RESEARCH PAPER *Asian Journal of Bio Science* (October, 2010) Vol. 5 Issue 2 : 178-180

Cyanogen content in bamboo plants

KANANBALA SARANGTHEM AND HOIKHOKIM
Department of Life Sciences, Manipur University, IMPHAL (MANIPUR) INDIA

(Accepted : May, 2010)

The emerging succulent bamboo shoots are edible. They are a delicious vegetable item. Bamboo shoots contain the cyanogenic glycoside (taxiphyllin) which is hydrolysed and decomposes to hydroxy benzaldehyde and hydrogen cyanide (cyanogen). The cyanide present in the fresh and fermented bamboo shoots was analyzed .The cyanide content were found to decrease substantially in the fermented samples below the human toxic level.

Key words : Cyanogen, Bamboo shoots, Phytotoxin

INTRODUCTION

Most of the succulent young tender bamboo shoots contain cyanogenic glycosides that break down to hydrogen cyanide (HCN), which can cause toxicity in humans. Cyanogenic glycosides are phytotoxins which occur as secondary plant metabolites in many plant species, of which a number of species are used as food in some areas of the world (Conn, 1979; Nartey, 1980; Rosling, 1994). In the intact plant, the enzyme and the glycosides remain separated, but if the plant tissue is damaged both are put in contact and cyanohydric acid is released (Bell, 1981; Gruhnert *et al.*, 1994). When the edible parts of the plants are macerated, the catabolic intracellular enzyme ß-glycosidase can be released, coming into contact with the glycosides. This enzyme hydrolyzes the cyanogenic glycosides to produce hydrogen cyanide, glucose and ketones or benzaldehyde (Harborne, 1972 and 1993). The hydrogen cyanide is the major toxic compound causing the toxic effects. Plant products, if not adequately detoxified during the processing or preparation of the food, are toxic because of the release of this preformed hydrogen cyanide.

The present work is undertaken to assess the content of cyanogens in fresh and fermented succulent bamboo shoots so as to search out the likelihood of cyanide intoxication from consumption of fresh and fermented bamboo shoots and to stimulate new uses of bamboo shoots in the existing markets.

MATERIALS AND METHODS

The emerging young fresh succulent bamboo shoots of the species of *Bambusa balcooa, B. tulda, Dendrocalamus halmiltonii, Melocanna bambusoides and Arundinaria callosa were* collected during the growing season (May- July) from different districts of Manipur, India. The outermost scale portions of the fresh succulent bamboo shoots (which are discarded) were peeled off and kept aside for the experiment. The inner delicious edible inner soft shoots were washed with water and any fibrous tissues at the base is trimmed and assessed for cyanide content (Bradbury *et al.*, 1999). To assess the cyanide content of the whole bamboo plant, parts of the plant like the stem, leave, rhizome, and inflorescence and seed of bamboo plant were also assessed.

Fermentation:

In Manipur, India, the fresh succulent bamboo shoots and the fermented preparation of bamboo shoot slices which were done in large scale, locally called *soibum* is a highly prized vegetable item. The traditionally fermented samples, locally called *soibum* were collected from different districts/localities in Manipur where traditional fermentation of bamboo shoots is done in large scales (Khongkhang, Andro, Noneh, Tengnoupal, Churachandpur, Kotha etc.). Bamboo shoots of many species like *Bambusa tulda, B. balcoa, Dendrocalamus hamiltonii, Melocanna bambusoides* and *Arundanaria callosa* were used for traditional fermentation. The *soibum* is prepared traditionally by storing thin slices of fresh succulent and soft bamboo shoots in certain containers/ chambers for 2-3 months. The fermented chambers are either made of bamboo planks or of roasted earthen pots. The inner surface of bamboo chambers are lined with banana leaves and a thin polythene sheets. The upper surface is sealed with polythene sheet and weights are

Kananbala Sarangthem and Hoikhokim (2010). Cyanogen content in bamboo plants. *Bio. Sci.*, **5** (2) : 178-180

then put on top for proper pressing. At the initial stage of fermentation the exudate is leached/drained out of the tilted side of the bamboo plank chamber. This fermented liquid or exuded is highly poisonous to animals. After fermentation is completed, which is indicated by the smell, colour and texure, *soibum* can be stored up to one year .The content of cyanogen was assessed in these traditionally fermented samples.

