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Issue Highlights

NOTE: Link to extra material, full references and websites from the web version of *EDN* 103.

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Aflatoxin in the Diet Makes the Progression of HIV/AIDS and Hepatitis Much Worse

By Martin Price, Ph. D.

I had a fascinating conversation about aflatoxin in human food and animal feed with Dr. Tim Williams, a professor at the University of Georgia who specializes in research on peanuts. (ECHO featured aflatoxin in *EDN* 87. Aflatoxin is an extremely powerful carcinogen that comes from infection of stored crops with a certain mold. You can read that article on our website, www.echotech.org, or write ECHO for a copy.)

Dr. Williams told me that in the developed world, government regulations keep aflatoxin in food so low that the only effect we normally see from it in people is a long-term effect—namely cancer, and especially liver cancer. On the other hand, animals often consume higher doses because animal feeds are not as heavily regulated. The U. S. government allows 30 ppb of aflatoxin in human food but ten times that amount, 300 ppb, in animal feed. Because of the higher exposure of animals to aflatoxin, one finds that articles published in veterinarian journals discuss many additional illnesses and nutritional problems caused by aflatoxin. These include lower nutritional status, lower birth weights, slower growth of the young, lower feed efficiency, suppressed immune system, increased rates of cancer and death.

In many developing countries, there is no or little governmental regulation of and inspection for aflatoxin in foods and feeds. Even if there is governmental control in food processing, there is no oversight of food sold in markets or consumed right on the farm. The result is that humans are exposed to levels of aflatoxin in food that are as high as or higher than that to which animals are exposed in feed. ***Dr. Williams' important conclusion is that, for developing countries, we need to look at veterinarian literature instead of human medical literature when evaluating what effects we might expect to see from eating food contaminated by aflatoxin.***

"This is important to know," says Dr. Williams, "because not much attention has been paid to aflatoxin in severely malnourished populations. The reason is that other overwhelming problems in these situations seemed more important than a future risk of liver cancer. Now we are learning that there are additional immediate problems that need to be addressed."

In this article, I share some of the surprising and disturbing effects of ingesting high levels of aflatoxin. I also share some good news about adding small amounts of a certain kind of clay (bentonite) to the diet, to protect against aflatoxin. Be sure to read through to the conclusion!

Effect of Aflatoxin on Birth Weight and Growth. Exposure to even very low doses of aflatoxin, both in the womb and after weaning, is harmful to infants. Reducing maternal exposure to aflatoxin during pregnancy can lead to a 0.8-kg increase in weight and 2-cm increase in height of children within the first year of life (Turner *et al*, 2008). A study in Benin and Togo showed that aflatoxin exposure increases markedly following weaning, and exposure early in life is also associated with reduced growth (Gong *et al*, 2003).

Modulating Effect of Aflatoxin Concentrations. Aflatoxin *modulates* (i.e. interacts with and has an effect on) certain existing health problems, such as being underweight, having infectious

diseases (such as HIV), drinking unsafe water, being exposed to smoke from open fires, and having deficiencies of vitamin A and iron.

People Living with HIV/AIDS Face Increased Aflatoxin Exposure and Harm. Families of people living with HIV/AIDS are often less able to afford non-contaminated food. To make matters worse, the HIV virus reduces the availability of anti-oxidants that are needed to help detoxify aflatoxin. In addition, often people who have HIV/AIDS are also positive for hepatitis B. The hepatitis B virus decreases the process in the human body that normally detoxifies aflatoxin, while aflatoxin greatly increases the risk of developing liver cancer in people already at higher risk on account of their positive hepatitis B status.

Animal data and, where it exists, human data on immune suppression and nutritional interference show that aflatoxin symptoms are comparable to HIV infection symptoms. However, an important difference is that the symptoms of aflatoxin exposure (but not cancer, if it has developed) disappear if aflatoxin is removed from the diet.

The HIV Virus May be More Readily Spread To Individuals with High Exposure to Aflatoxin. Susceptibility to infection depends on how easily the viral particles may penetrate barriers to infection. An antibody called "secretory IgA" is the main immunoglobulin found in mucous secretions and also in small amounts in blood.

Secretory IgA resists degradation by enzymes, so it can survive in harsh environments such as the digestive and respiratory tracts, to provide protection against microbes that multiply in bodily secretions.

