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# Grain Amaranth

Dawn Berkelaar and Jacob Alemu

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This exceptionally nutritious, high protein grain, that requires less rainfall than corn, has potential as a staple for the general population plus seems to offer special value in managing diseases such as HIV/AIDS.

The Amaranth family contains more than 60 species (most of them wild) and thousands of varieties. Wild species are weedy and often eaten as a vegetable, especially in rural areas. The weed is called “terere” in Kikuyu, and “pigweed” in English.

Vegetable varieties of amaranth have been developed, with leaves that are eaten as a green. The vegetable varieties are called “mchicha” in Kiswahili. Sometimes amaranth is also grown as an ornamental.

In this article we are dealing with amaranth’s use as a grain. Amaranth plants yield tiny seeds that can be used as a grain to make flour, porridge and other foods. Amaranth, a broad-leaf plant, is known as a “pseudocereal,” because it does not belong to the grass family (as true “cereal” crops do), yet it produces seeds that can be used as flour for bread. Quinoa and buckwheat are other examples of pseudocereals.

Grain amaranth was a staple food of the Incas in Mexico. However, amaranth use was mixed with religious rituals that included eating amaranth mixed with human blood. When the Spaniards arrived, they used drastic techniques in an attempt to eliminate the use of grain amaranth. They all but succeeded for several hundred years.

Three main amaranth species are grown for grain. *Amaranthus caudatus* has the shortest season, with 45 to 75 days to maturity. This is the species mostly being grown in Kenya. The maturation date depends on altitude; amaranth grain matures faster at lower altitudes. Usually *A. caudatus* matures in 60 to 70 days in Africa. Its short growing season makes it good for areas that have a short rainy season. *A. caudatus* is also grown as an ornamental that can be identified by its red or green, nodding or drooping, tail-like inflorescences.

*A. cruentus* has a mid-length season of 60 to 120 days. It is often grown in Mexico and is least sensitive to photoperiod (hours of sunlight each day). *A. hypochondriacus* has the longest season, maturing in 150 days. It also has the highest yields and is disease-tolerant.

## How is amaranth eaten?

Amaranth grain has a nutty taste. In Kenya, it is used in porridge with maize or cassava) and chapattis (flatbread). Flour is also mixed with wheat (ratio of 30:70 or 40:60) and made into fried snacks like donuts. Amaranth has been incorporated into many local Kenyan dishes. In fact, in coastal Kenya, introduction of grain amaranth by the Christian Reformed World Relief Committee (CRWRC) started with cooking classes.

Amaranth grain can be popped like popcorn, and then added to many different dishes. Baby food made from amaranth is similar in composition to commercial baby food, though the amaranth cereal is higher in fiber.

Dick Dugger, a man who has been instrumental in promoting the potential of grain amaranth in Africa, says, "Many people we visited in both Uganda and Zimbabwe told us that they make a thin gruel and drink this 2-3 times a day. In Uganda, they are selling a product made from peanut butter and popped amaranth. We found popped amaranth very good as a mixture with yogurt. I like to add fruit or honey in the yogurt mix. I also sometimes like the added flavor of peanut butter to the amaranth yogurt mixture."



Figure 1: Amaranth plant Uganda Photo by Tom Gill

### **Who is working with amaranth?**

Dr. Davidson Mwangi began variety trials and recipe development in the 1990's after he received his Ph.D. studying amaranth at the University of Iowa in the USA. His book *Introduction to Grain Amaranth* would be helpful for those who would like more information than is shared in this article.

CRWRC began to promote grain amaranth in Kenya in 1999 when a sister organization (Partners for Christian Development) was looking for an

alternative crop to the vernonia they had previously been promoting. In 1999, grain amaranth was introduced in two communities in Eastern Kenya. In 2000/01 they

joined forces with Dr. Mwangi who headed a grain amaranth pilot project with the Maasai Rural Training Center in southern Kenya. Today many groups in Kenya are working with grain amaranth.

CRWRC partners with other organizations to promote grain amaranth. Groups that are not linked with CRWRC are also promoting it. Hundreds of farmers have tried grain amaranth, and interest is spreading from farmer to farmer; it is probably not an exaggeration to say that thousands of farmers in Kenya are growing amaranth.

### **Nutritional Benefits, including Possible Treatment for HIV/AIDS**

Amaranth grain contains about 16 percent protein, compared to around 10 percent in most cereals. The protein in grain amaranth is of extremely high quality, meaning that it has a good mix of essential amino acids and is easily digested, absorbed and retained. When amaranth grain is combined with another grain, it can form a complete protein diet.

Amaranth grain is very high in lysine, an essential amino acid that is so low in most other grains that they must be combined with other protein sources to achieve a good balance. The lysine makes amaranth particularly helpful for HIV/AIDS patients. Lysine helps the body to “inhibit the growth and multiplication of the [herpes] virus” (Mwangi). Herpes weakens the immune system of those with HIV/AIDS.

