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The effects of bamboo shoots on lipid profile and body weight in healthy Balb/c mice

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Abstract
This study was designed to evaluate the effect of fresh and processed shoots of *Dendrocalamus hamiltonii* (Nees & Arn Ex Munro) on the body weight and lipid profile in healthy male Balb/c mice with a view to providing preliminary information toward effective utilization of processed shoots in developing safe functional foods and nutraceuticals. Aqueous extracts of fresh and different processed bamboo shoots were administered orally to the Balb/c mice (n=6 in each group) at the dose levels of 800 mg/kg, body weight for six successive weeks. Levels of serum total cholesterol (TC), high-density lipoproteins (HDL), low-density lipoproteins (LDL) and triglyceride (TG) were measured by using commercially available standard kits. The level of total cholesterol, triglyceride and low-density lipoproteins decreased significantly in all the groups with highest decrease in the group treated with fermented shoots (TC: 30%, TG: 48%, LDL: 62%) when compared with the control group. Fermented shoots also caused 6% decrease in the body weight of the mice. Hence, it was concluded that fermented shoots may be an effective way to tackle dyslipidemia and probably obesity which is a highly prevalent problem of the modern world and also a leading cause of cardiovascular diseases.

Keywords: Bamboo shoots, fermentation, bioactive compounds, obesity, lipid profile

Introduction
Cardiovascular diseases (CVDs) are identified as the prime root of death and its prevalence is rapidly growing in every region of the world [1]. Overweight and obesity has been shown to be a risk factor for CVDs worldwide [2, 3]. In addition to CVDs, obesity also increases the possibility of developing a number of pathological disorders, including hypertension, stroke, diabetes, cancer, sleep apnea and respiratory problems [4, 5]. The amount of calories people eat has a direct impact on their weight and lipid profile. There is ample research on foods and diet patterns that protect against heart diseases, stroke, diabetes and other chronic diseases. Low-fat diets such as fruits and vegetables have long been touted as the key to a healthy weight and to good health. Bamboo shoot is known as a heart protective vegetable because of its low content of fat and calories and high content of potassium [6]. It is mainly consumed as vegetable, salad, pickle, and in preparation of different types of curries and dishes in many Asian countries especially in India, China and Japan [7, 8].

Fresh juvenile bamboo shoot contains water (91%), proteins (3.5%), fiber (1.5%), minerals, vitamins and amino acids [6, 9, 10]. In addition to the nutrients, shoots contain bioactive compounds such as phenols, phytosterols, dietary fiber and more that have potential health benefits including anti-inflammatory, anti-oxidants, serum cholesterol lowering, anti-ulcer, and anti-cancer [11-14]. Nowadays, bamboo shoots, with their high nutritive and therapeutic value hold a great promise for utilization as a healthy food. However, freshly harvested shoots are generally consumed after processing and long term preservation due to the presence of high content of cyanogenic glycoside and very short shelf life of shoots [15]. The major processing techniques which are commonly used for enhancing shelf life of shoots and removal of anti-nutrients are soaking, boiling, salting and fermentation.

Processing improves palatability, increases shelf-life and, detoxifies shoots by removing anti-nutrients [16]. But along with enhancement of shelf life and palatability, it often brings about changes in many attributes of shoots including its nutritional, antioxidant and therapeutic value [17]. Hence, it is necessary to test the therapeutic quality of processed bamboo shoots using efficient techniques. Keeping this into consideration, a study has been carried out to find the impact of boiling, brine preservation and fermentation on the body weight and lipid profile in Balb/c mice with a view to providing preliminary information toward effective utilization of processed shoots in developing safe functional foods and possibly neutraceuticals.

Material and Methods

Collection and processing of Bamboo shoots

The juvenile shoots of *Dendrocalamus hamiltonii* were used for the study. Shoots were collected from Shillong, Meghalaya and transported to Botany Department, Panjab University, Chandigarh by air. In the Laboratory, shoots were washed properly under tap water and culm sheaths were removed. The shoots were then cut into thin slices, divided into four equal portions and subjected to processing (boiling (15 min), brine treatment (5%), fermentation) and dried at 40 °C. Thereafter, the shoots were pulverized to fine powder using mortar and pestle.