Human secretory IgA levels are decreased as a function of aflatoxin exposure. As a result, the integrity of membrane barriers is decreased and the person becomes more vulnerable to various infections, especially bacterial sexually transmitted diseases.

Dr. Williams said that people with HIV and aflatoxin are also more likely to infect another person.

Aflatoxin May Increase the Rate of Disease Progression in HIV/AIDS Patients. An investigation in the late 1980s looked into why there was an unusually rapid progression of HIV and AIDS in heroin addicts in the Netherlands and Scotland. The results revealed heroin that was contaminated with aflatoxin. The concentration of aflatoxin in urine of the patients was comparable to levels found in West Africans exposed through food (Henrickse *et al*, 1989).

It is "opportunistic infections" that usually debilitate and kill AIDS patients, rather than the actual virus directly. Aflatoxin exposure promotes opportunistic infections in animals and humans. Children with immune systems compromised by malnutrition and aflatoxin were found to be especially prone to infection.

Negative Synergy between Aflatoxin and Hepatitis Virus. The word "synergy" refers to situations where two good things, when combined, end up being extremely good—at least more than the total of what their individual contributions would amount to separately. Sometimes people explain synergy by saying it is like a situation where suddenly two plus two equals five. Negative synergy, in contrast, is where two bad things together are extremely bad.

In people who test positive for having hepatitis B (HPB), "aflatoxin is up to 30 times more potent than in persons without the virus. The relative risk of cancer increased from 1 for the general population to five for HPB-infected individuals to 60 for individuals who are both infected with HPV and exposed to higher levels of aflatoxin. In some areas where both agents are common, [liver cancer is] the predominant cancer and the leading cause of death (64% of cancers)" (Williams *et al*, 2004). In these areas, the incidence of liver cancer is estimated to be 16 to 32 times higher than rates in USA and Europe. Worldwide in the year 2000, it is estimated that 8.8% of cancer mortalities were from liver cancer (Williams *et al*, 2004).

Aflatoxin is 30 times more potent to persons that are also positive for hepatitis B.

But there is Hope!!!

There is some great news, though. Certain clays mixed in small concentrations with contaminated commodities bind the aflatoxin before it can be absorbed in the intestine. These clays are classified as "calcium bentonites." This special kind of clay has a lattice layer structure that is able to trap and hold the aflatoxin inside the structure. Other clays only adsorb aflatoxin to their surface, but not powerfully enough to prevent the digestive system from reversing the binding and allowing uptake.

Adding a bentonite to food in amounts one-fourth to one-half of a percent by weight provides protection against aflatoxin for all animals. Such clays are used in animal feeds worldwide, in both developing and developed countries. For example, Novasil is a bentonite product which has been steam treated to increase the space between layers. Bentonite is approved by the Food and Drug Administration in the USA for including in ***human*** food for functional purposes, e.g. to make food go down the throat more easily.

When I first learned of the ability of clay to bind aflatoxin, I thought of the practice common in some countries of eating "clay cookies." In Haiti this is especially common among pregnant women. I thought that this practice might be eliminating the absorption of aflatoxin from the gut. Unfortunately the bentonite clays are naturally found only in a few countries and at only a few places in those countries.

But where can calcium bentonite clays be found in the countries where aflatoxin is the greatest risk to the food supply? In countries where food or feed manufacturers use bentonite as a minor ingredient, it should be available in-country. Calcium bentonite clays are not expensive. Dr.

Williams estimates that the ingredient cost in the USA is 66 cents per YEAR per person. In other countries, where these clays are available and mined, the cost might be less. It is likely that the cost would be somewhat higher if the bentonite was being imported, but not prohibitively so.

Calcium bentonite has a very wide range of industrial applications, so sources include producers or importers of bentonite. Would industrial-grade bentonite be suitable as a food or feed additive? I asked Dr. Williams. He had significant reservations. "Because these clays were mined without thought of being used in food or feeds, one could not be certain that they are free from contamination of heavy metals and other toxins such as PCBs. There is also the biological contamination risk to consider. We would really hesitate to recommend using clays without knowledge of their chemistry, and that they are within allowed levels of metals and other products." (Personal communication, 2008)

Dr. Williams adds that the bentonite in food is also effective against rotaviruses. He suggests that bentonite in food/feed may thus have the added benefit of helping where this virus might be present in the water.

