

## Introduction

Some tropical crops contain cyanogenic glycosides, toxic substances that release hydrocyanic acid (HCN; also referred to as cyanide) when cells are crushed. Consuming these plants without cooking them can cause cyanide poisoning, with varying effects depending on cyanide levels and how long a person or animal has been eating that plant. Cassava roots and leaves contain cyanogenic glycosides, so people whose diets are heavily dependent on cassava are especially at risk. Traditional methods to process and detoxify cassava roots include fermentation, prolonged soaking and boiling. Chaya leaves also contain cyanogenic glycosides; it is best to cook chaya leaves before eating them, to boil off the HCN rather than ingesting it. To determine if a plant is safe to consume, either by humans or livestock, a simple cyanide screening test is very helpful. At the 2014 ECHO International Conference in Florida, Dr. Ray Smith provided ECHO with sample strips of Cyantesmo paper for screening plant material for HCN.

## Methods & Materials

This is a shortened version of instructions written by Dr Smith along with Drs Cindy Gaskill and Michelle Arnold (all at the University of Kentucky):

1. **Collect a large handful of leaves** to be tested. (Note: Collect all parts of the plant that will likely be consumed.)
2. **Tear leaves/forage into small pieces** mashing the plant material to cause additional plant cell injury, simulating the act of chewing.
3. **Place the sample into a quart-sized zip-lock baggie** (or something equivalent) with a one-inch (2.5 cm) strip of Cyantesmo paper taped to the inside of the bag toward the top.
4. Some plant juice should squeeze out when you mash the leaves. If the sample material is dry, **add about 1 tablespoon of water** to the baggie to dampen the material.
5. **Seal the baggie and place it in a warm area**, (direct sunlight will often heat it enough to release cyanide gas if it is present in the plant material).
6. **Wait 10 minutes**, and then evaluate the color of the test strip.
7. If the strip turns dark blue, the sample is positive for cyanide. If the strip is the same

very light green color as before adding the sample, the sample is negative for cyanide. Any blue color change indicates that some cyanide is present.

8. This test is simply a screening test to determine whether or not cyanide can be generated from the sample being tested. The exact concentration of cyanide cannot be accurately measured using this method, but a sample that quickly turns the strip dark blue is a quick indicator of a plant that could pose a significant risk for cyanide poisoning.

**Note:** The shade of blue can darken over time, indicating that trace amounts of cyanide are being generated. Test strips should be evaluated after 30 minutes, if possible, to detect trace amounts of cyanide..

