

ANNEX 2

REVISED-3 DRAFT

ROOTING OUT HUNGER IN MALAWI WITH NUTRITIOUS ORANGE-FLESHED SWEETPOTATO (OFSP)

A TRAINING OF TRAINERS' MODULE

FOR OFSP PROCESSING

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INTRODUCTION

The role of sweetpotato in Malawi is becoming more important and substantial, as the government has recognized its significant potential to contribute to food security, especially in densely populated areas where landholding size is severely constrained. Furthermore, OFSP can contribute to combating vitamin A deficiency (VAD) and can also serve as a wheat flour substitute in processed products. OFSP is a bio-fortified crop, in that it is a staple food whose micronutrient content has been enhanced to the point where impact on micronutrient status can be achieved (Bouis, 2002). In De Schutter's special rapporteur's report on the right to food (2011), submitted to the Human Rights Council of the United Nations General Assembly, he addressed the link between health and nutrition. The report stated that "biofortification"—the improvement at crop level of the micronutrient content of staples—can provide important benefits for rural populations, improving their access to micronutrient-rich foods produced locally at more affordable prices. In addition, Low *et al.* (2007) reported that promotion of OFSP in Mozambique reduced VAD significantly at the community level.

The development, promotion, and dissemination of pro-vitamin A rich OFSP varieties aligns perfectly with the food security and nutrition objectives of Malawi because of four key strengths:

- It is packed with pro-vitamin A. Just 100 g (1/2 cup) supplies the daily vitamin A needs of young children under 5 years of age and vulnerable women, the group most at risk of VAD (Hotz *et al.*, 2011). All sweetpotato varieties are good sources of vitamins C, E, K, and several B vitamins but only OFSP has pro-vitamin A. Research in South Africa (Jaarsveld *et al.*, 2005) has demonstrated the efficacy of OFSP as a bioavailable source of vitamin A, and community-level research in Mozambique (Low *et al.*, 2007) demonstrated that an integrated approach using OFSP can reduce VAD in a resource-poor population.

- Compared to many other crops, sweetpotato requires few inputs and relatively lower labor, making it particularly suitable for households threatened by migration, civil disorder, or diseases such as HIV and AIDS (Jayne, *et al.*, 2004).
- The ability of sweetpotato to produce relatively good yields under marginal conditions, its flexible planting and harvesting times that provide roots and leaves during the hungry season, and its good yield response to better management are factors driving its expansion in Sub-Saharan Africa (SSA) (Low *et al.*, 2009).
- As in many parts of SSA, sweetpotato is a women's crop in Malawi. Since women are responsible for the preparing food for their families, and are the primary caregivers for young children, the likelihood of OFSP uptake by the two groups most susceptible to vitamin A deficiency, young children and women of reproductive age, is vastly enhanced.

A formative research study on nutritional status related to poverty and food insecurity in Malawi was done by B. Mtimuni of Bunda College in 2011¹. Key information from the study is highlighted here. In Malawi, malnutrition is associated with maternal and child/infant mortality, and the micronutrient deficiencies, vitamin A (59.2%) and anemia (79.7%), were very high among children under the age of 5 years. Although VAD does not kill its victims directly, it weakens the immune system and leaves the child susceptible to diseases such as measles, malaria, and diarrhea. Those most severely affected are young children and pregnant and lactating women. In 2003, the Infant and Young Child Nutrition Policy was formulated by the Government of Malawi, and was revised in 2009 to include new WHO recommendations on feeding practices, for HIV exposed infants and young children. The review also helped to align the policy with the National Nutrition Policy and Strategic Plan (NPSP), which is the main document to guide implementation and provision of nutrition services, interventions, programs, and projects in the country for the period 2007–2012. It was recommended to conduct training exercises on nutrition education and communication as part of a comprehensive information education and communication (IEC) strategy. These activities are programmed under the “Scaling up Nutrition (SUN) 1000 Special Days” Initiative. Rooting out Hunger in Malawi with Nutritious Orange-Fleshed Sweetpotato project is aligned with this “SUN” movement.

The Rooting out Hunger in Malawi project is funded by Irish Aid. This project develops a 1 (“primary”), 2 (“secondary”), 3 (“tertiary”) vine multiplication system to rapidly and widely disseminate OFSP. The primary multiplication provides clean planting material and is managed by researchers at the research station; the secondary and tertiary multiplications are decentralized on farms and managed by farmers. The seed system, combined with nutrition and market-based approaches, aims to stimulate demand for OFSP and ensure that by the end of the project at least 20% of households growing OFSP will earn at least US \$100 per year from OFSP sales and will increase their yields by 50%.