Preparation of the extract

Bamboo shoot extract was prepared by the method of Bajwa *et al.* [18]. For preparation of aqueous extract, 10 g of each sample of bamboo shoot powder was taken and soaked in 100 ml of distilled water in a conical flask, plugged with cotton wool and then kept on a rotary shaker at 120 × g for 24 hr. Extract was then filtered and dried using a hot air oven at low temperature. The dried crude extract was weighed and stored in a refrigerator at 4°C in air tight bottles and used for further experiment.

Experimental design

Healthy male Balb/c mice weighing 25-30 g each, procured from Central Animal House, Panjab University, Chandigarh, were housed in polypropylene cages, bedded with sterilized rice husk. Animals were maintained at Department of Biophysics, Panjab University, Chandigarh. Mice in all the groups had free access to standard animal pellet diet (Ashirwad Industries Ltd., Ropar, Panjab) and clean tap water throughout the experiment. They were maintained in a 12 hr light/dark cycle at 25 ± 2 °C. All the experimental protocols were approved by the Institutional Ethics Committee (Panjab University, Chandigarh, India) and conducted according to the Indian National Science Academy Guidelines for the use and care of experimental animals. Mice were randomly assigned into five groups (n=6 in each group). Group-1 served as control group; received tap water and feed *ad libitum*. Group II animals received the fresh shoots extract, group III animals administered the extract of fermented shoots; group IV animals were given the extract of brine treated shoots while group V animals received the extract of boiled shoots. Fresh doses were prepared every day in distilled water and administered to the animals using oral gavage tube at the dose levels of 800 mg/kg, body weight in the dose volume of 1 ml/kg, body weight. The body weight of all the animals was measured once per week throughout the study period by using digital balance. After completion of the treatment period, the animals were kept on fasting overnight and blood was withdrawn from the retro-orbital plexus of the mouse eye with a capillary. Blood (500 µl) was withdrawn in micro centrifuge tubes and incubated in an upright position at 37 °C for 3 hr to allow clotting. After incubation, it was kept at 4 °C for 30 minutes and then centrifuged at 3000 × g for 10 min and the serum was carefully aspirated for further study. Organ weight changes are also accepted as a sensitive indicator of chemically induced organ damage because changes in organ weight might reflect changes in overall body weight. Therefore, the animals were sacrificed by cervical dislocation under chloroform general anesthesia; the liver and kidney tissues were collected and weighed using electronic weighing balance to determine the organ-body weight relationship.

Assessment of lipid profile

Serum total cholesterol (TC), high-density lipoproteins (HDL) and triglyceride (TG) level was measured using commercially available standard kit namely Med source (Medsource Ozone Bio-medicals Pvt. Ltd. Faridabad, India) and serum low-density lipoproteins (LDL) level was estimated using commercially available kit namely Meril Diagnostics Pvt. Ltd. Maharashtra, India.

Statistical analysis

The data obtained from the experiments are expressed as mean ± SD (standard deviation) and analyzed by comparison between the means of two unrelated groups by using student's t-test. One way ANOVA (analysis of variance) was used to determine whether there is any significant difference between the means of two or more independent groups followed by post-hoc test.

Results

Daily oral administration of aqueous extract of fresh, fermented, brine treated and boiled shoots of *D. hamiltonii* for six consecutive weeks did not induce any obvious symptom of toxicity in mice. No lethality was recorded during the observation period following fresh and processed shoots extract administration. The body weight of control, and boiled shoots treated group increased normally during experimental period while, the body weight of animals treated with brine preserved shoots first increased but a slight decrease was seen at the end of the study period (Table 1). Similarly, a decrease was observed in the body weight of animals treated with fermented shoots when compared with the control and other treatment groups (Fig. 1). Regarding organs, a significant increase was seen in the weight of liver of animals treated with fresh (4%) and brine preserved (9%) shoots while, liver weight decreased significantly in the animals treated with fermented (31%) and boiled (14%) shoots as compared to the control group (Table 1). The weight of kidneys increased in all the groups except fermented shoot administered animals where decrease in the weight was observed as compared to the control and other groups. The changes observed in the weight of kidneys were found to be statistically significant as compared to the control group (Fig. 2).