Grain amaranth is high in other nutrients in addition to protein. According to Lost Crops of the Incas, “Amaranth grain is also high in calcium, phosphorus, iron, potassium, zinc, vitamin E, and vitamin B-complex. Its fiber, especially compared with the fiber in wheat and other grains, is very soft and fine. It is not necessary to separate it from the flour; indeed it may be a benefit to human health.”

ECHO staff member Tom Gill visited farmers growing grain amaranth in Uganda. At ECHO’s Agricultural Conference last November, he reported that a mix of amaranth and moringa (one cup porridge with one Tbsp moringa powder) is being used in Uganda to combat HIV/AIDS, with people obtaining better results than with anti-retroviral drugs. Afterward, a conference participant commented, “You don’t have to admit you have AIDS in order to eat amaranth porridge [as you would in order to get anti-retroviral drugs].” That could be extremely important in places where AIDS is stigmatized.

Mwangi (in Introduction to Grain Amaranth) also wrote about amaranth in relation to numerous diseases. Apparently eating amaranth has helped to cure diseases caused by nutritional deficiencies (e.g. scurvy, kwashiorkor), helped prevent many lifestyle diseases (e.g. heart disease, high blood pressure), and helped manage or reduce symptoms of diseases such as tuberculosis, diabetes, and HIV/AIDS.

Dick Dugger has heard many comments about the benefits of eating amaranth. “[We heard] several stories of newborn babies who are taken off breast-feeding because the mother has AIDS. Babies [that are fed amaranth] are found to improve in weight and prosper ahead of schedule. We saw many cases in both Uganda and Zimbabwe of HIV/AIDS persons who tell of gaining new vitality and increased energy as a result of adding [grain amaranth] to their diet. A couple told us their blood pressure increases when they don’t have amaranth.

"In Zimbabwe, we stayed with Dr. Tagwira, the Dean of Agriculture at Africa University. He has approximately 75 farmers growing amaranth and he told us that all he can purchase is sold in a mix with moringa and goes to an AIDS program for feeding to AIDS infected persons. He also told us the boost to the immune system improves quality of life and also many of these have sores in the mouth that reduce a person's eating. The amaranth/moringa combination heals these sores and he attributes this to the lysine in the amaranth." [Dr. Mwangi told ECHO that the fermented amaranth porridge that was developed to meet local tastes is so smooth that patients can eat it without the pain they feel when trying to swallow many other foods.]

Linus Ndonga in Kenya shared with us about the work that his organization is doing with grain amaranth. Strategic Poverty Alleviation Systems (SPAS) works to promote sustainable and innovative technologies and practices to fight poverty. Their work includes helping poor communities to fight disease, including HIV/AIDS.

Ndonga shared, "SPAS has been providing grain amaranth to people living with HIV and AIDS, including children, with very encouraging results. All HIV and AIDS complications disappeared. Even for those experiencing side effects from conventional ARTs [antiretroviral] drugs, the side effects disappeared completely."

In addition to mentioning the role of lysine in HIV/AIDS treatment, Ngonga commented, "[Grain amaranth is also] rich in trace elements such as zinc, selenium and copper. Zinc has been shown to be important for memory, immunity, and wound healing. As for immunity, people with AIDS are almost universally deficient of zinc, which contributes significantly to the continued decline of their already damaged immune systems. Restoring their supply with grain amaranth could be one of the most important strategies for stabilizing their immune function and reducing complications from the disease."

We wrote in *Amaranth to Zai Holes* about *Amaranthus cruentus* and *A. hypochondriacus* (p. 75). That book also includes information on the nutritional limitations of amaranth (p. 287). It seems that raw seed of *A. hypochondriacus* contains some anti-nutritional factors. You can find the information from *Amaranth to Zai Holes* on our website ([www.echocommunity.org](http://www.echocommunity.org)) (<http://www.echocommunity.org/>).

According to Mwangi (*Introduction to Grain Amaranth*), "small levels of heat sensitive and chymotrypsin inhibitors are present [in grain amaranth, but are easily inactivated by cooking]. Grain amaranth's anti-nutritional factors are very low as compared to [those in] soybeans."

### **Amaranth for Leaves and Grain**

As stated earlier, there are grain types of amaranth and vegetable types of amaranth. The leaves of both types can be eaten, but the taste and yield of grain from a grain amaranth species will be better than the grain from a vegetable species.

