CHAPTER SIX

Cooking Greens to Maximize Nutrition

Even as some greens are more nutritious than others, some methods of preparing greens are healthier than others. A frequently asked question concerning the preparation of leafy vegetables is whether to cook them or eat them raw. Ordinarily lettuce is eaten raw, although there are recipes for heat-wilted lettuce salads. The Chinese often eat their lettuce cooked and the thick lettuce stem is sometimes cooked as a separate vegetable.

Some leaf vegetables, including spinach and cabbage, can go either way, raw in salads or cooked in a variety of dishes. Many greens are eaten raw only when they are very young. Sprigs of young Mizuna and other Asian mustards, arugula, red kales, and dandelion are sometimes used to give raw salads bolder flavors and colors. Levels of phytochemicals in cabbage family greens tend to be very high in young plants that are eaten raw. These compounds have anti-cancer, anti-viral, and anti-bacterial properties, but they also interfere with our utilization of iodine. Most people find the more mature leaves of these same plants too harsh for a raw salad. There are some greens that are always cooked, never eaten raw. Cassava, moringa, chaya, and many other tropical leaf crops fall into this category.

So which is better, raw or cooked? There is a perennial movement of people who advocate only eating raw foods. They claim that cooking debases the natural vitality of foods and that essential living enzymes are destroyed by cooking. Enzymes are proteins that are usually catalysts for specific chemical reactions. The metabolic systems of plants are sufficiently different from that of humans as to render nearly all plant enzymes useless in the human body. Most quickly break down in the highly acidic environment of the human stomach. Generally, like other proteins we consume, they are broken down into their component amino acids so that they can be reassembled or synthesized into new proteins. These newly assembled proteins include enzymes that, unlike the ones from the plants, have specific functions in the human body. Raw plant enzymes may be somewhat useful in the human diet as a source of protein, but no more so than other dietary proteins.

While the living enzyme argument seems somewhat misguided, there are good reasons for eating some foods raw. Some nutrients, especially vitamin C and folate, are easily damaged by heat, so any cooking at all results in some loss. Most fruits, which are rich in vitamin C, are nutritionally damaged by any cooking. Many other nutrients, including essential amino acids, fatty acids and other vitamins are damaged by very high temperatures or prolonged heat.

Once a plant food is harvested or separated from the rest of the plant it gains no further nutrients and begins to lose some of the

KEEPING GREENS GREEN

Cooks are often disgusted when the vibrant deep green of their leaf vegetables turns an unappealing olive drab when cooked. This is made more depressing by the phenomenon of the leaves turning a very bright intense green shortly after being put in boiling water before sinking to a dull olive color. The brightness is caused by air bubbles between leaf cells escaping and allowing us to see the bright green color of the chloroplasts more directly. Shortly after that happens the heat pushes the magnesium out of its central position in the chlorophyll molecule. In acidic conditions hydrogen ions replace the magnesium center, and the chlorophyll turns grayish-green. Even if the leaves are fried rather than boiled, heat breaks open cells, and the leaf's own acid will come into contact with its chlorophyll.

Historically, two solutions to the olive drab greens were employed. Both have been largely abandoned because the cure was worse than the problem. Old British cookbooks often recommended either cooking greens in copper pots or tossing a copper coin in with the boiling vegetables. Even in acidic water the copper ions, rather than the hydrogen ions, will replace the magnesium in the chlorophyll and allow the chlorophyll to keep its bright green hue. This practice has been discontinued because we are now aware that, beyond the tiny amount that we need, copper can damage both liver and brain function.

The second trick to keep greens green, still used in much of Africa, is to make the cooking water alkaline by adding baking soda or ashes. The alkaline solution restricts the availability of hydrogen ions and the bright green color is retained. There are two downsides to the use of ash or bicarbonate of soda, though neither is as troubling as liver and brain damage. The alkaline solution breaks down the pectin and hemicellulose in the cell walls quickly, and this results in a nice green color but an unpleasant soggy texture. The second problem with the alkaline approach is that vitamins are lost much more quickly, rendering the greens significantly less nutritious.

Can anything be done to keep greens green? One piece of advice that is sometimes offered is to drop the well-chopped greens into a large pot of boiling water with the lid off. The idea is to neutralize the enzyme chlorophyllase, which destroys chlorophyll once the plants cells are broken open by heat. Chlorophyllase is most active between 66° and 77°C (150° and 170°F), but it is completely neutralized by boiling. If a small amount of water is used, adding the leaves will cool the water and they will pass more slowly through the 66°–77°C temperature range of maximum chlorophyll loss. The large pot of boiling water plan also has two downsides. First, far more nutrients, especially B-vitamins and vitamin C, are lost to the water. Over twice as much vitamin C remains in vegetables that are steamed, microwaved, or cooked in a small amount of water, compared to vegetables boiled in a large enough volume of water to cover them completely.

