chongtham Nirmala[a*]

[a]Department of Botany, Panjab University, Chandigarh, India-160014

[b]Center for Science Education, NEHU, Shillong, India-793022

*Corresponding and presenting author : Oinam Santosh

E-mail: santoshoinam@gmail.com

Abstract

Bamboo shoot is a less known traditional delicacy consumed in many Asian countries since ancient times. The juvenile shoots are gaining worldwide importance for its health benefits due to its nutritional value and presence of bioactive compounds and are emerging as a potential ingredient for modern functional foods and nutraceuticals. The fresh juvenile shoots have been used since ancient times as food and medicine and have now gained recognition for various functional merits as a dietary supplement, food antioxidant, cosmetic ingredient and as a nutraceutical component for preventing diseases. During the last decade, people have become very concerned about health and a busy lifestyle has made people depend more on functional or fortified foods as they provide health benefits beyond the basic nutritional functions. In the present work, young juvenile shoots were processed and used for preparing fortified cookies. Higher nutrient and mineral content was observed in oven dried bamboo shoot flour as compared to wheat flour. Minerals analysis by Wavelength Dispersive X-ray Fluorescence Spectroscopy showed that potassium content was very high (5050mg/100g) in oven dried bamboo shoot flour. The incorporation of bamboo shoots shows increase in the nutritional value in fortified cookies as compared to control cookies. Oven dried bamboo shoot flour cookies shows higher content of amino (0.20/100g), protein (0.97g/100g), carbohydrate (14.48g/100g), starch (64.60g/100g), moisture (0.38g/100g) and ash (1.04g/100g). Bamboo shoots that are rich in nutrients and bioactive compounds can be used for the enrichment of bakery products such as cookies to produce healthy snacks.

Keywords: Bamboo shoot, Fortification, Cookies, Nutrition.

Introduction

Bamboo is one of the most economically important plants in the world as every part of the plant - culm, rhizome, root, leaves and young shoots can be used for different purposes. It is mostly known for its industrial uses but less recognized as a source of food or medicine. The young emerging shoots are a delicacy in many Asian countries and it is considered as an ideal vegetable for healthy diet (RFRI 2008). Bamboo shoots are gaining worldwide importance for its health benefits due to its nutritional value and presence of bioactive compounds and are emerging as a potential ingredient for

modern functional foods and nutraceuticals. The fresh juvenile shoots have been used from ancient times as food and medicine and have now gained recognition for various functional merits as a dietary supplement, food antioxidant, cosmetic ingredient and as a nutraceutical component for preventing diseases. The young shoots are not only delicious but are rich in nutrients, mainly proteins, carbohydrates, minerals, vitamins, and fiber and are low in fat and sugar (Shi and Yang 1992; Nirmala et al. 2011). However, the food potential of bamboo shoot remains as an underutilized seasonable vegetable. In most of the countries, people are still using the old-age traditional technology for processing and preserving the shoots and preparing traditional food items which are not liked by the modern generation, due to which bamboo is losing its popularity amongst the younger generation. Bamboo shoot has attracted significant research and commercial interest, and is gaining popularity as food item due to its many health promoting bioactive compounds which include effectiveness in decreasing blood pressure, cholesterol, increasing appetite, having anti-cancerous and anti-diabetic properties (Park and Jhon 2009; Hong et al. 2010; Koide et al. 2011; Nirmala et al. 2011; Singhal et al. 2013). It is also reported to be a good source of minerals such as K, P, Na, Mg, Ca, and Fe and it also contains trace elements such as cadmium, cobalt, copper, nickel, manganese, selenium, and zinc (Nirmala et al. 2011; Saini et al. 2017). Micronutrient deficiency is the source of hidden hunger in the world today affecting over two billion people worldwide (Abeshu and Geleta 2016). A way to address such deficiencies cheaply is through food fortification or supplementation and bamboo shoots which is rich in minerals and vitamins is a potential source.

