TECHNIQUES FOR MITIGATING CYANOGENIC GLYCOSIDES IN BAMBOO SHOOTS

Gemma A. Gruyal & Eddielyn B. Plaza
Department of General Teacher Training, North Eastern Mindanao State University-Cantilan Campus, 8317, Philippines
gemmagruyal@nemsu.edu.ph

***ABSTRACT*:** *Bamboo shoots are a popular and nutritious food source, but they naturally contain cyanogenic glycosides, which can release toxic cyanide when consumed. In this study, we investigated the effectiveness of two common detoxification methods—soaking and boiling—on bamboo shoots from two varieties: Bambusablumeana (Kajawan) and Gigantochloaatter (Kajali). The impact of different soaking and boiling durations (6, 12, and 24 hours) and varying concentrations of cyanogenic compounds (5 µL, 50 µL, and 100 µL) was assessed using the brine shrimp lethality assay to measure toxicity reduction. Results indicated that soaking bamboo shoots for extended periods was more effective at reducing toxicity than boiling. Furthermore, longer soaking times (up to 24 hours) and lower concentrations of cyanogenic glycosides correlated with lower brine shrimp mortality rates. These findings suggest that soaking is a more efficient method for detoxifying bamboo shoots, and emphasize the need for further studies to quantify cyanogenic glycoside levels and refine detoxification techniques. This research offers valuable insights into enhancing the safety and edibility of bamboo shoots for human consumption.*

Keywords: Bamboo leaves, detoxification, soaking, boiling, cyanogenic glucosides

I. INTRODUCTION

Bamboo shoots, the edible sprouts of bamboo plants, are a staple in various Asian cuisines. The Food and Agriculture Organization (FAO) of the United Nations estimates that by 2050, global food production will need to increase by 60% to meet the nutritional demands of a projected population of 9.3 billion Tian et al.[1]. Bamboo is a fast-growing, sustainable, and renewable plant. Given their nutritional profile, bamboo shoots have considerable potential to contribute to nutritional security Bajwa et al.[2]. Bamboo shoots are nutrient-dense, low in calories, and can be consumed in various ways, making them a potential resource for combating malnutrition Acharya et al. [3]. As a versatile natural food source, bamboo shoots are utilized in various culinary preparations across Asia, with global consumption exceeding 2 million tons annually. Although primarily consumed in Southeast Asia, international trade has expanded its availability to Europe, North America, Oceania, and Africa.

Despite their nutritional value, bamboo shoots contain significant amounts of cyanogenic glycosides, primarily taxiphyllin, which can degrade into hydrogen cyanide (HCN), a toxic compound. Fresh bamboo shoots have been reported to contain cyanide levels as high as 25 mg/kg, whereas processed shoots (dried, canned, or boiled) contain approximately 5.3 mg/kg Ding & Wang [4]. The acute lethal dose of cyanide for humans is 0.5–3.5 mg/kg, meaning that consuming 25–175 mg of free cyanide can be fatal to an adult Ding & Wang [4]. These high cyanide levels make processing bamboo shoots essential before consumption. It is necessary to detect cyanide in edible bamboo shoots at low concentrations because of its potent toxicity. Proper processing is required before consuming freshly harvested shoots, as their high levels of toxic cyanogenic glycosides present significant health hazards. However, several challenges complicate the measurement of cyanide levels in bamboo shoots. As a result, developing an efficient, sensitive, and simple method for determining cyanide content is crucial for improving their market value and encouraging their use.

Bamboo shoots are gaining recognition as functional foods and nutraceuticals, thanks to their bioactive compounds such as dietary fibres, phenols, and phytosterols Nirmala et al.[5]. They are also a rich source of proteins, carbohydrates, minerals (including selenium, silicon, and potassium), and vitamins Rana et.al. [6]. These characteristics make bamboo shoots a highly nutritious and health-enhancing food option.

