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Proximate and Mineral Composition of Indigenous Bamboo Shoots of Ethiopia

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ABSTRACT

Demand for natural and organic foods, including bamboo shoots has greatly increased. In Ethiopia, bamboo shoot of the two indigenous species is traditionally used for food. However, information on nutritional profile of the two indigenous bamboo species and bioavailability of important mineral elements is limited in the country. This paper describes the proximate and mineral composition of bamboo shoot of the two indigenous bamboo species of Ethiopian (*Arundinaria alpina* and *Oxytenanthera abyssinica*). Shoot samples, height 10-30 cm, were collected from North western Ethiopia and analyzed for their nutrient and mineral contents following the methods developed by Association of Official Analytical Chemists. The results indicated that *A. alpina* shoot has higher protein, Ca, P and Crude Fiber and low HCN contents. On dry weight basis, *A. alpina* contains 31.33% protein, 12.17% crude fiber and 13.67% ash. The mineral content, in mg/100 gm of bamboo shoots, was found to be potassium 1661.17, calcium 369.5, phosphorus 887, and sodium 17.33. *O. abyssinica* shoot has almost similar nutrient content to *A. alpina* shoot except difference in very few mineral elements. *O. abyssinica* shoot has higher potassium. On dry weight basis, it contains 27% protein, 8.67% crude fiber, and 11.33% ash. Its mineral contents in mg/100 gm, dry weight basis, were potassium 4737, calcium 203.8, phosphorus 704 and Na 16.67. The values for tannin and phytate are higher for *A. alpina* but with very low (below detection level) hydrocyanic acid. The result indicated that mineral and proximate contents also vary depending on location and species. Shoot size has no significant effect on proximate and mineral contents except tannin that increased with shoot size. Generally the two indigenous bamboos have good nutrient profile. Developing improved processing techniques that enhance bioavailability of Fe in bamboo shoot foods of indigenous species is required.

INTRODUCTION

Demand for natural and organic foods, including bamboo shoots, has greatly increased in the world (Narmilan and Amuthenie, 2015). Edible bamboo species play pivotal role in nutritional security of tribal communities in many countries (Nirmala, et al., 2011; Bhatt, et al, 2004) and also nowadays become one of the important items in the bamboo products global trade. In Ethiopia, bamboo shoot of the two indigenous species is traditionally used for food.

Bamboo shoot contains kinds of nutritive substances that human body needs, such as carbohydrate, protein, fat, fiber and many other inorganic nutritious substances, and Vitamin A, B, C as well. Fresh shoot generally contains: 88-93% water, 1.5-4% protein, 0.25-0.95% fat, 0.78 - 5.86% total sugar, 0.60-1.345% cellulose, 0.66-1.21% ash, 37-92 ppm phosphor, 4.2-30 ppm calcium and other nutrition (CFPH, 2010). Over 2.5% of the shoot is carbohydrate that can be absorbed by the human body and shoots also contain about 0.5% lipids. In addition, bamboo shoots contain the elements Mo and Ge, which have anticancer and aging-resistant functions, and Zn, Mn, Cr and other trace elements (Nirmala, et al., 2011) and other compounds (Pallauf and Rimbach, 1997).An overall decrease was observed in proteins and total phenols while dietary fibres and carbohydrates increased with ages of bamboo shoots (Ashok, 2013).

Bamboo shootis eaten after passing many steps or improving the test and washing out the anti-nutritional elements such as cyanogenic glycosides (Ashok and Vijayalakshmi, 2014). Reports indicate that if bamboo shoot is eaten raw or processed inadequately, its consumption may be potentially harmful due to the presence of taxiphillin (a cyanogenic glycosides), which breaks down to produce hydrogen cyanide. However, the potential toxicity can be significantly reduced by adequate processing to break down the cyanogenic glycoside and remove the resulting hydrogen. Current users of bamboo shoot in many countries have indigenous knowledge regarding the risks associated the consumption (FSANZ, 2005). The *Berta* and *Gumuz* people of Benishangul Gumuz Region, Northwest Ethiopia, have indigenous knowledge, that we will not be emphasized here.

