Research Article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Cyanogenic Glycoside Reduction of Bamboo Shoots Species and Their Prospective as Food Victuals

Neelam Chaturvedi[1], Neha Sahrawat[2], *Saloni Dua[3], and Prachi Banjola[4]

[1]Associate Professor, [2,3,4]Research Scholar
Department of Food Science and Nutrition, *BanasthaliVidyapith*, Rajasthan-304022, India.
*E-mail: salonidua345@gmail.com
DOI -https://doi.org/10.37794/IJSRR.2023.12405

ABSTRACT:

Bamboo encompasses a diverse array of bioactive compounds along with cyanogenic glycoside (*taxiphyllin*) that has deleterious impacts on human health. In the present study, an assessment of the nutritional and antioxidant profiles has been evaluated for two species of bamboo shoots and a diverse array of processing techniques were adapted to mitigate the presence of harmful taxiphyllin. The results for proximate parameters showed that *Bambusa vulgaris* had high levels of protein (4.41g/100g) and fiber (3.81g/100g) whereas,*Dendrocalamushamiltonii* exhibits high levels of iron (2.45mg/100g), calcium (35.12mg/100g), and phosphorus (38.14mg/100g). The phytochemical analysis of *Bambusa vulgaris* and *Dendrocalamushamiltonii* revealed the total phenolic content 38.04±0.7 mgGAE/g and the total flavonoid content 46.12±0.05 mgQE/g was found to be higher to that of*Bambusavulgaris*.Furthermore, processing methods aimed the degradation of cyanogenic glycoside content in both bamboo shoot species which were 512.43 mg/kg and 1180.15 mg/kg in *Bambusa vulgaris* and*Dendrocalamushamiltonii*respectively, involving a sequence of processing techniques such as boiling, soaking, steaming, and blanching at various durations to attain optimal cyanogenic glycoside elimination. The process of blanching bamboo shoots in a 1% acetic acid solution for a period of 2 minutes was determined to be the most efficient technique for both species and recorded the reduction up to 0.04 mg/kg. The present research aims to emphasize the potential of two species of young bamboo shoots, as food victuals, and its efficacy as a nutritious food source that is lacking awareness due to an insufficient knowledge among common people.

KEYWORDS: Bambooshoot,Nutritional content, Antioxidant profile, Processing technique, Cyanogenic glycoside

* Corresponding author

SaloniDua

Research Scholar
Department of Food Science and Nutrition, *BanasthaliVidyapith*, Rajasthan-304022, India.
*E-mail: salonidua345@gmail.com

INTRODUCTION

As a giant perennial arborescent plant, bamboo belongs to the family *Poaceae* and subfamily *Bambuseae*. It is native to China and widely distributed across continents, especially in tropical, subtropical and temperate regions with a mostly mesic to wet season.[3] Bamboo shoots are renowned as "power food" due to their high-quality proteins, dietary fiber, carbs, minerals, and vitamins as well as their low fat and sugar content.[10] In order to improve general wellbeing, bamboo shoots have taken their place among the plant foods that are added to everyday products like morning cereals, pasta, spreads, ketchups, yoghurt, a variety of dishes, including Manchurian soup and kheema, as well as canned bamboo juice, fried shoots, bamboo candy, pulav, and bamboo beer.[3]Numerous health benefits include bettering digestion and appetite, managing weight loss, curing cardiovascular disease, and exhibiting antioxidant, anti-inflammatory, and anti-cancer capabilities.[21] Major bioactive compounds present in shoots are phenols, phytosterols and dietary fibers that can provide desirable health benefits beyond their natural properties when consumed regularly. Ferulic acid, p-coumaric acid, caffeic acid, protocatechuic acid, p-hydroxybenzoic acid, catechin and chlorogenic acid are the prominent phenolic acids present in Bamboo shoots.[20]