Various techniques have been developed to reduce cyanogenic glycosides to safe levels. Boiling bamboo shoots helps break down cell walls, releasing antinutrients, including cyanogenic compounds.

Research indicates that boiling shoots at 98–102°C for 148–80 minutes can decrease cyanide content by up to 97% Ferreira et al. [7]. Boiling in brine has also proven effective Bajwa *et.al.* [2]. Soaking bamboo shoots, a traditional method, promotes enzymatic hydrolysis of taxiphyllin into glucose and other byproducts, significantly reducing cyanide levels Panda *et al.* [8]. Overnight soaking or using a 2% salt solution can lower cyanogen content to safe levels Chongtham et al. [9] Other methods, such as peeling, slicing, fermentation, drying, and canning, also help reduce cyanogen content. Regularly changing the water during cooking or soaking further improves cyanogen removal.

This study aims to determine the most efficient detoxification method—boiling or soaking—for reducing cyanogenic glycoside levels in different bamboo shoot varieties. Using the brine shrimp lethality assay, it also seeks to inform the community about which bamboo shoot variety has the lowest cyanogenic glycoside content and identify the most effective detoxification technique**.**

2. METHODOLOGY

a. Study sites

Samples of bamboo shoots were collected from two study sites: (i) Cantilan and (ii) Madrid, both located in Surigao del Sur. The study focused on two bamboo varieties: three-year-old clumps of *Bambusablumeana* (Kajawan) and *Gigantochloaatter* (Kajali). The collection was conducted from January to March 2024. The shoots were transported to

the laboratory, where physical parameters were recorded for two shoots of each species, both before and after peeling.

b. Processing Method

The processing methods used in this investigation were boiling and soaking. The shoot sample designated for processing is divided into two halves, one for boiling and the other for soaking.

b.1. **Boiling**

Shoot samples were boiled in distilled water at 100º C for three different time durations; 6, 12, and 24 hours. After boiling, water was drained off, samples were cooled, surface dried with blotting paper and then put into an air-tight glass container for storage at 4ºC until further use for analysis.

b.2. Soaking

The shoot samples were soaked in distilled water for three different durations: 6, 12, and 24 hours. After soaking, the water was drained, and the shoots were surface-dried using blotting paper. They were then placed in an airtight glass container for storage at 4ºC until further analysis.

c. Brine shrimp lethality assay

Brine shrimp eggs used in this study were purchased from a commercial store. The eggs were hatched in filtered pure seawater in a large container, equipped with illumination and an oxygen aerator. After 24 hours of incubation at room temperature (25°C), nauplii (the larvae) were collected using a glass dropper and transferred into vials. A powdered extract from aqueous extraction was prepared at a concentration of 2 mg/mL in seawater and dissolved in dimethyl sulfoxide (DMSO). Sample concentrations of 5 µL, 50 µL, and 100 µL were added to each vial. Three replicates were prepared for each treatment. A control group consisted of 0.5 mL of DMSO mixed with 4.5 mL of brine shrimp solution, without the plant extract. Ten nauplii were added to each vial. The vials were then examined, and the number of dead (non-motile) nauplii in each vial was counted after 6, 12, and 24 hours of incubation at room temperature (25°C), using a magnifying glass and under illumination.

d. Statistical test

Experimental analysis was performed in triplicate to note variability, and results are presented as percentages.

3. RESULT AND DISCUSSIONS

Techniques in detoxifying the cyanogenic glycosides or antinutrients present in bamboo shoots