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How Can a Diet Rich in Phosphorus Lead to Phosphorus Deficiency and Other Deficiencies?

By Dawn Berkelaar

Food's contribution to a person's good health involves three main parts: nutrition, digestion and assimilation. The first involves eating foods that contain the nutrients our bodies need. The second involves the body's ability to break down the food, so that the nutrients are available for use. The third part involves the body's ability to take those nutrients and use them to strengthen and repair the body. Sometimes, even when you are eating the "right" food, digestion is problematic and you will not get the full benefit.

Phosphorus in the hulls of plant seeds, especially legumes and grains, is bound up in an organic molecule called phytic acid. (If you know chemistry, phytic acid has six phosphate groups covalently bound to a ring of carbon atoms.) All seeds contain phytic acid, but soy products and oats contain particularly high amounts. Unless the phytic acid molecule is broken down, either before or during digestion, the phosphorus will be unavailable to the body.

In addition to the bound phosphorus, phytic acid can interrupt the body's ability to utilize minerals found in food. Phytic acid in its "salt" form is referred to as phytate; in this case, phytic acid binds with minerals that include calcium, magnesium, copper, iron and zinc. Unless phytic acid is broken down before or during digestion, regular dietary intake of phytic acid can contribute to mineral deficiencies and bone loss, because these important minerals are bound up in phytate rather than assimilated into the body. Phytic acid can also bind niacin, making it unavailable to the body. A deficiency of this B vitamin can cause pellagra (symptoms include fatigue, sore skin and mental disorders).

The textbook *Botany: An Introduction to Plant Biology* by James. D. Mauseth corroborates this information. Mauseth describes the concentrated mineral storage in seeds. When phytic acid dissolves in plant tissue, it ionizes, losing protons (H^+). When the developing seed begins to concentrate the phytic acid, "it puts cations on it rather than returning the protons, and the cations used are Mg^{2+}, Ca^{2+}, Zn^{2+} and K^+. This mineral-holding form is phytin, and it permits the [seed] to not only store . . . phosphate but all these other essential elements as well."

Ruminant animals can break down phytate molecules and use the phosphorus, because rumen microorganisms produce an enzyme (phytase) that releases phosphate from the phytate molecule. However, non-ruminants often lack the phytase enzyme. For them, phytates in the diet can cause problems. [This also means that manure from monogastrics like pigs and chickens contains a lot of potentially available phosphate when the manure decomposes—good for the garden, but bad for the environment if available in excess.] Sally Fallon, author of a book called *Nourishing Traditions*, had this to share after reading a draft of the article: "Monogastric animals and humans [sometimes] do have phytase in the digestive tract—depending on their intestinal flora and other factors. This is why in studies, some humans will develop mineral deficiencies with high-phytate diets and others will not. Also, there is some phytase in the grains themselves, and depending on the conditions in the gut, some people will be able to activate and use the enzyme to break down the phytic acid."

While cooking helps to reduce phytic acid in food, there are other simple and more effective methods of reducing the level of phytic acid in whole grains. These include soaking grains in water with acid added; lactic acid fermentation (lactobacilli, the "good" intestinal bacteria that produce lactic acid, are a source of phytase); and sprouting. As you read in the last issue of *EDN*, malting enzymes can also be used in porridges to break down phytic acid and phytates.

Sally Fallon, in *Nourishing Traditions* (*NT*), wrote: "Traditional societies usually soak or ferment their grains before eating them, processes that neutralize phytates and enzyme inhibitors and, in effect, predigest grains so that all their nutrients are more available. Sprouting, overnight

soaking and old-fashioned sour leavening can accomplish this important predigestion process in our kitchens. Many people who are allergic to grains will tolerate them well when they are prepared according to these procedures. Proper preparation techniques also help break down complex sugars in legumes, making them more digestible." (*NT*, p. 25)