Cookies are very popular and an easily available food products in most of the places due to low cost, satisfying taste, longer shelf life and more. Nowadays, consumers are not only concerned for energy giving food items but have also interest for food providing health benefits. The development of novel products fortified with bamboo shoots will enrich the quality of the food products and also open an area to take maximum benefit of this highly nutritive and healthy vegetable. In order to utilize this health food and to make it available throughout the year, there is a need for incorporation of the shoot for making common food products that is easily available throughout the year to overcome the malnutrition and food insecurity that is common particularly in rural areas.

Material and Methods

Material

Preparation of bamboo shoot sample

The juvenile shoots of *Dendrocalamus hamiltonii* Nees & Arn. ex Munro was procured from the local vegetable market of Shillong, Meghalaya (India), during the peak season from June- September and transported to Department of Botany, Panjab University, Chandigarh, India. The shoots were washed, peeled and cut into small chunks. Shoots were spread over a tissue paper to remove excess water and dried in an oven at 60^0C for 24 hour. The samples were grounded to powder and put inside a glass

bottle, sealed tightly and stored in a freezer until further use. Wheat flour was procured from the local market Sector 14, Chandigarh, India.

Figure 1. *Dendrocalamus hamiltonii* Nees & Arn. ex Munro, (A) Young shoots, (B) Peeled shoots, (C) Chunks, (D) Oven dried bamboo shoot flour.

Preparation of bamboo shoot cookies

Fortified cookies were prepared, with wheat flour and/ or oven dried bamboo shoot flour. One formulation was kept as control having only 100g wheat flour. In the other formulations 10% of wheat flour was replaced with oven dried bamboo shoot flour. The other ingredients used were as: ghee or clarified butter (30g), sugar (40g), milk (60ml) and baking powder (2g). All the ingredients were mixed for 5-10 min to make the dough. Uniform biscuits of thickness 3mm and a circular 2.5 diameter were prepared using a wooden rolling pin and baked at 200^{o}C for 15-20 min. Biscuits were cooled at room temperature and placed in an airtight glass bottle for further analysis.

Figure 2. A. Control cookies B. Oven dried bamboo shoot flour fortified cookies

Methods

Nutritional analysis for wheat flour, oven dried bamboo shoot flour, control cookies and oven dried bamboo shoot flour fortified cookies was performed using the established methods. Carbohydrate content was estimated by using the method of Whistler (1971), starch content by the method of MeCreddy et al. (1950), amino acids by the method of Lee and Takahashi (1966) and protein content by the method of Bradford (1976). Estimation of moisture content was done by weighing 1 g of sample and drying in an oven at 60_0C for 24 hrs. The ash content in the sample was estimated by using the dry-ashing method of Harbers (1994). The estimation of crude fat was done by using the Soxhlet method given by AOAC (1990).

Mineral content was estimated using Wavelength Dispersive X-ray Fluorescence Spectroscopy (WDXRF, S8 TIGER, Bruker, Germany) controlled by software Quant Express. All measurements were carried out for about 20 min in an individual sample. For analysis, samples were homogenized to a fine powder with mortar pestle and were sieved to attain a particle size less than 50 μm.

Result and Discussion

Nutrient and mineral content of bamboo shoot and wheat flour

Wheat is a good source of nutrients but some of the minerals which are essential for normal diet are not found in significant amount. In order to improve its nutritional value, the flour is fortified to overcome the deficiency. Bamboo shoot is one such plant which is a delicious vegetable, rich in nutrients and has a number of health promoting bioactive compounds. The young shoots are reported to be a good source of minerals such as K, P, Na, Mg, Ca, and Fe along with trace elements such as cadmium, cobalt, copper, nickel, manganese, selenium, and zinc (Nirmala et al. 2011; Saini et al.