Bamboo shoots contain an unsafe quantity of cyanogenic glycosides, which is referred to as a glycoside of hydroxynitrile, in addition to nutrients and health advantages. The amount of cyanogenic glycoside in plants is typically expressed as the amount of hydrogen cyanide (HCN) that is releasable; this HCN, upon endogenic hydrolysis, produces the anti-nutrient hydrocyanic acid, which should be evacuated before to consumption. According to studies, the acute fatal quantity of hydrogen cyanide for human ingestion should be between 0.5 and 3.5 mg/kg body weight.[18] If quantities of HCN in bamboo shoots are higher than recommended, it may be harmful to people. Therefore, it is required to eliminate the dangerous hydrogen cyanide from bamboo shoots in order to make them safe for human consumption. Traditional processing techniques like cutting up tender bamboo shoots into small pieces, boiling, soaking, steaming, blanching the shoots, or keeping them in hot water for a week, as well as partially drying fresh shoots, help to lower the cyanide concentration and degrade any potential health risks.[21] Consuming bamboo shoots that have been incorrectly prepared or processed can produce cyanide, which when consumed in dangerous amounts can have negative consequences on human health.Hence, major bioactive compounds present in shoots such as phenols and dietary fibers that can provide desirable health benefits beyond their natural properties when consumed regularly and removal of taxiphyllin thereby making the shoots safe for consumption. The current study aims to enhance awareness of the

nutrient and bioactive composition of two bamboo species and their potential as food victuals. Additionally, the study has been carried out to find the impact of various processing techniques on the anti-nutritional constituents of bamboo shoots which seeks to promote its utilization which is an underutilized agricultural product.

METHODS AND MATERIALS

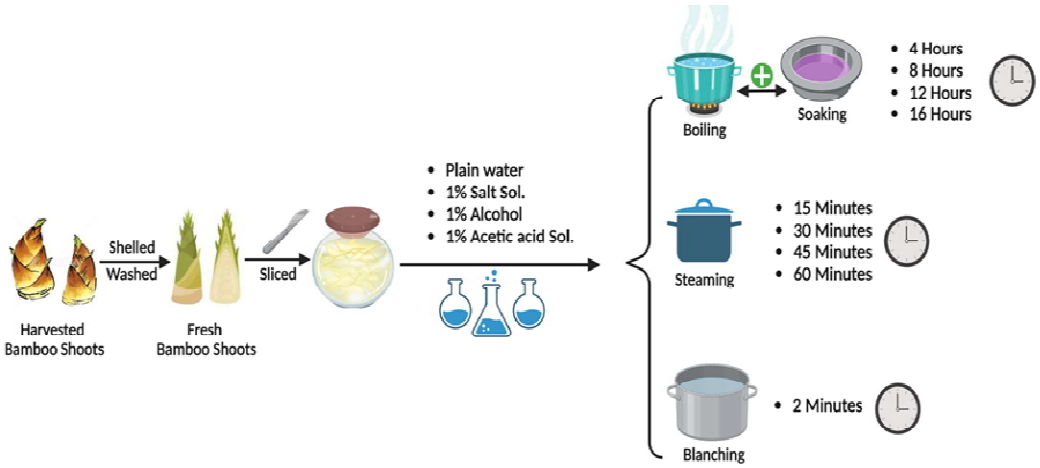
Chemicals: All chemicals used were of analytical grade. Folin-Ciocalteu reagent, glucose and sodium cyanide were obtained from Thermo Fisher Scientific (India).

Equipments: UV-Vis spectrophotometer model was used for spectrophotometric analysis of bamboo shoots. Laboratory centrifuge was used for centrifugation and digestion of samples for mineral analysis was performed in fume hood (Thermo Fisher Scientific, India).

Collection of Plant Material:The species selected for the study were *Bambusa vulgaris* and *Dendrocalamushamiltonii*, measuring approximately 20 cm in diameter and 30 to 60 cm in height, were procured from the Forest Research Institute (FRI), Dehradun, during the growth season (May to September). After peeling the sheaths, hard nodal portions were removed and only soft inter nodal portions were taken for analysis. The internodal portions were sliced into small pieces and subjected to various treatments.