The project is laying the foundation for the sustainable expansion of food and nutrition security and market-based use of OFSP to improve livelihoods of increasing numbers of households in Malawi. Major efforts on nutrition awareness and market development for both fresh and processed OFSP products will be complemented by private sector and community-based capacity development to improve production and postharvest practices.

Promoting the utilization of OFSP roots and leaves will foster household food and nutrition diversification. Additionally, diversified OFSP products can also significantly contribute to generating additional household income, through the establishment and improvement of small-scale businesses. Thus, sweetpotato product diversification can strongly contribute to improving

¹ This case study was part of the “Rooting out Hunger in Malawi” project implementation of Yr 1.

livelihoods of poor families in rural areas. Women are crucial and they are the primary focus of the Rooting out Hunger project since they are the primary managers of household meals and are the primary caregivers in most households.

Demand creation campaigns have focused on the “minus 9 months to 24 months” period and on the key “essential nutrition actions” (ENA) that OFSP can contribute to. Further work should continue with locally based nutritionists to incorporate OFSP as a “doable action” into the relevant essential nutrition actions and messages. This includes continued development of complementary multi-mix feeding recipes which use at least three food groups. These recipes should reflect the seasonal availability of different foods including sweetpotato roots and leaves, specific age-group needs, and should incorporate relevant care practices (e.g., meal and snack frequency, feeding style). Since vitamin A is a fat-soluble vitamin that is stored in the liver Haskell (2004) advised that a small amount of oil should be added included with OFSP recipes. Additionally, from the research done by Bechoff *et al.* (2011) it is suggested that a serving of porridge (one mug), boiled root (half a root), mandazis (two), or chapatti (one) would provide a significant part of the daily vitamin A requirements of a child under 6 years, i.e. one mug of porridge is 20% of daily vitamin A requirements, boiled root of half a root 46% , two mandazis 75%, or one chapatti 100%.

Sweetpotato products can be made from sweetpotato flour, mashed boiled sweetpotato roots, or fresh sweetpotato roots. Some products are:

- Sweetpotato Bread
- Sweetpotato Doughnuts
- Sweetpotato Juice
- Sweetpotato Thobwa (sweet beer)
- Mixed sweetpotato vegetables
- Multi-mix feeding recipes: roots with pigeonpeas, peas, tomatoes, fish, meat, etc
- Futali (boiled sweetpotato with peanut sauce)
- Chigomwa

Multi-mix meals were recommended during the working session to prepare the Education Information and Communication (EIC) materials for the “SUN” initiative in Malawi. The reason is that most rural Malawians do not have more than 2 cooking pots. It is suggested that multi-mix meals can serve the food for the whole family including the small children under 5. The mothers then mingle (mix and mash) the foods for feeding the infants.

LEARNING OBJECTIVES

To encourage creativity in cooking skills so a variety of nutritious dishes can be prepared using OFSP storage roots and leaves.

At the end of the modules participants should be able to:

- Understand the value of using OFSP in their multi-mix meals
- Create a variety of dishes that are made from OFSP roots and leaves
- Be able to teach others recipes that may assist them to develop a small business selling OFSP products to generate household income

This training module contains 2 main sessions, i.e., an interactive lecture to develop knowledge of OFSP nutritional value and use, and instructions preparing recipes

MODULE: Understanding of Food Processing and OFSP Nutritional base-food

Background

Food processing is the set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans or animals either in the home, or by food processing industry. For business purposes, the Malawi Bureau of Standards (MBS) should be involved to ensure that sweetpotato flour, the hygienic preparation of OFSP products, etc., is of high standard.

The various purposes and advantages of processed products may be listed as follows:

- Products are easier to market and distribute
- Preservation
- Toxin removal, i.e. in Cassava and soybeans
- Increases seasonal availability of a variety of foods
- Enables transportation of delicate perishable foods over long distances
- Makes foods safer to eat by reducing micro-organisms that cause spoilage and pathogenic

For sweetpotato, advantages of processing are:

- Improved palatability
- Extended storage time
- Easier transportation and marketing
- Increased seasonal availability of sweetpotato products

Carotenoids are found in nature as trans-carotenoids. Under stressful conditions such as heating and UV-light exposure, trans-carotenoids are isomerised into cis-carotenoids (9-cis; 13-cis and 15-cis for β -carotene). Isomerisation could be considered as a negative effect of processing since cis-isomers have less pro-vitamin A activity (about half) than trans-carotene. Isomerisation can occur in pro-vitamin A carotenoids at temperatures above 35°C. 9-cis is predominantly formed above 100°C whereas 13-cis and 15-cis are formed below 100°C (Doering *et al.* 1995).