Bioavailability of mineral elements of bamboo shoots to human body depends on the molar ratios of phyate and that of mineral elements. Phytic acid has a strong binding affinity to important minerals such as iron, zinc and calcium (Lisbeth et al, 2008). Molar ratio of phytate: Zn, phytate: Fe, and Phytate: Ca is used to estimate the likely absorption of the mineral elements zinc, Iron and calcium from a diet. Diets with a phytate: zinc molar ratio greater than 15 have relatively low zinc bioavailability, those with phytate: zinc molar ratios between 5 and 15 have medium zinc bio-availability and those with a phytate: zinc molar ratio less than 5 have relatively good zinc bio-availability (Melaku et al., 2005). Similarly, bioavailability of Fe and Ca is low when Phytate: Fe molar ratio > 1 and Phytate:Ca molar ratio > 0.24.

Bamboo shoot has interestingly been an integral part of indigenous cuisine in different countries in Asia such as Thailand, Vietnam, Japan, Karnataka, India and nowadays, it reaches many other countries via bamboo product international trade. The bamboo shoot industry in China has been shown in a recent INBAR funded study to preferentially increase incomes of the poorest members of the society compared to more affluent groups and is reported to be a proven means of reducing rural poverty (Xiao and Yang, nd).

Some superior monopodial and sympodial species for bamboo shoot production in the world include *Phyllostachys pubescens, P. praecox, P. praecox f. pervernalis, P. propinqua, P. dulcis, P. irridenscens*, *P. prominens*, *P. flexuosa, P. bambusoides, Dendrocalamus latiflorus*, *D. vario-striata, D. beecheyana, D. beecheyana var. pubescens*, *D. validus, and D. hamiltonii* (Xiano and Yang, nd).

In Ethiopia, bamboo shoot of lowland bamboo (*O. abyssinica*) is used for food by *Berta* and *Gumuz* ethnic groups of Benishangul Gumuz Region in north western Ethiopia (Zenebe et. al, 2014) and shoot of highland bamboo (*A. alpina*) is used for food in Masha Zone of Southern Ethiopia (Miftah, 2015). Bamboo shoot could probably be used to supplement food requirements in Ethiopia, especially in food insecured areas and also to ensure nutritional security in the country at large. However, information on nutritional profile of the two indigenous bamboo species, both the nutrients and mineral elements, their bioavailability and extent of nutritional and anti-nutritional factors at different moisture levels is limited in Ethiopia.

MATERIALS AND METHODS

Sample Bamboo shoot sample collection and processing

Both bamboo shoot samples were collected from northwestern Ethiopia. *O. abyssinica* bamboo samples were collected from Pawe, Assosa and Bambasi districts of Benishangul Gumuz Regional State, whereas *A. alpina* shoot samples were collected from Sinan Wereda of Amhara Regional State. Both samples were collected in July 2013, when bamboo shooting happens. Accordingly, from each bamboo species 30 randomly taken fresh shoot samples, *i.e*., 10 small sized shoot samples (10 cm in length); 10 medium sized shoot samples (20 cm in length) and 10 large sized shoot samples (30 cm in length) were collected from respective sites. The collected fresh bamboo samples were put into ice box and safely transported to Ethiopian Public Health Institute laboratory for the nutritional content determination. The samples were then passed the processing stage, i.e. pilled, washed and chopped and then the digested homogenous samples were prepared. Finally, the proximate and mineral content analysis for each species was carried out following the methods by Association of Official Analytical Chemists, AOAC (2017).

Laboratory analysis

Proximate composition of bamboo shoot powder was determined using standard methods according to AOAC (2017) as follows. Moisture content was determined by drying 5 g of sample at 105°C to constant weight. Protein content was determined by Kjeldahl method and protein content calculated by multiplying percentage nitrogen by 6.25. Fat was extracted by Soxhlet's method using Diethyl ether (b.p. 40-60°C) and determined gravimetrically after drying the extract in an oven. Ash content was determined by incinerating 2 g of the sample at 550°C until the ash turned grayish. Fiber was determined by consecutively boiling under reflux 2 g of sample in 1.25% H_2SO_4 and 1.25% NaOH. The residual after filtering was washed with acetone before drying and then incinerating at 550°C for 1 h. The difference in weight before and after incineration was calculated as percentage fiber content. Carbohydrates content was determined by subtracting the sum of moisture, fat, ash, fiber and protein content from 100.

Phosphorus was determined by Fiske and Subbarao method Ranganna (1986), sodium and potassium was determined by using Flame Photometer. Iron, Zinc and Calcium by Atomic Absorption Spectrophotometer (Shimadzu 6800 model), Cyanide level in bamboo shoot quantitatively determined by using acid hydrolysis of cyanogenic glucosides as described by Bradbury AOAC (2005).