The second drawback to cooking with large volumes of boiling water is that it requires more fuel and more time to cook. In many parts of the world shortage of cooking fuel is a serious obstacle to good nutrition, and it never makes sense to use more fuel than necessary. Stir-frying uses very hot surface temperatures (well above the boiling point) and relatively small pieces of leaf that cook very quickly, so it might be the best compromise between color and nutrition for leaf crops that need to be cooked. To a certain degree we are forced to choose between good nutrition and bright green leaf vegetables.

ones it had. Hence a very good argument can be made for eating foods as soon after harvest as possible. In fact, the unavoidable delay between harvest and eating is one of the fundamental weaknesses of a globalized food system.

Cooking affects food in several ways that are fundamentally different than the changes brought on by delays between harvesting and eating. As raw food advocates claim, cooking alters the nature of all foods. That is exactly the point of cooking. Usually this alteration is beneficial to our digestive system. The most obvious benefit of heating food—including leafy vegetables—is that it kills parasitic microorganisms. For instance, the deadly *E. coli O157:H7* that contaminated spinach in 2006 is killed in just fifteen seconds at 71° C (160° F). It is thought that the cooking of food has ancient roots and probably was well established by about 40,000 years ago. It has been nearly universally adopted. The decline in intestinal parasites must have been precipitous.

Killing parasites is just one of the benefits of cooking foods. Cooking softens cell walls and starches, and detoxifies many foods. Raw kidney beans, buckwheat greens, and potatoes have toxins that are at least partially destroyed by heat. Trypsin inhibitors in legumes and phytates in grains are partially neutralized by heat making these important foods more edible. Several nutritious leaf crops, such as chaya and cassava, are toxic unless cooked.

One of the most important effects of heating comes from the water within the cells expanding. Water expands about 4% when heated from room temperature to its boiling point. This is often enough to rupture the leaves' cell walls and that allows our digestive system much greater access to the nutrients within the cells. We accomplish some of the same cell rupture by chewing our food, and this makes a good case for chewing food thoroughly. However, even careful chewing doesn't achieve the degree of cell rupture that heat can. Because of this, steaming a carrot will roughly double the amount of vitamin A that the same carrot could provide raw. This is true also with most leaf vegetables.

Blending raw leafy vegetables in liquid breaks the leaf cell walls and can provide many of the benefits of cooking without as much vitamin loss. The high speed blades of the blender or liquefier dramatically alter or obliterate the vegetable's texture. This is fine for smoothies, many sauces, and creamy soups, including raw gazpacho type soups. It has been estimated that blending roughly doubles the bioavailability of the beta-carotene in most leafy vegetables. Various other means of pulping leaves, such as food processors, meat grinders or mortars and pestles, accomplish much of the same cell rupture, though electric blenders are the most effective.

As mentioned earlier, adding a small amount of cooking oil or fat to green leaves increases the conversion of beta-carotene to vitamin A significantly. Steaming, liquefying, and adding oil to green leafy vegetables are three simple measures that, either separately or taken together, could dramatically reduce the deadly scourge of vitamin A deficiency among the world's children.

Cooking damages some nutrients and makes others more available. The trick is finding an optimal way to cook greens for the minimum length of time that will give the best mix of nutrition, flavor, and texture. For most greens this means steaming, stir-frying or boiling for 3–5 minutes. Younger more tender greens can be eaten raw or cooked even more briefly and older tougher ones will of course require longer cooking. Stir-frying, steaming, or microwaving result in less nutrient loss than boiling. This is because B-vitamins and vitamin C are water soluble and leach out into the boiling water. Some of this loss can be recovered if the residual liquid or pot liquor is consumed. In the southern United States it was common practice, traced to slaves, to dip corn bread in the pot liquor in order to capture more nutrients. Microwaving essentially just steams the greens with their own moisture, causing the least loss of nutrients of any cooking method.

Okinawan spinach *(Guynura crepioides)*

There are a few edible leaf crops that require special preparation. For example, cassava leaves and chaya, both members of the euphorbia family, should not be eaten raw or even cooked for less than five minutes. They both contain compounds that can break down and release toxic hydrocyanic acid. Cassava leaves have far higher levels of this toxin than chaya and need to prepared more carefully. They are both valuable vegetables but they need to be handled differently than spinach or cabbage.

