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CONTENTS OF ANTI NUTRITIONAL SUBSTANCES OF BAMBOO SHOOTS AND RELATION OF THESE TO SENSORY CHARACTERS OF THEIR INTACT AND FERMENTED FORMS

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ABSTRACT
With the displaying of increasing vertical distribution from base to tip portions, cyanide contents of bamboo shoots belonging to six species were compared. Interestingly it was noted that bamboo shoot of a non edible species locally known as 'Utang' (*Bambusa* sp.) and an edible species (*Dendrocalamus giganteus*) have lowest and highest values of cyanide such as 50.83-114.72 mg/kg and 1575.12-2165.21 mg/kg respectively. Occurrence of discriminated levels of each of the anti-nutritional factors such as total phenols, tannins and phytate in bamboo shoots of different species had no relevance with their variation of sensory characters as well as with that of specific Soibum products produced from them by natural fermentation. But possession of cyanide in low amount by bamboo shoot was a criterion for its better sensory quality and also for Soibum too prepared from it.

INTRODUCTION

Most of the bamboo species of North East India are available in Manipur. In this region, although not for all of species, reproductive propagations (bamboo shoots) from rhizomes when succulent have been favouritely consumed as vegetable and they are recognized as edible species. Among the bamboo species of Manipur which have not been consumed at all, one locally known as 'Utang' (*Bambusa* sp.) has been presumed by the people to be highly poisonous based on dreadful legendary occasions originated from its use.

It was noted that immature part of bamboo possessed high amount of cyanide, a respiratory poison, in the form of cyanogenic glycoside (Nartey, 1980 and Schwarzmaier, 1977). Moreover, bamboo shoots also possess other anti nutritional substances such as total phenols, tannins, phytate (Giri, 1988) as do by legumes etc.

In Manipur, besides the consumption as vegetable, succulent bamboo shoots have been processed exclusively to produce 'Soibum' by natural lactic acid fermentation in presence of yeasts (Giri and Janmejoy, 1994). Soibum is one of the favourite fermented foods of the people of Manipur. However, demand on the consumption of bamboo shoots of different species as well as on Soibum products of different localities vary considerably. Such understanding is imperative to undergo study to compare the levels of the above mentioned anti nutritional substances of bamboo shoots of certain edible and non edible species, and for checking relationship of their levels to the sorting of being edible and non edible and also with sensory qualities of edible bamboo shoots of different species as well as of Soibum specifically produced from them thereof.

MATERIALS AND METHODS

The succulent bamboo shoots of about same maturity stage of the species such as *Bambusa burmanica, Bambusa sp., B. tulda, Dendrocalamus giganteus, D. strictus and Melocanna baccifera*, but of uniform size for a species were collected during rainy season from different places of Manipur.

A known mass of succulent bamboo shoot taken out from each of its tip, middle and base portions for each of the species was homogenized with distilled water in order to carry out determination of cyanide by colourimetric method (Sadasivam and Manickam, 1996).

The bulk of more than 10 kg of bamboo shoots of each species was thinly sliced and then mixed thoroughly. Such specific mashes of bamboo shoots were at once subjected to determinations of total phenols, tannins and phytate (Sadasivam and Manickam, 1996) and moisture (Ranganna, 1986). Then about 5 kg of sliced mash of each of species except for *Bambusa* sp. was given to semi trained 10 panelists without making known the species for sensory evaluation of a cooked bamboo shoot item (Kangshu) following nine point Hedonic Scale (Ranganna, 1986). About five kg of sliced mash

of each edible species was fermented into 'Soibum' inside 500 ml beakers by incubating at room temperature (24.6°C ± 0.7) for one month adopting exudate retaining method (Mina, 2009) but with compact packing of the mash and airtight sealing of the mouth of beaker. Sensory evaluation of specific Soibum products was conducted by panelists with the preparation of a favourite dish (Iromba) but Soibum products were supplied to them with concealing of species from which they had been produced.

Such overall operation was done in three replications. The data were statistically analyzed adopting ANNOVA (Kothari, 2004) and Dunkan Multiple Test Range (Stephen and Ruth, 2000).

RESULTS AND DISCUSSION

Table 1 is evidential that commonly succulent bamboo shoots possess increasing amount of cyanide from base to tip irrespective of the species. Succulent bamboo shoot of *D. giganteus* exhibited relatively higher amount of cyanide. In contrary to this, in every case of portion wise comparison, succulent shoot of *Bambusa* sp. exhibited lower cyanide content. The investigated ranges of cyanide contents of base, middle and tip portions of these materials were 50.83-1575.12 mg/kg, 84.65-1821.70 mg/kg and 114.72-2165.12 mg/kg respectively. It seemed very conspicuously that the lowest and highest values of these ranges were always for *Bambusa* sp. and *D. giganteus* respectively.