Table 1: Effect of fresh and processed shoots of *D. hamiltonii* on body and organs weight in Balb/c mice.

Weight (g)	Control	Fresh shoots	Fermented shoots	Brine preserved shoots	Boiled shoots
Initial body weight	31 ± 2.04	37 ± 0.72	36 ± 0.42	33 ± 0.57	30 ± 1.29
First week	35 ± 1.11	37 ± 0.17	36 ± 0.55	34 ± 0.92	32 ± 0.08
Second week	36 ± 0.78	38 ± 0.75	37 ± 0.05	38 ± 0.53	36 ± 1.51
Third week	37 ± 1.03	38 ± 1.16	37 ± 0.71	38 ± 0.64	37 ± 0.75
Fourth week	37 ± 1.31	38 ± 0.06	34 ± 1.31	37 ± 0.52	36 ± 0.14
Fifth week	38 ± 0.92	38 ± 0.26	34 ± 1.13	37 ± 1.34	37 ± 0.69
Sixth week	38 ± 1.10	37 ± 0.18	33 ± 2.07	37 ± 0.91	37 ± 0.39
Liver weight	1.37 ± 0.21	1.42 ± 0.17	0.948 ± 0.09	1.50 ± 0.14	1.17 ± 0.23
Kidney weight*	0.247 ± 0.04	0.295 ± 0.03	0.228 ± 0.05	0.270 ± 0.06	0.269 ± 0.04

Values are expressed as mean ± SD (n = 6 in each group): *Mean weight of both kidneys

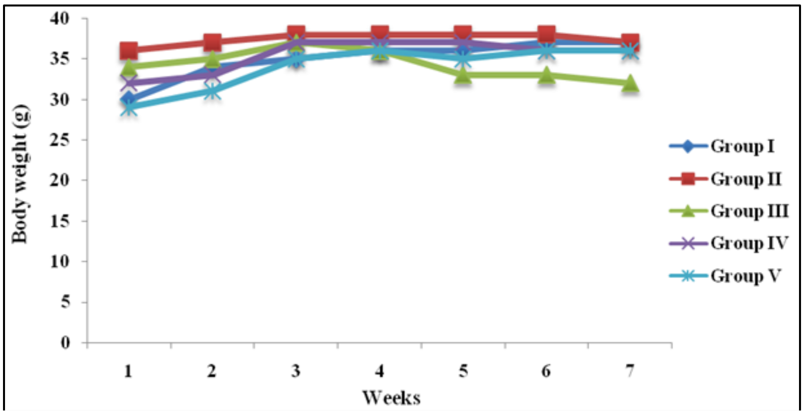

Fig 1: Comparison of body weight (g) changes among five groups of control (Group I), fresh shoots (Group II), fermented shoots (Group III), brine preserved shoots (Group IV), and boiled shoots extract (Group V) administered mice

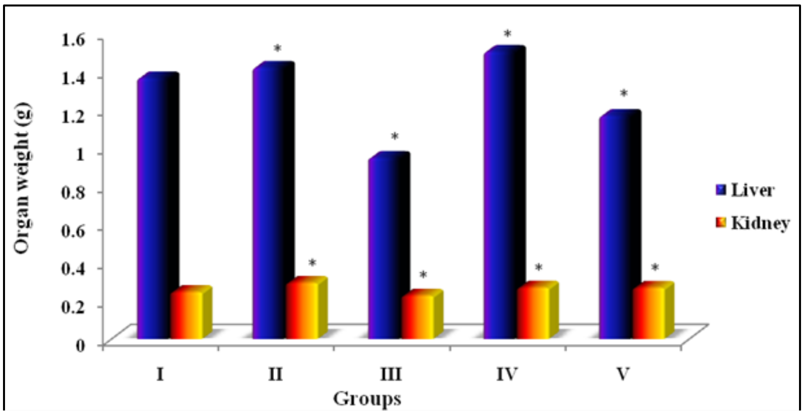

Fig 2: Comparison of changes in the weight (g) of liver and kidneys among five groups of control (Group I), fresh shoots (Group II), fermented shoots (Group III), brine preserved shoots (Group IV), and boiled shoots extract (Group V) administered mice; (*P < 0.05) significant as compared to control group