Some other leaves, such as quail grass or soko (*Celosia argentea*), are usually boiled, drained, and rinsed and then boiled a second time. This removes much of the tannin that can give the soko an unappealing dark color. There are a few of these problematic compounds, including nitrates, hydrocyanic acid and oxalates that are common enough in leaf crops to deserve further consideration. The pot liquor from leafy vegetables containing high levels of these compounds is not good to consume.

Actually a great many, if not most, foods have some toxic or anti-nutritional compounds in them. Why would anyone eat something that was toxic or poisonous? It is a rough-and-tumble world full of organisms trying to eat and not be eaten. Plants often use toxins to keep from being eaten. Animals often figure out a way around these toxins in order to eat. Over thousands of years humans have learned how to get around most of the toxins and gain access to the nutritional value of these foods.

NITRATES

Nitrates are fairly stable nitrogen compounds that plants absorb from the soil. The biggest danger from nitrates is that they can be degraded into nitrites. Nitrites are unstable and can combine readily with other compounds in the digestive tract to form carcinogenic (cancer-causing) nitrosamines. Currently, about 65 of the average 73 mg of the nitrates consumed daily in the U.S. come from vegetables. The World Health Organization has established a standard of 222 mg per day as a maximum daily nitrate intake.

For the most part soil nitrates are destined to be built into proteins. Immature leaves tend to have considerable nitrate accumulation because the plant has not had time to incorporate some of the nitrates into proteins yet. Leafy green vegetables and some root crops—especially lettuce, spinach, celery, beets, and radishes—contain the highest concentrations of nitrates.

There is often a tenfold variation in nitrate levels of the same variety of vegetables sampled from supermarkets. This is largely a function of the age of the vegetable when picked and the amount of nitrate fertilizer used to grow the crop. Nitrate levels of vegetables have gone up significantly in recent years because of increased use of nitrate fertilizers. Nitrate levels in carrots, lettuce, and spinach, for example, have roughly doubled since the 1970s in the U.S. Leaf crops grown with excessive nitrogen fertilizer can have dangerously high levels of nitrate. One study showed that turnip greens could contain up to thirteen times more nitrate when oversupplied with soluble nitrate fertilizer.[1]

Fertilizer applied shortly before harvest causes the greatest increase in leaf nitrate levels and should be avoided. Slower releasing nitrogen sources such as compost and leguminous cover crops can produce vegetables with significantly lower nitrates, and this is an area where the organic foods movement has led the way. If non-organic fertilizers are being used, ammonium nitrogen will grow lower nitrate vegetables than those fertilized with nitrate nitrogen. If ammonium-based fertilizers are to be used, it may be worth also applying a nitrification inhibitor, such as nitrapyrin, that slows the growth of the Nitrosomonas bacteria responsible for converting ammonium to nitrite in the soil. In small scale production, organic fertilization techniques will usually provide the best combination of good vegetable yields and lower nitrate levels.

1 Isabel S. Vieira, Ernesto P. Vasconcelos and António A. Monteiro, Journal of Nutrient Cycling in Agroecosystems. Springer, Netherlands. ISSN 1385-1314 (Print), 1573-0867 (Online). Volume 51, Number 3 / July, 1998

If people increase their vegetable consumption sharply, as they are advised to do, is there a danger to their health from the associated increase in nitrates? And if there is, what steps can be taken to minimize this increased risk?

There are two basic strategies to reduce the risks of nitrosamine exposure while greatly increasing consumption of vegetables, especially leafy vegetables. The first is to reduce the amount of nitrate in your diet; and the second is to prevent the nitrate from being converted to nitrites in the body. Stems, or petioles, tend to be very high in nitrates and low in nutrients, so there is a value to carefully trimming off stems of spinach and other greens. Some plants such as lettuce are high in nitrates relative to the nutritional contribution they make, and it is reasonable to begin substituting other vegetables in their place. Crisp head type lettuce tends to accumulate more nitrate than leaf type lettuce, giving yet another reason to choose the leaf varieties.

Varietal differences in nitrate content can be significant, and when possible it is prudent to choose a low nitrate variety, such as the smooth-leaved spinach (Tuftegard variety) over a high nitrate variety, such as the common home garden spinach (Bloomsdale variety), which typically has over 3½ times as much nitrate. As a general rule, smooth leaf spinach has less nitrate than crinkled leaf types. Increased consumer demand for low nitrate vegetable

Belembe *(Xanthosoma brasiliense)*

varieties could quickly lead to selection and breeding programs focused toward this end. Unfortunately the nitrate levels of different varieties are not listed anywhere that consumers or even researchers can easily access.

