A Comparative Study of Chemical Properties in Traditional Fermented and Natural Bamboo

Htay Htay Myint [*], Khaing Khaing Kyu[**], Than Than Swe [***]

Abstract

Bamboo shoots are considered as one of the most useful foods and provide lots of health benefits. The different ethnic communities take fresh or fermented bamboo as one of most preferred traditional food items. So, bamboo Shoots of *Bambusa tulda* (Thaik–wa) was collected from Ohn–Gyaw Village, Pathein Gyi Township, Mandalay Region. Firstly, phytochemical screening of natural bamboo shoots (sample–I) was carried out. Then, the bamboo shoots were prepared by decorating as the salt solution (sample–II), fermenting with water (sample–III) and without water (sample–IV). Some physico–chemical properties of these samples were compared. Moisture and ash contents were determined by Oven method. And also fat content present in these samples were determined by Soxhlet extraction Method. Nitrogen content present in these samples was measured by using Kjeldahal's method. Moreover, mineral contents were determined by EDXRF method. Furthermore, the trace element concentrations of these samples were analyzed by AAS method.

Keywords: *Bambusa tulda*, salt solution, fermenting, EDXRF, AAS

Introduction

Bamboo is found everywhere throughout the world. It supports the living things by many ways. Bamboo shoot is used as found by fresh or fermented form. Among the plants, Bamboo is the fastest growing plant in the world. It usually grows up to 100 cm per day. Nowadays, bamboo shoot available in either fresh or canned varieties (Ktsuko Kozukue & Nobuyuki Kozukue, 1981).

In Myanmar, bamboo shoots are used as food in various ways. Different types of preparation like bamboo candy, bamboo chutney, bamboo canned juice, bamboo beer are also available. Bamboo vinegar is also used as bio–fertilizer and bio–insecticide. The health benefits of bamboo shoots include healthy weight loss, control of bad cholesterol, strengthening of the immune system, possible cancer–fighting properties and anti–inflammatory properties. It also contains a significant amount of dietary fiber. Therefore, the comparative study of chemical compositions between natural and fermented bamboo shoots has been carried out in this research paper.

[*] Lecturer, Dr, Department of Chemistry, Yadanabon University

[**] Professor, Dr, Department of Chemistry, University of Mandalay

[***] MRes, Candidate, Department of Chemistry, Yadanabon University

Botanical Description

Figure (1) Shoot and Habit of *Bambusa tulda* (Thaik–wa)

Family – Gramineae
Botanical Name – *Bambusa tulda* Roxb.
English Name – Bamboo
Myanmar Name – Thaik–wa
Part used – shoots
Medicinal uses – Hypertension, hyperlipemia, hyperglycemia (T.Kalita and U.Dutta, 2012)

Materials and Methods

Materials

Commercial grade solvents such as ethanol, chloroform, petroleum ether and reagents such as hydrochloric acid, sulphuric acid, magnesium ribbon, ferric chloride, potassium ferric cyanide, iodine solutions, sodium hydroxide, potassium hydroxide, 10% lead acetate, Benedict's solution were applied as materials for the research.

Sampling

Bamboo shoot of *Bambusa tulda*, one of the varieties of bamboo is cultivated in Myanmar. It is locally known as Thiak–wa. It was collected from Ohn–Gyaw village, Pathein–Gyi Township, Mandalay Region, Myanmar.

Preliminary Phytochemical Tests of Bamboo shoot of *Bambusa tulda*

The phytochemical tests were carried out at Department of Chemistry, Yadanabon University, Myanmar to detect the different kinds of chemical constituents in the bamboo shoot sample I, II, III and IV. The tests were done to find the presence of the active chemical constituents such as alkaloids, terpenoids, steroids, flavonoids, saponins, polyphenols, phenolic compound, glycoside, reducing sugar and lipophilic compound by standard methods. The results are shown in Table (1).

Sample Treatment

Firstly, the bamboo shoots were used as natural i.e untreated (Sample–I).The bamboo shoots were boiled with water for about 30 min and decanted. Then they were percolated with salt solution (Sample–II). Some bamboo shoots were fermented with water (Sample–III) and other bamboo shoots were fermented without water (sample–IV). All of the above samples were sliced and thin slices of bamboo shoots were dried at room temperature. The dried samples were stored in stopper bottle ad used for analysis.