Soaking. "Our ancestors, and virtually all preindustrialized peoples, soaked or fermented their grains before making them into porridge, breads, cakes and casseroles. A quick review of grain recipes from around the world will prove our point: In India rice and lentils are fermented for at least two days before they are prepared as *idli* and *dosas*; in Africa… coarsely ground corn [is soaked] overnight before adding it to soups and stews, and they ferment corn or millet for several days to produce a sour porridge called *ogi*; a similar dish made from oats was traditional among the Welsh; in some [Asian] and Latin American countries rice receives a long fermentation before it is prepared; Ethiopians make their distinctive *injera* bread by fermenting a grain called teff for several days; Mexican corn cakes, called *pozol*, are fermented for several days and as long as two weeks in banana leaves; before the introduction of commercial brewers yeast, Europeans made slow-rise breads from fermented starters; in America the pioneers were famous for their sourdough breads, pancakes and biscuits; and throughout Europe grains were soaked overnight, and for as long as several days, in water or soured milk before they were cooked and served as porridge or gruel."

"Soaking allows enzymes, *lactobacilli* and other helpful organisms to break down and neutralize phytic acid. As little as seven hours of soaking in warm [acidified] water will neutralize a large portion of phytic acid in grains. The simple practice of soaking cracked or rolled cereal grains overnight will vastly improve their nutritional benefits." (*NT*, p. 452).

Sprouting. "The process of germination not only produces vitamin C but also changes the composition of grain and seeds in numerous beneficial ways. Sprouting increases vitamin B content, especially B2, B5 and B6. Carotene increases dramatically—sometimes eightfold. Even more important, sprouting neutralizes phytic acid…; sprouting also neutralizes enzyme inhibitors present in all seeds. These inhibitors can neutralize our own precious enzymes in the digestive tract. Complex sugars responsible for intestinal gas are broken down during sprouting, and a portion of the starch in grain is transformed into sugar. . . .Finally, numerous enzymes that help digestion are produced during the germination process." (*NT*, p. 112)

Effect of Neem Leaf Extract on N-Fixing in Beans

By Larry Yarger

As we look for "natural" solutions for pest and disease problems, we sometimes get more than we may have bargained for. In a recent publication of the *Journal of Agronomy for Sustainable Development*, researchers (Montes-Molina *et al*) found that the antibacterial properties of neem (*Azadirachta indica*) leaf extract significantly lower the soil population of the bacterium *Rhizobium* spp. in plantings of beans (*Phaseolus vulgaris*). Neem is a tree we have written about in the past, with natural pesticidal, antiseptic and anti-microbial properties. After reading a summary of the research, we wondered whether or not a warning about using neem on legumes was warranted. I located the original article and took a closer look.

In the experiment mentioned above, neem leaf extract was compared to extracts of leaves of the tree *Gliricidia sepium* (common names include mata-ratón, madre de cacao or simply gliricidia) and a synthetic pyrethroid, lambda cyalothrin (Warrior® or Karate®), all three of which are commonly used insecticides. A commonly grown bean cultivar was planted in individual 7-gallon plastic bags containing soil from local fields where beans had been previously cultivated. One-half of the bags were amended with composted cow manure. The neem and gliricidia extracts were taken from fresh, chopped leaves soaked for 72 hours in water. The plants were tended and measurements were made after 1, 2 and 3 months.

Normally pesticides such as neem, gliricidia and lambda-cyalothrin are applied to the foliage, but in this experiment ***the chemicals were intentionally applied to the soil surface and not to the foliage*** to test the effects of the active ingredients on the soil environment, and on plant growth and development. Also noteworthy is that the number of nodules on neem-treated plants in both types of soil did not differ statistically with nodule numbers in non-treated soil.

(As an interesting aside, plants treated with gliricidia produced significantly more pods than the neem and control, in both soil treatments. Perhaps there is a growth-stimulating hormonal effect from the gliricidia.)

So what can we conclude? Though neem is known to have antimicrobial properties, I do not think the information to date suggests that we should stop using neem on legumes. First of all, neem is normally applied to the foliage and not to the soil. In this experiment, the neem was applied to the soil and watered in so it would be in the root zone before having a chance to be broken down. Potential for movement in the soil of the active ingredients in neem is very low, so once sprayed on the plant, any that lands on the soil will soon (within 4 days) be broken down by sunlight and ambient moisture. Thus it will have little potential for affecting changes in the root zone (Martineau, 1994). Secondly, the final result of the experiment showed superior bean production in the neem-treated plants regardless of the number of nodules.

