Unsweetpotato – Breeding staple-type sweetpotato for West Africa and beyond

SASHA
Sweetpotato Action for Security and Health in Africa

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An applied, collaborative sweetpotato breeding program and support platform for West Africa was established in Ghana at the CSIR-Crops Research Institute in 2010. Consumer demand for staple-type (low sugar) or Unsweetpotato was confirmed and laboratory methods to assist with selection developed and used in a new Quality Laboratory. Seed populations were made available for distribution to regional partners.

Fig. 1. Ernest Baafi (center) in the Ph.D. program at WACCI discusses breeding strategy with Aboubakar Toure of AGRA and Dr. J.N. Asafu-Agyei of CRI (credit T. Carey)

What was the problem?

Sweetpotato by its very name implies sweetness, and many consumers enjoy this characteristic of sweetpotato. However, the sweetness of sweetpotato holds back its potential to play a greater role as a starchy staple in diets. This is particularly so in West Africa, where starchy staples such as rice, maize, yam, cassava, plantain and cocoyam, with lower "flavor impact" are the major starch sources in diets. Sweetpotato improvement has received little attention in West Africa, so the establishment of a breeding support platform under Phase 1 of the Sweetpotato Action for Security and Health in Africa (SASHA) project filled a significant gap. During the consultative process of setting priorities for SASHA, a consensus emerged that population development for low sugar (Unsweetpotato breeding) should be a hallmark of the West African breeding effort. West Africa leads other sub-regions in Africa on the diversity of processed products made with roots and tubers. Hence, attention also needs to be paid to how easily candidate Unsweetpotato varieties can be incorporated into value chains for processed products. Characteristics such as storability, poundability, etc. are likely co-traits needed with low sugar for varieties to fit into market value chains. Due to high vitamin A deficiency in Sub-Saharan Africa, selection of high beta-carotene orange-fleshed sweetpotato, is also a priority, but just not exclusively.

What did we set out to achieve in Phase 1?

CIP's breeding efforts under SASHA aim to develop improved breeding methods and establish efficient population improvement programs at a sub-regional level in SSA, linked with participatory varietal selection at the national level. This collaborative breeding effort for West Africa under SASHA sought to:

- *Refine our understanding of preferred taste among consumers for sweetpotato in West Africa, particularly in Ghana*
- *Strengthen capacity to efficiently select for preferred quality types, particularly unsweetpotato in West Africa, including development of screening techniques and human resource capacity to implement an applied sweetpotato breeding effort*

Where are we working?

Ghana is the lead country for root crops research under the West African Agricultural Productivity Programme (WAAPP), and the Council for Scientific and Industrial Research (CSIR) – Crops Research Institute (CRI) is the designated National Center of Specialization, so Ghana was the logical location for SASHA's sub-regional breeding effort for West Africa. SASHA established the Sweetpotato Support Platform for West Africa at the CSIR – CRI in Kumasi. *In vitro* laboratory facilities, virus indexing capacity, screen houses, crossing blocks, and a quality laboratory at CSIR-CRI provide the foundation for a collaborative breeding effort with selection sites in major sweetpotato production regions and agroecological zones of Ghana, with close links to breeding programs in Nigeria and Burkina Faso. In northern Ghana, the CSIR-Savanna Agricultural Research Institute (SARI) is an important partner in the breeding effort. Additionally, the presence of the AGRA[1] supported West Africa Center for Crop Improvement (WACCI) at the University of Ghana–Legon, provided opportunities for backstopping four doctoral students conducting thesis research on sweetpotato breeding (Figure 1).

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CIP
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SPHI
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[1] *The Alliance for a Green Revolution in Africa (AGRA) supports two five year doctoral level breeding programs in Africa, one in South Africa and one in Ghana, to address the significant shortage of qualified breeders on the continent.*

What did we achieve during Phase 1?

