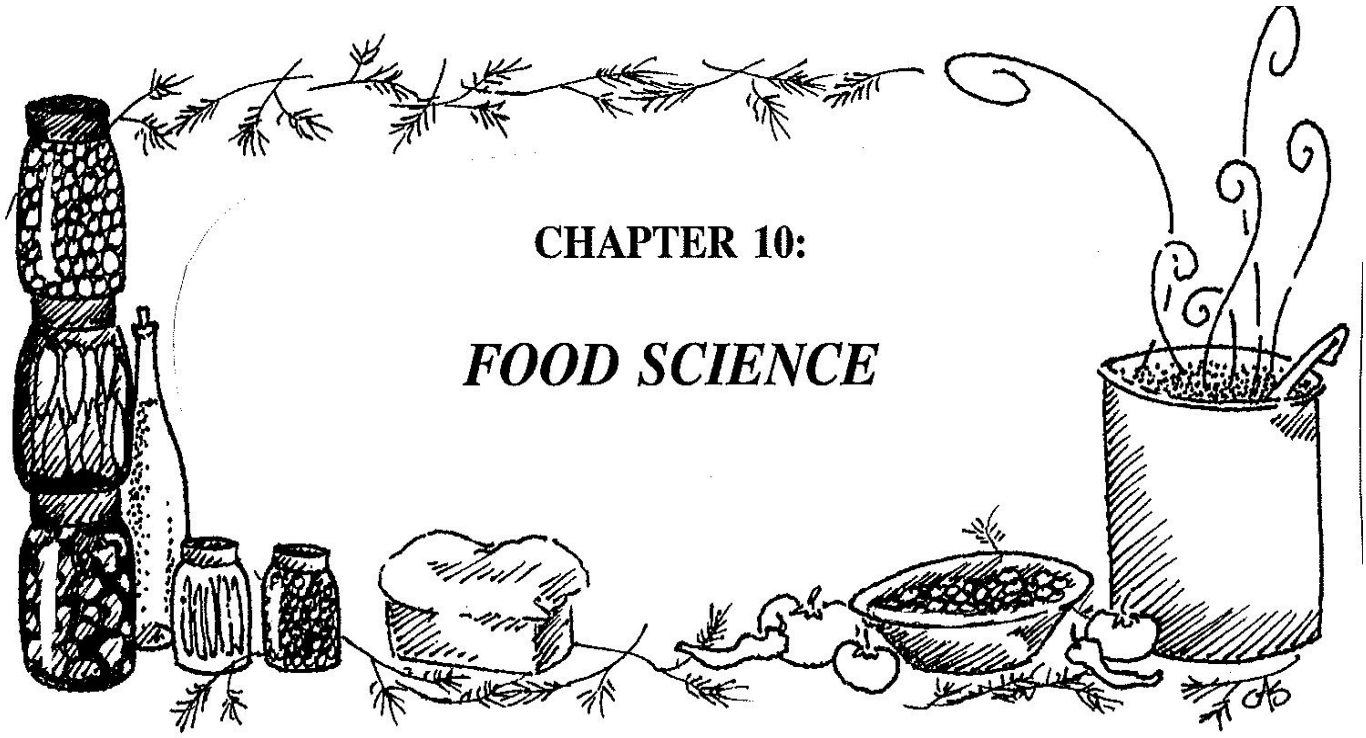


# CHAPTER 10:

# *FOOD SCIENCE*

The goal of most agricultural development is to improve people's nutrition, with an increase in quality, quantity, and diversity of food produced. Each issue of *ECHO Development Notes* discusses plants and techniques which can enable farmers to produce more food of higher nutritional value. Beyond increased production of more nutritious crops, there is much to be done to improve nutrition. It is important to know about food preparations which enhance nutrition, and some recipes to make new plants palatable and appealing.

Another major area deserving attention is protecting food during storage. Significant percentages of harvested foods are lost to pests and spoilage. Improved techniques for protecting and preserving products can have a tremendous impact on available food supplies and nutrition during seasonal food shortages. This chapter offers ideas on improving nutrition through new methods of food storage and preparation.

# CHAPTER 10: FOOD SCIENCE

## NUTRITION 259



## STORAGE AND PRESERVATION 269



## FOOD PREPARATION 276

# NUTRITION

**TECHNICAL NOTE "A BEGINNER'S GUIDE TO NUTRITION ON THE SMALL FARM"** by Dr. Frank Martin is a primer for those with little or no experience in this area. He offers some simple guidelines for a balanced diet. Discussed are nutrients in food, recommended daily allowances, individual differences and special needs, balancing the diet, and what to do when milk is missing from the diet. Available from ECHO.

**NUTRITION RESEARCH PROGRAM** at Judson College involves undergraduate biochemistry and cell biology students in nutrition-related research for developing countries. They have studied the toxin levels in velvet beans (see Chapter 11 on Human Health), and determined which methods are most suitable on the home scale; they plan to pursue similar research with jack bean. Interested students and others should contact Dr. Rolf Myhrman, Nutrition Research Program, Judson College, 1151 N. State St., Elgin, IL 60123, USA; phone 708/695-2500.

**A SIMPLE WAY TO IMPROVE STARCHY "WEANING FOODS."** The following is abstracted from information provided by Noel Vietmeyer (U.S. National Academy of Sciences) in the June 1993 issue of *Spore*.

"Throughout the developing world boiled starchy grains and roots are given as weaning food.... Boiled starch is so thick and pasty that it is difficult for the very young to swallow enough to gain adequate nourishment." Germinated grains release enzymes that break down starch (as in the process of malting). "A very small quantity of malted millet or sorghum flour added to a pot of mush made from corn meal, cassava, arrowroot, potato or other boiled staples turns it to liquid in minutes. It is liquid enough for the baby to swallow but dense enough to be filling. It is also more tasty because most of the starch has been converted to sugar." [Ed: Sprouted sorghum should not be eaten because of its cyanide content, but 2-3 grains should be harmless.]

We found further information in the book *Food from Dryland Gardens*, p. 332. It states that you can make 100 g of a millet porridge of suitable consistency for a weaning food that contains 25 kcal of energy and 0.4 gram of protein. On the other hand, 100 g of porridge of the same consistency made with addition of malt contains 83 kcal and 1.3 g of protein. We spoke with Mark Dafforn, Noel's assistant, for more details.

Q. Is this process actually used in some location among the poor or is it a totally new idea? Where did the idea come from?
A. Baby food manufacturers in developed countries routinely liquify their products, but it has a very short track record in developing countries. Noel found the recommendation in a technical report on a Swedish Development Agency (SEDA) project. It has been used in Tanzania and India, and the idea has now been picked up and is being tried in several other places. No one--including ourselves--has done a comprehensive look at its usefulness.

In a way, the concept of liquefying staples is like oral rehydration therapy (ORT) twenty years ago...an idea that was so simple it was ignored by scientists but picked up by desperate development workers--and since then ORT has saved hundreds of thousands of lives at a few pennies apiece.

Q. Does malting change the nutritional value of the porridge?
A. The porridge will be more runny, but that is because the water that was tied up in the starch is released. The starch is essentially predigested. All the original nutrients are still there.

Here is how malnutrition can develop if the porridge is not malted. Children in third world countries often go through a nutritional crisis when they are weaned. Babies are often weaned directly onto traditional adult porridges. Because babies have trouble swallowing the thick porridge, mothers dilute it with water. It can be so diluted that the child's stomach is filled without eating as much food as he or she should. Also, if unboiled water is used, disease organisms are introduced.

Q. The directions said "a small quantity" per pot of mush. How much is a small quantity?
A. Let's say a teaspoon, half a teaspoon, or even less malt for a big bowl. As you know, enzymes are catalysts which speed up reactions without being used up in the process. If you use less enzyme it will take longer. Of course, if the mush is really thick--think of dry mashed potatoes--it doesn't contain enough water to liquify in the first place.

Q. Where does one get malt? We used to buy malted milk shakes. Is this the same thing?
A. I think there's usually an important difference. In those malts the enzyme (called amylase) has been deactivated by heat so you get the flavor but you don't get runny milk shakes! (By the way, so little malt is used in liquefying staples that traditional flavors aren't overwhelmed.) You can usually purchase malt flour at health food stores. It's often called brewer's malt, because it's used to convert the starches in grains to sugars as the first step in making beer. By the way, please point out that though malt is used in brewing, it has no alcoholic content itself...that comes later, from fermenting sugars with yeast.

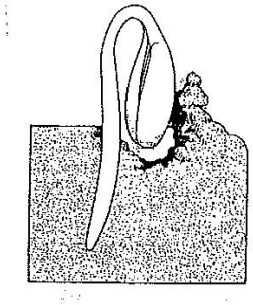
Q. Let's be very specific. When you used sprouted wheat, did you mash the fresh sprouts, or did you dry them first and then make them into a flour?
A. Well, actually I just crushed the fresh sprouts between my fingers, and stirred. The amylase content is reportedly highest just after the seed has softened and begun to burst.

Q. Are there other applications?
A. It can be used with people needing a liquid diet with a high nutrient density. A starch based dish like mashed potatoes can be liquified while still retaining its familiar taste. If your readers have other ideas or experiences, we'd be glad to know. Just ask them to drop a brief, informal note to us at the National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418, USA. [End of interview.]

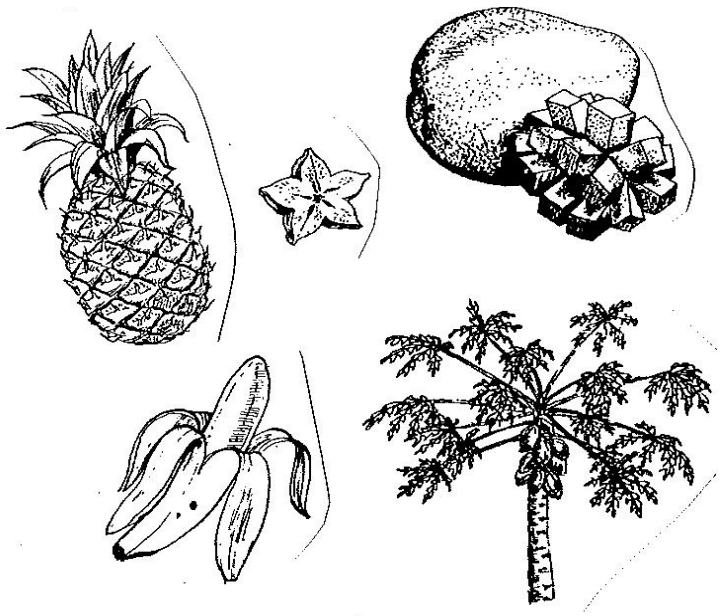
Isabel Carter, editor of *Footsteps*, provided additional details about using "power flour" to convert thick porridge into a sweeter, more runny food for infants. The following is abstracted from the September 1992 *Footsteps*. "Grains can be germinated by leaving them in water for a day. [Ed: They will not have spouted but the biochemical transformations involved in germination will begin.] During the sprouting process they develop high concentrations of amylase [the enzyme that converts starch to sugar]. Soak cereal grains (maize, rice, millet) for up to one day in a covered pot or bucket. Legumes such as mung beans, haricot beans and cowpeas can also be germinated. They need longer soaking--up to two days. Dry the grains well in the sun. If sorghum is the main cereal, this can also be used to make power flour, **but it must be allowed to act for a few minutes, then the porridge must be cooked for a few additional minutes.** Mill as usual for ordinary grains." They recommend using either cereal grain flour alone or a mix of 1 part legume to 2-3 parts cereal. Power Flour is available commercially in Tanzania as "kimea" and in India as "ARF" (amylase-rich flour).