ECHO can send a copy of the complete article upon request.

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Artemisia is in the News Again

By Martin Price

Artemisia is now a commercial crop in East Africa

In *EDN* 95, ECHO discussed how to grow and use leaves of artemisia as part of malaria treatment by those who have no access to commercial drugs. East African farmers have now become key suppliers of artemisia leaves for the pharmaceutical industry. The following comments are taken from a recent report on the IRIN website, www.irinnews.org/Report.aspx?ReportId=82486. (IRIN is the humanitarian news and analysis service of the UN Office for the Coordination of Humanitarian Affairs. Articles cover a wide range of subjects of interest to the development community.)

"*Artemisia annua* cultivation now supports at least 4,000 smallholder farmers growing more than 4,000 ha of the cash crop in 2009, up from 2,000-3,000 ha last year. . . . [Large commercial cultivation was started] with grants from the UK's Department for International Development (DFID) and later Novartis, the Swiss multinational pharmaceutical company . . . in 2004 in Kenya, Uganda and Tanzania. . . .In 2007, an artemisinin extraction plant was built in Kenya that supplied Novartis with enough artemisinin for more than 22 million artemisinin-based combination drug therapies. Smallholder farmers are paid "between $550-$600/tonne of dry leaf. . . . One hectare can bring in up to 2T of dry leaves and is usually cultivated without the use of much fertilizer or pest problems."

Parasites may be developing resistance to artemisinin, the best drug used to treat malaria

According to the *New York Times*, "The parasite that causes the deadliest form of malaria is showing the first signs of resistance to the best new drug [artemisinin] against it" and "increased efforts are needed to prevent drug-resistant malaria [from spreading around the world.]" The *Times* article points out that "several times in the past, [the] area around the Thai-Cambodian border appears to have been a starting point for drug-resistant strains of malaria, starting in the 1950s with the drug chloroquine. . . . It took decades for this resistance to spread across the world, so by the same token artemisinin-based drugs are almost sure to be useful for many years to come. . . . The Bill and Melinda Gates foundation . . . is giving $14 million to the Thai and Cambodian governments to help pay for a containment program."

The research the *Times* article refers to is published in the *New England Journal of Medicine*. The study involved 94 patients from Battambang Province in Cambodia who were ill with *P falciparum* malaria. 60 patients received high-dose artesunate therapy (4 mg per kilogram of body weight per day, orally, for 7 days) and 34 patients received quinine (30 mg per kilogram per day) plus tetracycline (25 mg per kilogram per day) in a split dose every 8 hours for 7 days. Artesunate is made by reacting artemisinin from the artemisia plant with succinic acid to create a similar drug that is sufficiently soluble to be given by injection, although in this case it was given orally. Four of the 60 patients who received artesunate had reemergence malaria between days 21 and 28 after the start of treatment; two of these patients (3.3%) were classified as having artemisinin-resistant infections, but they were eventually cured. It now takes 120 hours to clear the blood of parasites, compared to 48 hours just a few years ago.

The *New York Times* article concludes with a quote from Dr. Nicholas White, a malaria expert who is chairman of a joint research program between Oxford University and Mahidol University in Thailand. "This is not the death knell of artemisinin. The drug still works in Cambodia, maybe not as well as before." But resistant parasites are developing and could spread. The authors of the article in the *New England Journal of Medicine* recommend that "artemisinin monotherapy should not be used in areas where malaria is endemic; it requires an extended administration period and may lead to treatment failure, most frequently because of problems with compliance." (In other words, people stopped taking the artemisinin before the recommended treatment time was over.)

Does the recommendation against treatment with artemisinin alone mean that people should not treat malaria with tea made from leaves of the artemisia plant? The German organization Anamed (Action for Natural Medicine) has been teaching how to grow and use artemisia throughout Africa for more than a decade, with considerable success. Treatments with artemisia tea cost almost nothing compared to the commercial product that is made by isolating the artemisinin from the plant and placing it (or compounds synthesized from it) in pills. Treatment with artemisinin pills plus another drug costs even more (than artemisinin alone), has a greater risk of side effects, and is even less likely to be used by impoverished populations. But is use of artemisia tea, a proven herbal treatment, placing the world at risk because resistance might develop?

