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Research Article

CYANOGENIC GLYCOSIDES AND FOOD SAFETY: A STUDY OF HYDROGEN CYANIDE IN MONOCOT WILD EDIBLE PLANTS FROM BHANDARA DISTRICT OF MAHARASHTRA

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ABSTRACT

Hydrogen cyanide (HCN) is a natural plant toxin that is present in several plants, most of which are consumed by humans in the form of wild edible plants. HCN is produced by cyanogenic glycoside plants through enzymatic hydrolysis processes like chewing, crushing, and grinding during food processing. Plants usually produced hydrogen cyanide to defend themselves against bacteria, insects, predators, and herbivorous animals. Consuming cyanogenic glycosides, whether unintentionally or intentionally, can result in rapid breathing, decreased blood pressure, dizziness, convulsions, vomiting, growth retardation, and neurological symptoms due to tissue damage in the central nervous system. For many indigenous, tribal, and rural communities, these plants act as supplementary or alternative food sources, especially during periods of seasonal food scarcity and drought. In the Bhandara district, more than 125 WEPs are consumed by tribal, rural, and local people. Therefore, it is crucial to determine the presence of cyanide content in wild edible plants before using them.

Keywords: Hydrogen cyanide, Wild edible plants, Cyanogenic glycosides, Hydrolysis.

INTRODUCTION

In times of food scarcity, the majority of the Indian aboriginal, tribal, and rural population relies on natural resources, especially wild edible plants. Wild edible plants were crucial forest resources that improved the food security of the tribal and rural population. Approximately 60% of the rural population and more than 53 million tribal people in India directly depend on forest resources for their daily needs (Kandari *et al*., 2014). To improve crop yield, farmers use harmful insecticides and pesticides that contain toxic chemicals. These chemicals enter the human body through the consumption of different cereals, grains, and vegetables. Hence, the urban population prefers wild edible plants in their diet. WEPs refer to all plant species that are used as food from a variety of natural habitats, but are not cultivated or domesticated by people (Beluhan and Ranjogajec, 2010). Such wild edible plants are cheap and excellent alternative source of many nutrients and bioactive substances such as vitamins, minerals, protein, carbohydrates, unsaturated fatty acids, and phenolic compounds (Pinela *et al*., 2017). Compared to commercial crops, WEPs have the capacity to withstand climate unpredictability and drought and can provide nutritional support (Awash Tesfay, 2020).

No doubt WEPs are a rich source of nutrients, vitamins, and minerals; however, certain plants contain many natural toxins and secondary metabolites that might pose a risk to consumers. One of these secondary metabolites produced by plants is cyanogenic glycosides (CG). Cyanogenic glycosides are chemical compounds in plants that release hydrogen cyanide (HCN) during food processing activities like crushing, chewing, and digestion (Islamiyat *et al*., 2016). Cyanogenic glycosides, cyanohydrin, and hydrogen cyanide are collectively called cyanogen (Onojah and Odin, 2015). CG synthesis is widespread in the plant kingdom, with over 3000 plant species belonging to 130 families being cyanogenic, including ferns, gymnosperms, and angiosperms (Yadav *et al*., 2023). The toxicity of cyanogenic glycosides and their derivatives depend on the release of hydrogen cyanide. The CG plants produced hydrogen cyanide through the enzymatic hydrolysis process. Hydrogen cyanide plays an important role in plant defence against herbivores, pathogens, and predators (Beata P and Jana J., 2025). In humans, acute cyanide poisoning

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has been linked to the etiology of various chronic diseases like konzo or spastic paraparesis is a motor neuron disease and tropical ataxic neuropatty (TAN) (Wink, 1998; Cressey, 2012 and FAO/WHO, 2012). The clinical signs of cyanide toxicity can include rapid respiration, drop in blood pressure, headache, vomiting, stomach pain, mental confusion, and convulsion, followed by terminal coma. When a person can toxify, and the cyanide level exceeds the limit, cyanide poisoning can result in death (WHO, 1993). Younger plants have significantly higher cyanide content than older ones (Dreyer, Reese, and Jones, 1981). Also, seasonal variation in the cyanide level of a certain species has been reported. Some plants are not completely cyanogenic throughout the growing season (Busk, P. and Moller, B., 2002). The detection of cyanide in food is important for public health protection. Improper food processing can release toxic cyanide that is highly harmful to humans (Robakowski *et al*., 2016). Proper detection and processing, like soaking, boiling, fermentation, and drying can reduce or eliminate the cyanide level in wild edible plants. Therefore, it is crucial to determine the presence of cyanide content in wild edible plants before using them.