Determination of pH

The pH values of samples were measured by using pH meter (AOAC, 2000).

Determination of Moisture Content

5 g of samples were accurately weighed and then dried in an oven for about 2 hr at 101°C. It was then removed from the oven and cooled in a desiccators at room temperature and weight. The procedure was repeated until the constant weight was obtained (AOAC, 1990).

Determination of Ash Content

The sample 5 g of samples were weighed and placed in a preheated cooled and the crucible was weighed. The crucible was heated carefully in the furnace at 525°C for 4 hours burned off without flaming or until all the carbon was eliminated. When the materials are converted to white ash powder, the crucible was cooled at room temperature in a desiccators and weighed again. To obtain a constant weight, the heating, cooling and weighing were repeated (AOAC, 2000).

Determination of Crude Fibre Content

About (2g) of the sample–I was placed into a 500 mL flask having a 200 mL mark. Into the conical flask, hot dilute 1.25% sulphuric acid solution was added to the mark and the mixture was boiled. After 30 minutes, the boiling solution with insoluble materials was filtered through a fine piece of muslin cloth and washed three times with boiling water. The insoluble residue on the cloth was transferred carefully into the flask with 200 mL of 1.25% sodium hydroxide solution and boiled for 30 minutes. After boiling the residue was filtered again and was washed with hot water in order to free from alkali. Then the residue was washed with 15 mL of 95% ethanol. After washing the residue was introduced into a crucible and it was heated in an oven at 105°C until the constant weight was obtained. Finally the substance in the crucible was incinerated in muffle dull red the all carbonaceous matter had been removed. The contents with the crucible were cooled and weighed. This procedure, such as heating, cooling and weighing were made until a constant weight was obtained. The loss in weight during the incineration was referred to as crude fibre. The same procedure was done for other sample [II, III, IV].

$$\text{Fibre\%} = \frac{\text{Weight of fibre x100}}{\text{Weight of sample}}$$

Determination of Fat Content

Fat contents were determined by using the Soxhlet extraction method. 50 g of samples accurately weighed were introduced into a thimble and a piece of cotton wool was placed the open end of the thimble. The thimble containing sample was then placed in a Soxhlet apparatus. Then the apparatus was fixed with 500 mL round–bottomed flask containing 350 mL petroleum ether (b.p 40–60 °C). The extraction flask was heated on the water bath for 8 hours at the boiling point of petroleum ether. After the extraction was completed, most of the ether extract was distilled off. The content in the flask were carefully transferred to a weight specimen tube. The remaining ether in the specimen tube was vaporized until constant weight was obtained (AOAC, 2006).

Determination of Protein Content

1 g of sample was weighted and placed in the Kjeldahal's digesting flask. 5 g of $K_2SO_4$and (0.5g) $CuSO_4.5H_2O$,10 mL of 98% sulphuric acid and 10 mL of distilled water were added into it in such a way as to wash solid adhering to the neck. The flask was shaken until the contents were thoroughly mixed and it was heated till the mixture became colourless. The digestion was continued for half an hour to make sure that all nitrogen in the sample was converted to ammonium sulphate. Then it was allowed to cool. The Kjeldahal's distillation apparatus was setup, taking care that the tip of the condenser extended below the surface of the 4% boric acid solution 50 mL in the receiver. The digested solution was poured into the flask together with 50 mL of 40% sodium hydroxide to make mixture strongly alkaline. The sample is distilled until 100 mL of distillate are collected in 50 mL of 4% boric acid. The evolved ammonia was distilled off.

Add 2–3 drops methyl red indicator to the conical flask containing boric acid and titrate it with 0.1M HCL until a faint pink colour is obtained. A blank determination was carried out without sample using the reagents as in the case of sample. The nitrogen content of sample can be calculated by using following formula (AOAC, 2000).

Nitrogen(%) = V_S x V_B x M x14/ W

Where, V_S = the volume of acid used in the test

V_B = the volume of acid used in the blank

M = the concentration of acid used

14.01 = atomic weight of N

W = the weight of sample,

Protein (%) = Nitrogen × 6.25

Where, 6.25 = a factor of protein – Nitrogen conversion

Determination of Mineral Contents

Mineral contents of samples were determined by applying EDXRF (Energy Dispersive X–ray Fluorescence, EDXRF–700 Spectrometer) at Department of Physics, University of Mandalay.