Phytate was determined by Latta and Eskin method and Tannin was determined using Burns methods in UV-Vis Spectroscopy.

Data analysis

Data was summarized and analyzed using SPSS.ANOVA and t-test were used to statistically analyze the quantitative data. Results of proximate and mineral content of *O. abyssinica* bamboo collected from the three sites were statistically analyzed and compared each other. Resultsof *A. alpina* shoot samples are statistically analyzed and compared with the nearby site for *O. abyssinica* bamboo sample collection (i.e. Pawe district).

RESULTS AND DISCUSSION

Proximate composition of *O. abyssinica*

The moisture content of *O. abyssinica* shoot samples was more than 90 %, ranging from 91 to 92 %, for all the sites. Samples collected from Bambassi and Assosa districts had significantly higher crude fiber, fat and HCN (fresh basis) contents but with significantly lower protein content (Table 1) as compared to samples collected from Pawe woredas whereas samples collected from Pawe wereda have the highest protein content (dray basis) as compared to other sites. *O. abyssinica* bamboo shoot contains protein and ash, fresh basis, that is within the range and fat that is relatively higher than what is reported from shoots of bamboo species in China (CFPH, 2010).

Table 1. Proximate composition of *O. abyssinica* as affected by growing site

Proximate composition	Pawe	Bambassi	Assosa
Moisture %	92^{a}	91.67^{ab}	90.83^{b}
Crude fiber % dry	8.67^{b}	11.83^{a}	8.5^{b}
Crude fiber % fresh	0.69^{b}	0.10^{a}	0.77^{ab}
protein% dry	27^{a}	21^{b}	24.5^{ab}
Protein % fresh	2.12^{NS}	1.78	2.200
Fat % dry	4.83^{b}	14^{a}	13.33^{a}
Fat % fresh	0.38^{b}	1.18^{a}	1.19^{a}
Ash % dry	11.33^{NS}	10.00	11.50
Ash % fresh	0.88^{NS}	.836265	1.023841
mg HCN/100g	24.86^{b}	30.33^{a}	30.25^{a}

Note: "Values within the same row with different superscript letters are significantly different from each other (at p<0.05)

Mineral composition of *O. abyssinica* as affected by growing site

Samples collected from Pawe and Assosa had significantly higher average values in K, Zn, and Ca as compared to samples collected from Bambassi (Table 2). Samples collected from Pawe and Bambassi had significantly higher ($p<0.05$) Na content than that of Assosa, whereas samples collected from Bambassi wereda have higher values in average Fe and phytate content. Samples collected from all the sites had similar tannin content.

Table 2. Average mineral content of *O.abyssinica* shoot collected from three different sites

Mineral	Pawe	Bambassi	Assosa
Fe mg/100g dry	6^{b}	9.67^{ab}	10.67^{a}
Fe mg/100gm fresh	0.48^{b}	0.83^{a}	0.95^{a}
Zn mg/100gm dry	8.83^{a}	6.67^{b}	8.00^{ab}
Zn mg/100gm fresh	0.70^{ab}	0.56^{b}	0.72^{a}
Ca mg/100gm dry	203.83^{ab}	180.67^{b}	217.33^{a}
Ca mg/100gm fresh	15.89^{ab}	15.36^{b}	19.54^{a}
P mg/100gm dry	704^{a}	439.17^{b}	452.67^{b}
Phosphorus (mg/100g) fresh	55.4 ^{NS}	37.52	40.78
Na mg/100gm dry	6.44^{a}	6.11^{ab}	5.69^{b}
Na mg/100gm Fresh	6.44^{a}	6.11^{ab}	5.67^{b}
K mg/100gm dry	4736.67^{a}	3938.67^{b}	4643^{a}
K mg/100gm fresh	372.58^{ab}	322.90^{b}	416.63^{a}
Tannin (mg/100g) dry	23.17^{NS}	10.20	15.67
Tannin (mg/100g) fresh	1.87^{NS}	.87	1.39
Phytate (mg/100g) dry	133^{b}	187.33^{a}	199.83^{a}
Phytate (mg/100g) fresh	10.53^{b}	15.85^{a}	18.08^{a}

Note: "Values within the same row with different superscript letters are significantly different from each other (at p<0.05)

Effect of *O. abyssinica* shoot size on mineral composition

Shoot size had no significant effect on mineral composition of *O. abyssinica* bamboo shoot collected from three different sites of Benishangul Gumuz region, except tannin content. Large bamboo shoots had higher tannin content (25.5 mg/100g) than medium (15.6 mg/100g) and small (8.83 mg/100g) bamboo shoots (Table 3).