Rezaul and Howard (2002) mentioned that bamboo shoots contained upto 1600 ppm total cyanide in the tip reducing to 110 ppm in the base. According to WHO (1993), the concentration of cyanide in the immature shoot tip of bamboo was 8000 mg/kg while Ferreira *et al.* (1990) reported that the apical part of bamboo contained cyanide as much as 1000 mg/kg. Nevertheless Ferreira *et al.* (1995) reported that *D. giganteus* contained cyanide with average value of 894 mg/kg in apical portion of its bamboo shoot. But in the present contribution, it is noted that tip portions of succulent shoots of *B. tulda* and *Bambusa* sp. possess cyanide less than 1000 mg/kg with extremely low value of the latter. Moreover, this study displayed that even the base portion of succulent shoot of *D. giganteus* possessed cyanide at level of about double fold of the value reported by Ferreira *et al.* (1990).

Table 1: Vertical distribution of cyanide in succulent bamboo shoots of different species (mg/kg)

Species (local name)	Portion		
	Base	Middle	Tip
D. giganteus(Marubob)	1575.12	1821.70	2165.12
B. tulda(Saneibi)	354.45	598.26	900.00
D. strictus(Unal)	220.93	528.27	1348.32
M. baccifera(Moubi)	193.38	530.00	1630.00
B. burmanica(Khokwa)	480.00	633.33	2073.37
Bambusa sp.(Utang)	50.83	84.65	114.72

Values are the means of 3 replications. Values in each of the horizontal and vertical rows differ significantly ($p < 0.05$)

Regarding commercial edible bamboo species of North Eastern Himalayan region, India, cyanide contents were 100-200 mg/kg (Bhatt *et al.*, 2005). With this contribution, it is agreed with the values of base portion of *M. baccifera* sample only (Table 1).

The recorded values of total phenols and tannins of bamboo shoots of these species were respectively 21.22-59.72 mg/100 g and 7.19-33.60 mg/100 g. Highest values of total phenols and tannins were of *D. giganteus* while their lowest values being for *M. baccifera*.

The recorded values of phytate P of the succulent bamboo shoots were 19.80-66.44 mg/100 g, such smallest and greatest values being for *B. tulda* and *B. burmanica* respectively.

Giri (1988) reported the average contents of phenolic compounds of succulent shoot of *D. giganteus* and *B. tulda* to be 55.62 mg/100 g and 30.79 mg/100 g respectively. For each of the specific material, the present investigation also exhibited value closer to the above one. Dry seeds of phaseolus bean (red variety), chickpea, lima bean and winged bean possessed total phenols with the values of 1140 mg/100 g, 950 mg/100 g, 770mg/100 g and 1500 mg/100 g respectively (Salunkhe *et al.*, 1989). Total phenols contents of *Cassia laevigata* and *Tamarindus indica*, three germplasm of *Cassia floribunda*, five germplasm of sword bean, seven wild legume of South India, white and black seeds of velvet bean in dry weight basis were 1.14% and 6.4%, 0.3%-0.4%, 0.55%-1.07%, 0.41%-5.96%, 4.97% and 5.08% respectively (Siddhuraju *et al.*, 1995; Vadivel and Janardhanan, 2001 and 2005; Pugalenthi and Vadivel, 2005 and Vadivel and Pugalenthi, 2008). Whereas tannins contents of dry seeds of black gram, chickpea and green gram were in the range of 1.7-8.4 g/kg (Khan *et al.*, 1979; Rao and Deosthale, 1982). The recorded values of ratio of the content of total phenols to that of tannins for succulent bamboo shoots of the six species were 1:0.34-1:0.67. Such ratio values produced for dry seeds of three genotypes of *Vicia faba* (Inaomacha, 2007) was 1:0.62-1:0.67. The ratio values were noted to be closer.

Different samples of succulent bamboo shoots exhibited in most of the cases about significant variation of the contents for each of the anti-nutritional substances as due to species. Moreover, it had proven about cyanide that within succulent bamboo shoot, its content varied with maturation stage of different portions, the highest being for most immature part.