Determination of Some Selected Elements

The selected elements such as K, Mg, Cu, Zn and Fe contents were determined by Atomic Absorption Spectrophotometer (AAS).

Results and Discussion

Preliminary Phytochemical Tests on Bamboo shoot of *Bambusa tulda*

According to the phytochemical tests of the crude extracts from bamboo shoot (*Bambusa tulda*) sample contains many chemical constituents such as alkaloid, flavonoid, terpenenoid, steroid, glycoside, reducing sugar, polyphenol, saponin and lipophilic compounds respectively. The results of phytochemical tests of crude extract of bamboo shoot (*Bambusa tulda*) are shown in Table (1).

Table (1) Results of Phytochemical Screening on Crude Extracts of Bamboo shoot of *Bambusa tulda*

No.	Constituents	Extract	Reagents used	Observation	Remarks
1	Glycoside	Water	10% lead acetate solution	Yellow ppt	+
2.	Steriod	Ethanol	Acetic anhydride, Conc: H_2SO_4	No color change of test extract	+
3.	Flavonoid	Ethanol	Conc: HCl,, Mg turnings	red ppt	+
4.	Terpenoid	Ethanol	Acetic anhydride, $CHCl_3$,Conc:H_2SO_4	No pink color solution	–
5.	Saponin	Ethanol	Distilled water	No forth	+
6.	Polyphenol	Ethanol	1% $FeCl_3$, 1% $K_3[Fe(CN)_6]$ solution	Greenish blue solution	+
7.	Phenolic compound	Water	10% $FeCl_3$ solution	Deep purplish color solution	+
8.	Alkaloids	Ethanol	Saturated picric acid solution	Yellow ppt	+
9.	Reducing sugar	Water	Benedict's solution	Brick red ppt	+
10.	Lipophilic	Water	0.5 M KOH solution	Deep color solution	+

(+) sign indicates the presence of chemical constituents

(–) sign indicates the absence of chemical constituents

From phytochemical investigation, the constituents found in the extract of Bamboo shoot of *Bambusa tulda* were alkaloid, glycoside, flavonoid, polyphenol, steroid, saponin, phenolic compound, lipophillic and reducing sugar.

Determination of Some Nutritional Values in Samples

Moisture and ash contents in the samples were measured. The resulted weights were substituted in the formula and also the data were expressed in Table (2).The nitrogen contents of samples were determined by Kjeldahal's method. The results were also shown in Table (2).

Table (2) Some Nutritional Values of Bamboo Shoot Samples

Nutritional Parameter	Sample I	Sample II	Sample III	Sample IV
Moisture (%)	89.921	90.236	91.671	89.583
Ash (%)	6.612	9.184	4.952	4.036
Fat (%)	0.278	0.391	0.672	0.575
Crude Fibre (%)	4.423	1.676	5.974	5.752
Protein (%)	6.357	4.343	3.556	1.803

According to the results, moisture, fat and crude fiber contents of bamboo shoots fermented with water (sample III) were found to be 91.671 %, 0.672 % and 5.974 % respectively as the highest amounts. The high fibres and low fat in bamboo shoot help in reducing the thickening of arteries maintaining the blood pressure. Bamboo shoots had reducing effect on serum content of total cholesterol and low density lipoprotein (Park and John, 2009). Furthermore, bamboo shoots percolated with salt solution (sample II) consist of the highest value 9.184 % ash. Among four samples, crude protein was observed to be highest in natural bamboo shoots sample I (6.557%) while it was found as sample–I (6.357 %), sample–II (4.434 %), sample–III (3.556 %) and sample–IV (1.803 %) respectively. From this results, the content of protein in natural bamboo shoots are the richer than the other samples.