This issue also had some interesting comments about fermented foods. Fermented cereals "are widely used in Africa. Fermented legumes are often used in Indonesia and other Asian countries. The advantage ... is that naturally occurring bacteria [make the food acidic]. This improves the taste and also has the advantage that diarrhoea-causing germs cannot grow so easily. ...Because of lack of time and fuel, mothers are usually not able to prepare fresh food throughout the day, especially for feeding young children who need several meals a day. In a recent study in Ghana, it was found that the number of diarrhoea-causing organisms in food prepared using fermentation was **less than half** that in food which had been prepared freshly, then left lying around. The fermentation process also breaks down some of the fiber in the food and increases iron absorption. [The traditional process lasts 48 hours, not long enough to produce alcohol.] Why have people stopped using fermented food? A study in Kenya suggests that health workers feel that traditional fermented foods are not modern, and should be discouraged." *Footsteps* always includes this kind of practical information. It is free to individuals working to promote health and development. Specify English, French or Spanish. Write to Tear Fund, Footsteps, 100 Church Road, Teddington, Middx TW11 8QE, UK.

**CAN THE TRYPSIN INHIBITOR IN SOYBEANS BE OVERCOME BY GERMINATING THE SEEDS?** In Chapter 9, we discussed treatment of soybeans to inactivate the trypsin inhibitor prior to feeding to animals. Someone wrote suggesting that sprouting might have the same effect without the need to use a heat treatment. We found an interesting article that looks at various methods of preparing soybeans for food, including sprouting, in the *Journal of Plant Foods*, 1983, *5*, 31-37, (1983). Whole soybeans were soaked in water at 50°C for 3 hours, then allowed to germinate for 3 days, with a daily spray of water. Seed coats were discarded (I presume to make them more acceptable in human diets) and beans were dried in a hot air oven. The trypsin activity dropped from 107.5 in raw soybean to 59.7 in the germinated product. In a feeding trial with rats, rats fed a casein control (a milk product with exceptionally high quality protein) gained 64 grams in 4 weeks, rats fed raw soybeans gained 20.5 grams and rats fed germinated soybean gained 42.8 grams. Unfortunately the article did not test soybeans that had been treated for use in commercial animal feed. This information would have been very helpful. What is my conclusion? Without more information, I would suggest that heat treatment is preferable, but sprouting is a lot better than using raw soybeans.



**RELATIVE NUTRIENT VALUES OF FRUITS.** We made a "score" for each fruit by adding up its percent of the U.S. Recommended Daily Allowance (USRDA) for 9 nutrients plus fiber. (We printed only 3, because the others were usually low.) There is no USRDA for fiber or potassium (K), so we used 25 g for fiber and 3500 mg for K. For example, a quarter of a cantaloupe has 86% of the USRDA for vitamin A, 94% for vitamin C, 12% for potassium, 6% for folate, 4% each for fiber and niacin, 3% for thiamin, 2% each for iron and riboflavin, and 1% for calcium. After rounding, that adds up to a score of 213. Numbers for canned fruit are for two halves or slices, including the juice. If no number was available for a nutrient, we assigned it a value of 0, which makes the scores for some fruits lower than they should be.



| Fruit | Score | Vit. A | Vit. C | K | Fiber |
|---|---|---|---|---|---|
| Papaya (1/2) | 252 | X | X | X | X |
| Cantaloupe (1/4) | 213 | X | X | X | |
| Strawberries (1 cup) | 186 | | X | * | X |
| Oranges (1) | 169 | * | X | * | X |
| Tangerines (2) | 168 | X | X | * | X |
| Kiwis (1) | 154 | | X | * | X |
| Mango (1/2) | 153 | X | X | | * |
| Apricots (4) | 143 | X | X | X | X |
| Persimmons (1) | 134 | X | X | * | X |
| Watermelon (2 cups) | 122 | X | X | X | * |
| Raspberries (1 cup) | 117 | | X | * | X |
| Grapefruit, red or pink (1/2) | 103 | * | X | | |
| Blackberries (1 cup) | 101 | | X | * | X |
| Apricots, dried (10) | 97 | X | | X | X |
| Grapefruit, white (1/2) | 84 | | X | * | |
| Honeydew melon (1/10) | 81 | | X | X | |
| Peaches (2) | 77 | X | X | * | X |
| Pineapple (1 cup) | 77 | | X | * | * |
| Star Fruit (1) | 73 | X | X | * | na |
| Blueberries (1 cup) | 68 | | X | | X |
| Cherries, sweet (1 cup) | 64 | * | X | * | X |
| Pomegranates (1) | 61 | na | X | X | X |
| Bananas | 60 | | X | X | * |
| Plums (2) | 60 | * | X | * | * |
| Prunes, dried (5) | 59 | X | | * | X |
| Apples, w/skin (1) | 58 | | X | * | X |
| Boysenberries (1 cup) | 57 | | * | * | na |
| Pears (1) | 48 | | X | * | X |
| Grapes, green (60) | 46 | | X | * | |
| Peaches, canned in juice | 43 | X | * | * | |
| Apples, no skin (1) | 42 | | X | * | X |
| Pineapple, canned in juice | 40 | | X | | |
| Figs, dried (2) | 39 | | | * | X |
| Currants, dried (1/4 cup) | 36 | | | * | |
| Rhubarb, cooked (1/2 cup) | 36 | | * | | na |
| Raisins (1/4 cup, packed) | 35 | | | * | * |
| Dates (5) | 30 | | | * | * |

X = contains at least 10 percent of the USRDA  na = not available
* = contains between 5 and 9 percent of the USRDA

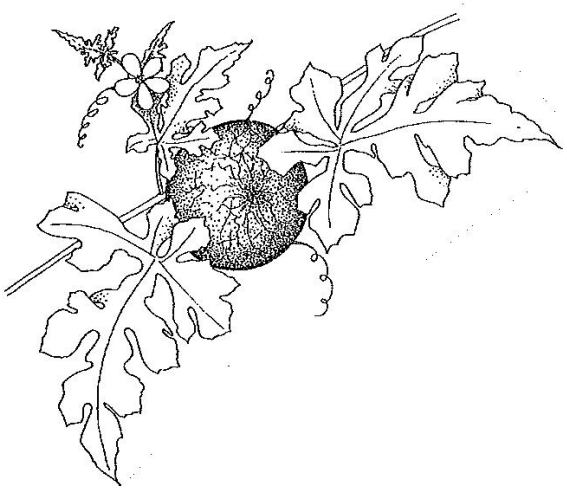


**NEW IDEA FOR AN EMERGENCY MILK SUBSTITUTE IN WEST AFRICA.** Ken Flemmer with Adventist Relief and Development International sent us the following report from two of his staff, Jim and Yoko Rankin. It concerns a totally new use for the egusi melon.

During a training seminar in Ghana a local farmer stated "that his wife did not have sufficient milk to feed their 6-month-old baby. Our first thoughts went to soy milk, but as they do not have soybeans it was not a practical solution. Also, soy milk is not easy to prepare and becomes acidulated very quickly."

"Someone suggested agushi melon seed [Ed: this is surely a Ghanian spelling of egusi]. I set up the blender, took 100 grams dehulled agushi seed and blended it with two cups (400 ml) of water and tasted it, added another cup of water, 2 teaspoons of honey and 1/4 teaspoon of salt and behold, we had a milk tastier and creamier than soy milk with a closer texture resemblance to real milk."

"The dry dehulled seeds resemble a large pumpkin seed. In the village every home has stone mills or small grinding plates. The seeds are easily crushed into a peanut butter consistency. Mixed with water, honey and salt --instant raw milk. To make it equal to mother's milk we found that we must add 6/7 cup of water per 1 cup (100 g) dehulled seed. It does not form gas and the school children who have tasted it have not complained of any problems."



"The agushi melon grows throughout Togo, Ghana, Cote d'Ivoire and Benin [Ed: also Nigeria, Zaire and probably elsewhere]. One type has large seed and a very thin papery hull which slips off when seeds are rubbed between the palms of the hand. The other two types have a very hard shell on seeds that are slightly larger than cantaloupe seed. We have tried making milk from all three types, but the smaller varieties with hulls intact make a slightly bitter tasting milk. I presume that if the hulls can be removed the bitter taste would disappear."

I mentioned all this to gardener Glen Munro in Indiana, lamenting that we had no idea how the "milk" tasted. Surprisingly, Glen had grown egusi in the summer and could do a few trials for us. Here are some highlights of his experience. Unlike in Ghana, he did not dehull the seeds.

"I blended 75 g seed, 1.5 cup water, 1/16 teaspoon salt and 1 teaspoon honey in our Osterizer blender at the 'liquify' setting. After straining I had 1/3 cup of meal and 1.5 cup of what looked like milk. It had a subtle raw cucumber-like taste. The meal was similar to corn meal mush with a distinct feel of some additional fiber and a raw flavor. After boiling the flavor was unchanged, but good. The flavor was a bit strong, but I believe I could adjust to eating it as a breakfast cereal.

"I repeated, using a Vita-Mix juice blender that more completely pulverized the seed, leaving out the honey. I then did a taste test with various additives, using 2% milk as a standard (rating of 5). The raw cucumber taste came through in all samples, but was hardly noticeable with Hershey chocolate syrup added (rating of 5-). After drinking 2 ounces, though, I noticed an itchy feeling in my throat, I think due to the fine fiber. Adding honey or maple syrup gave drinks that I rated as 4+."

The variety of egusi that ECHO distributes has seeds larger than watermelon seeds. Egusi, *Citrullus lanatus* ssp. *colocynthoides*, looks like a watermelon while growing, but the white flesh of the round, over 6-inch diameter fruits is bitter and inedible.

Of course, just because something looks and tastes like milk does not mean it can be a milk replacement. We found no information comparing the nutritional value of egusi to milk, but did find a very helpful article *Chemical, Functional and Nutritional Properties of Egusi Seed Protein Products* (J. Food Sci, 47, 829-835, 1982). We can send a copy if you are interested in that much detail. Dehulled seeds contain approximately 50% oil and 30% protein. They are good sources for the essential amino acids arginine, tryptophan and methionine, and vitamins $B_1$, $B_2$ and niacin and the elements sulfur, calcium, magnesium, manganese, potassium, phosphorous, iron and zinc. Egusi has potential as a source of calcium and niacin in low-milk-consuming regions.

Biological indices of protein quality were "lower than soybean but comparable to or higher than most oilseeds." The most limiting amino acids are lysine followed by threonine. "Histidine has been known to be an essential amino acid for infants. ...Thus the low content of histidine in egusi seed should be considered in the use of this product in food

formulations, especially if the foods are intended for infants."

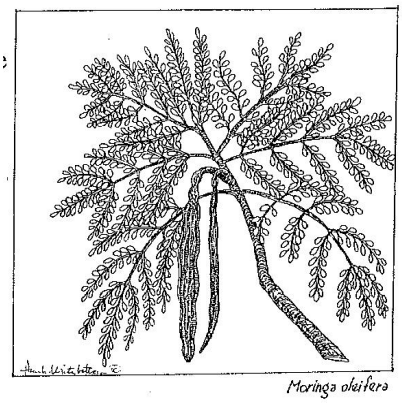
Heating the "milk" is going to be a problem. Glen writes, "as soon as the liquid felt hot to my finger it began to curdle. By the time it boiled it was clumped into 1/4 to 1/2 inch (0.6-1.2 cm) diameter particles that easily broke up when stirred."

One visitor from Africa told me that whenever a group of men were standing around talking, their hands were usually busy dehulling egusi seeds. It is ground into a paste and mixed with a variety of condiments to make stews, is made into a substance like peanut butter, roasted, cooked in soups, etc. The Paulsons in Central African Republic tell us that dry dehulled seeds can be placed on a skillet and popped like puffed rice. They add that egusi is one fruit that monkeys do not bother.