Greens harvested in the afternoon on a sunny day will contain fewer nitrates than those picked on a cloudy day or early in the morning. Generally, low light intensity, such as that found in cloudy climates, high latitudes and winter greenhouses, contributes to higher nitrate levels. Molybdenum deficiency in the soil can also lead to excessive nitrate accumulation in vegetables.

Once nitrate is consumed, vitamin C (ascorbic acid) is effective at preventing the conversion of nitrate to nitrite within the human body. Greens that are very rich in vitamin C, such as kale, may have enough vitamin C to protect us completely against the nitrates they contain. There are many other good reasons to increase vitamin C intake, besides its role in protecting against nitrite formation, and it is inexpensive nutritional insurance.

Two techniques that will be discussed later in this book can reduce the danger of nitrite and nitrosamine formation from increased consumption of greens. Leaf concentrate is essentially nitrate free, with an estimated 98% of the nitrates washed out in the residual liquid. The second technique involves drying and grinding of leaf crops. Because the dried leaves are ground to flour-like consistency, we can use more mature plants which are lower in nitrates. These plants may be considered too tough and stringy to be marketable.

By selecting species and varieties that are low in nitrates and high in vitamin C, and by growing them without synthetic nitrate fertilizer, we can dramatically reduce the danger from nitrates in vegetables. Crops grown in soil with abundant organic matter and moderate nitrogen levels will still produce heavily but with far safer nitrate levels. By making leaf concentrate or by drying and finely grinding more mature leaf crops, we can reduce the danger to an absolute minimum.

OXALIC ACID

Oxalic acid is a naturally occurring organic acid that is commonly made by plants, animals, and humans. It is plentiful in many leaf crops and it has two negative impacts on our health. Oxalic acid combines easily with calcium, making calcium oxalate salts. The calcium in these salts is unavailable to us which lowers the total amount of available calcium in our diet. The second impact is also from calcium oxalate salts. If urine becomes overly saturated with these salts, some will precipitate out as crystals. This is akin to adding sugar to tea until it can hold no more, then watching sugar precipitate and settle at the bottom of the glass or pitcher.

Chart 6–1
Oxalic Acid in Vegetables

OXALIC ACID	VEGETABLE	OXALIC ACID	VEGETABLE
GRAMS	100 G FRESH, EDIBLE PORTION		
1.70	Parsley	0.15	Cauliflower
1.48	Chives	0.13	Asparagus
1.31	Purslane	0.11	Endive
1.26	Cassava	0.10	Cabbage
1.09	Amaranth	0.05	Moringa leaves Okra Onion Pea Potato Tomato Turnip greens
0.97	Spinach	0.04	Parsnip Pepper
0.61	Beet leaves	0.03	Rutabaga
0.50	Carrot	0.02	Cucumbers Kale Squash
0.48	Radish	0.01	Coriander
0.45	Collards	0.01	Corn, sweet
0.36	Beans, snap Brussels sprouts Garlic		
0.33	Lettuce		
0.31	Watercress		
0.24	Sweet potato		
0.21	Chicory, Turnip		
0.19	Broccoli, Celery, Eggplant		

GOOD-FOR-YOU FOODS AND BAD-FOR-YOU-FOODS

Whether a food is good for you or bad for you is a surprisingly complex question. Anything, including water, can have a negative effect if you overdo it. When I was growing up whole milk was promoted as "Nature's most nearly perfect food." Nutritionists now question the wisdom of giving children that much saturated fat. Vegetable shortening was seen as a healthy alternative to lard and butter until the discovery that the trans-fats created in its hydrogenation process were tied to increased heart attack risk.

Many foods have naturally occurring compounds that have some downside for our health. For example, some cheeses contain tyramine, which can cause headaches and elevated blood pressure in susceptible individuals. Grains contain phytates that can block absorption of minerals. Green leaves have their share of these compounds as well.

Nitrates, oxalic acid, hydrocyanic acid, goitrogens, saponins, and tannins are all found in commonly eaten green leaves and all can have negative health consequences. Are they toxins? Anti-nutrients? It usually depends on the amount eaten and the general adequacy of the diet. For example, members of the cabbage family contain goitrogens, compounds that interfere with the absorption of iodine. Increasing iodine consumption offsets the effect of the goitrogens up to a point. Unless you have a thyroid condition, a very low intake of iodine, or eat a huge amount of cabbage family greens, the greens will likely provide far more health benefit than risk.