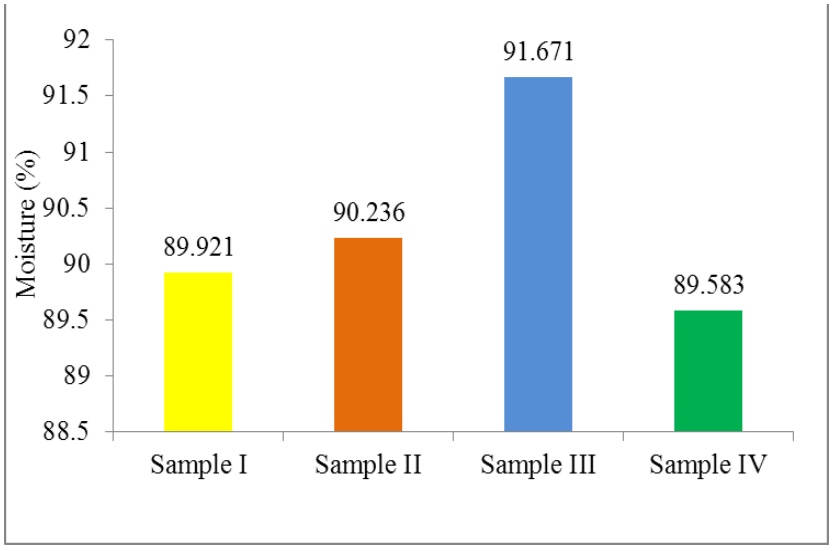

Figure (2) Comparison of the moisture content of samples

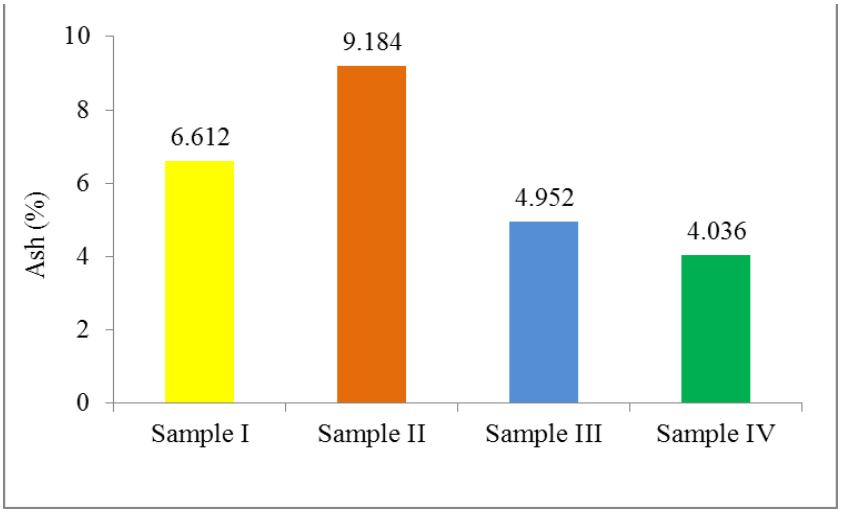

Figure (3) Comparison of the ash content of samples

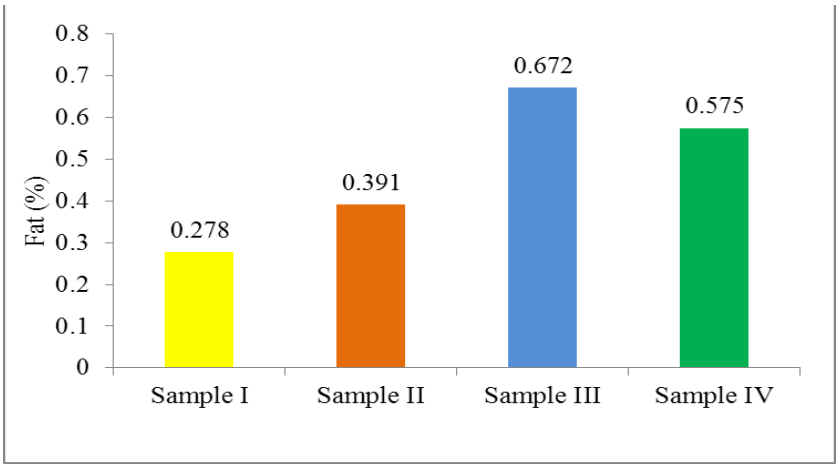

Figure (4) Comparison of the fat content of samples

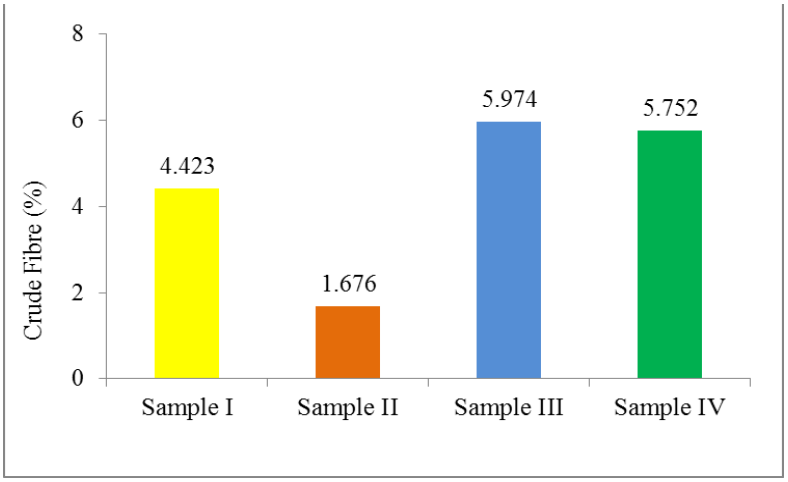

Figure (5) Comparison of the crude fiber content of samples

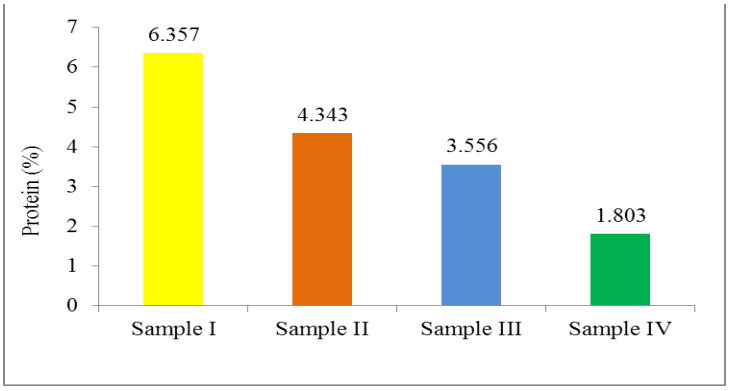

Figure (6) Comparison of the protein content of samples

The element compositions of samples were determined by EDXRF method and the results were showed in Table (3).

Table (3) Elemental composition of All Samples

No.	Elements (%)	Natural	Percolated with salt solution	Fermented with water	Fermented without water
1.	Aluminium (Al)	0.145	0.036	0.134	0.154
2.	Silicon (Si)	0.208	0.078	0.228	0.227
3.	Phosphorus (P)	0.652	0.151	0.365	0.503
4.	Sulphur (S)	0.088	0.049	0.079	0.105
5.	Chlorine (Cl)	3.675	9.286	3.339	2.748
6.	Potassium (K)	4.778	0.089	1.912	3.672
7.	Calcium (Ca)	0.354	0.445	0.616	0.321
8.	Vanadium (Va)	0.003	0.002	0.002	0.003
9.	Chromium (Cr)	0.001	0.002	0.002	0.001
10.	Manganese (Mn)	0.011	0.007	0.005	0.005
11.	Copper (Cu)	0.002	0.004	0.001	0.002
12.	Zinc (Zn)	0.009	0.005	0.006	0.006
13.	Iron (Fe)	0.028	0.442	0.209	0.097
14.	Selinium (Se)	0.0001	0.0001	0.001	0.001
15.	Bromine (Br)	0.002	0.002	0.001	0.002