In regard to the concentrations of TC, TG, LDL and HDL, bamboo shoot treated groups had significantly lowered TC, TG and LDL levels compared with the control group (Table 2). HDL level increased in all the groups, but the increase was found to be non-significant in the group treated with boiled shoots. When compared among the groups, the mice received fermented shoot extract had the lowest level of TC (82 ± 3.22 mg/dl), LDL (8 ± 0.74 mg/dl) and TG (119 ± 1.87 mg/dl) but highest level of HDL (97 ± 1.13 mg/dl) (Fig. 3).

Table 2: Effect of fresh and processed shoots of *D. hamiltonii* on lipid profile (mg/dl)

Parameter	Control	Fresh shoots	Fermented shoots	Brine preserved shoots	Boiled shoots
TC	118 ± 3.67	106 ± 4.25	82 ± 3.22	100 ± 1.13	97 ± 2.23
HDL	90 ± 0.94	94 ± 0.53	97 ± 1.13	93 ± 1.33	91 ± 0.61
LDL	21 ± 3.44	16 ± 1.52	8 ± 0.74	13 ± 2.84	10 ± 2.73
TG	228 ± 0.81	131 ± 1.35	119 ± 1.87	211 ± 3.84	176 ± 1.45

Values are expressed as mean ± SD (n=6 in each group)

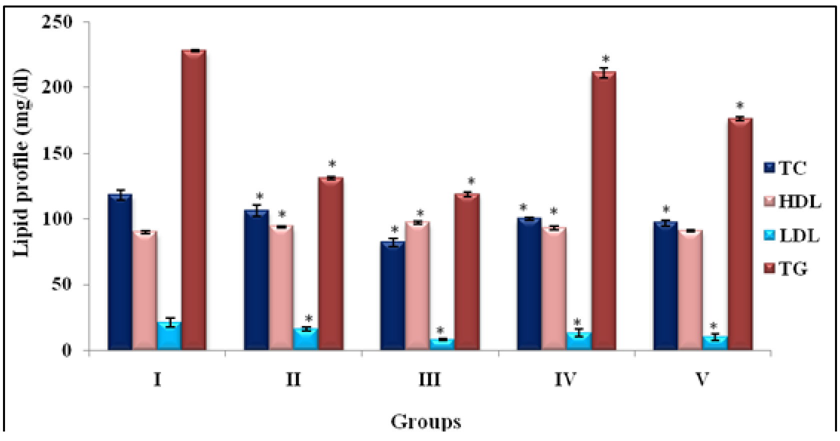

Fig 3: Comparison of changes in the level of total cholesterol, HDL, LDL and triglyceride among five groups of control (Group I), fresh shoots (Group II), fermented shoots (Group III), brine preserved shoots (Group IV), and boiled shoots extract (Group V) administered mice; (*P < 0.05) significant as compared to control group

Discussion

The present study shows the impact of fresh and processed shoots of *Dendrocalamus hamiltonii* on the body weight and lipid profile in Balb/c mice. When mice were administered with the aqueous extracts of fresh, fermented, brine treated and boiled shoots, a marked reduction was observed in the concentrations of serum TC, TG and LDL. This is evident from the data shown that, fermented bamboo shoots can play a vital role in maintaining a healthy body weight. These results are in accordance with the work of Park and Jhon [12] who found that bamboo shoots are rich in dietary fiber and could be used as functional ingredients as they improve not only digestive health, but also weight management, cardiovascular health and general wellness. The fiber content in bamboo shoots can be classified as Nutrient detergent fiber (NDF) which consisting of hemicellulose, cellulose, and lignin and Acid detergent fiber (ADF), primarily representing cellulose and lignin [19]. Bajwa *et al*. [17] analyzed the fiber content for the fresh, fermented, brine treated, and boiled shoots of *D. hamiltonii*. Results revealed a significant increase in the concentrations of ADF (47%), NDF (64%), lignin (69%), hemicellulose (102%) and cellulose content (40%) after fermentation. The majority of studies indicate that an increase in either soluble or insoluble fiber intake, increase post meal satiety and decrease subsequent hunger. The consumption of an additional 14 g per day fiber for more than two days is associated with a 10% decrease in energy intake and body weight loss of 1.9 kg over 3.8 months because fiber intake is inversely associated with body weight and body fat [20, 21]. Moreover, bamboo shoots are cheap source of fiber as compared to the oat, corn, potato, peas and soybean and now a common ingredient in breakfast cereals, shredded cheese, sauces, ketchup, beverages, fruit juices, meat products and bakery products [22]. Farris and Piergiovanni [23] found that incorporation of bamboo shoot fiber imparted a characteristic flavor, texture and taste to the cookies.