MATERIAL AND METHODS

Study region

The present study was conducted in the Bhandara district of Maharashtra to identify and document the wild edible monocot plants and detect the presence of 'HCN' in these plants. The Bhandara district is located in the Maharashtra state and is part of the Vidarbha region (Figure 1). It lies on the eastern side of Maharashtra and is bordered by the Gondia district to the east, the Chandrapur district to the south, the Nagpur district to the west, and the M.P. state to the north. Geographically, Bhandara is situated at approximately 21.09° N latitude and 79.42° E longitude. Bhandara district is well known as the Lake District of Maharashtra. The forest area is about 1343.77 sq. km. The district is known for its southern tropical dry deciduous-type forest, which contains 10 forest blocks (Census, 2011). Bhandara district has a mixed economy with agriculture, industries, and forest resources.

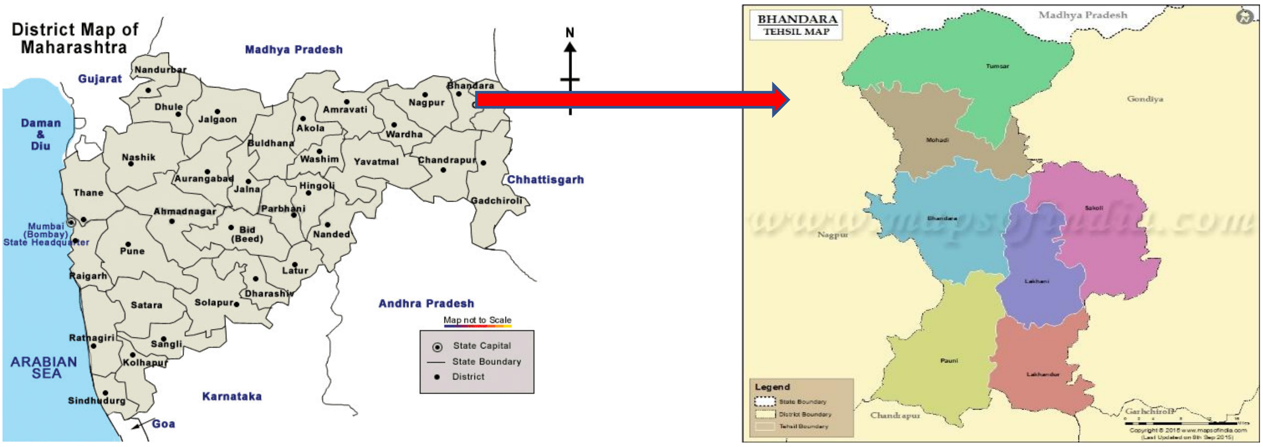


Figure 1. Map of Maharashtra and Bhandara District

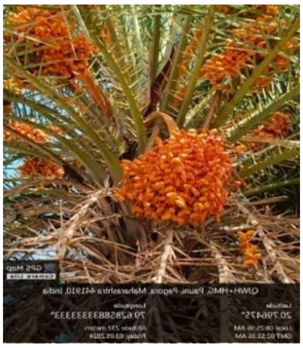
Data collection and the analysis of the sample

The study was carried out during the period of August 2024 to December 2025. Information and collection of monocot wild edible plant species through the field survey and interviews among old, ethnic, rural, and tribal people. Also, group discussion with traditional medicine practitioners, forest department people, and Ayurveda-knowledgeable persons. We collected plant material from different places like forest areas, Westland, roadside, and agricultural field. Plant specimens were collected and identified with the help of flora (Sharma *et al*., 1996, Singh *et al*. 2001 and Ugemuge, 1986). During the study, 15 monocot wild edible plants were collected from different places, in the Bhandara district (fig. 2). The fresh samples of these plants were used for the detection of hydrogen cyanide in these plants.

Analysis of Sample

The quantitative estimation of total cyanide in plant materials is a complicated process. However, a simple method and kit for semi-quantitative estimation of HCN is developed by Egan and Bradbury (Bradburry M. and Egan S. *et al*. 1999). So, the semi-quantitative estimation of 'HCN' in monocot wild edible plants was done by the sodium picrate paper kit provided through the courtesy of Prof. Bradbury. The method follows 100 mg of fresh plant material was placed on top of a paper disc loaded with phosphate buffer at pH 8, and 0.5 ml of distilled water was added in a flat -bottom plastic vial. After that, yellow picrate paper was immediately inserted in the vial. The vial was closed immediately with a screw lid and allowed to stand at 30°C for 16-24 hours. The color of picrate paper was compared with that of color shades from yellow to reddish-brown corresponding to 0-800 ppm HCN (1 ppm = 1 mg HCN per kilogram equivalent fresh weight).