Methods used:Nutritional analysis were conducted in triplicates for moisture, ash, crude protein (Kjeldahl method), crude fat (Soxhlet's method), crude fiber and carbohydrate content according to Association of Official Analytical Chemists.[1] Minerals such as phosphorus, calcium (titrimetric method) and iron (Wong's method) were analyzed by the methods given by Jacobs, 1999.[10] The total phenols were determined by Folin-Ciocalteu method and total flavonoids content was determined by colorimetric method.[12] The cyanogenic glycoside content in fresh shoots of species *Bambusa vulgaris* and*Dendrocalamushamiltonii* were determined according to the method explained by Haque and Bradbury.[9]

Processing Methods for Reducing Cyanogen Content in Bamboo Shoots: Fresh bamboo shoots contain a high amount of cyanogen content which is considered as toxic for human consumption. European Food Society Authority[7] stated that cyanogen level up to 10 mg/kg HCN is safe and not associated with any acute toxicity. In general, plants having cyanogen content above 20 mg/100g of fresh plant material are considered harmful for human health.[19,4] As shown in Figure 1 reduction of cyanogen content was performed by the application of processing techniques on young tender bamboo shoots such as slicing followed by boiling, soaking, blanching and steaming at different intervals respectively.



1: Processing workflow of bamboo shoots

Boiling followed by soaking*:* The fresh tender slices of bamboo shoots were boiled in solutions of 1% salt solution,1 % alcohol solution, 1% acetic acid solution and in plain distilled water for a time duration of 30 minutes. The excess water from the boiled samples was drained off and the samples were pat dried on filter paper. 5 g of boiled samples from each solution were taken and soaked for periods of 4 hours, 8hours, 12 hours and 16 hours respectively in distilled water, 1% salt solution,1% alcohol solution, and 1% acetic acid solution.

Steaming*:* 5 g of fresh bamboo shoots were steamed in a steamer in distilled water, 1% salt, 1 % alcohol solution and 1% acetic acid solution separately for the period of 15 minutes, 30 minutes, 45 minutes and 60 minutes respectively.

Blanching*:* 5g of fresh bamboo shoots were blanched by boiling in distilled water, 1% salt solution,1% alcohol solution and 1% acetic acid solution respectively for 2 minutes.

Cyanogenic toxicity assay: The shoots were processed by the following treatments: Boiling followed by soaking, steaming and blanching in (a) distilled water (b) 1% salt (c) 1 % alcohol solution and (d) 1% acetic acid solution for different time intervals to achieve proper removal of anti-nutrient. Bamboo shoot samples were taken out at regular intervals for chemical analysis. The cyanogenic toxicity assay was performed according to Singhal,[22] processed samples of bamboo shoot were ground using pestle-mortar. 25–50 mg of crushed processed bamboo shoots was added to 0.5 ml of 0.1 M phosphate buffer. A picrate paper [supplied in the picrate kit prepared by dipping filter paper in a solution of moist picric acid (0.5%w/v in 2.5% w/v sodium carbonate) and allowing the paper to dry in air and then cutting it to 1X10 cm size)] was inserted and the vial was immediately closed. After about 16–24 hrs at 30 °C, the picrate paper was removed and immersed in 5.0 ml water for 30 min and absorbance was measured at 517nm.

STATISTICAL ANALYSIS

Each experiment was replicated in triplicates and results were expressed as Mean±SD. Data were analyzed using SPSS (version 17.0) analytical software. Statistical analysis of the data included One way analysis of variance (ANOVA) at significance level of $p \leq 0.05$.

RESULTS AND DISCUSSION

1: Nutritional composition of *Bambusa vulgaris* and *Dendrocalamushamiltonii* shoots on fresh weight basis

Parameters (g/100g)	*Bambusa vulgaris*	*Dendrocalamushamiltonii*
Moisture	90.28±0.16	92.39±1.21
Ash	1.02±0.12	0.86±0.16
Crude Protein	4.41±0.31	3.99±0.21
Crude Fat	0.61±0.11	0.48±0.14
Crude Fiber	3.81±0.21	3.12±0.10
Carbohydrate	4.68±0.18	2.28±0.16