Achievements are presented for each of our major objectives:

Refine our understanding of preferred taste and consumer acceptance traits for sweetpotato in Ghana. A participatory, demand-led approach is required for breeding success. Participatory approaches used included conducting survey work prior to selecting thesis topics, the routine consumer assessment of cooked sweetpotato in advanced trials, and laboratory sensory analysis for preliminary selections. Survey exercises confirmed consumer and producer interest in high dry matter, medium to high carotenoid content, Unsweetpotato. Consumer sensory analysis of boiled or fried sweetpotato confirmed the program was selecting genotypes with low sweetness and high consumer acceptance. Interestingly, many consumers in a survey conducted in a number of regions of Ghana said they like sweetpotato because it is sweet! Study is continuing, but our current assessment is that sweetpotato preferred by Ghanaian consumers falls into the low to moderately sweet, relatively dry textured category, similar to staple-type sweetpotato preferred by consumers elsewhere in Sub-Saharan Africa.

Strengthen capacity to efficiently select for preferred quality types in West Africa. To effectively select for Unsweetpotato, we equipped a CRI laboratory with a near infrared reflectance spectrometer (NIRS) which permitted rapid evaluation of sugars and starch. By year 5, trained personnel were processing >2000 samples per year (Figure 2). However, we needed to extend our NIRS calibrations to be able to measure sugars in cooked sweetpotato samples. We did this by baking, boiling or microwaving Ghanaian sweetpotato genotypes. In addition to developing a robust calibration for sugars in cooked sweetpotato samples, this work confirmed that microwave cooking should not be used in our screening program, as maltose content of microwaved sweetpotato does not increase during cooking due to rapid inactivation of amylase enzymes. Since amylase[2] activity in sweetpotato influences both sweetness and texture in cooked sweetpotato, we examined this in varieties released by the Ghanaian breeding program to date, and found activities ranging from low (1 variety) to moderate (3 varieties), high (5 varieties) and very high (2 varieties). However, sweetness in cooked sweetpotato is also a function of sugar content in the raw sweetpotato, and after baking Ghanaian released varieties were classified as non-sweet (<12% sucrose equivalent (SE)[3]; 1 variety), low sweet (12 to 20% SE; 3 varieties); moderately sweet (21 to 28% SE; 7 varieties). None were sweet or very sweet. Figure 3 presents a popular form of sweetpotato consumption in Ghana: fried with hot pepper sauce, often with fried fish.

The hot lowland agroecologies of West Africa present serious constraints to sweetpotato, including high sweetpotato virus disease (SPVD) pressure in the forest transition zone; and drought and weevil pressure across environments. Thus, our breeding effort also addresses these constraints through a full program of hybridization using 80 parents in two genepools, and multi-stage selection using the accelerated breeding approach, with the release of the first batch of new varieties expect in 2016. To improve the efficiency of our work, bar code labeling of clones was introduced in 2013, reducing errors between the field and the quality analysis lab (Figure 4).

Next Steps

We will focus on strengthening and ensuring a productive breeding effort that will generate new varieties for Ghana and germplasm for the entire African region. The program will continue to emphasize Unsweetpotato breeding, exploiting heterosis (hybrid vigor), and will introduce a new, previously neglected breeding objective, selection for improved shelf life. We expect 10% to 20% of clones in the hybrid breeding population to show low sugar contents and low perishability. In collaboration with other projects, we will be testing the use of low sugar varieties for suitability for a range of processed products.

Fig. 2. Quality Lab Manager Eric Owusu-Mensah is also working on his PhD related to sweetpotato quality (credit T. Carey)

[2] *When sweetpotato roots are heated to 60-78ºC, its starch is degraded by amylase enzymes into maltose, a sugar. The amounts of starch and amylases vary by genotype.*

[3] *Sucrose equivalent (SE) is the total sugar content with the value of each sugar adjusted based on its sweetness relative to sucrose.*

Fig. 3. Unsweetpotato is a popular fried snack with pepper sauce in Ghana (credit T. Carey)

Fig. 4. Bar code labeling is helping to improve accuracy and efficiency of breeding efforts (credit T. Carey)

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