Table 3. Effect of shoot size on tannin (mg/100g) content of *O. abyssinica* shoots collected from three different sites of Benishangul Gumuz region (Tukey HSD, P=0.05)

shoot size (height in cm, category)	Average tannin (mg/100g) content of dry shoot samples	Average tannin (mg/100g) content samples)
10 (Small)	8.83b	0.70 b
20 (medium)	15.60ab	1.30ab
30 (Large)	25.50a	2.19a

Note: "Values within the same row with different superscript letters are significantly different from each other (at p<0.05)

Proximate composition of *O. abyssinica* and *A. alpina*

There was no significant difference in average moisture content of bamboo shoots of the two indigenous bamboo species. It was 92% and 93% for *O. abyssinica* and *A. alpina*. However, crude fiber and protein content of *A. alpina* shoot had significantly higher (p=<0.05)values than *O. abyssinica* bamboo shoots(Table 4).The protein content determined in this study is similar with protein content determined by Sisay (2013) from shoots collected from Tikur Inchini (central Ethiopia) but a bit lower than sample results reported from Injibara (north west Ethiopia) and Masha (south western Ethiopia). However, generally protein content of both indigenous bamboo species is within the range of what is reported for bamboo species in China (CFPH, 2010). Fat and Ash content of the two indigenous bamboo species was found to be similar.

Table 4: Proximate composition (mean + SD) of *O. abyssinica* (Pawe site) and *A. alpina,* in dry and fresh basis

Proximate	*O. abyssinica*	*A. alpina*	t	df	Sig. (2-tailed)
Moisture %	92±0.26	92.67±0.42	-1.348	10	.207
Crude fiber% dry	8.67±0.56	12.17±0.75	-3.748	10	.004
Crude fiber% fresh	0.69±0.03	0.9±0.07	-2.609	10	.026
protein% dry	27±0.86	31.33±1.5	-2.511	10	.031
protein% fresh	2.12±0.11	2.3±0.12	-1.185	10	.264
Fat % dry	4.83±0.31	5.5±0.62	-.964	10	.358
Fat % fresh	0.38±0.3	0.41±0.04	-.543	10	.599
Ash % dry	11.33±1.11	13.67±1.89	-1.063	10	.313
Ash % fresh	0.88±0.09	1.0±0.12	-.887	10	.396

Sig. (2-tailed) Values <0.05 indicate that the parameter values of the two species are significantly different from each other

Mineral content of *O. abyssinica* and *A. alpina*

A. alpina shoot has significantly higher Ca(369.5 mg/100gm dry basis) content but significantly lower K (1661.2mg/100gm) content than *O. abyssinica* bamboo shoots (Table 5). The Fe, Zn, P and Na content of the two species is similar. K content of *O. abyssinica* shoots (4,736.7) is higher than *M. stenopetala* (2095 mg/100 gm) that is often reported to be a miracle species in terms of its nutrient contents. Moreover, as compared to *M. stenopetala (*Zn 2.16, P 380, Fe 54.8, Ca 1918, Na 214 and P 380 mg/100 gm), the two bamboo species have higher Zn and P contents but lower Fe, Ca and Na contents (Abinet, 2009)

The HCN content of *A. alpina* shoot is low (2.36 mg/100gm) hence fresh shoots can be consumed without any harm for human body. However, as compared to *A. alpine shoot*, *O. abyssinica* shoot has higher HCN content (24.86 mg/100g fresh shoot) product protocol that even can make this level to below detection level. Preliminary information shows that native people in Benishangul Gumuz region of Ethiopia use bamboo shoot of this species after soaking in water for three days that highly reduces the HCN content significantly. A report by Hoikhokim, et al. (2016) place bamboo shoots amongst the most potentially toxic plant materials, exceeding apricot, bitter almond stones and considerably exceeding that of cassava. However, the cyanogenic glycoside in bamboo is in fact taxiphyllin (Nongdam and Leimapokpam, 2014). Taxiphyllin is unusual amongst other similar compounds in the sense that it degrades readily in boiling water. Thus boiling bamboo shoots or cooking bamboo shoots should remove any problem. As compared to HCN determined from bamboo shoots of *Dendocalamus hamiltonii* (155-291), *Bambosa balcoa* (88-317) and *Dendrocalamus strictus* (204-224 mg/100g fresh wt) that are amongst the species in the global bamboo shoot market, HCN of Ethiopian indigenous bamboo species is very low.