Values are illustrated as Mean±SD of triplicate determinations of Bamboo species

Table 1 revealed the nutritional composition of the young bamboo shoots species on fresh weight basis. The moisture content for *Bambusa vulgaris* and *Dendrocalamushamiltonii* were 90.28±0.16 and 92.39±1.21 g/100g respectively. In accordance with this study moisture content reported by Neto,[15] of *B. vulgaris*, *D. asper,B.nutans* and *D. giganteus*were ranged between 77.0 to 94.7%. The protein estimation

in *Bambusa vulgaris* was recorded (4.41±0.31g/100g) and was found to be high in comparison to *Dendrocalamushamiltonii*(3.99±0.21 g/100g). In consonance with a study by Mulatu,[14] which reported bamboo shoots to be affluent in protein content ranging between 1.78 and 2.12 g/100g. The fat content for *Bambusa vulgaris* and *Dendrocalamushamiltonii*were found to be 0.61±0.11 and 0.48±0.14 respectively. Both shoots contain low amount of fat and are therefore considered ideal food for healthy loss of weight, obesity and heart diseases.[23]The ash content for *Bambusa vulgaris* and *Dendrocalamushamiltonii*were 1.02±0.12 and 0.86±0.16 respectively. Consonantly, Chongtham[5] analyzed that bamboo shoots contain ash up to 1.38%. The fiber content for *Bambusa vulgaris* and *Dendrocalamushamiltonii* were 3.81±0.21 and 3.12±0.10 respectively. Nirmala[16] reported that shoots from bamboo are opulent, helpful source of dietary fiber that is helpful in the prevention or delaying of several chronic diseases and having an immense amount of fiber content, ranging from 2.23 to 4.20g/100g on fresh weight basis. The carbohydrate content of Bambusa vulgaris was determined to be 4.68 ± 0.18 g/100g, while that of Dendrocalamushamiltonii was found to be 2.28 ± 0.16 g/100g. Similarly, Kumbhare and Bhargava[13] reported that the carbohydrate content were 3.3, 3.4, 2.6 and 2.9% in *B.nutans*, *B. vulgaris*, *D. strictus*and*D. asper* species, respectively.

2: Mineral contents of *Bambusa vulgaris* and *Dendrocalamushamiltonii* shoots on fresh weight basis

Mineral content (mg/100g)	***Bambusa vulgaris***	***Dendrocalamushamiltonii***
Iron	1.31±0.10	2.45±0.21
Calcium	31.89±0.11	35.12±0.21
Phosphorus	32.31±0.05	38.14±0.10

Values are illustrated as Mean±SD of triplicate determinations of Bamboo species

Bamboo shoots are high in nutrients such as phosphorus, magnesium, salt, calcium, potassium, and iron, which are necessary for the body's metabolic activity and proper functioning. The results of the current study demonstrated a significant difference in the calcium content, with values of 31.89±0.11mg/100g for *Bambusa vulgaris* shoots and 35.12±0.21mg/100g for *Dendrocalamushamiltonii* shoots. Similarly, Kumbhare&Bhargava,[13] reported that the calcium content in the combination of leaves and shoots was ranging at 4.06-80 mg/100g for different species of bamboo such as *Dendrocalamusasper, Dendrocalamusstrictus, Dendrocalamusgiganteus*.The phosphorus content in *Bambusa vulgaris* shoots was determined to be 32.31±0.05mg/100g, while in *Dendrocalamushamiltonii* shoots, it was found to be 38.14±0.10mg/100g.Consonantly,

Choudhury[6]reported that phosphorus content in *B. vulgaris, Y. alpina*and*D. giganteus* were greatly higher ranging 19.3-28.1 mg/100g. The iron content was 1.31±0.10mg/100g and 2.45±0.21mg/100gin*Bambusa vulgaris* and *Dendrocalamushamiltonii* shoots respectively. Similar study by Nongdam and Tikendra,[17] reported that the iron content was ranging from 0.1 to 3.37mg/100g in different species *B. vulgaris, D. giganteus and Y. alpina.* As a result, it can be said that the young bamboo shoots of the *Dendrocalamushamiltonii*species contain higher mineral content compared to those found in *Bambusa vulgaris.*

