Leaf Protein Concentrate from Chaya Leaves?

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[Reader: please note that this article does not apply to people eating cooked chaya leaves. Boiling the leaves destroys the harmful substances mentioned. Boiled chaya leaves have been eaten in Central America and southern Mexico for centuries.]

In response to the articles on leaf protein concentrate and on chaya in EDN Issue 78, a reader asked whether or not leaf protein concentrate (LPC) could safely be made from chaya. As we mentioned in that issue, chaya leaves contain varying levels of hydrocyanic glycosides. These glycosides can be toxic if eaten in sufficient amount, because they can release hydrogen cyanide inside the digestive system. Fortunately the cyanide is driven from the leaves during the normal boiling process. Since the process of making LPC does not include boiling for longer than a few seconds, the question is whether the cyanide-containing compounds might end up in the LPC. Have most of the compounds been discarded when the liquid is discarded—or might they be concentrated in the LPC? We have found some helpful information and done a few experiments that will be described below.

LPC has been made from chaya leaves, according to an article about chaya in Economic Botany, Volume 56, Number 4 (Winter 2002). Armed with that knowledge, I tried making some myself. I tested both the fresh leaves and the LPC for cyanide content, using a cyanide testing kit developed by Dr. Howard Bradbury of the Australian National University (details about his easy-to-use cyanide testing kits will follow in a future issue of EDN). According to my results, fresh ground chaya leaves from a plant on ECHO's farm contained between 30 and 50 ppm of cyanide on a fresh weight basis [ppm stands for 'parts per million'; another way of saying it is 30 to 50 mg of cyanide per kg of leaves]. LPC contained 10 ppm, or 10 mg of cyanide per kg of wet LPC.

I asked Dr. Bradbury what these values mean in terms of the possible toxicity of the leaves and of LPC. Regarding the leaves, he said, "If you got a value of 50 ppm, then if you ate 1 kg of raw leaves you would intake 50 mg of cyanide which would correspond to about 0.7 mg per kg for a 70 kg adult. This could be a lethal dose!" However, an adult would probably not eat uncooked leaves and certainly would not eat that much—at most 250 grams which would only be one quarter of the amount of cyanide intake. Dr. Bradbury concluded, "Nevertheless, it could lead to acute intoxication (i.e. headaches, dizziness, stomach pains, vomiting, etc.)

"Dr. Bradbury said that in general, 50 ppm is considered an intermediate level and 100 ppm is considered dangerous. The World Health Organization has a safe level of 10 ppm for cassava flour [which is used as a staple and consumed in large

quantities in many areas]. For more information about the health effects of exposure to cyanide, see the article on this subject in our book Amaranth to Zai Holes: Ideas for Growing Food under Difficult Conditions (available on our web site). The article is titled "Toxicity and Food Security: A Review of Health Effects of Cyanide Exposure from Cassava and of Ways to Prevent these Effects." According to that article, the body of a normal adult with adequate protein in his or her diet can detoxify up to 10 mg of cyanide per day with no harmful effects.

Regarding our result of 10 ppm of cyanide in LPC, Dr. Bradbury wrote, "A value of 10 ppm is the top of the WHO safe level and I would think it would be quite okay. Extra heating [for example, if LPC were added to a dish that was then cooked further] could remove any free cyanide present as hydrogen cyanide (HCN), which is a gas with a boiling point of 27°C. However, the remaining cyanide might not be present as HCN, but as a cyanide compound not broken down by heating."

Also, keep in mind that people don't tend to eat pure LPC. It is usually used as an ingredient in a dish (pasta, for example). I looked through some recipes from the Leaf Protein Concentrate Manual and found that, in general, LPC makes up one-fourth or less (sometimes much less) of the total ingredients (by volume). For example, pasta can be made from one cup of LPC per six or seven cups of flour (plus a teaspoon of salt).

[As a side note, the 'whey' produced when making LPC (i.e. the liquid that is usually discarded) is not acceptable in the human diet because of the concentrations of nitrates, oxalic acid, and other anti-nutrients. Just for interest's sake, I tested the whey for cyanide content and found it at a level of 10 ppm. The fiber (removed during the first step of making LPC) contained 20 ppm of cyanide. Often the fiber is used for animal feed. Dr. Bradbury said that animals should be fine with 20 ppm of cyanide in the fiber.]

Why would LPC contain so much less cyanide than fresh leaves? Quite likely much of the cyanide is removed with the fibrous portion of the leaves and in the discarded water (whey). Additionally, the blending or grinding done in the first step of making LPC reduces the toxicity significantly. (Usually there are special enzymes in leaves that release cyanide from cyanogenic glucosides. They are in a separate part of the leaf cell to keep them from releasing the cyanide leaves, the structures keeping the enzyme and glucoside apart are destroyed and a dose of cyanide is released in the stomach.) In an article in our files (from the publication Mandioca EM FOCO, Numero 4, Outubro 1994), the author seems to confirm that blending or grinding greatly reduces the toxicity. The author reported results of a study on cassava leaf flour. Blending fresh leaves in a blender reduced the level of HCN by up to 90% compared to leaves that were dried first and then ground. (However, according to the above-mentioned article on chaya in Economic Botany, blending leaves was sufficient to remove the HCN IF it was left to sit for several hours, but the normal LPC procedure does not sit that long.)

Another likely reason for the lower level of cyanide in LPC is the heating and pressing involved in later steps. According to David Kennedy's Leaf Protein Concentrate Manual, heating the leaf juice to boiling (which is typical when making LPC) and pressing the curd very well should remove about 95% of hydrocyanic acid.

Though not related to the cyanide question, we came across an article with some additional helpful information about making LPC (Nagy, S., et al, 1978, Journal of Agricultural Food Chemistry 26(5): 1016-1028). The article includes cassava and chaya plants in a list of 19 leaves that have protein content higher than 30% (i.e. crude protein contents as a percentage of dry matter). To make LPC, the authors ruptured the plant cells (this is often done by grinding, beating or blending the leaves) and then added water at a ratio of 1:1 of water and leaves (i.e. equal volumes of each). Soft succulent leaves are easier to extract than those that are dry and fibrous. In leaves containing high proportions of acid, the juice also tended to be acidic and the protein tended to precipitate along with the fiber. It was better to make the pulp slightly alkaline (around pH 8.2). The yield of protein was less from juice that was allowed to remain at room temperature for extended periods before processing, due to actions of proteolytic and lipoxidase enzymes.

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