The serum TC, TG and LDL level in control group (118, 228, 21 mg/dl with standard deviation 3.67, 0.81, 3.44 respectively) was higher than bamboo shoot treated groups. It has been reported that, phytosterols are the main constituents in bamboo shoots which are responsible for hypocholesterolemic activity[24]. They are safe and effective cholesterol-lowering agents found in plant-based food. The level of total phytosterols in bamboo shoots ranged from 0.12% to 0.19% on dry weight basis in different bamboo species [25]. The key phytosterols identified in bamboo shoots are β-sitosterol (24.6%), campesterol (2.2%), stigmasterol (1.2%), ergosterol (0.2%), cholesterol (0.6%), and stigmastanol (<0.1%) [34]. Compared to fresh shoots, in fermented shoots, dietary fiber and phytosterol content increased to almost double which might be responsible for hypocholesterolemic and weight lowering activities of fermented shoots. The increase in phytosterol content in the fermented shoots is possibly due to anaerobic digestion by microorganism that caused degradation of organic matter and resulted in the enrichment of phytosterols [27].

Fermentation is a popular traditional method used for processing bamboo shoots. This technique not only preserves the shoots but also enhances the nutrient value, flavor and improve pharmacological values [28, 29]. In the North-east region of India, fermented shoots are very popular and eaten as a delicacy. The products from these shoots are known variously in different states of India as soibum, soidon, soijin in Manipur, mesu in Sikkim, rep in Mizoram, lung-siej in Meghalaya and iku, ipe, hikku, hi, nogom and hiring in Arunachal [30]. Though the shelf-life of brine preserved shoots was reported to be one month without any deteriorative changes in colour, flavor and texture [31], people rarely use brine preserved shoots as off-season vegetable in North-east region. For seasonal consumption, boiling is a commonly followed method for removal of antinutrients and other unwanted matter from bamboo shoots. RAS [32] reported 91% reduction in cyanide content when bamboo shoot slices were boiled in water for 15 minutes. Ferreira *et al*. [33] demonstrated that bamboo shoots contain 1000 mg/kg of cyanogenic glycoside in the apical portion of the shoots but boiling in water for 20 minutes at 98 ºC removed nearly 70% of the cyanogenic content while boiling at higher temperature for longer intervals removed up to 96% of cyanogenic content. Boiled shoots are soft in texture and sweet in taste hence, can be eaten as salad or used for value addition in number of food products such as bakery, dairy and meat products.

Conclusion

Bamboo shoot processing may decrease or increase the concentration of nutrients and bioactive compounds that further affect the nutritional and therapeutic value of the shoots. When Balb/c mice were administered with aqueous extract of fresh, fermented, brine preserved and boiled shoots of *D. hamiltonii*, different impacts were seen on the body weight and lipid profile. But no lethality was recorded during the observation period following fresh and processed shoots extract administration. The fermented shoots caused highest decrease in the body weight as well as in the concentrations of TC, TG and LDL of the animals as compared to the control and other groups. It indicated that, fermented shoot consumption may be an effective way to tackle obesity, CVDs and other related health problems and have enormous potential in the food and pharmaceutical industry.

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Conflict of interest

The authors declare that there are no conflicts of interest.