2017). In the present study, as compared to wheat flour, oven dried bamboo shoot flour shows higher content of amino acids (8.89g/100gm), protein (9.61g/100g), carbohydrates (9.80g/100g), moisture (3.50g/100g), ash (8.92g/100g) and fat (14.63g/100g) except starch (Table 1). Oven dried bamboo shoot flour also shows higher mineral content as compared to wheat flour (Table 2). Potassium, an essential macro-element is a heart-friendly mineral which helps to maintain normal blood pressure and in oven dried bamboo shoot flour its content (5050mg/100g) was very high as compared to wheat flour (160mg/100g). Iron content was estimated to be 2.4 mg/100g in wheat flour and 7.1 mg/100g in oven dried bamboo shoot flour. Iron deficiency is very prevalent in many parts of the world, particularly in developing countries like India (Kotecha 2011) and fortification of common and popular food items like biscuits with bamboo shoots can increase the iron content. Zinc is another micro mineral element and its deficiency may lead to retarded skeletal development and immunodeficiency disorders. In oven dried bamboo shoot flour, Zinc was found to be very much higher with 8.9 mg/100gm as compared to 1.2 mg/100gm in wheat flour. The content of copper was also higher (0.8 mg/100gm) in oven dried bamboo shoot flour compared to wheat flour (2.1 mg/100g). Bamboo is one of the richest sources of organic silicon and 190 mg/100g of silica was found in oven dried bamboo shoot flour whereas 28 mg/100gm in wheat flour. Dietary minerals are of great interest for health specialist and consumers, due to the number of biochemical processes they are involved in, and the benefits of their adequate and balanced intake have been highlighted.

Trace elements in bamboo shoots associated with antioxidant defense system are selenium, zinc, copper, iron, and manganese. These minerals are also indispensable for the activities of various antioxidant enzymes and their deficiencies have profound effects on metabolism and tissue structure. Hidden hunger due to micronutrient deficiency affecting billions of people worldwide can be minimize through food fortification or supplementation and bamboo shoots which is rich in minerals and vitamins is a potential ingredients.

Table 1. Nutrients (g/100g) comparison for wheat flour and oven dried *D. hamiltonii* shoot flour.

Parameter	Wheat flour	Oven dried bamboo shoot flour
Amino acid	0.21±0.01	8.89±0.01
Proteins	9.00±0.20	9.61±0.03
Carbohydrates	0.65±0.01	9.80±0.62
Starch	76.51±1.59	12.25±0.35
Moisture	8.72±0.50	3.50±0.28
Ash	0.62±0.15	8.92±0.03
Fat	1.75±0.12	14.63±0.31

Values reported are measurement replication means ± standard deviation (n = 03 replicates).

Table 2. Minerals (mg/100g) comparison for wheat flour and oven dried *D. hamiltonii* shoot flour.

Minerals	Wheat Flour	Oven dried bamboo shoot flour
K	160	5050
P	150	590
S	130	290
Na	-	20
Cl	60	890
Mg	50	230
Ca	30	170
Si	28	190
Zn	1.2	8.9
Fe	2.4	7.1
Cu	0.8	2.1
Ni	0.5	0.7

Nutrient content of oven dried bamboo shoot cookies

The proximate composition (Table 3) shows that cookies fortified with oven dried bamboo shoot flour has higher content of amino acids (0.20g/100gm), proteins (0.97g/100g), carbohydrates (14.48g/100g), starch (64.60g/100g), moisture (0.38g/100g) and ash (1.04g/100g) as compared to the control cookies whereas the content was amino acids (0.06g/100gm), proteins (0.40g/100g), carbohydrates (9.16g/100g), starch (57.05g/100g), moisture (0.14g/100g) and ash (0.62g/100g). The fat content was higher in control cookies. The amino acid content was observed to increase by more than thrice in oven dried bamboo shoot flour fortified biscuits. The increase in protein content of cookies fortified with bamboo shoot flour was also reported by Mustafa et al. (2016) and Choudhury et al. (2015). Sood et al., (2013) also reported increased protein content in bamboo shoot fortified nuggets and crackers. The starch content increased around 13.23% in oven dried bamboo shoot flour fortified biscuits. Increase of starch content in oven dried bamboo shoot flour fortified biscuits may be due to hydrolysis of starch as a result of heat treatment (Rehman and Shah 2005). The ash content of fortified cookies increased up to 67.74%. The increase in ash content may be due to the high mineral content in the fortified cookies (Francischi et al. 1994). The fat content of control biscuits was 26.23 g/100g and 22.00 g/100g in oven dried bamboo shoot fortified biscuit which showed decreased of about 16.13%. This was probably due to low fat content of bamboo shoot (Shi and Yang 1992; Nirmala et al. 2011).