If you smoke and have a diet low in protein, eating cassava leaves may do you more harm than good because of the hydrocyanic acid (HCN) content. Chaya leaves, on the other hand would always do more good than harm, because they contain significantly less HCN and are very rich in essential nutrients.

Nitrates from spinach or amaranth leaves can be converted into carcinogenic nitrosamines in our guts, and high nitrate levels have been linked with increased risk of some cancers. However, new research shows that high nitrate vegetables may offer protection against gastric ulcers and high blood pressure and that they may significantly improve the efficiency of muscle function.[1]

If you have a genetic predisposition to kidney stones or a very low intake of water, leaf vegetables containing oxalic acid should be avoided, while for most of us they are a healthy addition to the diet.

Some substances, such as polyphenols, tannins, and saponins were seen as purely negative dietary factors a few years ago. Their negative impacts are still acknowledged but now they are viewed more favorably, as researchers discover that they also exhibit disease-protective mechanisms.

Another example is dietary fiber. Too much fiber blocks the absorption of minerals; too little fiber leads to digestive tract problems. The average American adult has adequate mineral nutrition, but consumes less than half of the recommended 25 g [0.9 oz] of fiber per day. He is better off with more fiber. Young children in the tropics are commonly deficient in iron and zinc. They may be better off with less fiber.

You don't need to master organic chemistry to get good nutrition. Complexity is not the same as confusion. The human digestive system is phenomenally capable of sorting out naturally occurring chemical compounds in foods. Even as your body can maintain a nearly constant 37° C (98.6 ° F) temperature in very different climates, it can keep you well-nourished on very different diets. The key is simply to eat in moderation and to eat a wide variety of whole foods.

1 "Dietary inorganic nitrate improves mitochondrial efficiency in humans," Larsen, F., Schiffer T., Bornique, S. et al. Cell Metabolism, 2 February 2011.

A small percentage[2] of the population has a genetic anomaly that allows these tiny calcium oxalate crystals to form together into extremely painful kidney stones.

There is some controversy within the field of clinical nutrition over the actual risk from dietary oxalic acid. It is estimated that about 85% of the oxalate in our bodies is from metabolic by-products, and only 10–15% is consumed via food. Additionally, many researchers believe the actual loss of available calcium from dietary oxalate is relatively insignificant. About 75% of kidney stones formed by adults in the U.S. are calcium oxalate stones. However, many experts think that kidney stone formation is largely genetic and that it is not greatly affected by dietary oxalates.

If you or any member of your family has had a kidney stone, it is reasonable to be very cautious about oxalate content of vegetables. Otherwise the benefit of the greens almost certainly outweighs the problems cause by the oxalic acid. Chart 6–1 on page 53 gives a good picture of the oxalic acid content of many vegetables.

There are a few things that we can do, short of curtailing vegetable consumption, to reduce the impact of oxalic acid from greens. Getting enough calcium in our diets is the best protection against the loss of available calcium for bones and teeth. Unless your calcium intake is marginal or worse it is very unlikely that oxalic acid from foods will cause a deficiency.

As for kidney stones, the best, simplest, and surely the cheapest protective measure is to drink more water. Water dilutes the urine and reduces the likelihood of calcium oxalate precipitating and forming painful crystals. Other beverages, especially coffee, wine, and beer, are also said to be protective, perhaps because of polyphenols. Lemonade is especially effective because of the high levels of citrates, whereas heavy tea drinking seems to contribute to the formation of stones. Cooking doesn't have much effect on the oxalate content of foods. A decrease of 5–15% oxalate content is the most you are likely to see from cooking high-oxalate greens.

There are two other biological approaches to lowering the level of oxalates in our diet, both involving oxidase. This is an enzyme that quickly breaks down oxalic acid into harmless components. The first technique employs seedlings of rye, wheat, or barley that are naturally rich in oxidase. The seedlings are dried at low temperature, ground, and added to foods high in oxalic acid. Tests have shown a 70% decline in oxalates in less than two hours of contact.

The second use of the enzyme oxidase takes place in the field. Over thirty years ago it was discovered that spinach leaves, one of the highest oxalic acid foods, also contain oxidase, which could neutralize much of the oxalic acid. It was also discovered that nitrates deactivate this enzyme. Once again the most obvious course of action is to reduce the use of nitrate-based fertilizers, especially for growing greens.