3: Antioxidant contents in *Bambusa vulgaris* and *Dendrocalamushamiltonii* shoots

Antioxidant content	*Bambusa vulgaris*	*Dendrocalamushamiltonii*
Total Phenols (mgGAE/g)	26.2±0.13	38.04±0.7
Total Flavonoids (mgQE/g)	41.92±0.16	46.12±0.05

Values are illustrated as Mean±SD of triplicate determinations of Bamboo species GAE = gallicacid equivalent; QE = quercetin equivalent

The study showed significant differences for both *Bambusa vulgaris* and *Dendrocalamushamiltonii* shoots for total phenol and flavonoid content ($p \leq 0.05$). The phytochemical analysis of the current study showed that the total phenolics content (38.04±0.7 mgGAE/g)and the total flavonoid content(46.12±0.05mgQE/g) in *Dendrocalamushamiltoni*was greater as compared to *Bambusa vulgaris*. Similar results were found in the study reported by Baguistan,[2] where total phenolic content ranging from 28.14-49.90 mgGAE/100ml in different species of *B.vulgaris* and *D. asper*.

4: Cyanogenic glycoside content in *Bambusa vulgaris* and *Dendrocalamushamiltonii* fresh shoots

Cyanogenic glycoside content (mg/kg)	*Bambusa vulgaris*	*Dendrocalamushamiltonii*
Fresh sample	512.43±2.27	1180.15±3.46

Values are illustrated as Mean±SD of triplicate determinations of Bamboo species

The results pertaining to the hydrogen cyanide (HCN) content in bamboo shoot species are shown in Table 4, based on the fresh weight of the samples. Fresh bamboo shoots have been estimated to have HCN content as high as 512.43±2.27mg/kg in *Bambusa vulgaris* whereas, 1180.15±3.46mg/kg in *Dendrocalamushamiltonii.* Similar study reported by Ferreira[8] showed the HCN content of bamboo shoot ranged between 894-1000 mg/Kg.

5: Effect of different processing techniques on cyanogenic glycoside content (mg/kg fresh weight) in *Bambusa vulgaris* and *Dendrocalamushamiltonii* shoots

Processing Technique	*Bambusa vulgaris*				*Dendrocalamushamiltonii*			
	Medium							
	Plain Water	1% Salt Solution	1% Alcohol Solution	1% Acetic Acid Solution	Plain Water	1% Salt Solution	1% Alcohol Solution	1% Acetic Acid Solution
Boiling for 30 minutes followed by soaking								
4 h	5.94±0.01	7.82±0.54	6.05±1.11	5.40±1.66	7.72±0.42	8.12±0.09	6.45±0.80	6.01±0.24
8 h	5.61±0.51	7.79±0.33	6.01±0.62	0.21±1.45	7.24±1.44	7.64±1.10	6.21±0.22	2.14±0.06
12 h	4.32±0.79	7.56±1.55	5.32±1.42	0.16±0.05	6.86±0.50	6.35±1.42	5.97±0.05	1.37±0.54
16 h	4.16±1.02	6.39±1.71	5.23±1.07	0.13±0.01	5.24±1.13	5.04±0.09	5.12±0.43	0.64±0.69
f-value	2.68	1.37	0.67	2.05	1.59	2.32	0.59	2.11
Steaming								
15 min	6.72±0.10	0.32±0.05	4.32±1.89	0.21±0.22	7.23±0.23	1.43±0.17	6.23±0.22	1.46±1.05
30 min	5.12±0.08	0.31±0.01	4.16±1.21	0.20±0.48	6.45±0.17	1.04±0.31	4.25±0.21	0.57±1.12
45 min	1.08±1.25	0.04±0.14	0.31±0.04	0.07±0.02	2.39±0.60	0.61±0.09	2.13±0.60	0.31±0.04
60 min	0.02±0.51	0.03±0.44	0.03±0.70	0.03±0.08	1.45±0.09	0.28±0.01	0.48±0.02	0.07±0.02
f-value	3.19	1.60	1.55	3.94	2.66	1.82	1.43	2.04
Blanching								
2 mins	0.40±0.21	0.27±1.18	0.27±0.07	0.04±0.10	1.24±1.14	0.81±1.07	0.42±1.12	0.05±1.19