Cryptocoryne retrospiralis



Pheonix sylvestris

Xanthosoam sagittifolium

Theriphonum minutum

Dendrocalamus strictus

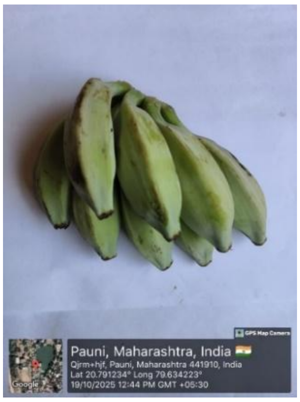
Commelina benghalensis

Oryza rufipogon

Amrphophallus paeoniifolius

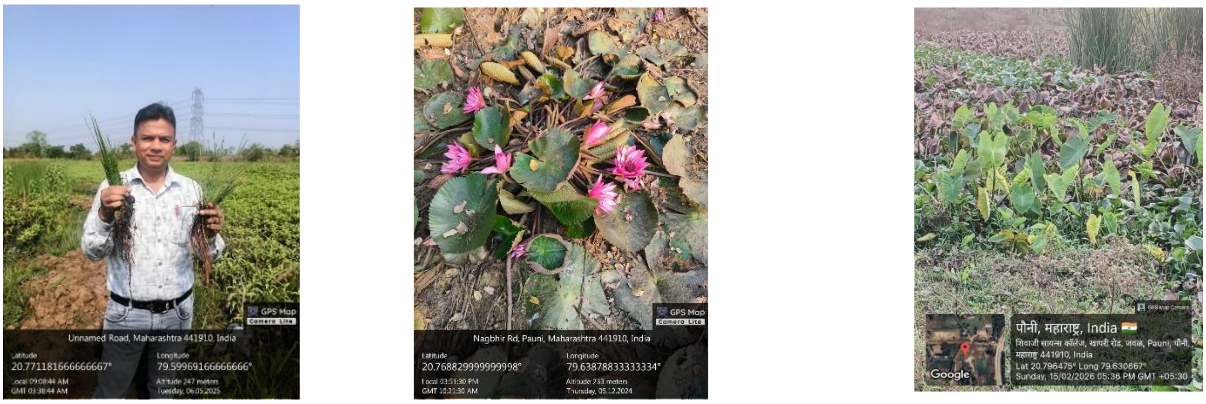
Borassus flabellifer

Nelumbo nuvifera



Musa acuminata

Amorphophallus margaritifer



Cyperus rotundus *Nymphaea alba* *Colocasia esculenta*

Figure 2. Picture of monocot wild edible plants.

Table 1. Presence of hydrogen cyanide in monocot WEP's.

S. No	Botanical Name	Family	Vernacular Name	Parts used	HCN in ppm
1	*Amorphophallus paeoniifolius* (Dennst) Nicolson	Araceae	Suran	Rhizome	30
2	*Amorphophallus margaritifer* (Roxb) Kunth	Arecaceae	Gaicha var	Petiole	30
3	*Borassus flabellifer* Linn.	Arecaceae	Tal	Fruit	30
4	*Colocasia esculenta* Linn.	Araceae	Kochai	Leaves	30
5	*Commelina benghalensis* Linn.	Commelinaceae	Kena	Leaves	30
6	*Cryptocoryne retrospiralis* (Roxb) Kunth	Araceae	Pashan bhed	Leaves	20
7	*Cyperus rotundus* Linn.	Cyperaceae	kachar kanda	Rhizome	20
8	*Dendrocalamus strictus* (Roxb) Nees	Poaceae	Bamboo shoot	Young shoot	800
9	*Musa acuminate* Colla	Musaceae	Jangali kel	Fruit	50
10	*Nelumbo nucifera* Gaertn.	Nelumbonaceae	Bhisi	Rhizome	20
11	*Nymphaea alba* Linn.	Nympheaceae	Water lily	Fruit	10
12	*Oryza rufipogon* Griff.	Poaceae	Devbhat	seed	30
13	*Pheonix sylvestris* (L) Roxb.	Arecaceae	Sindhi	Fruit	20
14	*Theriphonum dalzellii* Schott	Araceae	Undirkan	Leaves	30
15	*Xanthosoam sagittifolium* (L) Schott	Araceae	Dhopa	Leaves	30