References

1. Kumar S. Cardiovascular Disease and Its Determinants: Public Health Issue. J Clin Med Ther. 2017;2:1.
2. Van Gaal LF, Mertens IL, De Block CE. Mechanisms linking obesity with cardiovascular disease. Nature 2006;444(7121):875-80.
3. Kachur S, Luvie CJ, Schutter AD, Milani RV, Ventura HO. Obesity and cardiovascular diseases. Minerva Medica. 2017;108:212-228.
4. Ali AT, Crowther NJ. Health risks associated with obesity. J Endocrinol Metabol Diabetes. 2005;10(2):56-61.
5. Kim D, Park KP, Yang DJ, Cho ML, Yoo CU, Park J, *et al*. The relationship between obesity and health-related quality of life of office workers. J Phys Ther Sci. 2015;27(3):663-666.
6. Nirmala C, Bisht MS, Sheena H. Nutritional properties of bamboo shoots: Potential and prospects for utilization as a health food. Compr Rev Food Sci Food Saf. 2011;10(3):153-165.
7. Kumbhare V, Bhargava A. Effect of processing on nutritional value of central Indian bamboo shoots. Part 1. J Food Sci Technol. 2007;44(1):29-31.

8. Singhal P, Bal LM, Satya S, Sudhakar P, Naik SN. Bamboo shoots: A novel source of nutrition and medicine. Crit Rev Food Sci Nutr. 2013;53(5):517-534.
9. Sood S, Walia S, Gupta M, Sood A. Nutritional Characterization of Shoots and Other Edible Products of an Edible Bamboo-*Dendrocalamus hamiltonii*. Curr Res Nutr Food Sci. 2013;1(2):169-176.
10. Bajwa HK, Santosh O, Koul A, Bisht MS, Nirmala C. Quantitative determination of macroelement and microelement content of fresh and processed bamboo shoots by wavelength dispersive X-ray fluorescence spectrometry. X-ray spectrum. 2019a;48(6):637-643.
11. Choi J, Lee E, Lee H, Kim K, Ahn K, Shim B, *et al*. Identification of campesterol from *Chrysanthemum coronarium* L and its antiangiogenic activities. Phytother Res. 2007;21(10):952-959.
12. Park EJ, John DJ. Effects of bamboo shoot consumption on lipid profiles and bowel function in healthy young women. Nutrition. 2009;25(7-8):723-728.
13. Bajwa HK, Santosh O, Koul A, Bisht MS, Nirmala C. Antioxidant content and antioxidant activity of aqueous extract from processed shoots of an edible bamboo *Dendrocalamus hamiltonii* Nees & Arn. Ex Munro and their effect on hepatic lipid peroxidation levels in Balb/c mice. J Pharmacogn Phytochem. 2018;7:3248-3255.
14. Dr. Vittal BG, Dr. Abhijith D. Fasting and non-fasting lipid profile: A comparative study. Int. J Adv. Biochem. Res. 2021;5(1):06-08. DOI: 10.33545/26174693.2021.v5.i1a.56
15. Rawat K, Nirmala C, Bisht, MS. Processing Techniques for Reduction of Cyanogenic Glycosides from Bamboo Shoots. In: Proceedings of 10th World Bamboo Congress, theme: Food and Pharmaceuticals, Damyang, Korea 2015, 1-12. http://www.worldbamboo.net/proceedings/wbcx.
16. Chongtham N, Bisht MS, Premlata T, Bajwa HK, Sharma V, Santosh O. Quality improvement of bamboo shoots by removal of antinutrients using different processing techniques: A review. J Food Sci Technol, 2021 Jan 27:1-1. https://doi.org/10.1007/s13197-021-04987-9
17. Bajwa HK, Nirmala C, Koul A, Bisht MS. Changes in organoleptic, physicochemical and nutritional qualities of shoots of an edible bamboo *Dendrocalamus hamiltonii* Nees and Arn. Ex Munro during processing. J Food Process Preserv. 2016a;40(6):1309-1317.