Bamboo shoots, with their high nutritive and therapeutic value hold great promise for utilization as a health food. Recipes such as chutney, pulao, halwa, curry, and bhaji have been standardized by Engineering Resource Group, Bangalore (NMBA 2009). Several other value-added products such as candies, nuggets, crackers, chutney, chips, cookies, chappaties, and buns have now been prepared from bamboo shoots. Farris and Piergiovanni (2008) prepared a popular Italian food namely, 'Amaretti cookies' using bamboo fiber as an ingredient. Incorporation of bamboo fiber imparted a characteristic flavor, texture and taste to the cookies. Bamboo shoots not only improved their shelf-life, sensory and nutritional qualities but also increased their physicochemical and nutraceutical properties.

Table 3. Comparison of nutrients (g/100g) in control and oven dried bamboo shoot flour fortified cookies.

Parameter	Control Cookies	Oven dried bamboo shoot flour fortified cookies
Amino acid	0.06±0.01	0.20±0.01
Proteins	0.40±0.07	0.97±0.04
Carbohydrates	9.16±0.43	14.48±0.27
Starch	57.05±0.63	64.60±0.18
Moisture	0.14±0.04	0.38±0.08
Ash	0.62±0.02	1.04±0.09
Fat	26.23±0.49	22.00±0.30

Values reported are measurement replication means ± standard deviation (n = 03 replicates).

Conclusion

Bamboo shoots are a rich source of nutrients and health promoting bioactive compounds such as phenols, phytosterols, and dietary fiber. A large number of studies in a variety of *in vitro* and *in vivo* system show that dietary fiber, phenols, and phytosterols have many biological effects that potentially might contribute to prevention of coronary heart diseases, cancer, diabetes and more. The present study revealed that, cookies fortified with oven-dried bamboo shoot flour had high amount of amino acid, protein, carbohydrate and starch content which holds a great promise for utilization in the development of novel bamboo shoot-based food products. The results indicate that oven-dried bamboo shoot flour being a rich source of nutrients, could also be utilized for the preparation of bakery products with improved nutraceutical qualities.

Acknowledgement

The authors are grateful to the Ministry of Food Processing Industries and Department of Biotechnology, New Delhi, Govt. of India, American Bamboo Society and Ned Jaquith Foundation, USA for providing financial assistance to conduct this research work.

Reference

Abeshu, M.A.; Geleta, B. 2016. The Role of fortification and supplementation in mitigating the 'hidden hunger'. Journal of Nutritional Science 6,459.

AOAC 1990. Official Methods of Analysis. (15th ed.). Association of Official Analytical Chemists, Washington, DC.

Bradford, M.M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Analytical Biochemistry, 144, 514-531.

Choudhury, M.; Badwaik, L. S.; Borah, P.K.; Nandan, S.; Deka, C. S. 2015. Influence of bamboo shoot powder fortification on physico-chemical, textural and organoleptic characteristics of biscuits. Journal of Food Science and Technology, 52(10), 6742–6748.

Farris, S.; Piergiovanni, L. 2008. Effects of ingredients and process conditions on 'Amaretti' cookies characteristics. International Journal of Food Science and Technology, 43, 1395–1403.

Francischi, D.; Salgado, J.M.; Leitao, R.F.E. 1994. Chemical, nutritional and technological characteristics of buckwheat and non-prolamine buckwheat flours in comparison of wheat flour. Plant Foods for Human Nutrition, 46, 323-329.