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ECHO's farm manager Danny Blank has commented: "In general, I am far more impressed with grain amaranths than with what are typically called vegetable amaranths with the exception of 'Tigerleaf' and 'Jamaican Calalu'. But if I had to

choose between Tigerleaf and a grain type, I think I would still choose grain types. They are so much more vigorous. I have seen fields in the Central African Republic (C.A.R.) and Haiti of grain amaranths growing. I think in both places it was being raised for leaf production despite being a grain type. They are incredibly vigorous and can be coppiced [plants are cut back and resprout] for several harvests. However, in C.A.R. people sow incredibly thick patches and then several weeks later harvest a section of the patch and [take out] the entire plants— stems, leaves, and roots. They are about 12 inches tall and [people] sell them in the market that way with the roots still attached. (I think leaving the roots attached helps extend their life from the field to the market and home). Several patches will be sown at different times allowing for continual harvest. Some plants are left to go to seed. From what it appeared to me, the folks were using the grain types.”

I (DRB) asked Tim Bootsma, working in Zambia, what experience he has had with grain amaranth. He responded, “Some years ago when Stephan [with CRWRC] came for a visit of some of our projects, he left behind some grain amaranth. I distributed it to some of our field staff. Several times over the past years I’ve seen it growing in gardens. When I’ve asked the people what they use it for they say that it’s a good leafy green!!!! Clearly the information did not get through that this had great value as a grain. A close relative to amaranth grows wild here in Zambia during the rainy season. It is considered to be a weed, but they will pluck the leaves to cook as greens.”

Clearly amaranth seems to have a larger profile as a leafy vegetable than as a grain. Even when growing the plant for grain, it is okay to harvest some of the leaves to eat as greens. Just be careful not to harvest too many, since the leaves are necessary for photosynthesis and for grain production.

### **Drought tolerance**

In addition to its nutritional excellence, amaranth is extremely drought tolerant. Some grain will be produced as long as there is enough moisture in the soil for the seeds to germinate, and as long as there is one good rainfall about three weeks after emergence. Mwangi wrote that when Kenya experienced a severe drought between 1984 and 1985, amaranth was still harvested from trials, when even sorghum crops had failed.

Amaranth’s drought tolerance seems to result from two things. First, the plant develops a deep and extensive root system. Second, it can go dormant under extreme drought conditions. Amaranth has a C4 metabolism, meaning that it uses a type of photosynthesis that is particularly efficient, especially under dry, high temperature conditions with bright sunlight. Amaranth requires much less water than maize, even under good conditions (i.e. conditions that will result in a high yield). It requires 40 to 50% less water than maize.

A. caudatus, the grain amaranth species with the shortest season, is very photoperiod sensitive, and the number of days to maturity will depend on the variety, the region, and environmental factors such as day length, temperature, and available moisture.

### **Small Seeds**

Amaranth seeds are very tiny; an individual seed is between 1 and 1.5 mm in diameter. 1000 seeds weigh less than 1 gram. By contrast, 1000 wheat seeds weigh 35 to 45 grams. The small size of amaranth seeds means they can be difficult to work with. For planting, you only need ½ to 2 pounds per acre (for wheat the planting rate is 90 to 120 pounds per acre). Planting more densely would not be of benefit, because amaranth seems to be self-suppressing. Under a high population, a number of plants will not produce seed.

Tim Bootsma commented, “[Of] all the grain amaranth that I have seen growing in Zambia, most of it remains very small, about knee high when fully mature. Only in my garden have I grown amaranth that was 2 meters tall. I’m thinking this is partially because people plant it too close together (too high population) and secondly the average soil fertility is not good enough to get the good growth. However these are only my observations and not based on researched data.” [Ed (MLP): Grain amaranth is very sensitive to day length. When we plant it during the shortest days of the year at ECHO, some varieties begin flowering when only a few centimeters tall, and plants do not have enough energy to produce a meaningful crop.]

In a document called “Promoting Amaranth Grain in Kenya,” Jacob Alemu states that thinning of an amaranth crop is what determines the yields.

Amaranth grain is well suited for manual planting and harvesting. For hand seeding, the tiny seeds can be mixed with sand, ground corn or a similar material so that a “pinch” of the mixture will likely contain only one or two seeds.

Harvesting amaranth by hand is labor-intensive. However, seed threshers and cleaners that can handle amaranth are available.

### **Difficulty establishing crop**

The small seed size means shoots might have difficulty emerging. If possible, plant in low-clay soils to reduce crusting. Seeds should not be planted too deep. Between ¼ and ½ inch (6 and 12 mm) has been recommended.

Weed control is very important while seedlings are getting established, because the amaranth plants grow slowly while their root systems are developing. Once plants are about six inches tall, they begin to grow rapidly.

Franklin Voorhes in Guatemala tried several varieties of amaranth and wrote in July 2005 that his results had been disappointing, with none of the seeds sprouting. “We’ve had a lot of rain—I don’t know if that’s bad for amaranth. We’ve had several days with 2-3 inches of rain in an hour.” He planted other amaranth seeds (from a food store), which sprouted but “seem a little too yellow to be healthy.”