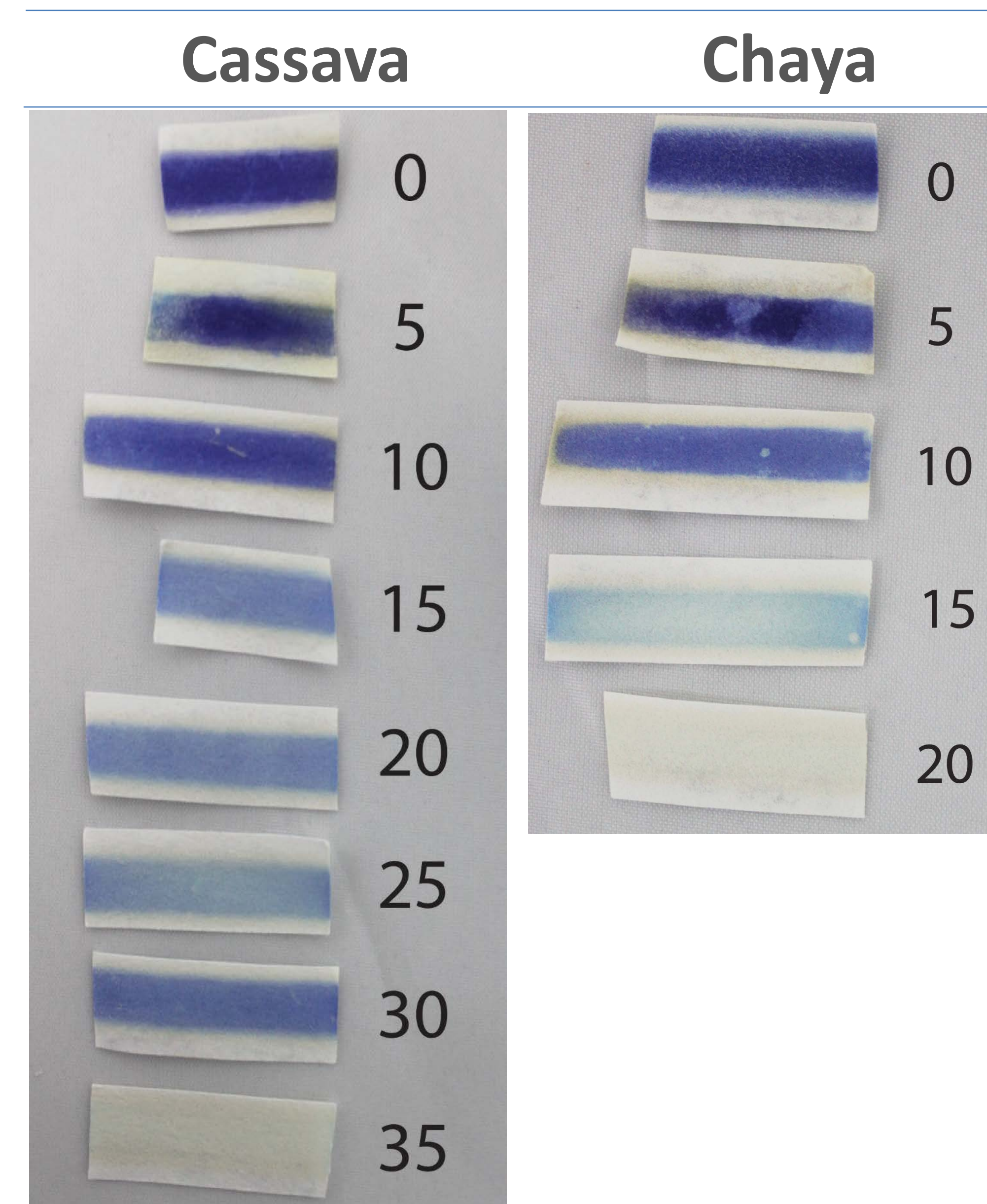


**Figure 1:** Chaya and cassava leaves were separately chopped (top left) prior to boiling (top right). Fresh leaves (bottom left) and boiled leaves (bottom right) were placed in zip-lock baggies along with test strips to detect cyanide presence. Source: Tim Motis

## Results

With raw cassava and chaya leaves, the strips turned a dark blue color almost immediately, a strong indicator of the presence of cyanide (Fig. 2). For both crops, the shade of blue lightened considerably between 10 and 15 minutes of boiling time. However, it took 15 minutes longer for cassava than for chaya to reach the point where no blue color could be seen on a test strip.

**Figure 2:** Color of Cyantesmo test paper in response to boiling chopped leaves of cassava from 0 (raw) to 35 minutes and chaya from 0 (raw) to 20 minutes. The numbers in the photo below indicate the number of minutes that chopped, green leaves were boiled.



## Conclusion

- The results indicate that cassava leaves are safe to consume after 35 minutes of boiling time.
- Chaya leaves can be eaten after 15-20 minutes of boiling.
- These results are not definitive, since only one sample was prepared for each boiling time.
- The 15-20 minute time frame for chaya is consistent with research showing that a boiling time of 15 minutes lowers HCN content to safe levels (Ross-Ibarra and Molina-Cruz, 2002). Many people boil chaya leaves for 15-20 minutes to reach a preferred level of tenderness.
- The 35 minutes for cassava leaves is consistent with West African culture, where the young, tender leaves are typically pounded and then boiled for up to 30 minutes before eating (FAO 1999). The combination of pounding and boiling effectively reduces the cyanide to safe levels.
- In this experiment, the test strip in the cassava, after 30 minutes of boiling, was surprisingly dark, which could have something to do with the ratio of older to younger leaves (assuming they differ in cyanide levels) in the sample. .

## Practical uses for this test

Cyantesmo paper could be used for a number of applications:

- The same series of boiling times could be tried for leaves from different varieties of cassava, which naturally tend to have differing levels of cyanogenic glycosides.
- To test how well cyanide is removed with other methods of food preparation, such as drying or frying.
- For assessing HCN released from mashed or cooked cassava roots.
- To determine the presence of cyanide in animal feed, by comparing HCN levels in different plant materials and resulting from different feed preparation methods

## Further Reading

Food and Agriculture Organization (FAO). 1990. Oke, O.L. (edited by J. Redhead and M.A. Hussain). *Roots, tubers, plantains and bananas in human nutrition*. FAO (Rome) URL: <http://www.fao.org/docrep/t0207e/t0207e08.htm>

Food and Agriculture Organization (FAO). 1999. Bokanga, M (edited D. Mejia and B. Lewis). *Cassava: Post-Harvest Operations*. FAO (Rome) URL: <http://www.fao.org/3/a-au998e.pdf>

Ross-Ibarra, J. and A. Molina-Cruz. 2002. The Ethnobotany of Chaya (*Cnidoscolus aconitifolius* ssp. *aconitifolius* Breckon): A Nutritious Maya Vegetable. *Economic Botany* 56:350-365.

Smith, R., C. Gaskill and M. Arnold. 2012. *Beware of Cyanide (Prussic Acid) Poisoning*. University of Kentucky. URL: <https://www.uky.edu/Ag/Forage/2012%20Cyanide%20Test%20Kit%20Out%20of%20State.pdf>

## Articles in ECHO Development Notes:

Issue 81: Information on a cyanide testing kit developed by Dr. Howard Bradbury, using picrate paper and a color code to indicate cyanide levels in parts per million. Though we are unsure whether or not the kits are still available, an internet search with the terms "Bradbury cyanide method" will yield a number of related publications.

Issue 80 : Information on cyanide levels in leaf protein concentrate made with chaya leaves

Issue 89: Perspective on cyanogen content in cassava tubers/flour.