We posed this question to Dr. Hans-Martin Hirt, founder and Executive Director of Anamed. In his response, Dr. Hirt pointed out that using the tea made from artemisia leaves is not a monotherapy, because artemisia tea is a combination of 10 anti-malarial products. The commercial drugs are based on only one of these (artemisinin) or a combination of artemisinin and some other drug that has been in use for some time (e.g. the drug Coartem is a combination of artemisinin and lumefantrin).

Dr. Hirt commented that he shares the concern that the malaria parasite might develop resistance to artemisinin. "But we have absolutely no fear that by using artemisia tea we are increasing this risk. The tea has been used in China for 2000 years,

without resistance developing. Now the pharmaceutical industry has become involved. Drug companies have isolated artemisinin and produced tablets of this single anti-malarial component, and in less than 20 years the first signs of resistance have been observed [see article by Afonso *et al*]. If artemisinin were to become ineffective, then, sorry, it is industry and not natural herbal therapy that would be to blame." To be on the safe side, he recommends that the tea be taken only to treat the disease, not as a prophylactic (i.e. taken every day to keep from getting malaria).

Dr. Hirt told ECHO that "throughout history there is in fact no record of any parasite becoming resistant to a whole plant extract. For example, there is resistance to synthetically made chloroquine, but tea made from the bark of the cinchona tree is just as effective today as it has been for hundreds of years."

Extra information related to this article can be accessed from the online pdf version of *EDN* 103.

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ECHOES FROM OUR NETWORK

Baobab Gardens for Leaf Production

By Dawn Berkelaar

The seed bank article in this issue of *EDN* is about indigenous leafy vegetables. Baobab (*Adansonia digitata*) leaves are also a kind of indigenous leafy vegetable. They are a staple food in the Sahel of West Africa. Baobab leaves are nutritious (particularly high in vitamin A) and are eaten almost daily in sauces. Baobab is also important for many additional reasons: during the dry season, fruit is either eaten fresh or dried; fiber from baobab trunks is used for rope; and beehives are hung in the trees to provide honey.

But there are some problems with harvesting leaves from baobab trees in the wild. The trees are huge, which makes harvesting the leaves risky. The leaves grow during the rainy season (June to September), which is also when annual crops need work. Drying leaves is difficult to do during harvest (when labor is needed elsewhere), and vitamin A content is reduced.

The World Agroforestry Center in Mali has experimented with and promoted baobab gardens. Tiny baobab plants produce tender leaves that can be harvested every two weeks. An ICRAF News Update quotes from Tata Dembele, a woman who now has her own baobab garden. "I love it. The sauce with fresh leaves is delicious. My husband and children love it. I would like to double the size of my garden, so I could have even more fresh baobab. Now we can eat like rich people!"

Baobab gardens have other benefits. For example, 90% of "wild" baobabs do not bear fruit because too many leaves have been harvested. If people can grow their own baobab leaves, the wild trees will be healthier and will bear more fruit.

Jonathan and Ali Nichols tried the technique of baobab gardens in Burkina Faso. They contacted the World Agroforestry Center to learn specifics. They shared, "Trees are spaced at about 12 inches by 12 inches [30 cm by 30 cm], so that a plot of 4 yards by 4 yards [3.7 m by 3.7 m] would [contain] about 150 trees. After only 6 weeks the little trees are about a foot high, and you can start to harvest the top third every week or two. The trees tolerate the frequent harvests, but never grow very large. Consider some of the advantages: (1) no more climbing the slippery-barked baobab, risking life and limb to harvest leaves from older trees, (2) if the garden is watered in the dry season, then nutritious fresh baobab leaves are produced year-round, (3) if the technique is widely adopted the wild trees may eventually be less stressed by leaf-picking and therefore produce more fruit."

I asked the Nichols about their experience planting baobab trees in Burkina Faso. Jonathan responded with several comments.

"We tried to water the baobab gardens in the dry season, but they did not respond well. We may not have been watering them enough, but we also suspected that they had an internal calendar running.

Figure 1: Boiling baobab seeds for improved germination rates. Photo: Jonathan Nichols.

