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REDUCTION OF CYANIDE OF BAMBOO SHOOT DUE TO A TRADITIONAL MANIPURI METHOD OF PROCESSING

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ABSTRACT
Succulent bamboo shoots of *Bambusa nutans, Dendrocalamus latiflorus, D. strictus* and *Melocanna baccifera* noted to possess cyanide with values of 840.16, 1013.45, 706.52 and 480.81 in mg/Kg were separately processed following method for popular Manipuri 'Utsoi kangshu' dish preparation. The above values had been reduced by 78.42-83.25% when their thin slices were water soaked for 12 h at 20.36 ± 0.53ºC and afterward drained. When these treatments were followed by 30 min boiling , draining and squeezing of liquid from the mash , the total reduction of cyanide became 88.89-93.30%.These data show that extents of cyanide reduction caused by each of these combined treatments in species assorted mashes are closer. Relative to cyanide content of boiled and drained mash, combined treatments with boiling, draining and squeezing caused 40.32-60.76 % reduction of cyanide with inter species difference in the range of 1.84-20.44%. The overall treatments had left cyanide in the mashes in the range of 40.72-112.57 mg/Kg in correlation with its initial levels. Interestingly bamboo shoot of *Chimonobambusa callosa* procured from Imphal markets was noted to be insensitive to cyanide determination done by picrate paper method.

INTRODUCTION

The cyanogenic character of bamboo among cyanogenic plants is due to presence of taxiphyllin (Schwarzmaier,1977 and Nartey,1980). But among the sixty different cyanogenic glycosides of plants, taxiphyllin is unusual because of its degradation in boiling water readily (Hunter and Yang,2000). This is one of the reasons for rendering bamboo shoots consumable. Moreover, Ferreira *et al*.(1995) and Rawat *et al*.(2015) reported that cyanide of bamboo shoots could be reduced due to boiling and soaking at extent depending upon the treatment and species. Nonetheless, the contributions of Hunter and Yang (2000), Sayanika *et al*., 2013 and Rawat *et al*. (2015) were evidential for the inter species as well as intra species difference of cyanide content of bamboo shoots. Thus it is considered to be very problematic in developing a general method which can bring down the contents of cyanide of bamboo shoots at comparable low values.

Amidst the favourite consumption of bamboo shoots as vegetable by the people of countries viz, China, Japan, Thailand, and Indonesia etc. (Mina, 2009), those of north east India and tribals of north east Chhatisgard and Orissa (Kumbhare and Bhargava, 2007 and Giri, 2013), people of Manipur too have been similarly consuming such vegetable since ancient time mainly by preparing into a popular dish locally known as 'Utsoi kangshu'. Herein it can be mentioned that all popular edible species of bamboo shoots of Manipur are cyanogenic (Sayanika *et al*., 2013; Mina *et al*., 2014 and Rawat *et al*., 2015). Though cyanide could be reduced due to soaking and boiling adopted in the preparation of the dish, the level of cyanide retained in it would be depended upon entire processing method and species concern. The present study is therefore undertaken to display the levels of cyanide retained in the processed bamboo shoots of different popular species for the preparation of the above dish.

MATERIALS AND METHODS

Succulent bamboo shoots of *Bambusa nutans, Dendrocalamus latiflorus, D. strictus* and *Melocanna baccifera* of about uniform size and maturity for each species were randomly procured from markets of Imphal in the month August, 2015. Similarly bamboo shoots of *Chimonobambusa callosa* were procured in the month September, 2015 from Imphal markets. The sheaths and outer fibrous part of succulent bamboo shoots were manually removed and then about 1 Kg of bamboo shoots of each species was thinly sliced with the help of a knife. But, for *C. callosa* bamboo shoot, slicing was done only after manual removal of sheaths. These species assorted mashes were subjected to processing treatments for the preparation of 'Utsoi kangshu' a popular Manipuri dish. For doing so, a major portion of the mash of slices of each species was soaked with tap water for 12 h at ambient temperature of 20.36±0.53ºC after mixing in the proportion of 1 Kg:2 L and then drained. The slices were then mixed with tap water in the above proportion and then boiled for 30 min in a steel utensil and afterward drained. The liquid of the slices was squeezed out as much as could by exerting compression between palms. The HCN of raw bamboo shoots, soaked + drained mash, soaked + drained + boiled