Various processing methods are often used to remove antinutrients and improve the shelf life, flavor, and palatability of food. These methods include slicing, peeling, cooking, soaking, boiling, fermentation, drying, and canning. According to Kong et al. [10], boiling is a commonly used cooking process that enhances tissue softening, tenderness, colour, and flavour, while also affecting the bioavailability of nutrients. Boiling achieves this by altering the chemical composition of food and inactivating toxic substances in vegetables. Conversely, soaking can induce microbial activity, which may impact the colour, taste, and odour of the food. This method also alters the chemical composition and reduces the goitrogenic potency of cyanogenic plants, as noted by D'mello [11]. In this study, boiling and soaking techniques were applied to detoxify cyanogenic glycosides, or antinutrients, present in*Bambusablumeana* and *Gigantochloaatter* shoots. Results in Table 1 indicate that soaking *Bambusablumeana* shoots led to a lower percentage mortality rate compared to boiling, as depicted in Figures 1 and 2. These findings align with the study of Kanchan et al. [12], which reported that soaking is one of the most effective methods for reducing cyanogenic content to permissible levels. The cytotoxicity of *Bambusablumeana* shoots to brine shrimp nauplii was assessed at varying concentrations using different detoxification methods. Results showed that lower concentrations resulted in reduced mortality rates. The lowest mortality rate was observed at the lowest concentration (5 µL) for both soaking and boiling methods. Regarding incubation time, the lowest mortality rate was recorded at 24 hours across all methods.

This analysis highlights that soaking is particularly effective for reducing cyanogenic glycosides and minimizing cytotoxic effects, making it a favourable technique for detoxifying *Bambusablumeana* shoots.

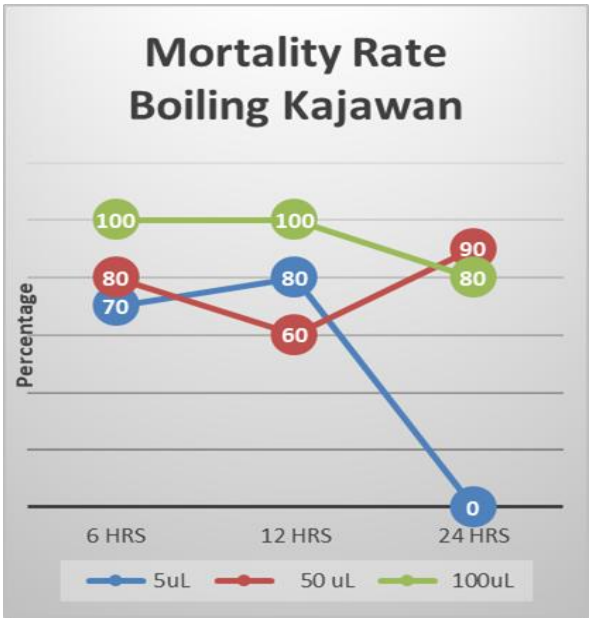

Figure 1. Mortality rate soaking Kajawan

Table 1. Cytotoxicity to brine shrimp nauplii of *Bambusablumeana*" Kajawan" shoot at different techniques in detoxifying cyanogenic glycosides at different concentrations and incubation time intervals

Bambusa blumeana " Kajawan"					
		6 Hours	12 Hours	24 Hours	
Methods	Concentration	No. of Mortality Rate Naupli Average %	No. of Mortality Rate Naupli Average %	No. of Mortality Rate Naupli Average %	Average Mortality Rate
Soaking	5uL	80	80	0	26.66
	50uL	60	60	40	53.33
	100uL	100	100	50	83.33
Boiling	5uL	70	80	0	50.00
	50uL	80	60	90	76.66
	100uL	100	100	80	93.33