"Establishing the baobab garden was the most difficult part—we found that seeds treated by immersion in boiling (rolling boil!) water for 20-25 minutes was best (Figure 1). Even so, germination rates do not get much above 60%, which is more-or-less standard for the baobab. We tried concentrated sulfuric acid too, but found it too complicated and inferior for germination rates. We used locally harvested seed because we were too cheap to buy from the National Forest seed bank.

"Because the germination rate is low and the germination times vary widely

(14-400 days—yes, we had some seeds germinate the second year, in spite of treatment), we found it annoying to try to establish several hundred seeds in a tight grid spacing. There are inevitably lots of "blanks" and those spaces become difficult to fill once the others have taken off. As we left Burkina, we were experimenting with planting the seeds very densely in a nursery bed and then transplanting them. In our experience, baobab is reasonably tolerant to transplantation, so the method should be an improvement.

"The baobab garden was one of the most admired features of our garden (Figure 2). Local Burkinabes loved the idea and were keen to harvest the leaves. Moreover, our workers told us that the leaves from mature trees are not as consistently sweet and tender as those from the garden—ours would command a higher price in the market if we were to take them there.

"If I remember correctly, baobab is quite hard on the soil, especially taking more than its share of calcium. Our garden was two years old when we left and we had not yet noticed a change in production.

"We used neem, Bt [*Bacillus thuringiensis*], and physical plucking against insects and larvae. Right after the rains began, the baobabs were among the first green things to appear, so the insects were after them. Cattle and other animals would also jump our fence for a taste, so protection is essential and better that the garden be close to the house."

The ICRAF News Update can be accessed at this address: www.worldagroforestry.org/ar2003/downloads%5CAIA_Baobab.pdf

Note from Tim Motis: "When I attended the under-utilized crop conference in Tanzania, there were two talks on baobab. It was interesting to note that, in parts of Africa, baobab is believed to be inhabited by spirits."

Figure 2: A baobab garden in Burkina Faso. Photo: Jonathan Nichols.

FROM ECHO'S SEED BANK

Indigenous Leafy Vegetables

By Tim Motis, Ph. D.

If you work in a country that is not your own, chances are you sometimes wonder about which crops to grow and promote. A good first step is to find out what is already being grown in-country. It will quickly become obvious what the staple grains are. Less apparent, and often greatly under-utilized, are indigenous (naturally occurring) and traditional (introduced in the past and incorporated into the culture) leafy vegetables.

In many areas, the knowledge and use of indigenous leafy vegetables (ILVs) has declined as vegetables such as cabbage, tomatoes and carrots have gained prominence. In recent years, however, organizations such as the Asian Vegetable Research and Development Center (AVRDC), Bioversity International, and Farm Concern International have been influential in promoting ILVs. Consequently, there may well be growing interest in and new opportunities to market ILVs. Resource-poor farmers can easily grow ILVs, as these plants are well-suited to local conditions and thrive with minimal inputs (e.g. water and fertilizer). Moreover, ILVs are important sources of vitamins A and C, iron and other nutrients. They are readily incorporated as supplements to carbohydrate-based staples.

When looking for ILVs, expect the unexpected. In Tanzania, I saw a species of nightshade (*Solanum scabrum*) being grown for leaf consumption on local farms around the city of Arusha. Nightshade is often thought of as a poisonous weed; plants in this family contain varying amounts of solanin, which is poisonous if present in high enough levels. Boiling reduces solanin content, and cooked leaves of several species (*Solanum scabrum*, *S. americanum*, *S. villosum*) are eaten in parts of Africa. You will also see crops that, instead of being grown for their seeds (e.g. cowpea) or tuberous roots (e.g. sweet potato), are being cultivated for their leaves. It would be interesting and worthwhile to conduct your own variety trials to identify cowpea and sweet potato varieties that produce an abundance of edible leaves.

Though a host of wild plants are used as vegetables in specific regions, a few ILV species are quite common and widespread. Consider the following examples of ILVs for household use or for sale in local or regional markets.

Figure 3: Amaranth leaves (Amaranthus sp.) in Haiti. Photo by Larry Yarger.