It is usually intercropped, e.g. with corn, coffee and cotton. After 4 weeks of growth the plants completely cover the soil surface. Flowering occurs 4-5 weeks after planting and fruits mature at 7-8 weeks. Fruits are softened by beating with a club and allowed to rot for about a week to make the seeds easier to remove. Seeds are washed and dried for storage.

Since it is such an important crop in West and Central Africa, it is surprising that we have heard no reports of acceptance elsewhere from people to whom we have sent seed. Perhaps its possible use as an emergency milk will make a difference. ECHO has seeds if you would like to try egusi. Please let us know if you try this technique.

Fr. Gerold Rupper in Tanzania wrote concerning mothers with insufficient milk for nursing. "This was the problem which led to the introduction of soybeans into southern Tanzania. But the scheme is only succeeding because we were fortunate to get the solution for making pure soy flour without any nasty taste--remove the hulls (skin). The flour tastes like chocolate. It keeps fresh for at least one month under our conditions. It is true that the milk does not keep long, but this is the case with any milk."



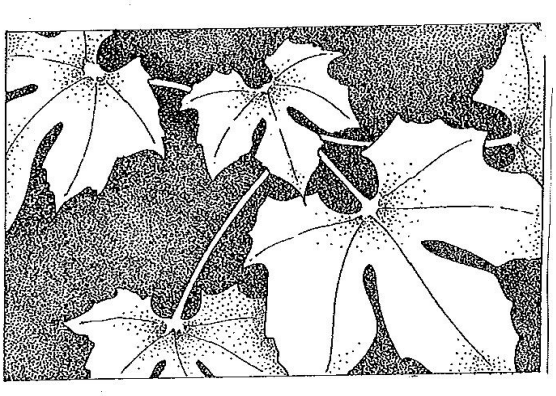

**MORINGA AND CAROTENE.** Dr. C. E. Peterson wrote, "I have removed fresh moringa leaves and left them overnight in my greenhouse, where they very promptly dry and can be rubbed over a screen to make a powder. The fresh weight value of beta-carotene is about 88 ppm and the dried leaves will be about 300 ppm, equal to some of our best high-carotene carrots.

"Even if addition to rice were to be limited to a teaspoon or so without any detectable flavor change, if it were done 2-3 times a day every day it could be a very substantial source of vitamin A where deficiency is causing blindness and other serious health problems."

I would add that if people eat soups, substantially more of this powder could be added. Joel Matthews in Niger says people there preserve dried moringa leaves (not crushed) for use during the dry season as a food. They use it in their sauces. One popular food is a mixture of leaves and peanut press cake.

Dr. Warwick Kerr in Brazil wrote, "Concerning moringa, Drs. Rodrigues, Godoi and I tested the leaves and found them to contain 22,000 units of vitamin A per 100 g, more than reported in the literature [Ed: my sources list 11,500]. This means that one glass of leaves gives the daily dosage of vitamin A to 10 people!"

**LEAF CONCENTRATE** (LC) is an extremely nutritious food used to alleviate malnutrition. The process of making LC separates the protein, vitamins, and minerals from the fibrous portion of fresh green leaves. LC can be made from by-product leaves of commercial vegetables (beets, broccoli, etc.) or even from productive forages or cover crops not normally used as human food. Incorporated into local recipes, it boosts the nutritional content of a variety of foods.



LC is very rich in vitamin A, iron, calcium, high-quality protein, and other key dietary elements. Green leaves are very efficient producers of these nutrients, and leaf products can be the lowest cost source of iron and vitamin A, critical nutrients often missing in poor diets. LC technology is most appropriate for nutrition programs with groups of children, pregnant or nursing women, or elderly people who suffer from dietary deficiencies. For a community project designed to supplement children's diets, mechanized equipment costs about US$1500.

The basic process for making LC is to harvest and wash fresh leaves, grind them to a pulp, press juice from the pulp, bring the juice to a boil, separate out the curds which form in the heated juice, and press the liquid out of the curd. The solid portion of the mild-flavored curd is the leaf concentrate, which can be added to traditional recipes fresh or preserved in various forms. David Kennedy of Leaf For Life (see below) visited ECHO and prepared some pasta using LC made from broccoli leaves (in a household blender) and flour; even the staff who ate only a small portion of this (green) pasta for lunch did not feel hungry for the rest of the afternoon due to the high protein content of the leaf concentrate.

One difficulty in introducing LC-enriched foods is that the concentrate imparts an intense green color to the foods. Considerable work on recipe development has been helpful. One recipe which can substantially increase the leaf nutrient intake by children takes advantage of the bright color: green LC lemonade. To make the syrup, dissolve two kilograms of sugar and 40 g of salt in 1 liter of lemon juice. Mix this into 1 kg of moist LC. The mixture is ground or blended in a high speed mixer until smooth, then bottled. The concentrate is stable for months. Prepare the lemonade by mixing 30 ml of syrup in 200 ml of water. Combining the LC with a good source of vitamin C improves the body's absorption of the leaves' iron as well. A pitcher of LC lemonade made from moringa leaves was served at a staff dinner at ECHO. Most people seemed surprised at how tasty it was, though a few added extra sugar to reduce a "green grassy taste."

It is important to remember that not every leaf is suitable for LC production. David Kennedy states that "many edible leaf crops such as *Basella alba* [Malabar spinach], sweet potatoes, chaya, okra, lettuce, and many cucurbit family leaves do not work well. Leaves that are too wet or dry (above 90% or below 80% water) don't usually work well in the LC process. Neither do leaves that are acidic like sorrel or dock [*Rumex* sp.]; mucilaginous leaves like *Basella alba*, purslane [*Portulaca oleracea*] or roselle [*Hibiscus sabdariffa*].

"A fairly large number of edible leaves, such as sweet potatoes and mulberry, form a curd that is very fine and hard to separate. In some leaves, like cassava, phenolic compounds combine with proteins when the leaves are pulped and render the protein much less available to the body. Amaranth consistently gives lower yields of LC than leaves from legumes like alfalfa, cowpeas, peas, berseem clover or common beans or from wheat. Amaranth typically makes a fine curd that is difficult to separate in filter cloth.

"[Disagreeable] taste often has to do with poorly made LC that is either burnt during coagulation, made from partially spoiled leaves, has spoiled during storage, or very often was inadequately pressed. When the moist curd is not pressed to about 60% moisture there are often strong flavors from saponins or other antinutritional substances like oxalic acid and nitrates remaining in the curd. ...When the leaves are well pulped and pressed, the residual fiber is pale green in color and far too fibrous to make an acceptable human food."

Very small scale LC production without some mechanization is generally not feasible because of the very high labor demands on women. LC yields are substantially lower when leaves are pulped and strained by hand compared to mechanical grinders and presses. About 50 g of LC may be produced from 1000 g of fresh leaves, and "a fair amount of that will be lost sticking to the pan or clinging to the filter cloth. Making tiny amounts of LC involves a lot of clean-up relative to the benefit. Effective LC programs will necessarily have powered leaf grinding equipment...for sufficient cell rupture, and at least a manual hydraulic press for adequate separation of the juice from the fiber and of the curd from the whey.

"I also think they need to operate on a larger scale; probably processing a minimum of 100 kg of fresh leaf crop per day and more likely 500 or 1000 kg per day. These projects are most likely to succeed where there is commercial production of leguminous forage crops such as alfalfa, berseem, or cowpeas that can be used for preparing LC. The issues of quality control, preservation of the LC, economic use of the fiber, and distribution become much more important as one moves from a domestic to a village or cooperative level of production.

"A project processing a ton of leaf crop per day should be able to provide about 3300 children with 6 g of dried LC or 15 g of fresh LC per day. This can make a genuine contribution to community health, but it requires some infrastructure, capital, and organization. In many villages where malnutrition is prevalent, conditions don't indicate that LC is likely to be a cost-effective food for nutrition intervention. In many of these areas, simpler techniques to increase consumption and improve utilization of leaf crops will probably be more appropriate. These techniques include better leaf crop selection, and improved methods of blanching, drying, and grinding of leaves, as well as innovative uses of dried leaf powders."

The organization Leaf For Life (called Find Your Feet in the UK) has been investigating and promoting LC for improved nutrition in tropical villages for thirty years. They also work with simpler techniques to better utilize leaf crops for food enrichment, such as drying leaves in ways that maintain more of their nutrients. They have a comprehensive, experience-based "Field manual for small scale leaf concentrate programs" (192 pp.) which details processing of LC, basic nutrition, information for evaluating and growing various leaf crop species, economic considerations in organizing a LC program, and recipes from around the world. The manual is available in English (Spanish translation in process) for US$20 within the US/$25 overseas surface mail from Leaf For Life, 260 Radford Hollow Road, Big Hill, KY 40405, USA; tel/fax: 606/986-5418. In the UK, contact Find Your Feet, 37/39 Great Guildford St., London, SE1 0ES; fax 44 1 71 261 9291.

***VALOR NUTRITIVO Y USOS EN ALIMENTACION HUMANA DE ALGUNOS CULTIVOS AUTOCTONOS SUBEXPLOTADOS DE MESOAMERICA***, by FAO. 115 pages, Spanish only. The book was written to help professionals working in agriculture, food science, and nutrition promote Mesoamerican crops to contribute to the nutritional and economic development of the region. It provides a brief overview of native Central American fruits, vegetables, roots and tubers, and cereals. Each plant receives a two-page description with plant family, scientific and common names, nutritional value, uses, geographic distribution, morphological description, and areas of needed research. Information on known toxicities of some of these plants was lacking; for example, no reference to toxicity was given in the description of chaya, which contains cyanide. Each plant has an accompanying color picture.

As a nutritional guide, this book does not offer much information on the indigenous uses or agricultural practices for the described plants. It is a good introduction to anyone interested in becoming familiar with native Central American plants and their nutritional contribution to the diet. Available free upon request from Dr. Cecilio Morón, Oficial Regional de Política Alimentaria y Nutrición, Oficina Regional de la FAO para América Latina y el Caribe, Casilla 10095, Santiago, Chile; fax (56-2) 2182547.

***TOXICITY AND FOOD SECURITY: A review of health effects of cyanide exposure from cassava and of ways to prevent these effects***. For several years I have been on the lookout for something that could provide a perspective on this important question. Many thanks to Dr. Hans Rosling for sending the 31-page booklet with the above title that he wrote for UNICEF. It is just what I had hoped to find. The subject is so important that I have summarized much more of the material than in a normal review. I include the extra detail so you will be able to anticipate when conditions such as dietary limitations, economic changes or social turmoil might cause

a problem to suddenly appear.

Dr. Rosling does not like the statement "cassava contains cyanide." A food that contained pure hydrogen cyanide could be easily detoxified (it would be driven off as a gas by cooking). If any free cyanide is present in cassava, it can easily be driven off into the air by temperatures over 28°C (82°F).

The "cyanide" in cassava is actually a complex and very stable molecule called linamarin, one part of which is a cyanide molecule. If that part of the molecule is broken off it will become cyanide. Compounds such as this that produce cyanide when broken down are called "cyanogenic" compounds. Some cyanogenic compounds are broken down by boiling. For example, although chaya leaves contain a cyanogenic compound, the cyanide is driven off by boiling for 5 minutes.

Unfortunately the cyanogenic compound in cassava is largely unaffected by boiling. Boiling whole pieces of cassava does little to reduce the danger of cyanide poisoning (although boiling fermented or grated cassava will remove most of the cyanide, as we will see later).

Linamarin is not itself toxic. If some of it is absorbed from the gut into the blood it is probably excreted unchanged in the urine. The "cyanide" in linamarin can be liberated in two ways. First, enzymes secreted by microbes in the gut can decompose linamarin, liberating cyanide in the process. Second, certain enzymes in the cassava root itself can liberate cyanide from linamarin. In the intact plant, these enzymes never get a chance to degrade linamarin because they are stored in separate places. But when the root structure is disrupted by grating or fermentation, the two come into contact and cyanide is liberated (and will evaporate at temperatures of 28°C or higher).