OFSP is an excellent source of bio-available β -carotene. Nevertheless β -carotene bio-availability is affected by processing that we must consider. Processing can lead to a decrease in the amount of *all-trans*- β -carotene, and an increase in 13-cis-beta-carotene. Processed OFSP has significantly higher bio-available β -carotene than raw OFSP. Bio-availability varied with processing treatments: **raw<baked<steamed/boiled<deep fried**. Heat processing improves the accessibility of β -carotene in OFSP by disrupting cell walls and breaking the protein complexes in which the carotenoids are embedded (Tumuhimbise *et al.*, 2009). Chandler and Schwartz (1988) reported that processes that most induce cis-isomerisation in OFSP were (in order of less to more damaging): **steaming<blanching<pureeing<microwaving<canning<baking<drum drying**. Shade and sun drying did not initiate cis-isomerisation in the examples found in literature on OFSP or leafy vegetables respectively (Mulokozi and Svanberg 2003).

β -carotene Biosynthesis in Leafy Green Vegetables and OFSP Roots

β -carotene is the carotenoid with the highest provitamin A activity (100%) because it can be entirely converted into two molecules of vitamin A (retinol) (Bechoff, 2010). *All-trans*- β -carotene represents about 80-90% of the total carotenoid in OFSP (Bengsston *et al.* 2008). In plant cells, carotenoids are contained in semi-autonomous organelle structures. In leafy green vegetables, carotenoids are

present in the chloroplasts and are bound with protein and chlorophylls that are green, and mask the orange colour of the carotenoids (Galston *et al.*, 1980; Bartley and Scolnik 1995; Vishnevetsky *et al.* 1999). Chromoplasts usually derive from chloroplasts. During the transformation of chloroplasts into chromoplasts, the photosynthetic apparatus disintegrates and carotenoids accumulate in the novel plastid. This transformation can be observed, for instance, in autumn leaves or during fruit ripening (Galston *et al.*, 1980).

Plants accumulate storage substances such as starch, lipids and proteins in certain phases of development in different organs and tissues such as seeds, shoot tubers (potato) and root tubers as in sweetpotato. The primary function of storing is to provide a reservoir to be used in later stages of plant development as source of energy and/or nitrogen providing appropriate conditions for embryo development in seeds and for root formation in shoot and root tubers. In Sweetpotato storage roots the accumulation of carbohydrates (starch) and proteins (Sporamins and Cystatin) provide the possibility for the plant to sustain adverse environmental conditions. This accumulation occurs in parenchyma cells of the root. In sweetpotato, the carbohydrates (starch) and proteins (Sporamins and Cystatin) are deposited in the sink tissues of storage roots. The two genes, namely Beta-amylase and DnaJ-like Protein, are found to be responsible in the transformation of amyloplast to chromoplast regulating the accumulation of starch and β -carotene in Sweetpotato storage root (Desai, 2008).

The potential health benefits of the sweetpotato Sporamins in helping prevent oxidative damage to our cells should not be surprising since sweetpotato produces Sporamins whenever subjected to physical damage to help promote healing (<http://www.whfoods.com/genpage.php?tname=foodspice&dbid=64>).

In OFSP, initial levels of carotenoids are influenced by variety, root maturation and location (Kósambo *et al.* 1998). Sweetpotato varieties can be grouped into four general categories based on their β -carotene content on a dry weight basis non-detectable (<1 $\mu\text{g/g}$), low β -carotene (1-39 $\mu\text{g/g}$) – pale orange, moderate β -carotene (40-129 $\mu\text{g/g}$) – orange, and high β -carotene (>130 $\mu\text{g/g}$) – dark orange (Simonne *et al.* 1993).

For further reading, please see the Facilitator Resource in this module as well as other valuable resources elsewhere.

Through the sessions of this module, we are focusing on simple processing practices that most rural households can easily learn and adopt. Ingredients are locally available.