Values are illustrated as Mean±SD of triplicate determinations of Bamboo species

The results of reduction in HCN content by boiling followed by soaking at intervals of 4h, 8h, 12h and 16h in plain water, 1% salt, 1% alcohol and 1% acetic acid presented that there was observed significant difference in the values of HCN at all intervals when soaked in plain water ($p \leq 0.05$).Significant difference was also observed in soaking at all intervals in 1% salt and 1% alcohols solution($p \leq 0.05$).The treatment of soaking of fresh bamboo shoots in 1 % acetic acid solution showed significant difference between 4h and 8h and thereafter no significant difference was observed($p \leq 0.05$) which indicates that after 8h,the reduction was near about the same. The results of reduction in HCN content by steaming at intervals of 15 min, 30 min, 45 min and 60 min in plain water, 1% salt, 1% alcohol and 1% acetic acid presented that there was observed significant difference in the values of HCN at all intervals when steamed in plain water ($p \leq 0.05$). Significant difference was also observed in steaming at all intervals in

1% salt and 1% alcohols solution ($p \leq 0.05$).The treatment of steaming of fresh bamboo shoots in 1% acetic acid solution showed non-significant difference between 15 min and 30 min ($p \leq 0.05$) which indicates that HCN reduction was the same at 15 min and 30 min interval. But thereafter significant difference at 45 min indicates that significant reduction was observed after 30 min. non-significant difference at 60 min indicates that beyond 45 min the HCN content was stabilized and was constant after mentioned time. Blanching of fresh bamboo shoots for 2 minutes in different mediums showed that maximum reduction of free cyanide was observed while blanching the shoots for 2 minutes in boiling solution of 1% acetic acid solution. Since marked difference is observed in reduction of free cyanide by blanching in plain distilled water and 1% acetic acid solution, it can be observed that leaching of cyanide is affected by acid which releases maximum bound cyanide. Therefore, blanching in 1% acetic acid solution of both species can be considered as the best treatment among all mediums.

CONCLUSION

Different types of fresh bamboo shoots have quite different nutritional profiles. The central region of India could potentially benefit from the production of edible shoots because to *Dendrocalamushamiltonii*higher nutritional levels than *Bambusa vulgaris.* The integration of tribal knowledge with modern scientific understanding has resulted in a simple, incredibly productive, and cost-effective bamboo shoot processing technology. Hydrogen cyanide (HCN) levels have been effectively mitigated through processing techniques in both the species *D. hamiltonii* and *B. vulgaris*, including boiling, soaking, steaming, and blanching at different intervals of time. Among these techniques, blanching in a 1% acetic acid solution was found to be the most efficacious treatment for degrading the HCN content in harvested bamboo shoots. Strategic initiatives aimed at promoting widespread access to bamboo shoots for diverse customer bases in domestic and international markets should be implemented to enhance profitability. This approach has the potential to yield substantial economic benefits for the entire nation while also fostering socioeconomic growth at the regional level.

REFERENCES

1. AOAC. Official methods of analysis, 16th ed., Association of Official Analytical Chemists, Washington, DC, USA. 2017.
2. Baguistan BJ, Waing KG, Valentino MJ. Phytochemical screening and determination of the biological activities of *Bambusa vulgaris* var. *striata* and *Dendrocalamusasper* shoot extracts. International Journal of Biology, Pharmacy and Allied Sciences, 2017; 6(11): 2109-2119.