Table 2: Moisture, total phenols, tannins and phytate contents of succulent bamboo shoots of different species

Species	Moisture%	Total phenols mg/100g	Tannins mg/100g	Phytate mg/100g	* Ratio
D. giganteus	88.72 $^{a/d}$	59.72	33.60	25.92	1 : 0.56
B. tulda	90.31 $^{b/d}$	31.24	22.27	19.80	1 : 0.71
D. strictus	87.33 $^{a/c}$	54.03	24.06^{a}	37.60	1 : 0.45
M. baccifera	86.63^{C}	21.22	7.19	58.04	1 : 0.34
B. burmanica	86.60^{C}	40.16	20.97^{a}	66.44	1 : 0.52
Bambusa sp.	90.46^{b}	39.19	26.47^{a}	47.10	1 : .67

Values except for ratio are means of three replications. Means without same superscript in a column differ significantly except for right end column ($p < 0.05$).
* Ratio of the content of total phenols to that of tannins.

Table 3: Sensory evaluation of succulent bamboo shoots of different species and Soibum produced from them in specific assortment

Species	Succulent bamboo shoot					Soibum				
	Colour	Taste	Flavour	Texture	Overall acceptability	Colour	Taste	Flavour	Texture	Overall acceptability
D. giganteus	7.3^{a}	6.4	7.1^{b}	7.2^{b}	7.1^{C}	7.1^{a}	6.8	7.3^{b}	7.5^{b}	7.1^{C}
B. tulda	7.4^{a}	7.8^{a}	7.9^{a}	7.7^{a}	8.2^{a}	7.4^{a}	7.9^{a}	7.9^{a}	7.9^{a}	8.5^{a}
D. strictus	7.3^{a}	7.9^{a}	$7.5^{a/b}$	7.7^{a}	$7.9^{a/b}$	7.2^{a}	7.8^{a}	$7.6^{a/b}$	7.8^{a}	$8.0^{a/b}$
M. baccifera	7.3^{a}	7.4^{a}	$7.5^{a/b}$	$7.6^{a/b}$	$7.5^{b/c}$	7.3^{a}	7.5^{a}	7.7^{a}	$7.6^{a/b}$	$7.5^{b/c}$
B. burmanica	7.2^{a}	4.5	6.2	3.5	4.1	6.5	4.7	5.9	3.7	4.2

Values are the means of three replications of scores obtained from 10 panelists using 9 point Hedonic scale (1-dislike extremely and 9 - like extremely). Values with same superscript in each of the columns do not differ significantly ($p > 0.05$).

Table 3 displays about the sensory qualities of succulent bamboo shoots of different species and Soibum produced from them in specific assortment. Herein, it can be inferred that Soibum is an acidic food possessing flavouring agents such as diacetyl, acetoin, 2-3 butanediol, esters and volatile phenols (Giri and Janmejoy, 1994).

Among the succulent bamboo shoots and specific Soibum products of the species *B. burmanica, B. tulda, D. giganteus, D. strictus* and *M. baccifera* those of third species exhibit comparatively inferior taste (Table 3) probably from the impact of very exceeding occurrence of cyanide (Table 1). Indeed from one month old Soibum of *D. giganteus* and *B. tulda*, releasing out of HCN from taxiphyllin due to hydrolysis caused by acid accumulated was found to be comparatively more intense from the former which could possibly ensue from still retention of greater amount of taxiphyllin in the former mash than in that of latter. But for *B. burmanica*, poor taste, flavour and texture qualities of its succulent shoots were factors affecting severely the overall acceptability of it and that of its Soibum as well. Moreover *B. burmanica* followed *D. giganteus* in possessing higher amount of cyanide which was attributable for bitter sensation about which the panelists rendered lesser score for taste as noticed from asking the reason. In addition other factor might involve in affecting taste of succulent bamboo shoot of *B. burmanica*.

It seemed that restriction of succulent bamboo shoot of *Bambusa* sp. from consumption had no quantitative relevance of cyanide because it did not excel bamboo shoots of any other edible species in containing this toxic substance.

From narration of data of Tables 1-3, it could be inferred that contents of total phenols, tannins and phytate have no correlation with the sensory quality of bamboo shoots. As in legumes, these anti-nutritional substances might not have manifested their anti-nutritional properties probably from occurrence in lower concentrations in bamboo shoots. Previously it had shown that seeds of legumes contained profoundly higher levels of these antinutritional substances than bamboo shoots. The levels of such antinutritional substances changed during Soibum fermentation (Giri, 1988) and therefore their levels in raw materials had no correlation with the sensory quality of Soibum too. It is ascertained from table 1 that in any of the portion wise comparison, bamboo shoots of *B. tulda, D. strictus* and *M. baccifera* have lower cyanide contents. Except the cases of colour and flavour of bamboo shoots of these three species, values of any other sensory character of two or all of the above species excel those of other species as the matter was also for Soibum products except for the case of colour (table 3). Thus it can be affirmed that low content of cyanide is a criterion not only for better sensory quality of bamboo shoot but also for production of better quality Soibum as well.

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