Table 5. Mineral content (mean ± SD) of *O. abyssinica* and*A. alpina*bamboo shoots

Mineral	*O. abyssinica*	*A. alpina*	t	df	Sig. (2-tailed)
Fe mg/100g dry	6±0.365	8±1.366	-1.414	5.711	.209
Fe mg/100gm fresh	6±0.40	6±0.58	-.930	10	.374
Zn mg/100gm dry	8.83±0.31	8.5±0.67	.452	10	.661
Zn mg/100gm fresh	0.70±0.03	0.63±0.08	.845	10	.418
Ca mg/100gm dry	203.8±16.43	369.5±48.896	-3.212	6.114	.018
Ca mg/100gm fresh	15.9±1.16	27.85±4.86	-2.395	5.563	.057
P mg/100gm dry	704±46.86	887±102.95	-1.618	10	.137
Phosphorus (mg/100g)	55.40±4.70	65.32±7.98	-1.072	10	.309
Na mg/100gm dry	16.67±1.60	17.33±3.94	-.156	10	.879
Na mg/100gm Fresh	6.44±0.16	6.83±0.36	-.988	10	.346
K mg/100gm dry	4736.7±214.8	1661.17±99.92	31.795	10	.000
K mg/100gm fresh	372.58±15.17_	122.07±5.17	15.627	6.146	.000
Tannin (mg/100g) dry	23.17±4.98	276.67±55.54	-4.546	5.080	.006
Tannin (mg/100g) fresh	1.87±0.43	19.85±3.69	-4.847	5.135	.004
Phytate (mg/100g) dry	133±12.52	1773.17±55.45	-28.855	5.509	.000
Phytate (mg/100g) fresh	10.53±1.17	130.11±4.70	-24.655	10	.000
mg HCN/100g (fresh)	24.86±0.85	2.36±0.02	26.407	5.008	.000

Sig. (2-tailed) Values <0.05 indicate that the parameter values of the two species are significantly different from each other

Anti-nutritional factors and bioavailability of mineral elements in bamboo shoots of indigenous bamboo species

The values for tannin and phytate contents of *A. alpina* shoots are significantly higher than that of *O. abyssinica* shoots indicating that developing processing techniques that reduce these values is required.

Anti-nutritional factors and bioavailability of mineral elements in bamboo shoots of indigenous bamboo species

In this study, Phytate : Zinc molar ratios of *A. alpina* is nearly 4 and that of *O. abyssinica* is nearly 9 indicating the relatively good bio-available of Zinc in shoots of *O. abyssinica* than *A. alpina* that has a medium bio-availability. Phytate: Fe molar ratios for *A. alpina* and *O. abyssinica* shoots are 5 and nearly 7, respectively (Table 6), indicating that Fe in the bamboo shoots of the two species is not bioavailable. Phytate: Calcium molar ratios is very low for both the species (<0.24) indicating that Ca is bioavailable. In this case therefore, developing more effective methods than the traditional method of bamboo shoot food preparation need to be identified to enhance bioavailability of Fe in bamboo shoot foods of *A. alpina* and *O. abyssinica.*

Table 6. Bioavailability of mineral elements (from duplicate samples) *O. abyssinica* and *A. alpina* shoots

Bamboo species	Phytate : Iron molar ratio[a]	Phytate : Zinc molar ratio[b]	Phytate : Calcium molar ratio[c]
Arundinaria alpina			
	5.091954	3.990274	0.101555768
	5.007172	3.917083	0.100733026
Oxytenanthera abyssinica			
	7.106089	9.237656	0.17062837
	6.482932	8.465718	0.158436455

a= mg of Phytate/MW of Phytate: mg of iron/MW of iron
b= mg of Phytate/MW of Phytate: mg of Zinc/MW of Zinc
c= mg of Calcium/MW of Calcium: mg of phytate/MW of phytate

CONCLUSION AND RECOMMENDATION

Generally the two indigenous bamboo species of Ethiopia have a good proximate and mineral profile that makes bamboo forests one important food source in the country. The content of the shoots varies depending on sites the shoots are collected and depending on the species. Shoot size from 10 to 30 cm height has no effect on proximate and mineral composition except tannin content. As compared to many edible bamboo shoot species, HCN content of indigenous bamboos is low; *A. alpina* shoots have very low HCN content. Moreover, from experiences of other species in other countries, there is possibility lowering HCN contents very lowor below detection level for *O. abyssinica shoots*. Thus, modern ways of processing bamboo shoots, especially for *O. abyssinica* is required. Bioavailability of Zn and Ca in shoots of the two species is good but that of Fe is low. Hence effective methods need to be identified for maximizing bioavailability of Fe. Generally, bamboo product protocols should be the next step for both highland and *O. abyssinica* shoots. Management techniques for bamboo shoot stand management need to be developed.

