Baobab - Homegrown vitamin C for Africa

The project aims to build capacity for sustainable agriculture among rural communities in Cinzana and Katiena

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The baobab (*Adansonia digitata*) is well distributed throughout The Sahelian and Sudanian zones of Mali. The greatest concentrations of trees are found in former and present village sites, where villagers protect and even manage the trees' growth and survival. Baobab trees are usually allowed to survive until their natural death in cultivated fields, where they are left undisturbed among the crops. On the Seno Plain of Dogon country, along Mali's southern border with Burkina Faso, villagers often plant baobabs within their own courtyards and nurture them until they are 2-3m tall, before transplanting them along the edges of cultivated fields.

The uses of baobab are many. The bark and rind are used for cord fibres and to fuel the slow and hot pottery-baking processes. The young, tender leaves of all the baobabs, particularly the dark-leaf vegetable types, are used as green or dried vegetables in sauces. The black- and red-trunk baobabs are often preferred for their fruits. The white, powdery pulp of the fruit capsule is extracted and used as a flavoring in a variety of cool and hot drinks.

The baobab capsule pulp is reported to have a high content of vitamin C. One source reports that

the content of vitamin C in the baobab fruit is 1690 mg/kg, compared with 1060 mg/kg for fresh hot pepper (Agbessi Dos-Santos 1987). This level is nutritionally interesting, so we decided to sample a large number of Malian baobab capsules to determine the range in vitamin C content - determine whether there were significant differences in vitamin C concentration from 1 tree to another and whether such differences were related to any recognized morphotype or geographic region.

We made the fruit collection in March 1995, in 3 collection areas - each with a distinct soil type, rainfall pattern and ethnic group. Within each region, 4-5 villages were chosen, within which 2-3 trees were sampled. Villagers were asked to choose trees from which they would normally harvest capsules and pulp. We made an effort in each village to harvest each of the 3 major tree morphotypes. From each tree we harvested 5 fruits randomly, for a total of 120 fruits from 24 trees.

At the Sotuba Research Station we broke these open, scraped out the pulp and pounded it with a pestle. We separated the pulp powder from the seed and fibre, using the screen used traditionally in Malian villages. The extracted powder per fruit ranged from 20 to 128g, with an average of 41g We then scaled the pulp powder in polyethylene sachets, for shipment to Basel, Switzerland.

In July 1995, the samples were analyzed in the laboratories of F. Hoffman-La Roche Ltd, using an extraction procedure described by Keller and others (1988); the results are shown below.

Analysis of variance of the entire collection revealed a highly significant difference between individual trees for the vitamin C content. The F ratio for variance within and between trees was 26.3; the LSD for comparing tree means was 531.

There were no significant consistent differences in vitamin C content either between regions or between types of trees.

1 Nutrition and food technology

The high concentration of vitamin C in baobab fruit, given the widespread distribution of the tree in semiarid parts of Africa, offers exciting opportunities for more research and for immediate action in public health.

Sauberlich (1994) summarized the state-of-the-art information on the nutritional and clinical uses of vitamin C, also known as ascorbic acid. It is a powerful antioxidant and extremely important in human nutrition - vitamin C has been shown to be related to low blood pressure, enhanced immunity against many tropical maladies, lower incidence of cataract development and lower incidence of coronary disease. Because of its many beneficial effects, it has become a major nutritional supplement. In addition to its many natural sources, several thousand tonnes of the vitamin are produced synthetically each year for use as a nutritional supplement.

Vitamin C can be adversely affected by moisture during storage or by heat during food preparation. Fortunately, the current traditional storage and food preparations of baobab powder in West Africa are very favorable to the preservation of the vitamin. The baobab fruits are either stored whole until food is prepared or the pulp powder is extracted and stored in a dry state. Baobab powder is often conditioned and marketed in polyethylene sachets, which protect the powder against ambient moisture. The use of baobab powders in food preparation is almost exclusively limited to cool and hot drinks and gruels. The powder is never cooked as the hot drinks are being prepared, rather it is added at the end of the preparation process, after the drinks are allowed to cool. Traditional food technologies for baobab powder need to be encouraged and their principles maintained in any innovative technologies.

As local technologies are already very good and already widely practiced, intensification of the consumption of baobab powder in West Africa could be focused on education as to appropriate nutritional uses and recommended dosages.

The daily recommended intake for healthy, non-smoking adults is 65 mg; smokers need more vitamin C than non-smokers. While 65 mg a day is the minimum recommended intake, a full saturation of the total pool of vitamin C in the body is about 140 mg per day. Convalescents recovering from infectious diseases or nursing mothers benefit significantly from daily intakes exceeding, 250 mg (HE Sauberlich, pers. comm.).