+ drained + squeezed mash was determined adopting the picrate paper method (Sadasivam and Manickam,1996). The steps of determination were saturation of whatman filter paper no. 1 strips (10 cm x 0.5 cm) with alkaline picrate solution, fine homogenization of a weighed portion of each sample with chloroform (4 drops for 1 g sample) with the help of mortar and pestle, transfer of the homogenized mash into 250 ml conical flask, hanging of alkaline picrate soaked filter paper strip for 24 h inside the conical flask from rubber cork used to close its mouth tightly, elution of colour by dipping filter paper strip in 10 ml of distilled water, development of colour of standard cyanide and measurement of OD at 625 nm . Such determination was done in three replications for each species. Data were statistically analyzed following ANNOVA and Dunkan Multiple Test Range(Stephen and Ruth, 2000).

RESULTS AND DISCUSSION

Table 1 displays that bamboo shoots of different species possess significantly varied amounts of cyanide, the highest being of *D.latiflorus* (1013.45 mg/kg) followed by those *of B. nutans* (840.16 mg/Kg), *D.strictus* (706.52 mg/kg) and *M. baccifera* (480.81 mg/Kg). Rawat *et al*. (2015) reported cyanide contents (mg/Kg) of bamboo shoots of *B. nutans, D. strictus, D. giganteus* and *M.baccifera* with significant inter species variation having been the values as 1709.66, 1717.85, 988.17 and 285.12 respectively. Cyanide content of bamboo shoot increased from base to tip with such values in mg/ Kg being 199-300, 267-1001, 216-1548, 779-1579 and 920-2604 for *C. callosa, B. nutans, M. baccifera, B. tulda,* and *D. gigangteus* respectively (Sayanika *et al*., 2013) as noted as 193.38-1630.00, 220.93- 1348.32, 354.45- 900.00 and 1575.12- 2165.12 for *M. baccifera, D. strictus, B. tulda* and *D. giganteus* respectively (Mina *et al*., 2014). From the above values displayed from literature and those of present investigation (Table 1), it could be affirmed about inter species as well as intra species variation of cyanide content of bamboo shoots. Hunter and Yang (2000) also reported that bamboo shoot at initial harvest contained more cyanide than at peak harvest. As compared with the level of cyanide of immature shoot tip of bamboo which is 8000 mg/Kg (Who,1993), the present succulent bamboo shoots possess 7.89-16.63 times lower level of cyanide. However, the levels of cyanide of *B. nutans*, *D. latiflorus* and *M. baccifera* bamboo shoots (Table 1) lie above the permissible limit which is 500 mg/ Kg (Rawat *et al*., 2015)

Interestingly bamboo shoot of *C. callosa* is noted to be insensitive to picrate paper method of cyanide determination. Previously the range values of cyanide possessed by *C. callosa* bamboo shoot (Sayanika *et al*., 2013) have been given. However, according to Rawat *et al*.(2015) the level of cyanide in *C. callosa* bamboo shoot is as low as 31.68 mg/Kg. Moreover, Sayanika *et al*. (2013) mentioned that bamboo shoot of *C . callosa* growing at high altitude often possessed cyanide in lower amount as compared with those of other species growing in low altitude. Naithani *et al*.(2010) reported that growing sites of *C. callosa* in Manipur are Mao, Koubru, Ngariyan village of Bishenpur, Chawangkining, I.T. Road, Charoi (Tupul), Hundung village, Shiroy village and Nungghar of Ukhrul. The *C. callosa* bamboo shoot analyzed by Sayanika *et al*.(2013) was from Leimaram locality of Manipur. The detection limit of picrate paper method of determination was 0.50 µg HCN (Sylvia *et al*.,1998) and the author of this contribution recorded insensitive determination for sample weight up to 20 g. Thus in Manipur it is very probable about the growing of *C. callosa* (Laiwa) variety possessing nil or trace of cyanide. It had affirmed that Laiwa bamboo shoots were brought from different growing sites of Manipur to Imphal markets for selling.