If you want to remove all of the oxalic acid in the leaf crops that you eat, leaf concentrate is your best option. Essentially all of the soluble oxalic acid is washed out with the whey.

Some leaves, such as those of the taro plant, contain insoluble oxalate crystals called raphides. These don't combine easily with minerals and don't contribute to kidney stones or the loss of absorbable calcium. The needle-like raphides, however, can be extremely irritating to your tongue and throat, so it is imperative that taro leaves and those of related plants be cooked well (at least ten minutes) before eating. Recently, it has been discovered that the intense irritation is actually due to the effect of the sharp raphides puncturing the tissues of the mouth and throat, combined with proteases (enzymes that break down proteins) attacking the punctured tissues.

HYDROCYANIC ACID

Hydrocyanic acid (HCN) doesn't sound like something that would be good to eat, and indeed it is not. In fact, it is closely related to cyanide gas that is sometimes used to execute doomed prisoners. Cassava, Lima beans, and sprouted sorghum are some of the foods that have caused HCN poisonings. The toxins in these plants are

2 In the U.S. the proportion of people prone to kidney stones appears to have grown from under 4% in the 1970s to over 5% by the mid-1990s.

Cassava *(Manihot esculenta)*

cyanogenic glycosides, compounds that release HCN when they break down.

Acute HCN poisoning is quite rare. The minimum lethal dose is estimated at 0.5–3.5 mg per kg of body weight. So a child weighing 20 kg (44 lb) would need to consume between 10 and 70 mg of HCN and an adult three or four times that. Chronic exposure to HCN can damage the nervous system; especially the optic nerve. Chronic or long-term toxicity is rare.

Among edible leaf crops, cassava leaves have the highest concentration of HCN and are by far the most troubling. HCN poisoning has been reported mainly where there is a great dependence on cassava and low protein intake. Low consumption of proteins—especially sulfur-bearing amino acids, cigarette smoking and air pollution—all intensify the body's negative reaction to HCN.

Three other leaf crops that contain HCN are chaya (*Cnidosculus chayamansa*), from the Yucatan Peninsula in Mexico; fluted pumpkin (*Telfairia occidentalis*); and bitter leaf (*Vernonia amygdalina*), from west Africa. They all have much lower and safer levels of HCN than cassava, but should be boiled for at least five minutes for a margin of safety. 100 g (3½ oz) of fresh chaya leaf will typically have less than 1 mg of HCN (or 10 parts per million). After 5 minutes in boiling water no detectable HCN remains. Fluted pumpkin and bitter leaf have only about one-tenth as much HCN as chaya.

The HCN content of cassava leaf is quite variable, but could be 50 times or more as high as that of chaya. With cassava, like chaya, the HCN is driven off with boiling water. Because of the greater content of HCN it is advised to boil cassava leaves for 15 minutes instead of 5 and to rinse them before eating. If a large quantity of cassava leaves are being chopped or pulped at any given time it is important to ensure good ventilation.

One would be tempted to steer clear of cassava leaves altogether to avoid any toxicity problems, except that the plant has several important attributes as a leaf crop. It produces large quantities of leaves throughout the year in many locations. Cassava leaves are high in dry matter, protein, and micronutrients. Cassava grows in thin, infertile acid soils, where aluminum toxicity prevents more profitable crops from thriving. It grows where there is malnutrition; the prevalence of the cassava root may be both a symptom and a cause of that malnutrition. People are currently eating cassava leaves as a vegetable in much of Africa, parts of Asia, and Latin America. The question may not be whether to eat cassava leaves, but rather how to.

Developing and distributing low-HCN varieties is critical to this effort. In Brazil and elsewhere great progress has been made on selecting and breeding cassava with low-HCN leaves. Besides prolonged boiling and rinsing, which eliminates a substantial portion of its vitamins, there are techniques for drying cassava leaves that remove most of the HCN. The leaves should be pulped while fresh before drying. Simple chopping will not rupture enough cells to allow for sufficient HCN to pass into the air. To put the pulping and drying technique in perspective, the Brazilian Ministry of Agriculture offered the figures in Chart 6–2, in parts per million (ppm) of HCN, for one variety of cassava leaf (Cigana).

Chart 6–2
Hydrocyanic Acid in Cigana variety cassava leaves

HCN *(ppm)*	Food
737	Fresh leaf
124	Powder from dried whole leaf
76	Powder from dried shredded leaf
34	Powder from dried pulped leaf