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REFERENCES

Abinet T (2009). Nutritional Profile of *Moringa stenopetala* Species Samples Collected from Different Places in Ethiopia and their Comparison with *Moringa oleifera* Species. Ethiopia Health and Nutrition Research Institute. Proceedings of the workshop on Commercialization of Moringa in Ethiopia, EIAR. Addis Ababa, Ethiopia

AOAC (2017).Official methods of analysis, 16th ed., Association of Official Analytical Chemists, Washington, DC, USA.

Ashok KP and Vijayalakshmi O (2014).Precooking processing of bamboo shoots for removal of anti-nutrients. *J Food Sci Technol.*51(1): 43–50.

Ashok P (2013). Standardization of harvesting age of bamboo shoots with respect to nutritional and anti-nutritional components, *Journal of Forestry Research* 24(1): 83−90.

Bhatt BP, Singha LB, Sachan MS and Singh K (2004). Commercial edible bamboo species of the North-Eastern Himalayan Region, India. Part I: young shoot sales. *J. Bamboo and Rattan*, 3 (4): 337–364

CFPH (2010). China Forestry Publishing House (CFPH), Technical Manual on Asian Tropical Bamboo Shoot Production, Processing and Utilization, Beijing, China.

EHNRI (1997/98). Food composition table for use in Ethiopia. Part III.

FSANZ (2005). Cyanogenic Glycosides in Cassava And Bamboo Shoots: A Human Health Risk Assessment, Technical Report Series No. 28. Food Standards Australia New Zealand. ISBN 0 642 34551-1.

Hoikhokim NA and Kananbala S (2016). Cyanogenic glycosides in Edible Succulent Bamboo Shoots of Manipur, India, *Int. J. Curr. Res. Aca. Rev*. 4(8): 64-72

Lisbeth B, Anne S and Søren K (2008).Phytate: impact on environment and human nutrition. A challenge for molecular breeding, *J Zhejiang Univ Sci B* 9(3): 165–191.

Melaku U, West CE and Habtamu F (2005).Content of zinc, iron, calcium and their absorption inhibitors in foods commonly consumed in Ethiopia. *J. Food Comp. Anal.* 18: 803–817.

Miftah F, Emnar C, and Peter D (2012). Household Contribution of Bamboo in Masha District, Southern Ethiopia Natural forest. Proceedings of the workshop on Forestry and Forest Products in Ethiopia, EIAR.

Narmilan A and Amuthenie S (2015). Demand for Organic food Products in the urban areas of the Batticaloa District, Sri Lanka, *Res. J. Agriculture and Forestry Sci.* 3(11): 21-26.

Nirmala C, Madho S and Sheena H (2011). Nutritional Properties of Bamboo Shoots: Potential and Prospects for Utilization as a Health Food *Comprehensive Reviews in Food Science and Food Safety* 10: 154-169. doi:10.1111/j.1541-4337.2011.00147.

Nongdam and Leimapokpam T (2014). The Nutritional Facts of Bamboo Shoots and Their Usage as Important Traditional Foods of Northeast India, *International Scholarly Research Notices* 2014, 17 pages.

Pallauf J and Rimbach G (1997). Nutritional significance of phytic acid and phytase. *Arch Tierernahr* 50(4):301-19.

Sisay F (2013). Site factor on nutritional content of *Arundinaria alpina* and *Oxytenanthera abyssinica* bamboo shoots in Ethiopia, Full Length Research Paper. *Journal of Horticulture and Forestry* 5(9): 115-121.

Xiao JH and Yang QP (nd). Transfer of Technology Model (Totem) Bamboo Shoot Plantation. Research Institute of Subtropical Forestry INBAR, Chinese Academy of Forestry and INBAR. Zhejiang, China.

Zenebe M, Adefires W, Temesgen Y, Mehari A, Demel T, and Habtemariam K (2014). Bamboo Resources in Ethiopia: Their value chain and contribution to livelihoods, *Ethnobotany Research & Applications*: 12 (1): 511-524.

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