Estimation of cyanogenic glycosides:

Cyanogenic glycosides estimation was done using the technique of the picrate-impregnated paper (Bradbury *et al.*, 1999). The assay was performed in triplicate. Fresh plant material (bamboo shoots) was cut into small pieces and crushed in a pestle and motar and immediately placed into a small flat bottomed vial. 0.5 ml of phosphate buffer (0.1M, pH 7) and 6 drops of chloroform was added followed by brief crushing the materials with a glass rod. A picrate paper attached to a plastic backing strip was added and the vial immediately closed with a screw stopper and left for about 16h at 30^{0}C. The liberation of the HCN occurred rapidly after crushing the bamboo shoots. A colour change of picrate paper from yellow to brown-red or reddish colour, indicate the release of HCN by the plant samples. The change in the picrate paper is in proportion to the amount of hydrogen cyanic acid evolved. The picrate paper was then removed and the colour is eluted by immersing the paper in a clean test tube containing 5.0 ml water for 30 min. The absorbance was measured at 510 nm and the total cyanide content was determined using potassium cyanide as the standard solution.

RESULTS AND DISCUSSION

The results in Table 1 give the total cyanide content of tip, middle and base of the outer hard sheath (discarded portion) covering the soft inner tissues and the inner soft bamboo shoots samples taken for consumption as food determined by the picrate method. The results showed an average of 0.02 to 0.17mg/g of HCN in the outer hard sheath and 0.03 to 2.42 mg/g of HCN in the soft portion of the bamboo shoots as shown in Table 1. The total cyanide levels are highest at the tip and lowest at the base of the soft inner shoot but just the reverse for the hard cover sheath. Although there are reports elsewhere of bamboo species containing significant potentially very toxic amounts of cyanogenic glycosides in their shoots (WHO, 1993), however the available materials do not confirm that some bamboo species do indeed contain very high level of cyanogenic glycosides in their shoots.

Table 1: Total cyanide content in bamboo plants determined by Picrate method

Name of the species	Portion of the fresh bamboo shoots	Conc. of HCN (mg/g) in outer hard sheath	Conc. of HCN (mg/g) in inner soft bamboo shoots
Bambusa	Tip	0.02±0.05	2.42±0.22*
balcooa	Middle	0.036±0.03	2.16±0.23
	Base	0.086±0.05	1.15±0.62
Dendrocalamus	Tip	0.043±0.05	2.15±0.82
hamiltonii	Middle	0.063±0.32	1.88±0.43
	Base	0.104±0.01	1.62±0.38
Bambusa tulda	Tip	0.08±0.03	0.17±0.22
	Middle	0.10±0.05	0.83±0.07
	Base	0.13±0.03	0.28±0.05
Arundanaria	Tip	0.02±0.02	0.14±0.03
callosa	Middle	0.01±0.03	0.05±0.01
	Base	0.07±0.03	0.03±0.03
Melocanna	Tip	0.06±0.02	1.81±0.05
bambusoides	Middle	0.10±0.02	0.68±0.03
	Base	0.17±0.05	0.35±0.02

*Standard error of the mean (n=3)

Table 2 represent the total cyanide content in different portion of the bamboo plant (*Melocanna bambusoides).* It has been reported that the level of cyanogenic glycosides produced is dependent upon the parts of the plant, age and variety as well as the environmental factors (Cooper-Driver and Swain, 1976; Woodhead and Bernays, 1977). The fleshy fruits of *Melocanna bambusoides a*re eaten raw or cooked, its seeds are also eaten by the people as a substitute for rice. It contains low concentration of HCN (0.01mg/g) which renders it toxic free for consumption. The rhizome, which is not utilized also contain HCN (0.14mg/g).

The acute lethal dose of HCN for human beings is 0.5-3.5 mg/kg body weight, animals is 0.66 to 15mg/kg body weight (Reddy, 2006). Cyanide is extremely toxic to a wide spectrum of organism, due to its ability of linking with metals (Fe++, Mn++ and Cu++) that are functional

Table 2 : Total cyanide content in different parts of the bamboo plants (*Melocanna bambusoides*) etermined by Picrate method

Name of the species	Parts of the plant	Concentration of HCN (mg/g)
Melocanna	Fruit	0.01±0.03*
bambusoides	Leaves	0.09±0.01
	Inflorescence	0.07±0.03
	Rhizome	0.14±0.03

*Standard error of the mean (n =3)

groups of many enzymes inhibiting the action of cytochrome oxidase, carbonic anhydrase and other enzyme system. It blocks the final step of oxidative phosphorylation and prevents the formation of ATP and its use as energy source. It reduces the oxygen carrying capacity of the blood by combining with the ferric iron atom (Harborne1972, 1993).