Using the average vitamin C content of baobab fruit, 2800 mg/kg, we can convert these recommendations into amounts of baobab powder. The daily recommended dose of vitamin C can be obtained from 23 g of baobab powder. The daily saturation of the vitamin C pool in the body requires 50 g of baobab powder; the special dosage for convalescents is 90g. There are enough baobab trees to provide those amounts of vitamin C to the millions of people in semiarid West Africa. Vitamin C is not lacking - information about basic vitamin C nutrition is!

2 Conclusions

The sampling of baobab trees in Mali reveals that there can be a 3-fold difference in the concentration of vitamin C in the trees. There is significant potential for selecting trees and clones with high vitamin C content. This study indicates that the traditional grouping of baobabs on trunk color is not useful as selection criteria for vitamin C content. The study also indicates that very high vitamin C levels could be found in all major tree types and within 3 major production zones. Further study needs to be done to identify simple plant characteristics that might be reliably linked to vitamin C content.

The senior author of this paper has successfully grafted baobab trees (Sidibé 1992). Young trees 3 months to 2 years old readily accept graft stock. Additionally, graft stock can be stored moist and at ambient temperatures for up to 2 weeks. Grafted baobabs offer not only faster development and lower bottom branches that make fruit harvest easier but also a fabulous opportunity for propagating individual trees selected for high vitamin C levels in the fruit pulp.

While there is plenty of room for improvement through tree selection, the average vitamin C content of more than 2500 mg/kg is already very high. Education on the nutritional value and use of baobab fruit could raise nutritional standards and also stimulate the market availability and trade of baobab powder. And there is no need to stop there. Nutritional tables indicate that baobab leaves contain an interesting level of vitamin A, and baobab trees thrive in many of the areas where there is a nutritional need for vitamin A!

3 Authors' note

There is no intention to commercially exploit any of the work done on the baobab fruit. This work was done in the context of the Syngenta Foundation's support of the Cinzana Research Station near Ségou, Mali. The purpose is to bring agronomic, nutritional and food technology information to bear on the correct use of baobab fruit as a source of vitamin C in the Malian diet. Markets for nutritious foods and nutritional additives are created out of a demand for such products. This kind of research is used to increase educational awareness, which can gradually develop the indigenous market demand for natural products such as vitamin C in baobab.

Modibo Sidibé is head of the Forestry Resources Program, IER, BP 258, Bamako, Mali
J Scheuring is the maize hybrid breeding manager for Novartis Seeds (now Syngenta) and scientific adviser to the Syngenta Foundation for Sustainable Agriculture, Basel 4002,

Switzerland.

D Tembely is the biologist and M M Sidibé is a forestry engineer; both are in the Forestry Resources Program in Bamako

P Hofman is the analytical chemist, Vitamins and Fine Chemical Division, Hoffman-La Roche Ltd., Basel 4070, Switzerland.

M Frigg is the secretary of Task Force Sight and Life, Hoffman-La Roche Ltd, Basel 4070, Switzerland.

4 Additional information

4.1 recent updates

a. *Baobab Fruit Vitamin C follow up.* Trees that had been sampled in 1994 were again resampled in 1998 to confirm the year-to-year stability of Vitamin C content. There was a remarkable consistency of Vitamin C levels. The tree with the highest content had 4991, 5127, and 4920 ppm Vitamin C from fruit harvested in 1994, 1997, and 1998 respectively. With such remarkable consistency of such a remarkable high level of Vitamin C, we have decided to propagate the high Vitamin C level of that tree through tree grafts. On the station we have established an orchard of 100 young baobab trees, which have all been grafted with graft stock coming from the tree with the highest Vitamin C level. First fruit from these grafted trees is expected by the year 2010. If the Vitamin C content of the grafted trees is again as high as the graft stock tree, the Cinzana orchard can serve as donor scions for the future Baobab "Vitamin C" orchards of future farmers!

b. Baobab Leaf Vitamin A has been determined for various tree types, drying methods, and processing methods. We demonstrated that the simple use of shade drying of leaves rather than sun drying doubles the pro-Vitamin A content of leaf powder (the typical for of consumption). The pro-Vitamin A is additionally boosted by the choice of small leaf types. This work as well as the Vitamin C was done in full collaboration with Roche's Task Force Sight and Life. technical sheets have been established and are being translated into vernacular literacy programs by the Malian Indigenous Literacy group (DNFLA).

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