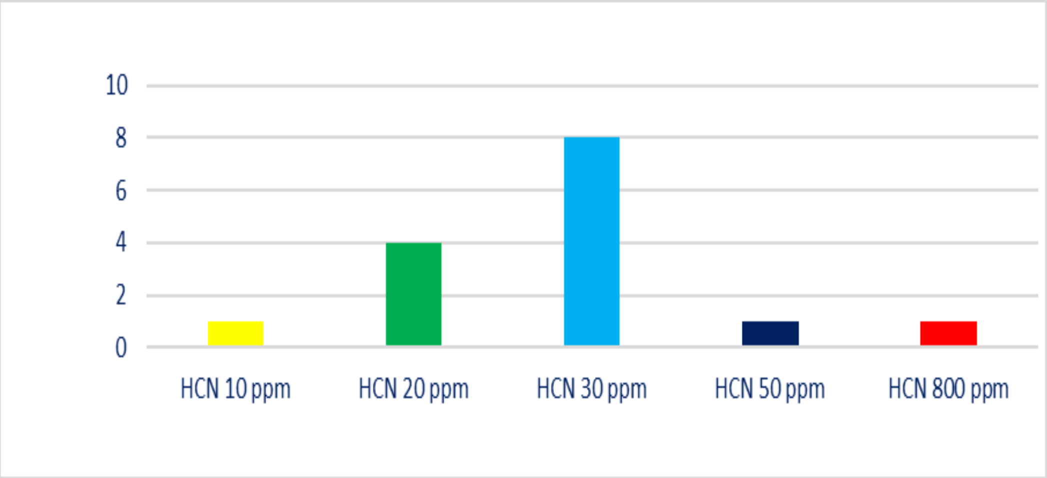


Figure 3. HCN in ppm/100 mg present in monocot wild edible plants.

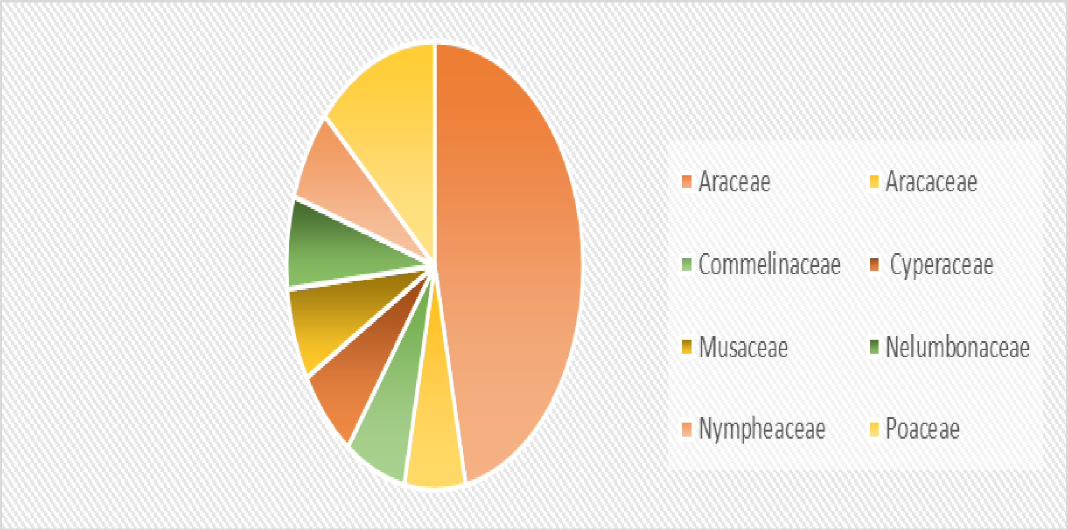


Figure 4. Family wise monocot wild edible plants.

RESULTS AND DISCUSSION

In the present study there are about 15 species of monocot WEPs that have been identified as belonging to 8 families of angiosperm (Table 1). With respect to families, Araceae shared the largest proportion consisting of 5 species, was followed by Aracaceae with 3 species, and was followed by Poaceae with 2 species; the rest of the families, Nelumbonaceae, Commelinaceae, Nympheaceae, Cyperaceae, and Musaceae, had a single species each (Figure 4). These are all monocot WEPs used by tribal and rural people throughout the district due to their rich nutrient content. All these monocot WEPs parts were taken from various locations of the Bhandara district for detection of HCN present in these plants. The results of detection and semi-quantitative estimation of HCN in monocot WEPs parts are presented in Table No.1. Out of the 15 monocot WEP species tested, all species are positive for the presence of HCN. The maximum amount of HCN is found to be 800 ppm/100 mg in young shoots of *Dendrocalamus strictus* (bamboo shoots). In remaining plants, the HCN content is below the threshold level (>200 ppm/100 mg). So, consumption of young bamboo Shoots without processing can lead to acute health problems (Figure 3). The result reported above suggests the presence of cyanogenic glycosides in the form of hydrogen cyanide that develop as a result of hydrolysis, rendering it poisonous at certain concentrations in most of the monocot WEPs. So, the cyanide detoxification methods were carried out before the material was consumed (Chongtham *et al.*, 2022 and Nampoothiri, V. 2017).

CONCLUSION

The analysis for the presence of hydrogen cyanide in monocot WEPs shows the maximum amount of HCN is found to be 800 ppm/100 mg in the young shoot of *Dendrocalamus strictus* (bamboo shoot). So, it is recommended that before use, young bamboo shoots be cut into smaller pieces and boiled for up to 30 minutes to reduce the level of HCN. After boiling young bamboo shoots the HCN level reduces up to 50 ppm/100 mg and is safe for consumption.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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