The cyanogenic glycoside present in bamboo is taxiphyllin. Taxiphyllin is hydrolyzed to glucose and hydroxybenzaldehyde cyanohydrin. This benzaldehyde cyanohydrin then decomposes to hydroxy benzaldehyde and HCN (Schwarzmair, 1997). Taxiphyllin is a p-hydroxylated mandelo-nitrile triglochinin and therefore, one of the few of the cyanogenic compounds that decomposes quickly when placed in boiling water. Bamboo becomes edible because of this instability (Nahrstedt, 1993).

Bamboo shoots may contain high levels of HCN; however, the HCN content is reduced substantially during fermentation process prior to consumption. The results showed a decrease of cyanide level from 2.42mg/g present in fresh bamboo shoot slices (Table 1) to a non significant toxic level ranging from 0.21 to 0.29mg/g cyanide content after fermentation (Table 3). The most probable reason is that in the drained out exudates during fermentation, the content of HCN is high with 13.22mg/g Table 3. This may contribute to the loss of cyanide content during fermentation. Moreover, since HCN are highly volatile (WHO, 2004), the loss of HCN during the fermentation processes like peeling, slicing, cutting, repeated washing (3-4 times) is quite rapid.

Table 3: Total cyanide content in fermented bamboo shoot slices (soibum)

Sr. No.	Fermented bamboo shoots collected from different districts of Manipur	Conc. of HCN (mg/g)
1.	B. Salvaphai -CCpur District	0.21±0.03*
2.	Khongkang- CDL District	0.28±0.06
3.	Tengnoupal -CDL District	0.29±0.05
4.	Exudate (khongkang fermentation)	13.22±0.03

*Standard error of the mean (n=3)

The non-pathogenic microorganisms involved in fermentation may be degrading the hydrolytic enzyme (beta-glycosidase) thus decreases the HCN formation, but this need further intensive research. Thus bamboo shoots as food may perhaps not present a health problem for consumers. However, due care in preparation remain necessary.

REFERENCES

Bell, E.A. (1981). *The biochemistry of plants.* Academic Press, New York.

Bradbury, M.G., Egan, S.V. and Bradbury, J.H. (1999). Determination of all forms of cyanogens in cassava roots and cassava products using picrate paper kits. *J. Sci. Food Agric.*, **49:** 93-99.

Conn, E.E. (1979). Cyanogenic glycosides. International review of biochemistry. In: *Biochemistry and Nutrition* 1A. (Eds. Neuberger A & Jukes TH)., University Park Press, Baltimore. pp.21-43.

Cooper-Driver, G.A. and Swain, T. (1976). Cyanogenic polymorphism in bracken in relation to hervivore predation. *Nature,* **260**:604.

Gruhnert, C., Biehl, B. and Selmar, D. (1994). Compartmentation of cyanogenic glucosides and their degrading enzymes. *Planta,* **195**:36-42.

Harborne, J.B. (1972). Cyanogenic glucosides and their function. In: *Phytochemical ecology*.Academic Press, London, pp.104-123.

Harborne, J.B. (1993). Plant toxins and their effects on animals. In: *Introduction to Ecological Biochemistry*. Academic Press, London, pp.71-103.

Nartey, F. (1980). Toxicological aspects of cyanogenesis in tropical foodstuffs .In: *Toxicology in the Tropics*. (Eds Smith RL and BababumniEA), Taylor & Francis Ltd, London, pp. 53-73.

Nahrstedt, A.F. (1993). Cyanogenesis and food plants. In: *Proceedings of the International Symposium on phytochemistry and agriculture*,22-24 April 1992, (Eds.Van Beek TA and Breteler H), Wage ningen. Oxford, Oxford University Press, pp.107-129.

Reddy, K.S.N. (2006). *The essential of forensic medicine and toxicology*. Suguna Devi K, 25th Ed., Hyderabad, pp. 548-550.

Rosling, H. (1994). Measuring effects in humans of dietary cyanide exposure from cassava. *Acta Hort.,* **375:**271-283.

Schwarzmaier, U. (1977). Cyanogenesis of *Dendrocalamus*: taxiphyllin. *Phytochemistry*, **16:**1599-1600.

Woodhead, S. and Bernays, E. (1977). Change in release rates of cyanide in relation to palatability of *Sorghum* to insects. *Nature,* **270**:235-236.

World Health Organization (WHO) (1993). Toxicological evaluation of certain food additives and naturally occurring toxicants. *WHO Food Additive Series* 30. World Health Organization, Geneva.

World Health Organization (WHO) (2004). Hydrogen cyanide and cyanides: Human Health Aspects, World Health Organization, Geneva.