Voorhes added, “I visited another project on the other side of the same mountain, and they have a little amaranth that is doing very well. It was 30 inches tall and seemed great. So I know it can grow around here, but there’s a secret I’m missing.”

Danny Blank responded, “Even though the store-bought seed sprouted and the seed from ECHO did not, I would say it has more to do with the rain than seed quality. If one gets over 2" of rain in one rain event while the seed is germinating I would presume it washed away. Amaranth seed is so small.” [Ed: Ants might have carried it away too.]

Tim Motis wrote from Haiti in July 2005, to share his experience with amaranth. "I have tried eight ECHO varieties in the garden at HAFF. Four were grain varieties; the other four were vegetable. The first time we planted all eight directseeded in rows, chickens got in and scratched the beds to the point that the seeds probably became exposed to the hot sun and very few survived. Those that did germinate and form small seedlings endured more damage by chickens and were destroyed.

"I tried again with all eight varieties this rainy season. Chickens are much less of a problem during the rainy season because there is more forage around. Again, I planted in furrows and covered the seeds with a thin layer of fine soil mixed with bat manure (very powdery and fine-textured). The furrows were also covered with sugarcane bagasse after planting. The bagasse was removed little by little as the seeds germinated. Germination was fine for all eight varieties. Interestingly, though, insects "decapitated" (cut the stems close to ground level) almost all the plants of the vegetable varieties. It almost looked like they didn't even germinate, but the stems (minus the leaves) could be seen by looking closely at the ground. Some of the seedlings of grain varieties were destroyed by insects, but they seemed to have more seedling vigor, grew quickly, and soon developed stems that were thick enough to withstand the insects. The grain varieties are now growing beautifully. I have not given up on the vegetable varieties, but am starting them in the nursery in pots instead of direct seeding. Even in the nursery, I have had quite a few seedlings destroyed (presumably by small caterpillars we have seen once or twice).

### **Other Suggestions and Comments**

Amaranth has minimal fertilizer requirements. Cow manure seems helpful when added to the soil.

Spacing suggestions vary. 75 cm (30 inches) has been suggested between rows. During a discussion at ECHO's Agricultural Conference last November, spacing of 1 m (40 inches) by 30 cm (12 inches) was suggested.

Amaranth seed heads are not damaged by birds to the extent that sorghum and millet are. In addition, Stephan Lutz (with CRWRC) commented that stored amaranth is less appealing to insects than are other stored grain crops. Practice of good rotation will help minimize diseases and insects. Suggested rotation crops include millet, maize, potatoes, and cowpea.

Kenya and Uganda are between 4°N and 4°S of the equator. CRWRC suggests trials for other semi-arid parts of West Africa, such as Niger, Mali, Burkina Faso, Chad and Nigeria. These countries range in latitude from 2 to 24°N. It is not yet known what effect different latitude would have on days to maturity. At ECHO, we only plant grain amaranth in the spring when days are lengthening. If we plant too early they bloom when the plants are tiny and we get no yield. The summers are too wet to be able to harvest, so we plant as early as we dare so we can harvest before the rainy season begins. We do not plant in the fall because by then caterpillars have become such a problem that we would need to use a lot of spray to control them.

High levels of rainfall are undesirable. Too much water can waterlog the soil; can lead to tall growth and lodging; and can promote mold growth. If lodging (falling over during storms) is a problem, try planting seeds slightly later to reduce plant height. The Rodale Institute in the United States did extensive research on amaranth

but concluded that you can't grow amaranth well east of the Mississippi because of high humidity and rain during harvest time. Also note that amaranth is not at all frost-tolerant.

### **Where can I get seed?**

Enormous variability exists between varieties of amaranth of the same species. Before you decide to introduce amaranth, it would be wise to evaluate several varieties. When you request amaranth seed, you can choose from ECHO's varieties or request that we choose a few for you. However, if you plant them as a variety trial (several varieties planted in the same time and place), there is danger of outcrossing; after harvest you will need to request another trial packet of any varieties that do particularly well (or save some of the seed from the trial packets before planting). Alternatively, you can separate the varieties as much as possible, or plant them one at a time. Also note that *A. caudatus* is considered an "heirloom" seed variety, and can be purchased through most commercial seed catalogs and at most lawn and garden stores in the US.

Dr. David Brenner at Iowa State University suggests that seed multiplication of grain amaranth should be done locally. This would improve the local economy and would help keep seed costs lower. However, producing seed locally has its challenges. A higher level of management is needed to produce seed than to produce the grain for consumption. Care must be taken to avoid out-crossing with wild or weedy types, such as the red root pigweed, *A. retroflexus*. Seed color is often an indicator of out-crossing. Grain amaranth is usually light in color, while outcrosses are dark in color. When growing for seed, weed out the pigweed; save seed from large seed heads; and take seed from the center of the patch (where seed will be most pure).

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