SESSION 1: Interactive Lecture

| | |
|----------------------------|--|
| Time | 30 minutes |
| Learning Objectives | <ul style="list-style-type: none"> • To be familiar with the 6 food groups using examples from Malawi • To understand the importance of food processing related to nutritional values in daily diets • To understand how to use OFSP in processed foods at the household level • To develop complementary multimix feeding recipes which use at least three food groups. • To create awareness of opportunities for use of OFSP in home-industries and school meal programs |
| Preparation | <ul style="list-style-type: none"> • Read through the sessions and familiarize yourself with the process and |

| | |
|------------------|--|
| | activities <ul style="list-style-type: none"> • Prepare photocopies of the background information (Handout, ppt) • Do simple bookkeeping of expenditures for ingredients |
| Materials | <ul style="list-style-type: none"> • Photocopies of background information • Plain papers • Prepared flip chart papers • Facilitator Resource • Projector (if available) • Pictures/diagrams • Ingredients of recipes to be practised |

Activity: Interactive lecture

- Ask participants to briefly explain their backgrounds and knowledge of food processing in general, and sweetpotato in particular.
- Using the Facilitator Resource related to the learning objectives (e.g. showing the schematic processing, pictures of OFSP products, examples of the 6 food groups, some ingredients for OFSP products), interactive discussion should be initiated.
- Clearly emphasize that β -carotene can be more available for the body when used with a little fat/oil.


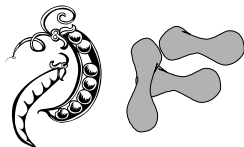
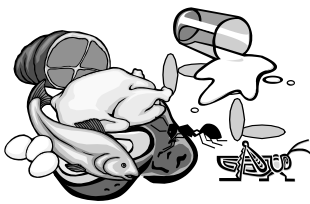
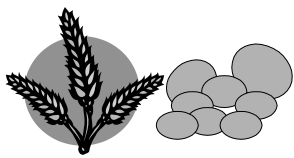
Tips for Preparing Sweetpotato

- You can eat the entire storage root, flesh and skin, or just peel it after cooking
- As the flesh of sweetpotato will darken upon contact with the air, you should cook them immediately after peeling and/or cutting them. If this is not possible, to prevent oxidation, keep them in a bowl covered completely with water until you are ready to cook them.
- Sweetpotato can be eaten in savoury dishes cooked in a similar way to Irish potato, or enjoyed in doughnut, buns, relish, etc.

FACILITATOR RESOURCE

SIX FOOD GROUPS FOR MALAWI

Different foods contain a mixture of nutrients, but no one food contains all the nutrients needed by the body. Some foods have more of some nutrients and different nutrients than others, for example green vegetables are more nutritious than pale green or white vegetables like cabbage. Proper food selection and combinations helps the body to get the needed balance of nutrients. Proper food combination also helps the body to get more total nutrients and improve the absorption of various nutrients. For example fats facilitate absorption of vitamin A from vegetables and fruits while vitamin C helps in absorption of iron from vegetables. Therefore diets should be made from a variety of foods from the six food groups which include vegetables, fruits, legumes and nuts, animal foods, fats and staples.

1. **Vegetables:** including green leaf and yellow vegetables such as amaranth (bonongwe), blackjack (chisoso), common bean leaf (khwanya), pumpkin leaf (mnkhwani), sweetpotato leaf (kholowa), rape, Chinese cabbage (mpiru), (kamganje), carrot, eggplants, pumpkin, tomato and others such as mushroom. These mostly provide vitamins, minerals, and water. Vegetables also contain fibre that is necessary for proper digestion. 
2. **Fruits:** including citrus (oranges, lemons, tangerines), bananas, pineapple, pawpaw, mango, masau, bwemba, malambe, masuku, peaches, apples, guava, watermelon and many others. Fruits provide mostly carbohydrates, vitamins and water.
3. **Legumes & Nuts:** This group includes groundnuts, soybeans, beans, peas, cowpeas, ground beans/bambara nut (nzama), pigeonpeas. They provide mainly protein and carbohydrate. Soybeans and nuts also contain high proportions of fat in addition to protein and carbohydrate. 
4. **Animal Foods:** foods in this group include meat, eggs, milk products, fish, and insects. They provide protein, fats, vitamins and minerals. 
5. **Fats:** This group includes oil seeds (soybeans, groundnuts, and sunflower seed), avocado pear, cooking oil, milk and milk products such as butter, margarine, yogurt, meat, fish, and poultry. These mainly provide fat.
6. **Staples:** Foods in this group include cereals such as sorghum, millet, maize, rice, wheat. Starchy roots such as cassava, sweetpotato, potato and starchy fruits such as banana and plantain are also in this group. Staples mostly provide carbohydrates. They also provide other nutrients such as proteins and minerals depending on how they are processed. 