Harbers, L.H. 1994. Ash analysis In: Introduction to Chemical Analysis of Foods (ed. Nielsen, S.S.). Jones and Bertlett Publishers, Boston, London, 113-121.

Hong, E.J.; Jung, E.M.; Lee, G.S.; Kim, J.Y.; Na, K.J.; Park, M.J.; Kang, H.Y.; Choi, K.C.; Seong, Y.H.; Choi, I.G.; Jeung, E.B. 2010. Protective effects of the pyrolyzates derived from bamboo against neuronal damage and hemato aggregation. Journal of Ethnopharmacology, 128(3): 594-599.

Koide, C.L.; Collier, A.C.; Berry, M.J.; Panee, J. 2011. The effect of bamboo extract on hepatic biotransforming enzymes–findings from an obese-diabetic mouse model. Journal of Ethnopharmacology, 133: 37–45.

Kotecha, P.V. 2011. Nutritional anemia in young children with focus on Asia and India. Indian Journal of Community Medicine, 36(1), 8.

Lee, Y.D.; Takahashi, T. 1966. An improved colorimetric determination of amino acids with use of ninhydrin. Annals of Biochemistry, 14, 71-77.

Mecreddy, R.M.; Guggolz, J.; Silviera, V.; Owens, H. S. 1950. Determination of starch and amylose in vegetables. Analytical Chemistry, 22(9), 1156-1158.

Mustafa, U.; Naeem, N.; Masood, S.; Farooq, Z. 2016. Effect of bamboo powder supplementation on physicochemical and organoleptic characteristics of fortified cookies. Food Science and Technology, 4(1), 7-13.

NMBA 2009. Bamboo shoot composition. National Mission on Bamboo Application. http://www.bambootech.org/subsubTOP.asp?subsubid¼89&subid¼29&sname¼USAGE.

Nirmala, C.; Bisht, M. S.; Sheena, H. 2011. Nutritional properties of bamboo shoots: Potential and prospects for utilization as a health food. Comprehensive Review in Food Science and Food Safety, 10, 153–169.

Park, E.J.; John, D.J. 2009. Effects of bamboo shoot consumption on lipid profiles and bowel function in healthy young women. Nutrition, 25(7-8): 723–728.

RFRI 2008. Bamboo as food and medicine. Report of Rain Forest Research Institute (RFRI). Jorhat, India.www.icfre.gov.in/new/rfri/Bamboo_%20food_%20medicine_ 221206.pdf. Accessed on 11th March, 2010.

Rehman, Z.; Shah, W.H. 2005. Thermal heat processing effects on antinutrients, protein, and starch digestibility of food legumes. *Food Chemistry*, *91*, 327–331.

Saini, N.; Rawat, K.; Bisht, M.S.; Nirmala, C. 2017. Qualitative and Quantitative Mineral Element Variances in Shoots of two Edible Bamboo species after Processing and Storage Evaluated by Wavelength Dispersion X-ray Fluorescence Spectrometry. International Journal of Innovative Research in Science, Engineer and Technology, 6(5), 8262- 8270.

Shi, Q.T.; Yang, K.S. 1992. Study on relationship between nutrients in bamboo shoots and human health. Proceedings of the International Symposium on Industrial Use of Bamboo: Bamboo and Its Use, International Tropical Timber Organization and Chinese Academy: Beijing, China, 338–346.

Singhal, P.; Bal, L.M.; Satya, S.; Sudhakar, P.; Naik, S.N. 2013. Bamboo shoots: a novel source for food and medicine. Critical Reviews in Food Science Nutrition, 53(5), 517–534.

Sood, S.; Walia, S.; Gupta, M.; Sood, A. 2013. Nutritional Characterization of Shoots and Other Edible Products of an Edible Bamboo – *Dendrocalamus hamiltonii.* Current Research in Nutrition and Food Science, 1(2), 169-176.

Whistler 1971. Methods in Carbohydrate Chemistry. Academic Press Inc., New York, 1-6.