Amaranthus species: The genus *Amaranthus* includes as many as 800 species, some of which have been cultivated since as long ago as 6700 BC. Some *Amaranthus* species are best suited for grain production (*A. cruentus*; *A. hybridus*; *A. hypochondriacus*), while others are grown for their leaves (*A. tricolor*;

Figure 3). The leaves of grain types can also be eaten. A few noteworthy vegetable varieties (of the species *A. tricolor*) at ECHO are Jamaican Calalu and Tigerleaf R135. Amaranth leaves are noted for their high protein, mineral and vitamin content. More information can be found in ECHO's Amaranth Technical Note, available on our website.

Vigna unguiculata (cowpea): Cowpeas are often grown for the seeds harvested from mature, dry pods. The leaves are also edible, served boiled or fried along with a staple porridge. ECHO's seed bank carries two varieties (#83-060 and Zipper Cream) that, in our trials, have been found to have a more spreading growth habit favorable for leaf production. When used as a vegetable, the young leaves are harvested beginning about four weeks after the seeds are planted.

Corchorus olitorius (jute mallow): Native to Africa, jute mallow is widely cultivated in both wet regions of the Sub-Sahara and drier areas of North Africa. Young leaves and shoot tips can be eaten raw or cooked, and contain high levels of protein and vitamin C. Jute mallow leaves can also be dried, ground into powder and stored for use during the dry season. It is grown as an annual, though it may act as a perennial in some locations. The fibers can be used in making twine, cloth and burlap.

Solanum scabrum (edible African or broad-leaved nightshade): In 2008, ECHO obtained and multiplied seeds of this vegetable nightshade species. It has broader leaves and, thus, greater leaf production than two other cultivated African nightshade species, *S. americanum* or *S. villosum*. It is also less bitter than other African nightshades. Prepare the leaves by boiling and discarding the water.

Also consider leafy greens such as moringa (*Moringa oleifera* and *M. stenopetala*), chaya (*Cnidoscolus aconitifolius*), and katuk (*Sauropus androgynus*). Because they are perennials, these plants can be harvested for many years after planting the initial seed (moringa) or cutting (chaya and katuk).

In selecting leafy greens to grow, eat, and/or promote, it is wise to do some reading. A good place to start is *EDN* 62-1, which discusses issues such as nutrient bioavailability and the presence of anti-nutritional or harmful substances. A valuable quote from *EDN* 62 reads, "…a *variety* of fresh green leaves should be eaten as soon after picking as possible, stored cool…and cooked quickly for maximal retention of nutrients."

Another helpful resource is the book *Edible Leaves of the Tropics*, available from ECHO's bookstore.

Visit www.bioversityinternational.org/publications/Web_version/500/begin.htm for information on ILVs for various regions. Links to additional helpful websites can be accessed from the online pdf version of this *EDN* issue.

We would love to hear of your experiences with traditional or ILVs. Members of ECHO's overseas network may request a sample packet of one or more of the above-mentioned plants free of charge. Non-members working on behalf of the poor overseas may contact ECHO (Email: echo@echonet.org; Phone: 239-543-3246) to request a network registration form.

UPCOMING EVENTS

16th Annual ECHO Agriculture Conference (EAC)

Fort Myers, Florida
December 8 to 10, 2009

Registrations are being accepted for the 16th annual ECHO Agriculture Conference. This year, delegates have an opportunity to register online. To do so, go to the echoevents.org website and click on "ECHO Ag Conference" (on the left) and then "Register Online Here."

Like last year, the conference will be in early December rather than November.

2nd ECHO Asia Agriculture Conference

September 21-25, 2009
Empress Hotel, Chiang Mai, Thailand

The ECHO Asia Agriculture Conference is similar in format to the annual EAC in Florida, but the content is geared towards persons who serve Asia's poor. The conference offers three mornings of plenary sessions featuring knowledgeable and experienced speakers.

The conference will also include dozens of afternoon and evening workshops and discussion groups led by regional agricultural development workers and experts. Several members of the ECHO team based in Ft. Myers, Florida, will be at the conference.

Conference sessions run from September 22 to 24. September 25 includes post-conference tours to notable venues in northern Thailand.

For more information (e.g. about plenary speakers and conference fees) and to register online, see the ECHO Events webpage (www.echoevents.echotech.org).

PLEASE NOTE: At ECHO we are always striving to be more effective. Do you have ideas that could help others, or have you experimented with an idea you read about in EDN? What did or did not work for you? Please let us know the results!