NUTRIENT CONTENT OF OFSP STORAGE ROOTS

Considering its fiber content, complex carbohydrates, protein, vitamin A and C, iron, and calcium, the sweetpotato ranked highest in nutritional value. Sweetpotatoes with dark orange flesh have more β -carotene than those with light-colored flesh (Simonne *et al.*, 1993). Despite the name “sweet”, it may be a beneficial food for diabetics, as preliminary studies on animals have revealed it helps to stabilize blood sugar levels and to lower insulin resistance

(<http://www.whfoods.com/genpage.php?tname=foodspice&dbid=64>; the world's healthiest foods: Sweetpotato, 2001-2012, the George Mateljan Foundation).

Sweetpotato is among crops of containing soluble fiber. The total of fiber in a half-medium root of sweetpotato is 3 grams and 1 gram is a soluble fiber (<http://ocw.tufts.edu/data/47/531408.pdf>). Research has shown that for every 1-2 grams of daily soluble fiber intake, LDL (bad) cholesterol is lowered 1% (Nelson, L., 14th July 2009 at <http://www.lisanelsonrd.com/blog/lower-ldl-cholesterol-diet-%E2%80%93-step-2>)

The table below presents information on nutritional value of sweetpotato and other food staples. While sweetpotato provides less edible energy and protein per unit weight than cereals, it is a higher density source of most vitamins and minerals than cereals.

Table 1. Comparison of sweetpotato to other food staples (in a raw material form)

| Staple | Maize/ corn | Rice | Wheat | Potato | Cassava | Soybean | Sweet Potato | Sorghum | Yam | Plantain |
|------------------------------------|----------------|--------|--------|--------|---------|---------|-----------------|---------|--------|----------|
| Component (per 100g portion) | Amount | Amount | Amount | Amount | Amount | Amount | Amount | Amount | Amount | Amount |
| Water (g) | 76 | 12 | 11 | 79 | 60 | 68 | 77 | 9 | 70 | 65 |
| Energy (kJ) | 360 | 1528 | 1419 | 322 | 670 | 615 | 360 | 1419 | 494 | 511 |
| Protein (g) | 3.2 | 7.1 | 13.7 | 2.0 | 1.4 | 13.0 | 1.6 | 11.3 | 1.5 | 1.3 |
| Fat (g) | 1.18 | 0.66 | 2.47 | 0.09 | 0.28 | 6.8 | 0.05 | 3.3 | 0.17 | 0.37 |
| Carbo- hydrates (g) | 19 | 80 | 71 | 17 | 38 | 11 | 20 | 75 | 28 | 32 |
| Fiber (g) | 2.7 | 1.3 | 10.7 | 2.2 | 1.8 | 4.2 | 3 | 6.3 | 4.1 | 2.3 |
| Sugar (g) | 3.22 | 0.12 | 0 | 0.78 | 1.7 | 0 | 4.18 | 0 | 0.5 | 15 |
| Calcium (mg) | 2 | 28 | 34 | 12 | 16 | 197 | 30 | 28 | 17 | 3 |
| Iron (mg) | 0.52 | 4.31 | 3.52 | 0.78 | 0.27 | 3.55 | 0.61 | 4.4 | 0.54 | 0.6 |
| Magnesium (mg) | 37 | 25 | 144 | 23 | 21 | 65 | 25 | 0 | 21 | 37 |
| Phosphorus (mg) | 89 | 115 | 508 | 57 | 27 | 194 | 47 | 287 | 55 | 34 |
| Potassium (mg) | 270 | 115 | 431 | 421 | 271 | 620 | 337 | 350 | 816 | 499 |
| Sodium (mg) | 15 | 5 | 2 | 6 | 14 | 15 | 55 | 6 | 9 | 4 |
| Zinc (mg) | 0.45 | 1.09 | 4.16 | 0.29 | 0.34 | 0.99 | 0.3 | 0 | 0.24 | 0.14 |
| Copper (mg) | 0.05 | 0.22 | 0.55 | 0.11 | 0.10 | 0.13 | 0.15 | - | 0.18 | 0.08 |
| Manganese (mg) | 0.16 | 1.09 | 3.01 | 0.15 | 0.38 | 0.55 | 0.26 | - | 0.40 | - |
| Selenium (mg) | 0.6 | 15.1 | 89.4 | 0.3 | 0.7 | 1.5 | 0.6 | 0 | 0.7 | 1.5 |
| Vitamin C (mg) | 6.8 | 0 | 0 | 19.7 | 20.6 | 29 | 2.4 | 0 | 17.1 | 18.4 |
| Thiamin (mg) | 0.20 | 0.58 | 0.42 | 0.08 | 0.09 | 0.44 | 0.08 | 0.24 | 0.11 | 0.05 |
| Riboflavin (mg) | 0.06 | 0.05 | 0.12 | 0.03 | 0.05 | 0.18 | 0.06 | 0.14 | 0.03 | 0.05 |
| Niacin (mg) | 1.70 | 4.19 | 6.74 | 1.05 | 0.85 | 1.65 | 0.56 | 2.93 | 0.55 | 0.69 |
| Pantothenic acid (mg) | 0.76 | 1.01 | 0.94 | 0.30 | 0.11 | 0.15 | 0.80 | - | 0.31 | 0.26 |
| Vitamin B6 (mg) | 0.06 | 0.16 | 0.42 | 0.30 | 0.09 | 0.07 | 0.21 | - | 0.29 | 0.30 |
| Folate Total (mcg) | 46 | 231 | 43 | 16 | 27 | 165 | 11 | 0 | 23 | 22 |
| Vitamin A (IU) | 208 | 0 | 0 | 2 | 13 | 180 | 14187 | 0 | 138 | 1127 |
| Vitamin E, alpha- | 0.07 | 0.11 | 0 | 0.01 | 0.19 | 0 | 0.26 | 0 | 0.39 | 0.14 |