According to Table (3), potassium was found to be present in sample I 4.778 % as the highest value. Sample II consists of 9.28 % of chlorine and 0.4419 % of iron as the highest values. And also calcium 0.615 % was found as the highest amount in sample III. Minerals are required for the proper functioning of many useful metabolic activities of our body.

The trace element concentrations of samples were analyzed by AAS method and the resulted data were displayed in Table (4).

Table (4) Concentrations of Some Selected Elements in All Samples

No.	Elements	Natural	Percolated with salt solution	Fermented with water	Fermented without water
1	Potassium (mg/L)	70.53	47.46	70.39	69.55
2	Magnesium (mg/L)	9.885	9.496	9.972	9.963
3	Copper (mg/L)	0.223	0.062	0.313	0.243
4	Zinc (mg/L)	1.496	1.063	2.079	1.540
5	Iron (mg/L)	4.497	24.52	5.773	4.205

From Table (4), 70.53 mg/L K in sample I, 9.972 mg/L Mg in sample II, 0.313 mg/L Cu in sample III, 2.079 mg/L Zn in sample IV, 24.52 mg/L Fe in sample II were found to be as the highest values. Potassium is an important component of cell and body fluids. The daily recommended dose of potassium is 2.0 to 5.5 g/d and it confers protection to human heart by maintaining normal BP and stable heartbeat of an individual (Belitz and Grosch, 1999). The iron requirement by women at pregnancy and during the nursing of child is very high (Tapiero, Gate, and Tew, 2001).