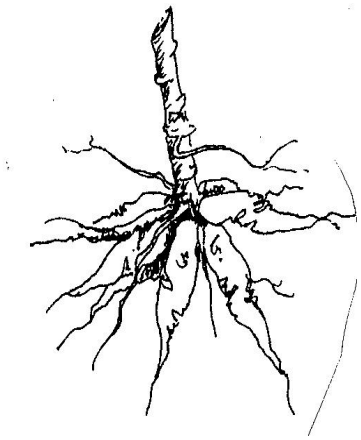
I am preparing this review while visiting a major cassava-growing area in the Amazon Basin of Brazil. It is interesting to fit observations about farmers' practices into the understanding provided by the book. For example, I am told that the roots are fermented and/or grated (which puts the enzyme and linamarin together), then washed with water and squeezed. Free cyanide is washed out in the water. As the water is left to stand, tapioca settles to the bottom. If a hog or other animal drinks this water, unless it is cooked or considerable time has elapsed, they reportedly can die quickly from the dissolved cyanide. There would be very little cyanide nor linamarin remaining in either the tapioca or the ground, dried cassava, which are consumed in large amounts along with fish.

"Considerable cassava consumption has developed in some areas using processing methods like sun drying, which are very ineffective in removing cyanide. This has probably been possible because initially only the less toxic sweet varieties were used. When these varieties were later replaced by more productive toxic varieties, the established processing practices may suddenly have become insufficient. ... this is probably the case in many cassava growing areas of East Africa. ... sun drying for long periods is not fully efficient, although levels will be lower than after only a few days of drying."

"From the toxicological aspect, strict adherence to the method is as important as the type of method. Soaking in water ... as well as grating and sack-fermenting processes ... are effective as long as the soaking or fermenting steps are not shortened and fermentation conditions are not changed. Sun drying, if performed according to traditional practices, should be extended over several weeks. Populations using prolonged sun drying probably rely on infestation of insects in the roots to achieve a sufficient removal of cyanide.

What if there is an emergency situation in which the water for soaking or some necessary equipment is lacking? A method emerging in coastal Tanzania and Mozambique and Rwanda which "is probably an appropriate and effective way of reducing the cyanide" is called dry fermentation. "A pile of peeled root pieces is covered with leaves or peels for 3-4 days, after which each root piece is completely covered by a black mould growth. The root pieces are dried in the sun and as much of the mould is removed as possible. These pieces are finally consumed after pounding. Unfortunately **this method seems to result in a very high exposure to aflatoxins from the mould growth**...aflatoxin exposure must thus also be considered as a possible side-effect when cassava provides food security in drought-affected areas." Aflatoxins cause liver damage and are powerful carcinogens.

What happens to cyanide in the body? The body is protected from cyanide in two steps. The blood contains a substance which can, within minutes, bind up to 10 mg of cyanide. This is then taken to the liver and detoxified in a process that takes a few hours.



If more than 10 mg of cyanide is consumed, but not enough to be fatal, it is converted to a far less toxic substance called thiocyanate. The thiocyanate is eventually excreted in the urine. This detoxification process requires the element sulfur, which is obtained from protein in the diet. In protein deficient diets the detoxification process ceases to operate. So lack of protein in the diet accentuates the toxicity of cassava. "It should be noted that considerable amounts of fish are consumed in areas of the Amazon, the Congo basin and southern India where cassava has been established as the dominating staple for centuries."

If other food is not available, "an adult will consume daily about ... 0.5 kg dry (1.5 kg wet) weight of cassava." "**The newly developed high-producing varieties with less cyanide-yielding capacity still contain 50-100 mg of cyanide per kg of fresh weight.** This amount will easily be removed by processing, but if roots are consumed unprocessed, even these varieties may cause intoxication." ["Intoxication" is medical terminology for "have a toxic effect."]

Diseases related to cassava toxicity: immediate symptoms. Symptoms usually occur 4-6 hours after a meal and consist of vertigo (dizziness), vomiting, collapse and, in some cases, death within 1-2 hours. Antidotes are effective, safe and cheap. Intravenous injection of thiosulfate will increase the sulfur available to convert cyanide to thiocyanate. Nitrite acts more rapidly but must be handled with care as an overdose is itself toxic.

Cyanide intake from cassava is probably a factor in two types of paralysis. In tropical ataxic neuropathy, one of the sensory tracts in the spinal cord is damaged. This results in an uncoordinated gait called ataxia. It occurred in Nigeria, mostly in adult males, with successive occurrences over several years. High cyanide intake with low protein diets were suggested causes.

Epidemic spastic paraparesis occurs mainly among women and children. It permanently cripples the victim "from one day to the next" [in a 24 hour period?] by damaging parts of the spinal cord that transmit signals for movement. Muscles are not flaccid, as in polio, so the legs usually support affected persons sufficiently to let them stand, especially if supported by a stick. Walking is often uncontrolled jerks. Outbreaks have been reported in two locations in Zaire during the dry season and during a drought in one location each in Tanzania and Mozambique.

In each of these four cases cassava was the only food available in quantity and roots were inefficiently processed. This disease has never been reported from a population that did not consume cassava, nor from populations eating balanced diets.

In Mozambique 1102 people were stricken. Cassava was the only food due to a drought [hence no protein for the body's own detoxification process]. Once other foods were gone, they did not have enough *processed* cassava to replace them. Also the people wanted to leave the roots in the ground as long as possible so that they would grow bigger. When they finally harvested, the people had no time for the lengthy sun-drying process. Studies on this population indicated "that acute intoxication may appear when cyanide intake reaches 30 mg in 24 hours."

Health workers should be aware of the following possible causes of cyanide poisoning: 1) varieties that are normally sweet may produce high levels of linamarin under adverse conditions; 2) a new, but toxic, variety may be introduced to the market and surprise people; 3) hungry, unsupervised children have been known to eat toxic roots in spite of their bitterness; and 4) cassava is sometimes introduced without adequate training in processing methods.

Diseases related to cassava: delayed symptoms. Other diseases develop only after exposure to cyanide over a long period of time. Continuous exposure to insufficiently processed cassava can lead to goiter and cretinism. This problem is especially prevalent in Africa. The thyroid gland, situated in front of the neck, is not normally visible. Its main function is to produce iodine-containing hormones that regulate body metabolism. If the diet contains too little iodine the thyroid gland becomes larger so as to be more efficient in extracting what little iodine is in the blood. Some children born to iodine-deficient mothers suffer from cretinism (mental retardation and stunted growth).

How is inadequately processed cassava responsible? The thiocyanate produced when cyanide is detoxified (see above) interferes with uptake of iodine by the thyroid gland. Fortunately this interference can happen only when iodine intake is already low, below 200 micrograms per day. Populations in northern Zaire with very low iodine in the diet and who

regularly ate inadequately processed cassava suffered from severe endemic goiter and a high prevalence of cretinism. When iodine supplements were used the goiter problem decreased considerably even though the cassava was still not adequately processed due to adverse conditions.

Do all varieties of cassava contain cyanide? The hundreds of cassava varieties are grouped according to taste into bitter and sweet. The bitter varieties generally have more linamarin than the sweet, but there is no clear-cut division into the two groups. "Cassava-growing peasants plant several varieties. The sweet ones in smaller amounts are eaten as snacks or cooked fresh as vegetables. The bitter varieties are grown in large quantities to serve as staple food after processing."

In most cassava-growing areas the bitter and more toxic varieties have been found to be more productive, probably because of the toxicity. For example, monkeys and wild pigs will not feed on toxic varieties. "Peasants often plant small amounts of sweet varieties in the center of a field of toxic varieties" to keep animals from eating the former.

"Breeding programs should continue to take cyanide levels into consideration, but so far no high yielding variety has been found that makes processing unnecessary." "Even 'high-yielding low-cyanide' varieties developed by IITA in Nigeria have a cyanide-yielding capacity of about 5-10 mg of cyanide per 100 g of fresh weight. ...consumption of these new varieties without any processing may still result in considerable cyanide exposure. ... strict adherence to efficient processing methods is still needed if large amounts of roots from these new varieties are consumed."

Dr. Rosling has offered copies of his book Cassava Toxicity and Food Security free of charge as long as they are available. Write him at International Child Health Unit, Dept. of Pediatrics, S-751 85 Uppsala, Sweden.

An update from Dr. Rosling. Three recent articles give additional details on the occurrence of spastic paraparesis in the Bandundo region of Zaire (110 live and 24 dead cases). The start of these outbreaks in 1974 coincided with the completion of a new tarmac road to the capital, which facilitated the transport of cassava and made it the main cash crop. "The affected population consumed flour made from short-soaked (one day) cassava roots and thus had high dietary exposure to cyanide (urinary thiocyanate in 31 children was 757 vs. 50 units for a population where cassava had been soaked for the normal three days)."

"The reason for processing shortcuts ... [is that cassava is] exclusively produced and processed by women in very poor households. Roots are short-soaked when women are in a 'hurry' to gain cash."

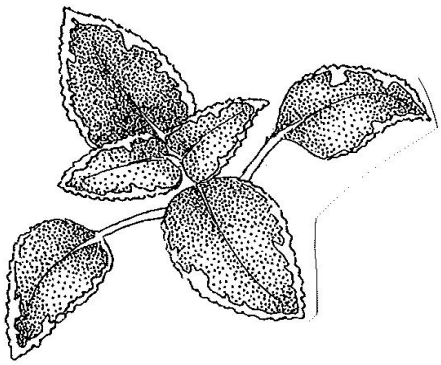
**SWEET AND BITTER CASSAVA AND CYANIDE CONTENT.** Dr. M. Bokanga writes in the March 1993 issue of *IITA Research* that "varieties of cassava classified as sweet may have a high cyanogenic potential and those classified as bitter may be low." He measures cyanide as "cyanogenic potential" because pure cyanide does not occur in cassava--it is produced upon processing or eating. A panel rated several cassava varieties as bitter or nonbitter. Taste was not a reliable indicator of cyanogenic potential. Nonbitter varieties ranged from 0.91 to 10.6 mg cyanide per 100 g fresh weight of cassava. The range for bitter varieties was 5.0 to 39.9 mg.

Boiling is not an adequate method for detoxifying cassava, but it does reduce the toxin, according to the authors. "Boiling cassava roots, which is considered minimal processing, reduces the cyanogenic potential by at least half." This conflicts with the book *Toxicity and Food Security* reviewed above. Other processing methods can reduce it by more than 90%.

**ARE RAW VEGETABLES MORE NUTRITIOUS THAN COOKED ONES?** People taking the educational tour at ECHO often ask, "Can this vegetable be eaten raw?" The unexpressed implication may be that raw vegetables are better for you. Delia Hammock, registered dietitian and nutrition editor for *Good Housekeeping* magazine says this is not necessarily the case. "While it's true that overcooking reduces the nutritive value of all foods and even moderate heat can destroy certain vitamins, raw foods are not always more nutritious. Some raw foods contain natural substances that actually block the digestion of nutrients or interfere with the absorption or use of vitamins. Cooking inactivates these nutrient blockers." There are also many examples of toxic substances in plants that are detoxified by cooking.

In addition, the digestibility of many foods is improved as heat alters their physical structure. "Cooking carrots breaks down the cell walls making more of the carotenes available for absorption by the body. While on average only 5 percent of the beta-carotene is absorbed from a raw carrot, cooking makes 25-30 percent available. This is a 5-6 fold increase. Pureeing cooked carrots boosts absorption even more."