3. Chauhan OP, Unni LE, Chitravathi K, Pakalapati SR, Batra HV. Bamboo Shoots: composition, nutritional value, therapeutic role and product development for value addition. International Journal of Food and Fermentation Technology, 2016; 6(1): 1.
4. Chongtham NB, MS Haorongbam S. Nutritional properties of bamboo shoots: Potential and prospects for utilization as health food. Comprehensive Reviews in Food Science and Food Safety, 2011; 10(3):153–168.
5. Chongtham NB, MS Premlata T, Bajwa HK, Sharma V &Santosh O. Quality improvement of bamboo shoots by removal of antinutrients using different processing techniques: A review. Journal of Food Science and Technology, 2022;1-11.
6. Choudhury D, Jitendra SK, Sharma GD. Bamboo shoot: Microbiology; Biochemistry and Technology of fermentation- A review. Indian Journal of Traditional Knowledge, 2012;11(2): 242-249.
7. EFSA. Opinion of the scientific panel on food additives, flavourings, processing aids and materials in contact with food (AFC) on hydrocyanic acid in flavourings and other food ingredients with flavouring properties. European Food Safety Authority, 2004;105.
8. Ferreira VL, P Yotsuyanagi K, Carvalho CRL. Elimination of cyanogenic compounds from bamboo shoots Dendrocalamusgiganteus Munro. Tropical Science (United Kingdom),1995.
9. Haque MR, Bradbury JH. Total cyanide determination of plants and foods using the picrate and acid hydrolysis methods. Food Chem, 2002; 77:107–114.
10. Jacobs MB. The chemical analysis of food and food products (3rd edition). New Delhi, India, 1999.
11. Karanja P, Kenji GM, Njoroge SM, Sila DN, Onyango CA, Koaze H, Baba N. Compositional characteristics of young shoots of selected bamboo species growing in Kenya and their potential as food source. Journal of Food and Nutrition Research, 2015; 3(9): 607–612.
12. Koley TK, Kaur C, Nagal S, Walia S, &Jaggi S. Antioxidant activity and phenolic content in genotypes of Indian jujube (*ZizyphusmauritianaLamk.).* Arabian Journal of Chemistry, 2011.
13. Kumbhare V, Bhargava A. Effect of processing on nutritional value of central Indian bamboo shoots. Part 1. Journal of Food Science. 2007; 44(3): 935-936.
14. Mulatu Y, Bahiru T, Kidane B, Getahun A, Belay A. Proximate and mineral composition of indigenous bamboo shoots of Ethiopia. Greener Journal of Agricultural Sciences. 2019; 9(2): 215-221.

15. Neto JA, Barbosa NP, Beraldo AL, Melo AB. Physical and mechanical properties of *Bambusa vulgaris* as construction material. Engenharia Agricola, 2021;41(2): 119–126.
16. Nirmala C, Bisht MS, Laishram M. Bioactive compounds in bamboo shoots: Health benefits and prospects for developing functional foods. International Journal of Food Science and Technology. 2014; 49:1425–1431.
17. Nongdam P, Tikendra L. The Nutritional facts of bamboo shoots and their usage as important traditional foods of Northeast India. International Scholarly Research Notices. Editor: MerahO.Hindawi. 2014.
18. Pandey AK, Ojha V. Precooking processing of bamboo shoots for removal of anti-nutrients. Journal of Food Science and Technology, 2014; 51: 43-50.
19. Rawat K, Nirmala C, Bisht MS. Processing techniques for reduction of Cynogenic Glycosides from bamboo shoots. Theme: Food and Pharmaceuticals. 10th World Bamboo Congress, Korea. 2015.
20. Santosh O, Bajwa HK, Bisht MS, Chongtham N. Antioxidant activity and sensory evaluation of crispy salted snacks fortified with bamboo shoot rich in bioactive compounds. Applied Food Research, 2021; 1(2): 100018.
21. Saraswathi KJT, Baskaran B, Rathore TS. In vitro propagation of Bambusa vulgaris cv. Wamin by axillary shoot proliferation. International Journal of Fundamental and Applied Sciences (IJFAS), 2014;3(4): 53-58.
22. Singhal P, Satya S, Naik S. Fermented bamboo shoots: A complete nutritional, anti-nutritional and antioxidant profile of the sustainable and functional food to food security. Food Chemistry: Molecular Sciences, 2021; 3: 100041.
23. Wang Y, Chen J, Wang D, Ye F, He Y, Hu Z, Zhao G. A systematic review on the composition, storage, processing of bamboo shoots: Focusing the nutritional and functional benefits. Journal of Functional Foods, 2020;71: 104015.