Conclusion

In this research, Bamboo shoots belonging to Gramineae family, eaten them as curry and also food additives in Myanmar was selected for chemical analysis.

According to results shown in Table (1), bamboo shoots consisted of alkaloids, flavonoids, polyphenols, steroids, glycosides, phenolic compound, saponins, lipophilic compound and sugar respectively. In addition, moisture and ash contents of all samples were measured by oven dried method. According to data resulted, sample III displayed the highest moisture contents (91.6%). In accordance these values, sample II contained the highest ash content 9.184%. Fat contents of these samples were determined using Kjeldahal's method. From the results of fat, the highest amount was observed in sample III (0.672%). Moreover, fibre contents of the samples were measured by standard method. As results obtained, 4.4%, 1.6%, 18.3% and 5.7% of crude fibre were present in these samples. Sample III had the highest fibre. The fibre possesses number of health benefits as it controls blood pressure, hypertension, and obesity and also protects our body from coronary diseases and potential carcinogens (Anderson and Strong, 1983). The results data were expressed in figure (2).

The elemental compositions of all samples were measured by EDXRF spectrophotometer and the results obtained were shown in Table (3). According to this table, potassium was found to be present in sample I 4.778 % as the highest value. Potassium helps controlling heart rate and blood pressure by countering effects of sodium. Sample II consists 9.286 % and 0.442 % of chlorine and iron as the highest values. Regular consumption of iron rich bamboo shoots will provide the necessary iron requirement of the individual. And also calcium 15 % as the highest amount in sample III.

Concentrations of trace elements in these samples were measured by AAS method and the data were shown in Table (4). From these results, 70.55 mg/L K in sample IV, 9.885 mg/L Mg in sample I, 0.3l3 mg/L Cu in sample III, 2.079 mg/L Zn in sample III, 24.52 mg/L Fe in sample II were found to be the highest values.

In comparison of data obtained, natural bamboo shoots can fulfill the requirements of plant–based protein and potassium contents for human nutrition. So we should eat natural bamboo shoots than other bamboo shoot samples.

Acknowledgements

The authors would like to express the deepest thank to Pro–rectors, Dr Si Si Khin and Dr Tint Moe Thuzar, Yadanabon University for their permissions to do this research paper. We wish to mention our special thanks to Professor and Head, Dr Hlaing Hlaing Myat and Professor, Dr Htay Htay Win, Department of Chemistry, Yadanabon University for their interest, valuable guidance and encouragements throughout this research work. We also wish to express many thanks to a member of ethical research committee members for their reading and valuable suggestions.

References

AOAC International. AOAC Official Method 960.19, pH of Wines. Official Methods of Analysis (OMA), 17*www.aoac.org* th edition. 2000.

AOAC, 2006. Official Methods of Analysis. Association of Official Analytical chemists, 18th ed. current. Revision I. Maryland.

AOAC. 1990. Official Methods of Analysis. 15th ed. Association of Offical Analytical chemists, Washington.

Etusko Kozukue & Nobuyuki Kozukue. 1981. "Journal of Food Science", 46, 751–755.

E. J. Park and D. J. John, 2009. “Effects of bamboo shoot consumption on lipid profiles and bowel function in healthy young women,” *Nutrition*, vol. 25, no. 7–8, pp. 723–728.

H. D. Belitz and W. Grosch, 1999. *Food Chemistry*, Springer, New York, NY, USA, 2nd edition.

H. Tapiero, L. Gate, and K. D. Tew, 2001. “Iron: deficiencies and requirements,” *Biomedicine and Pharmacotherapy*, vol. 55, no. 6, pp. 324–332.

J. Anderson and M. F. Strong, 1983. “The effect of fiber on nutrition of man,” *India Journal of Nutrition and Dietetics*, vol. 81, pp. 279–285.

T.Kalita and U.Dutta, 2012., “Acomparative study on indigenous usage of bamboo shoot in the health care practices in NE India”, The Clarion,vol.1, no.2, pp. 130–141.