Table 1 is evidential that 12 h water soaking (WS) of slices of bamboo shoots and then draining (D) causes 78.42-83.25% reduction of cyanide. According to Rawat *et al*.(2015) such reduction should be from enzymatic degradation of taxiphyllin into HCN, glucose and hydroxybenzaldehyde. During 12 h soaking of slices of bamboo shoots of *D.giganteus* and *D. hamiltonii*, Rawat *et al*. (2015) observed 63.62% and 49.52% reduction of cyanide which had been increased to 81.97% and 84.95% reduction respectively due to 24 h soaking. In furtherance, Rawat *et al*.(2015) narrated that extent of cyanide reduction depended upon soaking temperature and medium. Thus in the present case certain factor might enhance leaching of cyanide into soaking medium. When the water soaked + drained mash was further treated by boiling (B) + draining + squeezing (S), cyanide reduction noted was 88.89- 93.30% relative to control values. But in the overall reduction of cyanide, B + D + S imparted only 7.50- 13.12% reduction. However, relative to cyanide content of water soaked + drained mash, B + D + S causes 40.32-60.76 % reduction of cyanide (Table 1). It could be inferred that cyanide reduction of the

Table 1: Levels (mg/Kg) of cyanide of raw bamboo shoots and their processed mashes and its reduction due to processing

Species & type of	*Raw bamboo shoot	*WS + D	*WS + D + B + D + S	% Reduction I	II	III
Sprout from rhizome						
D. latiflorus (Maroobob)	1013.45	188.62	112.57	81.39	88.89	40.32
B. nutans (Saneibi)	840.16	140.72[a]	56.32[a]	83.25	93.30	59.98
D. strictus (Unan)	706.52	138.66[a]	58.04[a]	80.37	91.79	58.14
M. baccifera (Moubi)	480.81	103.76	40.72	78.42	91.53	60.76
Soft and immature apical portion of culm						
C. callosa (Laiwa)	ID	ID	ID	-	-	-

Each value is a mean of three replications. *Means with same superscript in a vertical row do not differ significantly(P > 0.01); WS: Water soaking, D: Draining, B: Boiling, S: Squeezing, ID: Insensitive determination;I: Reduction caused by WS + D relative to values of raw materials;II: Reduction caused by WS + D + B + D + S relative values of raw materials;III: Reduction caused by B + D + S relative to values of water soaked and drained mashes;Scientific names of bamboo species are given according to Naithani *et al*.(2010);Local names of bamboos are given inside parenthesis

bamboo shoot of *D.giganteus* and *D. hamiltonii* due to 20 min boiling was 86.05% and 87.05 % respectively (Rawat *et al.*,2015). According to Ferreira *et al.*(1995), 20 min cooking of bamboo shoot of *D.giganteus* at 98º C under ambient pressure could reduce cyanide by 68.10%. These authors further reported that 96.90% reduction of cyanide of bamboo shoot could be achieved by boiling at 98ºC for 180 min under ambient pressure. Moreover, elongation of cooking time led to further increase of cyanide reduction (Ferreira *et al.*,1995 and Rawat *et al.*, 2015). It is conspicuous that the attributes of the present processing as one of the best methods of bamboo shoot processing are shorter time of cooking, reduction caused mainly by pre cooking soaking and elimination of high amount of cyanide by overall treatments.

In case of cyanide reduction caused by either of WS + D and WS + D + B + D + S, inter species difference seems to be very small (Table 1). But B + D + S has ensued inter species difference of reduction of cyanide in the range of 1.84-20.44%. Rawat *et al.*(2015) also observed inter species difference in the reduction of cyanide of bamboo shoots due to boiling.