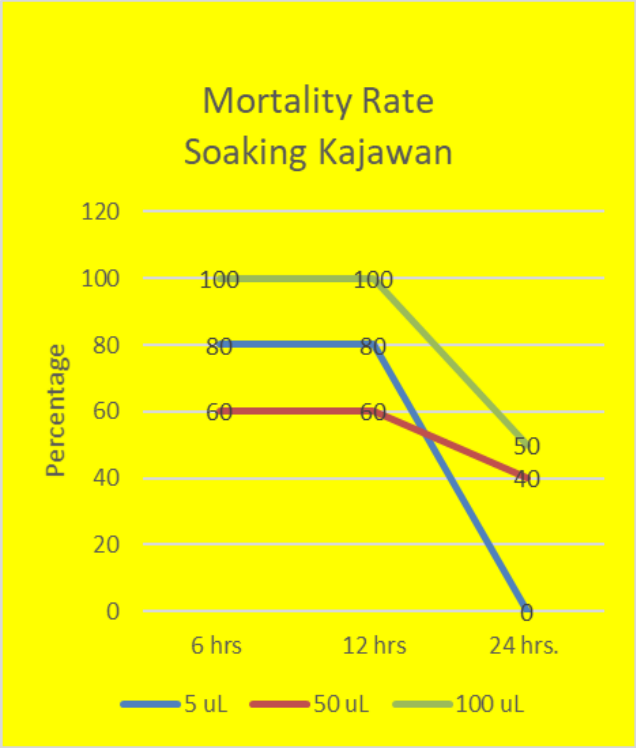

Figure 2. Mortality rate boiling Kajawan

Table 2 demonstrates that the soaking method applied to Gigantochloaatter ("Kajali")shoots results in a lower mortality rate of nauplii. Among the various concentrations tested, the lowest mortality rate is observed at 5 µL, while the shortest incubation period of 24 hours also yields minimal mortality. These findings indicate that soaking is a more effective method for detoxifying antinutrients in bamboo shoots. This observation aligns

Table 2. Cytotoxicity to brine shrimp nauplii of *Gigantochloaatter*" Kajali" shoot at different techniques in detoxifying cyanogenic glycosides at different concentrations and incubation time intervals.

Gigantochloa atter " Kajali"					
		6 Hours	12 Hours	24 Hours	
Methods	Concentration	No. of Mortality Rate Naupli Average %	No. of Mortality Rate Naupli Average %	No. of Mortality Rate Naupli Average %	Average Mortality Rate
Soaking	5uL	20	100	70	63.33
	50uL	80	100	80	86.66
	100uL	100	100	0	66.66
Boiling	5uL	50	100	100	83.33
	50uL	100	100	100	100.00
	100uL	100	100	100	100.00

With the findings of Kanchan et al.[12], further validating the efficacy of the soaking method in reducing antinutritional factors.

4. CONCLUSION

Detoxifying cyanogenic glycosides or antinutrients in various bamboo shoot varieties demonstrates that prolonged soaking is a more effective method of detoxification. This process enhances the safety and nutritional value of bamboo shoots, making them an excellent and reliable food source.

Figure 3. Mortality rate Soaking Kajali

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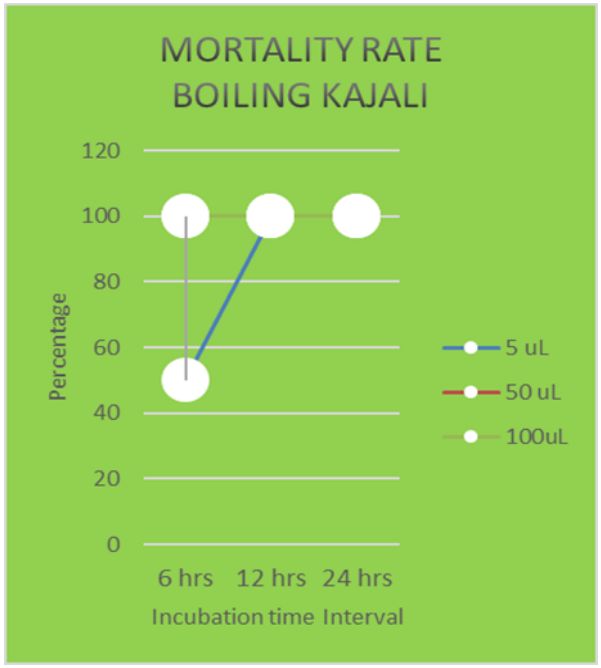

Figure 4. Mortality rate boiling Kajali

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