## STORAGE AND PRESERVATION



**IS MORNING ALWAYS THE BEST TIME TO HARVEST VEGETABLES AND HERBS?** Not in the case of basil. *National Gardening* magazine (July/August 1994) reports findings from a University of Michigan project that basil picked in the evening stored twice as long as basil picked in the morning. A possible explanation is that basil picked in the evening has just spent the day building up sugars. This may somehow help it to survive the shock of being cut longer than basil that has been actively growing all night (and using up sugars).

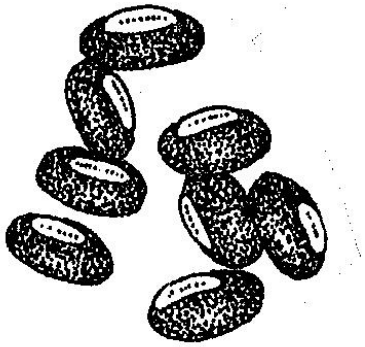
No extrapolation was made to other plants. In light of the magnitude of the effect, however, it might be worth checking the influence of harvest time on leafy vegetables or herbs if you are having trouble with storage life.

**INSECTS IN TROPICAL STORES (A POSTER).** The Natural Resources Institute has a poster with color pictures of 14 insects which are found where food is stored in the tropics. Accompanying an enlarged photo of each insect are the scientific and common names, a guide to actual size, and notes on the commodities they damage and their biological development and behavior. From NRI, Publications Distribution Office, Central Ave, Chatham Maritime, Kent ME4 4TB, UK.

**USE OF VEGETABLE OILS TO PROTECT STORED BEANS FROM BRUCHID BEETLE ATTACK.** Steve Mason at Purdue University sent us this interesting article on research done at CIAT in Colombia, which was inspired by an ancient Indian method. African palm oil or crude (i.e. unpurified) cottonseed oil were applied to dry beans, *Phaseolus vulgaris*, at a rate of 5 ml of oil per kg of beans, and tumbled at 35 rpm for 5 minutes. They were then infested with bruchid beetles, *Zabrotes subfasciatus*, at 1 day and again at 75 days. After 6 months the adults were counted. The untreated controls averaged 251 beetles, the African palm oil had none and the crude cotton seed oil averaged 0.2 beetles per 100 g sample of beans. Treatment with 1 ml of oil per kg of beans was less effective (6.4 and 5.2 beetles per 100 g). It is not clear how the oils work. Dormant oil sprays on fruit trees are thought to interfere with insect respiration. Their action must be more complex, however, because other work has shown that insects completely deprived of oxygen still live longer than those treated with oil.

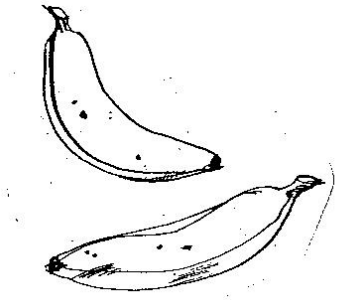
Other oils (purified cottonseed, maize or corn, purified soybean, crude or purified coconut palm) averaged roughly 75% reduction in the number of beetles, but this may not be enough for consumer needs. Cottonseed oil even reduced the number of beetles emerging when the oil was applied after the larvae had penetrated the seeds, but only from 650 to 387. The added oils did not decrease germination of the beans. Manual mixing of the oil and beans for 5 minutes in a glass jar was much less effective than tumbling, apparently because the surface of the beans was less completely covered. Crude oils are not only cheaper than refined oils, but also contain more antioxidants. These delay rancidity, which might affect taste. Of course the treatments are not toxic. Based on prices of oil and beans in 1978, the oil would cost 0.5% of the market price of beans.

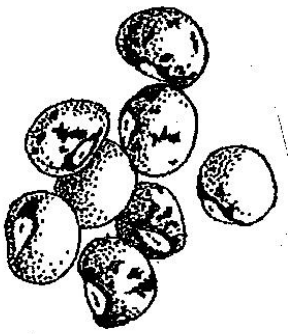
The April 1986 issue of *Agricultural Science Digest* summarized a report in *Agriculture, Ecosystems and Environment* showing good control of rice weevils in stored corn (maize). Shelled corn was shaken with peanut, coconut or palm oils at a rate of 1, 5 and 10 ml of oil per kg of grain, until the grain was evenly coated. Adult weevils were then introduced. Most were killed within a day and all were dead within a week at the 5 and 10 ml/kg concentrations. Few eggs were laid and fewer offspring hatched. After 60 days the 10 ml treatment was reinfected with adult weevils. Again nearly all were dead within one day, except for the palm oil treatment. (Palm oil gave the best results in the earlier study.) The oil treatment did not affect germination of treated seed corn, nor water uptake during cooking.



Burus Ali in Nigeria reports they have had success controlling weevils in their community projects by adding 1 tablespoonful (about 5 ml) of peanut (groundnut) oil to each kilogram of cowpeas. In this way, 1 liter of oil will treat about 200 kg (440 pounds) of peas. After thorough mixing, peas treated this way can keep 4-6 months without any problem. Beetles lay their eggs on the surface, then larvae bore into the seed and later emerge as mature beetles leaving a characteristic hole. Oil interferes with egg laying and development of larvae. Once inside the seed, oil has no effect. If about 6 months after treatment farmers begin to see holes left by emerging beetles, they can extend protection easily up to a year by a second identical treatment. This is based on a procedure recommended by the International Institute of Tropical Agriculture in Nigeria. (Oil treatment reportedly works with cereals too. We would like to hear of your experiences with oil treatment.)

**BANANA JUICE PROTECTS SEEDS FROM INSECTS.** Duane Neuenburg wrote from Mozambique, "While working at a German hospital/orphanage in Uganda I observed an effective seed storage method to protect against insect damage. They immersed beans and maize kernels momentarily in a vat of banana juice. The juice is the material from which they ferment an alcoholic beverage (rombe), only they used it before fermentation in this application. They then spread the seeds on a rack to dry. As soon as they were dried they were placed in sacks. The seeds showed no damage 4 months later." This is a new one to us at ECHO. Has anyone else seen this method? How is the banana juice prepared? Have you seen it tried with an untreated control to prove whether or not there is a difference? Do you have any idea why it works (if it does)?





**THE SIMPLEST WAY TO CONTROL BEAN BEETLES.** According to the Michigan State University News-Bulletin, a graduate student from Tanzania, Martha Quentin, and her research advisor, Dr. J.R. Miller, developed a simple solution to one of the world's major food storage problems. The following is taken from that article and the authors' technical publication, "Bean Tumbling as a Control Measure for the Common Bean Weevil."

Weevil larvae bore entry holes in the bean surface and eat the insides, leaving empty shells. Fumigation methods are effective, but are not always possible [or desirable] in the third world. Quentin attacked the problem by studying how soft-bodied larvae are physically able to bore through the smooth hard surface of a dried bean.

They learned that the larvae scrape the holes with their mouths, but first must brace themselves against a hard surface--a neighboring bean or the wall of a container holding the beans. A bean that does not abut another bean or other hard surface cannot be invaded.

They also learned that it takes 19-24 hours for a weevil to bore an entry hole. They hit on the idea of occasionally tumbling stored beans in order to dislodge weevil larvae before they could finish scraping their holes.

They calculated that it would be highly unlikely after tumbling that a previously started hole would still be close enough to an abutting surface to be useful to a larva. The larvae would have to start new holes.

Experiments proved them right. "Rather than the normal 20-fold increase per generation, beetle populations in tumbled beans fell to 1/3 of the starting population." Tumbling intact beans morning and evening in a variety of glass and plastic containers, as well as burlap bags, consistently gained excellent results. The tumbled containers had 97 to

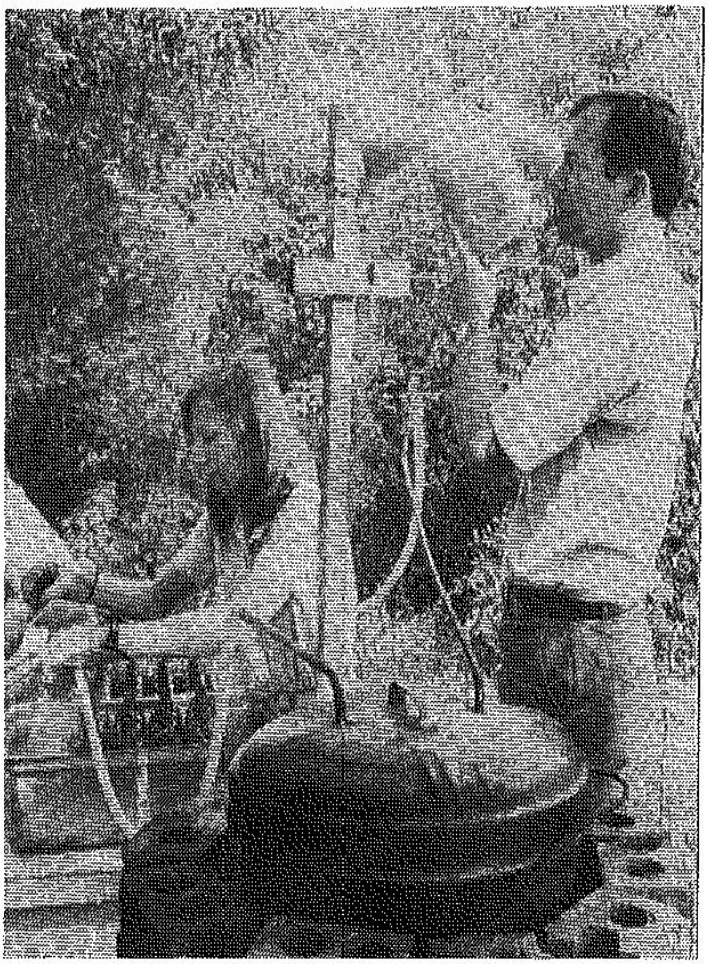
98% fewer weevils than were found in stationary control containers. Even when many of the beans had been cracked during harvesting, results were excellent (95%). After only two or three days, the larvae, except for the few that manage to enter a bean, either starve or are crushed by the tumbling.

How was the tumbling done? "Sacks of beans were twice turned end-over-end 2-3 times a day. Tumbling was faithfully conducted until about one week after inspection revealed no live adults."

Will tumbling be a useful control for other storage pests? "Tumbling is unlikely to be as disruptive to the cowpea weevil, whose larvae bore directly into beans from eggs glued to the seed surface." Several criteria of pest biology are listed to help in evaluating the likely success of tumbling. But even if the pest biology is not known, "regular tumbling could be attempted, just to see if there were benefits worth the modest effort."

**APPROPRIATE TECHNOLOGY JUICE PASTEURIZER**. The "tubular juice pasteurizer," as it is formally called, strikes me as an "appropriate technology" with unusual promise.

It is designed for situations where a large quantity of fruit is available for a limited period of time and for which there is no ready market or where marketing is not feasible because of difficulties in transporting the fruit to market. It also assumes a segment of the population would benefit either financially or nutritionally if it could produce an inexpensive pasteurized fruit drink.



The technology was developed in the late 1980s by Dr. Phil Crandall and colleagues while he was with the University of Florida's Lake Alfred Experiment Station. Dr. Crandall's team developed the pasteurizer specifically for difficult third world situations. His criteria included: low cost, no moving parts, easy to build, easy to move, rugged, and providing agitation (for even heating). Heating lowers quality, so an emphasis was placed on what he called HTST (high temperature short time). The result is a pasteurizer which can be carried by one person to the most remote site.

ECHO waited on this innovation for several years in hopes that the pasteurizer would become available commercially. It now appears that this will not happen. We had a volunteer, Dale Fritz, make four units for ECHO and are convinced that this simple device can be made in any country with no special tools or mechanical skills for a little over $100 counting accessories. So here are the details.