The mashes of slices of different species subjected to overall treatments possess mostly discriminated values of cyanide in the range of 40.72-112.57 mg/Kg (Table 1). Thus it is conspicuous that amounts of cyanide retained in the mashes after processing have correlation to its initial levels, the values in mg/Kg being 40.72, 56.32, 58.04 and 112.57 against their initial values of 480.81 (*M. baccifera*), 840.16 (*B. nutans*) 706.52 (*D. strictus*) and 1013.45 (*D. latiflorus*) respectively. Though among these bamboo shoots, that of *D. latiflorus* does not possess superior sensory quality (Mina *et al.*,2014) it has been consumed mainly on account of most abundant availability. It appears that bamboo shoots of the species *B. nutans*, *D. strictus* and *M. baccifera* have been lesser consumed due to low availability and economic policy. The recipe of Manipuri favourite dish Utsoi Kangshu includes mainly bamboo shoot processed as above, soaked and boiled dry pea, fermented fish, chilly and salt etc. Under this condition it cannot be considered to be a dish exclusively of bamboo shoots. Thus during the consumption of Utsoi Kangshu, an individual would get sub lethal amount of cyanide since enough consumption can be with less than 1/4 Kg of this favourite dish and lethal dose of cyanide is 1 mg/Kg live weight (Cereda and Mattos, 1996). Hipolito and Julie(2011) reported that konzo an epidemic paralytic disease had been caused from consumption of insufficiently processed cyanide containing food such as cassava. Cassava contained cyanogenic glycoside linamarin (Rawat *et al.*, 2015) and some of the cassava eaters of Africa suffered from neurological diseases related with weakness of fingers and toes, difficulty walking, dimness of vision and deafness etc. (Stephane, 2012). Moreover, it had reported that even at sub-lethal levels, cyanide can cause significant health problems(Stephane, 2012).In furtherance, Sayanika *et al.*(2013) reported that in iodine deficient region there could be death, incidence of exacerbate goitre and cretinism from prolonged and acute consumption of diet containing cyanogen derivatives. However, in Manipur, it seems that even during peak season of appearance of bamboo shoots, a family neither consumes bamboo shoot excessively in a meal nor very frequently. Nonetheless, when the bamboo shoot is in recipe of another popular alkaline dish of Manipur known as Mangal utti, its inclusion is small. Perhaps the ancestors of this state might have tried to eliminate maximally the acrid taste of bamboo shoots by adopting above ways of processing treatments and since then such processing has been undergoing through generations. It might be due to these reasons that as yet in Manipur, there is no proclamation by the concerned authorities and experts about the incidence of the aforesaid diseases in relation with consumption of bamboo shoots . Above all, in Manipur with adoption of traditional methods, bamboo shoots have been also commercially processed by natural lactic acid fermentation into Soibum (Giri, 1998 and 2015) a chief fermented food. The acid accumulated during Soibum fermentation caused degradation of taxiphyllin which ensued continual release of HCN from the fermenting mash (Giri and Janmejay,1994 and Mina *et al.*, 2010) so that one year old Soibum contained such very low level of it as 9.17-20.00 mg /Kg (Mina,2009).

People of Manipur consume Laiwa bamboo shoot as a main bamboo vegetable by preparing into dishes such as Eromba(a chutney like dish), Athongba (curry prepared boiling with other ingredients) and fried. Usually, such dishes have been prepared after soaking at least overnight. It means that in Manipur bamboo shoot of any type has been always consumed after subjecting to safety treatments. It is worthwhile in stating that Laiwa bamboo shoot is one of the main bamboo vegetables of Manipur.

The availability of Laiwa bamboo in Manipur recorded to be free of cyanide is an opportunity. At this juncture it is very much urgent for joining by concerned authorities and workers to find out growing sites of such Laiwa bamboo and then undergo exploitation of it in the commercial processing of safe bamboo shoot food products of export quality with expanded and intensified growing of this bamboo. This would be one of the measures of resource mobilization of this state for uplift of economy. Moreover, the study has informed that precooking soaking of bamboo shoots and subsequent draining should be unavoidably adopted as pre cooking treatments for magnificent reduction of cyanide. The mode of processing and consumption of bamboo shoots by the people of Manipur might be related with refraining from the related cyanide intoxication diseases.

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