18. Bajwa HK, Santosh O, Koul A, Bisht MS, Nirmala C. Sub-acute oral toxicity evaluation of aqueous extract of bamboo shoots (*Dendrocalamus hamiltonii*) in Balb/c mice. J Food Safe & Hyg. 2019b;5(3):137-145.
19. Yang J, Wu L, Yang H, Pan Y. Using the Major Components (Cellulose, Hemicellulose, and Lignin) of *Phyllostachys praecox* Bamboo Shoot as Dietary Fiber. Front Bioeng Biotechnol. 2021;9:669136. Doi: 10.3389/fbioe.2021.669136
20. Howarth NC, Saltzman E, Roberts SB. Dietary fiber and weight regulation. Nutr Rev. 2001;59(5):129-39.
21. Slavin JL. Dietary fiber and body weight. Nutrition. 2005;21(3):411-418.
22. Nirmala C, Bisht MS, Laishram M. Bioactive compounds in bamboo shoots: Health benefits and prospects for developing functional foods. Int J Food Sci Technol. 2014a;49(6):1425-1431.
23. Farris S, Piergiovanni L. Effects of ingredients and process conditions on ‘Amaretti’ cookies characteristics. Int J Food Sci Technol. 2008;43(8):1395-1403.
24. Lu B, Xia D, Huang W, Wu X, Zhang Y, Yao Y. Hypolipidemic Effect of Bamboo Shoot Oil (*P. pubescens*) in Sprague-Dawley Rats. J Food sci. 2010;75:H205-11. 10.1111/j.1750-3841.2010.01716.x
25. Bajwa HK, Santosh O, Chongtham N. Bioactive Compounds in Bamboo Shoot. In: Murthy, H.N., Paek, K.Y. (Eds) Bioactive Compounds in Underutilized Vegetables and Legumes. Reference Series in Phytochemistry. Springer, Cham 2021. https://doi.org/10.1007/978-3-030-44578-2_24-1
26. Basavaraj V Savadi, Gaurang K Anandpara, BM Rashmi, Bhagyajyoti Nalwarkar. Association of lipoprotein (a) and high-sensitive C-reactive protein in preeclampsia. Int. J Adv. Biochem. Res. 2021;5(1):30-34. DOI: 10.33545/26174693.2021.v5.i1a.62
27. Sarangthem K, Singh TN. Microbial bioconversion of metabolites from fermented succulent bamboo shoots into phytosterols. Curr Sci. 2003a;84:1544-1547.
28. Tamang JP, Tamang N, Thapa S, Dewan S, Tamang B, Yonzan H, *et al*. Microorganism and nutritive value of ethnic fermented foods and alcoholic beverages of North-East India. Indian J Tradit Knowl. 2012;11:7-25.
29. Nimachow G, Rawat JS, Dai O. Prospects of bamboo shoot processing in India. Curr Sci. 2010;98:288-289.
30. Nongdam P. Traditional fermented bamboo shoot foods of North-East India and their characteristic natural microbial flora. In: Proceedings of 10th World Bamboo Congress, theme: Food and Pharmaceuticals Damyang, Korea; c2015 Sep 17. p. 1-13. http://www.worldbamboo.net/proceedings/wbcx.
31. NMBA. Training Mannual on Processing Bamboo Shoots. Training Manual, ed. N.M.B.A. (NMBA). Delhi, India, Department of Science & Technology, Government of India, 2005, 33.
32. RAS (Risk Assessment Studies). Natural Toxins in Food Plants. Report No. 27, 2007 Available at: http://www.cfs.gov.hk/english/programme/programme rafs/programme rafs fc 01 17 report.html.
33. Ferreira VLP, Yotsuyanagi K, Carvalho CRL. Elimination of cyanogenic compounds from bamboo shoots (*Dendrocalamus giganteus* Munro). Trop Sci. 1995;35:342-346.
34. Lu B, Ren Y, Zhang Y, Gong J. Effects of genetic variability, parts and seasons on the sterol content and composition in bamboo shoots. Food Chem. 2009;112(4):1016–1021.
35. Nirmala C, Bisht MS, Santosh O, Bajwa HK, Indira A. Mineral elements in Bamboo shoots and Potential role in Food Fortification. J Food Compost Anal. 2021;95:e103662. doi.org/10.1016/j.jfca.2020.103662