Pasteurization of fresh citrus juice requires a temperature of 90°C (194°F) for a few seconds. Calculations showed that an acid fruit juice could be pasteurized by passing it through a stainless steel coil of precise dimensions that was immersed in a container of boiling water. Dr. Crandall bent a 6 m (20 ft) length of stainless steel tubing into nine coils 19 cm (7.5 in) in diameter by wrapping by hand around a cylinder of the appropriate size (he said the cylinder could be something as simple as a log). The tubing used was grade 316 seamless, 9.5 mm outside diameter and 7.7 mm inside diameter. Inlet and outlet tubes protruded 30 cm over the sides of the can and were connected to plastic tubes. The coil rested on a block of wood to prevent it from touching the bottom of the can.

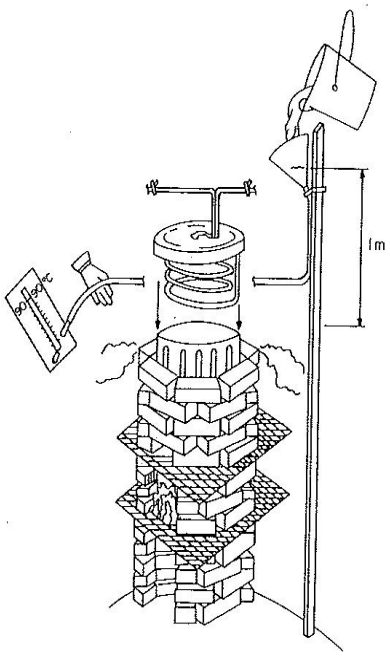
The length of time the juice is in the coil is controlled by hydrostatic pressure. The inlet to the coil is attached via a tube (he used tygon) to a plastic funnel into which the juice is poured. The higher the funnel, the greater the pressure

and so the faster the juice flows. In practice it is usually fastened about 1 meter above the coil. The temperature of the juice as it leaves the coil is periodically checked. If it is too low, the funnel is lowered to reduce the flow rate; if too high, it is raised.

Juice is collected in recycled bottles. Dr. Crandall used brown beer bottles, but soft drink bottles would also work well. After attaching a cap, bottles are laid on their side for 3 minutes to sterilize the cap, then are cooled in running water (if available).

Dr. Crandall says that juice can be stored without refrigeration for some months. Pasteurization did not significantly decrease vitamin C content, but 3 months' storage at 21°C did, by about the amount that would be expected for pasteurized juice stored at that temperature. However, each bottle (375 ml) still contained over three times the US recommended daily allowance of 60 mg. Effects on color were similar. An instrument that measured the vacuum in the bottle showed that no fermentation had occurred after 3 months. Though there is no microbial degradation, chemical oxidation of canned or pasteurized foods still occurs. So the lower the storage temperature the better.

To keep the water boiling efficiently, construct a simple oven with loose bricks (see illustration). Dr. Crandall built it from used housing bricks to make a 40 cm diameter circle with an air draft in the front and out the top. An iron grate at 55 cm supported the fire and another at 75 cm supported the can.




*An overview of the portable pasteurizer showing the gravity juice feed, heating oven, coil (lifted out of place), and checking the outlet temperature.*

A tasting panel of 21 experienced assessors graded juices from 1 (dislike extremely) to 9 (like extremely). The fresh orange juice was rated 7.2 (liked moderately); pasteurized 4.2 (disliked slightly). Dr. Crandall suggests this may be due to the panel's familiarity with commercial juice, which has flavoring oils added after heating.

I tasted the orange juice while visiting the Small Farm Resource Development Center in Belize (Christian Reformed World Relief Committee). Tom Post took me to a small store operated out of a home. If I recall correctly, the owner spent about 10¢ on juice and labor and sold the juice for 30¢, about half the price of a bottle of cola. I found the taste similar to other pasteurized orange juice, which is always a much different taste than fresh juice. The next season Tom took the pasteurizer to different communities which kept the bottles for their own use during the Christmas season. This was in 1991.

In 1994 I called Tom for an update. He had been assigned outside the country for some time and then returned. The pasteurizer was not being used. He cited three reasons. Belize is relatively well off for a third world country; the cost of a drink is not prohibitive for most, so they are not that motivated to use the pasteurizer. "If I had been around promoting it, they would have been happy enough to use it. But their interest is not great enough to take the initiative in seeking it out." Also there are fewer oranges around than appears at first sight, especially when large quantities are picked for processing. Finally, the season of excess ripe fruit is extremely short there, only a couple weeks or so. The pasteurizer would have been much more successful if there was some juice available for processing at many other times of the year.

This brings up the subject of what other juice can be processed. About the only limit is that it must be an acidic juice (pH<4.5; safer to say <4.0). This includes apple, some tomatoes, lemon, lime, passion fruit, cashew etc. Dr. Crandall only experimented with orange and apple juice and a drink similar to one liked in Nepal called "orange squash" (25% orange concentrate, 42.5% sugar and 32.5% water).

The apple juice only required a temperature of 80°C, so the height of the funnel was raised accordingly. The taste panel rating was essentially unchanged (7.0 and 6.7 for fresh and pasteurized juice respectively). The "orange squash" was not evaluated.

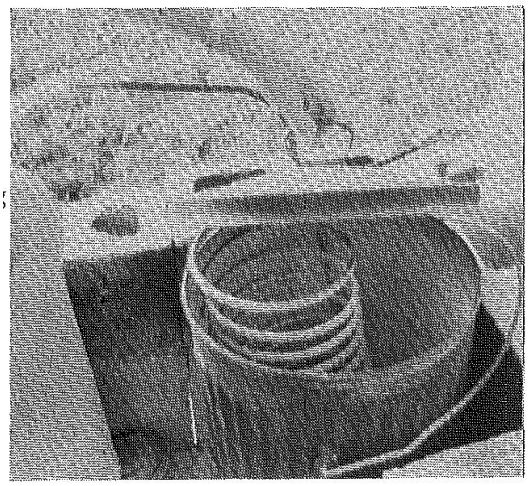
If someone was willing to do some "recipe developing," it should be possible to come up with some very tasty juices. Different fruits, mixtures of fruits, and adding sugar or flavorings could all be tried. Concentrates to be mixed with water or lemon juice and sugar by the consumer might be popular. If the juice is not quite acidic enough, it could be adjusted with a bit of lemon, lime or passion fruit. Also consider: Andean blackberry, guava/passion fruit, tamarind,

grapefruit, soursop, red mombin, etc.

Dale Fritz said it cost him $25 to make a coil (made from seamless stainless steel 3/8 inch od x 20 ft long, type 316 tubing). He checked out the current retail price of other accessories that would be needed. Input and outflow tubing $1.60; thermometer $11.90 - $19.95; bottle capper $29.95; bottle caps, 10 gross for $19.00; a potato ricer/fruit press, $8.99; funnels about $1.50. You would also need a 5 gallon metal bucket with lid, bottles, container for the extracted juice, a pitcher for pouring, a stick to support the funnel and material for the fire box. He points out that the USA and Canada use different sized beer bottles, so one must be sure the size of caps and bottle capper is right for the country. [Dr. Crandall has never found this to be a problem.] He said that both are readily available in stores that sell supplies to people who make their own beer.

I phoned Dr. Crandall to clarify some points. The interview follows.

Q. Your article states that orange juice was heated to 90°C and apple to 80°C. How do we know what temperature a juice will require?
A. I would just recommend that every juice be heated to 90°. The microbes in orange juice are probably killed at a lower temperature, but it must reach that temperature to inactivate an enzyme called pectin esterase. Have you noticed that a couple days after you extract fresh orange juice there is a clear layer on top and "crud" on the bottom? When this enzyme breaks down esters in the juice, some complex acids are formed. These combine with calcium to make something that at the molecular level might be described as a 'fish net,' which settles to the bottom. Apple juice does not have this enzyme, so it does not need the extra temperature. Solids still settle out in apple juice for a different reason. This is going to happen even with the most sophisticated equipment.



Q. What is the margin for error in temperature?
A. This depends on how great a content of microbial life is in the juice and on the pH. A target temperature of 90°C allows some margin for error. The pH (a measure of acidity) is really important. Below 4.5 clostridia spores will not germinate even if they are present. Over pH 4.5 one bottle could kill a person! You should have some pH test paper which turns different colors based on pH. With simple equipment, it might be well to shoot for a pH of 4.0 for an extra margin of safety.

Q. How is the pH lowered?
A. Just add lemon or lime or any other very sour juice. Be sure not to have acidic juices in contact with lead, aluminum or copper containers as the acid can react to produce toxic heavy metals compounds.

Q. At what pH is food too sour to enjoy? Give us a perspective.
A. Apple and pineapple juices are less than 4.5. Tomato juice is borderline (caution!). Most citrus juice is about 3.5; lemons and limes are about 2.0.

Q. Are all citrus equally suited for pasteurizing?
A. The citrus that are easy to peel, like mandarins, make terrible juice. A chemical is formed (a lactone) that tastes like kerosene. That is why you almost never see pasteurized tangerine juice on the market. Use oranges that are difficult to peel.

Always run the raw juice through a strainer or colander to remove larger particles, which might plug up the coil. We chose a small diameter coil because it makes the "ride" through the coil more turbulent for the juice. This assures that every bit of it is in contact with the hot sides of the tube and reaches 90°C.

Q. Do you have any thoughts on mixtures of juices and flavorings?
A. Almost any culture will prefer a colored, sweet and acidic juice. Add some passion fruit for color, acid and flavor and sugar for sweetness. For a first test, heat some juice in a pan on the stove, let it cool, then taste. If you like it, you will love it when pasteurized in the coil (which is a lot gentler treatment than heating in a pan).

Q. Where do you buy bottle caps in the third world?
A. I recommend recycling bottle caps. You can simply flare out the sides on an appropriately sized rock, then cap it down tightly on the bottle with the bottle capper.

Q. Is there danger of using bottles in which chemical poisons have been stored?
A. Every bottle must be cleaned in hot, soapy water. After that if the human nose cannot detect a smell it is very unlikely that enough of something will be present to cause a serious health problem.

ECHO recommends that you purchase all the parts that you can in the country where you work. Dale is putting together 4 complete kits for ECHO. One we will set up at ECHO (and demonstrate during our agricultural missions conference!) and one we are sending to Haiti where we are helping with a Small Farm Resource Center (at Bohoc near Pignon).

**LARGE CAPACITY SOLAR RICE DRYER.** Harry Leightner in Costa Rica asked me to keep my eyes open for a solar dryer with a capacity large enough to dry beans. They must be harvested during the wet season and dried before they can be shelled. We obtained plans for a one ton solar rice dryer from the Renewable Energy Resources Information Center (RERIC) in Thailand which appears to be well tested and is recommended for the drying of many products in addition to rice, including beans, fish, cocoa, coffee, cassava, maize, bananas, coconuts, et. al. For a handbook, contact the Director/RERIC, AIT., P.O. Box 2754, Bangkok, THAILAND. Part One is intended mainly for agricultural scientists and officials and gives general information on the background, design calculations and principles involved. Part Two is intended for those who will make and use the dryer. This part includes 86 photographs and 45 figures and is in considerable detail. They estimate the cost of materials in Thailand to be $112, or $57 if free locally grown bamboo is available (1982 prices). If you give this a try, please consider sharing your experiences with us and our other readers.

**WOOD ASH TO PRESERVE TOMATOES FOR MONTHS.** Ken Hargesheimer sent us a copy of the "From Garden to Kitchen" newsletter published by UNICEF. It provides a way for Pacific Island populations to share gardening and nutrition information suited to the local region. If you are in the Pacific Islands, you are eligible to receive this newsletter (no fee). Write South Pacific Commission Community Education Training Centre, c/o UNDP, Private Mail Bag, Suva, FIJI; phone 300439; fax (679) 301667. The following is from issue #10.

Farmers know all too well the problem of large quantities of tomatoes (and low prices) during season, followed by short supply and higher prices. The Bureau of Education in the Philippines says you can extend the season in which tomatoes are available. Fresh tomatoes can be preserved in wood ash for up to three months.

Preserve only newly picked tomatoes which are ripe but not soft and overripe. They must be free of bruises and blemishes. Select a wooden or cardboard box or woven basket and line it with paper. Gather cool ash from the cooking fire and sift to remove sharp particles. Spread the ash evenly on the bottom, 1.5 inches (4 cm) thick. Arrange the tomatoes upside down (stem end facing down) in one layer and pour another thin layer of ash on top. Continue layering tomatoes and ash until the container is full. Cover and seal the container and keep in a cool dry place. [The article does not say how to cover and seal. My best guess is to cover with ash then a loose-fitting cover to keep the ash from being disturbed.] The skin will wrinkle but the pulp inside will remain juicy.

The article does not mention what effect the wrinkling of the skin has on marketability. If you try this method, I would be interested in your observations.

**CASHEW FRUIT DRYING AND NUT PROCESSING**. [Summarized from an article in the September 1990 *Appropriate Technology*.] The cashew "apple" is a bell-shaped pseudocarp which holds the "nut" below it. The "apple" (or fruit) is often used for juice, preserves, candy, and jam in Asia. The first step in drying the fruit is to boil the apples in salty water for 15 minutes to remove the bitter taste that is unpleasant to some. Then the apples are perforated and compressed in specially cured wooden devices. The compressed apples are then boiled in sugar for two hours. Some 350 kg of sugar are used with every 1,000 apples with enough water to cover the apples. The sugar is re-used twice.

The boiled apples are then dried in a solar drier. The apples are put in 1.2m x 0.6 m wire trays to a depth of 2.5 cm, inside a 1.5 m x 1.2 m wooden cabinet which is covered with plastic film. Underneath the wire

trays there is a black collector plate. The cabinet is inclined at 80°, set toward the east in the morning and moved during the day. The apples are dried in one day and have a shelf-life of 6-8 months.

This has been extremely successful. By 1985, over 5,000 kg of cashew produce had been marketed and orders for 1987 were more than 35,000 kg. This provides employment for 2,000 families at £5.00 (rather than £1.50) a day.

Ian Wallace, Igreja Evangelica da Guine-Bissau, wrote on cashew: "On the whole I am not greatly enamored with cashew as a crop and would advise anyone thinking of large-scale cashew production to proceed with caution." His letter arrived just as I had visited some sites in the Amazon basin where cashews seemed to produce well and was wondering if I had been too negative (see page 123). Perhaps someone in our network knows of a very successful cashew project. If so, please drop me a line. I would like to correspond with you. Ian's helpful observations follow:

"I was interested in your article on cashew production. Here vast areas of virgin bush have been cleared and planted with cashew trees in the past 10 years. Certainly the crop has not fulfilled all that was expected of it. Perhaps expectations were too high, or orchards are inadequately tended. Because the initial stages of raising the trees is so straightforward, there is a tendency to sit and wait for the tree to do its stuff with many orchards remaining uncleaned. The crop is unreliable.

"The little that is processed locally is of poor quality, the toxic skin being burnt off in an open fire. The majority of the nuts are exchanged by the government for rice then shipped raw to foreign processing centers. The true value of the crop remains unrealized since much of the profit is only added after processing. We have seen a disastrous fall in rice production as well. It is easier to collect cashew nuts and exchange them for imported rice than it is to work the rice fields. Although this is obviously a fault of the exchange policy, it is hard to see an alternative. There are no other markets for unprocessed nuts and the government has no other means of paying.

"You are right in saying that it is a labor intensive crop. Harvest time involves an army of workers, many of whom are children from age 6 upwards who are taken out of school for that purpose. It is rare to see men involved in the harvest. It appears that the system which is evolving is oppressive to the weaker members of the community, who rarely see any great benefit from the harvest.

"Cashew production has aggravated another social problem, drunkenness. The squeezed juice ferments quickly and without human intervention, to make a strong alcoholic drink in days. The cashew wine is available in far greater quantities than palm wine. Cashew season sees a very marked increase in drunkenness."

## FOOD PREPARATION

**BREADFRUIT BREAD.** Another interesting item in the UNICEF "From Garden to Kitchen" newsletter (see above) was this recipe for one loaf of bread using 25% (by volume) grated cooked breadfruit and 75% wheat flour (originally from the Methodist Handicraft and Farming School in Fiji). If breadfruit goes to waste where you live, this is a good use and will cut down on need for imported wheat flour.

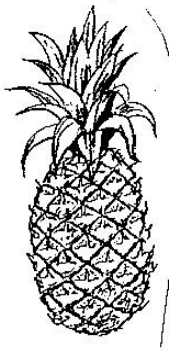
Sift 1 3/4 cup flour, 3 teaspoons baking powder and a dash of salt. Pound very ripe breadfruit until mushy. Mix 1 1/4 cup breadfruit pulp, 1/3 cup oil, 2 tablespoons of milk, 2 eggs. Add 2/3 cup sugar. Stir into flour mixture, pour into greased pan and bake 1 hour at 350°F (175°C).

**STORING COOKED EGGS.** Just because eggs can be stored for some time without refrigeration does not mean the same is true of cooked eggs, according to *Science News* (August 10, 1985). "In its raw state, the egg has several antimicrobial defenses. The cuticle, or outside portion of the shell, protects the eggs from bacterial invasion as long as this layer remains intact." The shell membrane may be an even more resistant barrier for bacteria. Furthermore an enzyme called lysozyme in the shell membrane and in the egg white destroys many bacteria. Cooking not only inactivates the egg's lysozyme, but also enlarges the shell's pores. The most important breakdown in defenses may occur when boiled eggs are cooled in water. The egg's contraction during cooling creates an air pocket which produces a vacuum that can draw in bacteria present in the cooling water.

Eggs that were cooled in water that had been inoculated with botulism spores resulted in the toxin being produced in the eggs. Because botulism bacteria thrive in the absence of oxygen, eggs stored in complete absence of oxygen spoiled first (2-3 days), those in tightly sealed plastic storage containers in a week and those in open air about 8 days.

So keep these three facts in mind: (1) Hard-boiled eggs spoil more quickly than uncooked eggs and should be refrigerated. (2) Cooling in the air may be preferable to cooling in water, especially if the water is not pure. (3) It is better not to store them in air-tight containers.

**WHAT IS THE HOT PEPPER AROMA** that is released when they are heated in cooking oil? The substance that makes peppers hot, capsaicin, breaks down into vanillin and some other substances. Vanillin is the main flavor in vanilla. (Abstracted from *Organic Gardening*, p. 25, April 1993.)



**PINEAPPLE JUICE SHORTENS COOKING TIME OF BEANS.** Amaglo Newton at the University of Science in Kumasi, Ghana is excited about a discovery of one of his masters students, Viggo Dodoo-Ghana. "For some time I have been working to introduce soybeans to some missionaries. One major problem is the difficult cooking properties of the bean. ...[We now find that] a group of proteolytic enzymes (bromelin) found in pineapple juice is able to digest the outer seedcoat and ease the difficulty of cooking the bean.

"The beans are soaked for 6-10 hours in water to which pineapple juice has been added. It is then easy to peel off the seed coat. The cooking is then easy." [Ed: There is a good chance that the enzyme has been destroyed in canned juice, in which case you would need to make fresh juice.]

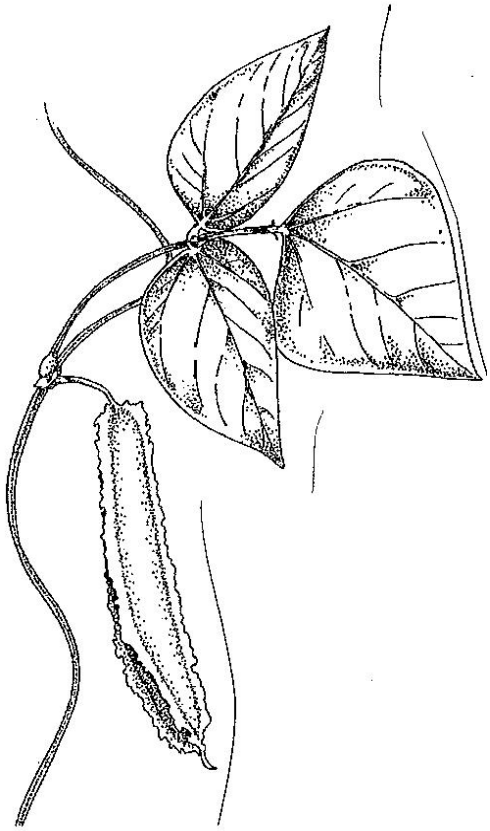
A few years ago Roland Bunch told me that women in Guanople, Honduras used papaya leaves when they cooked beans. Apparently papain in the leaves softened the seed coat also. I have no further details. A volunteer tried cooking some beans the way we imagined the process would be, but the taste was so bitter they were inedible.

Both of these approaches might be worth pursuing. A shorter cooking time for beans would both be more convenient for the cook and use less firewood. If you experiment, let us know the results.

**SQUASH CATSUP.** When I give educational talks, I help the audience visualize the importance of new plant introductions by asking them to imagine what Italian cooking must have been like before the tomato was introduced from the Andes. Where would fast foods be without catsup? This recipe from "From Garden to Kitchen" (see above) stretches my imagination a bit. But many of you work where it is difficult to grow tomatoes. If it works, and you could get used to orange catsup, it might be worth a try. "Squash catsup can be made using squash [or tropical pumpkin] puree cooked with varying amounts of vinegar, salt, pepper, sugar and other spices. Corn flour is used as a binder and thickener." Presumably winter squash or tropical pumpkin would be interchangeable.

Another interesting squash/pumpkin recipe is suggested. "Mix 7 parts of squash puree and 3 parts corn flour then form into chips and dry. Later they are deep fried in oil...."

**PREPARE DIFFUSION-PROCESSED SWEET POTATO AT HOME.** Dr. Frank Martin is a research specialist in sweet potato breeding. He writes, " A persistent nagging question is why people don't eat and don't want to eat more sweet potatoes. We believe this is due to sweetness itself, as well as flavors and textures that are not liked. We developed a new product that anyone can make at home that is less sweet, of more agreeable texture, and of better flavor than most sweet potatoes. People who don't like sweet potatoes do like our product. Please try this recipe in your kitchen and let us know what you think: (1) Peel the sweet potato and eliminate any bad spots. (2) Cut very carefully into slices about 1/8" (3mm) thick. (3) Cover the slices with water. Leave for two hours, moving slices 3-4 times so that all sides are exposed to the water. (4) Discard the water and rinse. (5) Boil 20 minutes. (6) Discard the water. (7) Mash. At this time salt, milk or margarine can be added. (8) Serve mixed with mayonnaise or salad dressings, beans or bean sauce, meats or gravy, or mixed into soups. It can also be molded into patties and fried. The product is best used fresh, and should not be stored for long periods."



**HOW ARE WINGED BEANS COOKED?** Peace Corps volunteer Henry Kobie in Liberia wrote that he has had considerable success introducing winged beans, but folks know little about how to cook them. I thought our readers might be interested in what we turned up for him. I have often wondered why a plant that has received so much attention, because of its potential both for production in hot humid climates and also for its high nutritional value, is not making a greater global impact. Uncertainty on how to use it is no doubt part of the problem.

The most difficult question is how to prepare the mature seeds. A few years ago I asked a researcher at CIAT in Colombia why they were not eaten on a large scale. He said that if I had ever tasted them I would know! The long cooking time required to soften whole, mature beans is also a problem in firewood-short countries. I think we can take a lesson from the soybean. In the countries where soybean is an important food, they have developed rather elaborate and unusual processing methods (making "milk", tempeh, etc.). The winged bean seed is nutritionally comparable to the soybean and, I suspect, requires similar processing methods.

A friend here in town makes a spread from ground up mature winged bean seeds that I quite enjoyed. He adapted this and other recipes from soybean recipes in "Recipes for a Small Planet." Perhaps you could adapt it to local conditions, at least for the palates of our American readers. The ingredients are 2/3 c dry beans cooked until tender, a large onion sauteed in oil with a bit of garlic, juice of 2 lemons, a tablespoon soy sauce, 1/4 cup sesame butter (or any nut butter), 1/2 cup roasted and ground sesame seed, and 1/2 tsp salt.

The National Academy of Sciences' most recent booklet on the "Winged Bean: A High Protein Crop for the Tropics" (1981) is quite helpful. The following are excerpts adapted from that booklet, with my comments in [ ]. Pods are the most popular part of the plant in most countries where the bean is grown and the easiest to introduce as food. They can be eaten raw or used in salads, soups, stews and curries and may be boiled in water or coconut milk or sauteed in oil. [If you grasp the pod in both hands it should be flexible. If not it will be too stringy to eat. Varieties differ in how long pods can grow before becoming fibrous.] In Papua New Guinea, pods that are too fibrous to eat whole are often steamed in oil drums or the "mumu" pit, or baked in open fires; the seeds and mucilage are then scraped out and eaten. [This is probably of higher nutritional value because protein accumulates as the pods mature.] Alternatively, the half-ripe seeds can be removed from the pod and cooked. The immature pod provides primarily bulk with comparatively low energy content, but is valuable for the minerals and vitamins. No adverse effects have been reported from cooked immature pods. [A missionary recently told me that he required his workers to eat at least one raw bean at the beginning of each day. They were seriously undernourished. They soon began feeling so much better that they ate it on their own and requested seed.]

The seeds are the most nutritious part. They can be steamed, boiled, fried, roasted, fermented, or made into milk, tofu (bean curd) or tempeh. Because of antinutritional substances, they should be soaked overnight, then boiled in water until tender, with the soaking liquid discarded. [I understand that some varieties from regions that grow winged beans primarily for tubers may have more toxic substances present in the seeds, so be cautious if collecting your own varieties in such places.] If seeds are soaked in a hot, 1-percent sodium bicarbonate [as in Arm and Hammer soda] solution, the hard seed coats are more easily removed. Mature seeds are more difficult to dehull by this process because the cotyledons swell and press firmly against the hull. When fried or baked, they make a delicious nut-like snack. The high temperature breaks open the tough seed coat. It is not certain, however, whether this method of cooking removes the antinutritional substances. Sprouted winged bean seed can be used as an alternative to mung bean sprouts. Extracting oil from winged bean seeds leaves a high-protein meal. Infants fed winged bean meal suffer little or no flatulus discomfort [gas]. In storage the seeds show remarkable resistance to bruchid beetles which are such a bad pest of stored legumes.

Tubers have several times the protein of potatoes. They can be boiled, steamed, fried or baked. The brown skin peels off readily after 40 minutes of cooking, leaving a white or cream-colored flesh that is firm and moist, with a distinctive nutty, earthy flavor. They are always eaten cooked.

Winged bean sprouts and shoots may be eaten raw or cooked as green vegetables. The top three sets of leaflets are the most tender; they taste slightly sweet. They have an average amount of protein, but are exceptionally high in the amino acid tryptophan. Thus even a small amount of the leaves can greatly improve tryptophan-deficient diets, e.g. those based on corn. Adding cooked leaves to diets of weaned infants and preschool children is recommended for the minerals and vitamin A precursor. The latter is among the highest ever recorded in green leaves of tropical plants. Excessive consumption of raw leaves has produced dizziness, nausea and flatulence, so large amounts of raw leaves should not be encouraged. Properly cooked they are safe in quantity. Also flowers can be eaten raw. When steamed or fried they have the color and consistency of mushrooms.

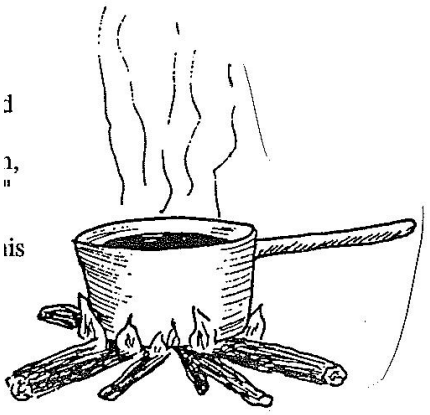
Commercial efforts were just getting underway when the book was published. Efforts are underway to make flour. A gruel for weaning infants has been produced in Ghana. Mixed with corn, it provides the nutritive equivalent of milk. In Thailand a similar gruel made of winged bean meal, rice, and banana is being fed to refugees from Cambodia. Because of its similarity to the soybean, many soybean recipes are being tried. Tempeh and tofu are made commercially in Indonesia. Both white milk and a chocolate-flavored milk have been made from the seed in Thailand and sterilized for longer shelf life. Researchers have made tasty snacks from tubers sliced thin, fried and salted, or softened in sugar syrup. Immature pods are used in pickles commercially in South India. One researcher in Indonesia has made a coffee substitute by roasting the seed (the grounds are edible) and a tobacco substitute from the dried leaf. Both of these should be free of alkaloids.

By the way, the dry pod left after threshing contains 10% protein and has been tested satisfactorily in animal feeds. In Thailand this pod residue is being used successfully as a medium for growing straw mushrooms.

Let me know if you are able to adapt any of these ideas and what the people's reactions are. We would be especially interested to know of any successful introductions you have made and how the local people prepare them. Winged beans are native to hot, humid tropical regions. If you have had success introducing them into other climates we would especially like to know the details (e.g. in dry or high altitude regions).

**WINGED BEAN RECIPES**. Dr. Andy Duncan sent us several recipes; write us for a photocopy. Dr. Frank Martin sent this information on winged bean seeds: "Probably no region of the tropics uses the seeds regularly as food. Seeds are parched in Java, but probably only immature seeds are used. They are used for making a vegetable curd similar to tofu from soybean, but our experience showed that such curds are definitely inferior to those of soybean. The 4-hour cooking time is an obstacle [to use of the seed]. ...The heavy seed has been suggested to cause abdominal pain. The evidence is persuasive that dry winged bean seeds are difficult to eat."

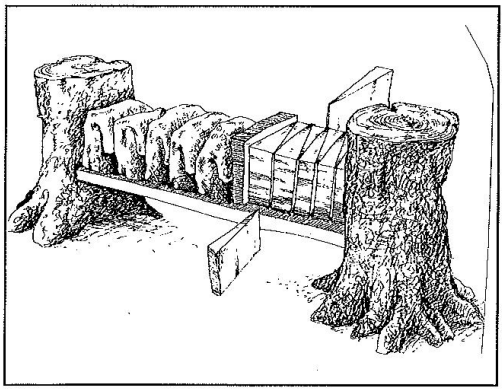
This was "confirmed in tests of 20 different lines.... Seeds left to soak absorbed water slowly, and some not at all. Three or four hours were required to cook soaked beans, and then some remained hard and unswollen. Cooked beans were harsh and nut-like, acceptable as an occasional food, but not attractive to the eye or the palate. When cooked beans were ground into soups and flavored with other ingredients, an acceptable product was obtained. Although variety differences were seen, these were not sufficient to permit selection of lines of acceptable value."



Frank suggested a different method of cooking. "The beans treated in this fashion are very soft. Even the seed coats are pliable and edible. Such beans have a mild and agreeable flavor comparable to that of other beans. Tests so far suggest that people who eat beans regularly accept them readily. [They can be] used in many traditional dishes. Not all varieties are equally suited to this technique. In many, a few seeds remain hard, and many are intermediate. In these lines, however, the softened seeds can be separated from the hard seeds with a large mesh screen. Here is that better method:

"Measure the volume of beans to be cooked. Rinse and add 5 volumes of water. To the water add 1% sodium bicarbonate sold as soda or baking powder [about 1/2 teaspoon per cup of water]. Boil the beans and simmer for 3 minutes. Remove from heat and soak the beans in the solution overnight. The following day, discard the soaking water, rinse twice with fresh water and boil in double their volume of fresh water for 20 to 25 minutes."

**FOOD CYCLE TECHNOLOGY SOURCEBOOKS** are eleven well-illustrated manuals (40-70 pages) which discuss different aspects of food processing, both traditional practices from around the world and modern equipment and techniques. With specific, basic information on technology choice for individuals and small businesses, they are most relevant for people who introduce innovations in food processing. Each book has a helpful checklist for planning your project or enterprise before you begin.



Most ideas involve a purchased technology upgrade, suitable for medium-scale processing with commercial potential. However, interesting and simple local technologies are also included. For example, the book on Root Crop Processing mentions the "wedge press, an adaptation of a traditional Chinese press used to extract oil. Tree stumps or logs provide support for a wooden beam inserted between them [see drawing]. Sacks of grated pulp are placed on the beam and pressure is applied when wooden wedges are hammered into the space between the sacks and tree stump."

The eleven titles are: Oil, Fruit and Vegetable, Cereal, Fish, Root Crop, and *Dairy Processing; Drying; Packaging; Storage; *Rural Transport; and *Women's Roles in the Innovation of Food Cycle Technologies. The books are particularly helpful for those interested in adding value to harvests by processing crops for storage or market. Available for US$13.50 (* for $15.50) plus postage. Discounts are available for orders of 10 or more books. Request the catalog from Women, Ink.; 777 United Nations Plaza, New York, NY 10017 USA; phone 212/687-8633; fax 212/661-2704.

***CULTIVOS ANDINOS SUBEXPLOTADOS Y SU APORTE A LA ALIMENTACION***, by Mario Tapia, FAO. 205 pages, Spanish only. This book was prepared by the FAO to provide practical knowledge of Andean ecology and agriculture, the domestication of Andean species and agricultural techniques used to grow these plants, agroindustrial potential, and their nutritional value and use. The task of the book is to provide a base to develop and improve under-exploited Andean crops.

The book begins with a brief history of the domestication of Andean plants. There are listings of wild relatives of modern Andean crops and the plants cultivated at the time of the Spanish invasion. The book also contains ecological classifications of different areas of the Andes, and the elevations at which the principal Andean plants are grown. However, most of the book provides detailed information of principal Andean cereal, tuber, and root crops (quinoa, kañiwa, amaranth, tarwi, oca, ulluco, isaño, arracacha, yacón, maca, and chago). For each crop there is a botanical description, comparison of varieties, cultivation and rotational practices, pests and diseases, brief harvesting and storage techniques, uses, and nutritional value tables. The book contains excellent color pictures and diagrams of the

different Andean species. The cereal crops quinoa, kañiwa, amaranth, and tarwi receive more attention than many others. The author briefly explains indigenous and mechanized practices to remove toxins present in some plants. He also devotes a chapter to the commercial development of underexploited Andean crops so that indigenous people might benefit from growing their native plants.

The book is written for people who conduct research oriented toward larger-scale development. However, the book could be helpful to anyone working in the Andes in agriculture or nutrition. For anyone interested in introducing Andean crops into their own communities, it is a good starting point with many references.

***MANUAL SOBRE UTILIZACION DE LOS CULTIVOS ANDINOS*** (121 pp., FAO) is a recipe source complementary to the above book. Traditional and non-traditional soups, drinks, desserts, breads, and other dishes are included. Most of these recipes include several Andean crops and would be most appropriate for the region. The books are only available in Spanish (with some Quechua throughout the text). Available free upon request from Dr. Cecilio Morón, Oficial Regional de Política Alimentaria y Nutrición, Oficina Regional de la FAO para América Latina y el Caribe, Casilla 10095, Santiago, CHILE; fax (56-2) 2182547.