| | | | | | | | | | | |
|---------------------------------|------|------|------|------|------|------|------|------|------|------|
| tocopherol (mg) | | | | | | | | | | |
| Vitamin K (mg) | 0.3 | 0.1 | 0 | 1.9 | 1.9 | 0 | 1.8 | 0 | 2.6 | 0.7 |
| Beta-carotene (mcg) | 52 | 0 | 0 | 1 | 8 | 0 | 8509 | 0 | 83 | 457 |
| Lutein+Zeaxanthin (mcg) | 764 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 30 |
| Saturated fatty acids (g) | 0.18 | 0.18 | 0.45 | 0.03 | 0.07 | 0.79 | 0.02 | 0.46 | 0.04 | 0.14 |
| Monounsaturated fatty acids (g) | 0.35 | 0.21 | 0.34 | 0.00 | 0.08 | 1.28 | 0.00 | 0.99 | 0.01 | 0.03 |
| Polyunsaturated fatty acid | 0.56 | 0.18 | 0.98 | 0.04 | 0.05 | 3.20 | 0.01 | 1.37 | 0.08 | 0.07 |

Notes: corn (sweet, yellow), wheat (durum), rice (white, long-grain, regular), potato (flesh and skin), soybeans (green). Source: Sweetpotato Wikipedia: http://en.wikipedia.org/wiki/Sweet_potato; Nutrient Data Laboratory, United States Department of Agriculture.

NUTRIENT CONTENT OF SWEETPOTATO LEAVES (RAW)

Sweetpotato leaf is an excellent source of lutein. From the research done by Kachathrian *et al.* (2003), they concluded that sweetpotato leaves may help in the fight against age-related macular degeneration (AMD).

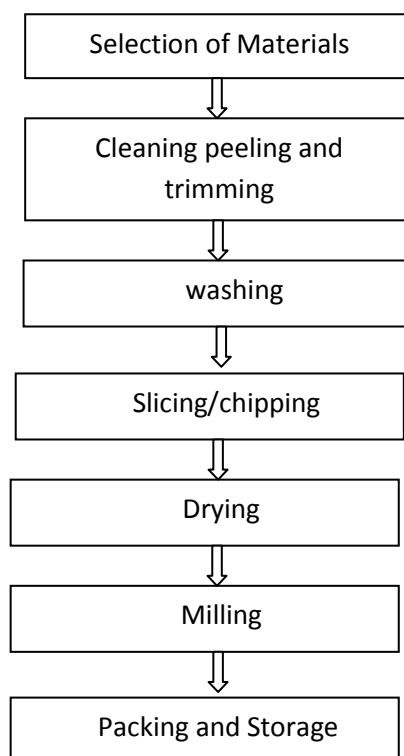
Risk factors for macular degeneration include age of 75 beyond, diabetes and all its complications (hypertension, retinopathy, arteriosclerosis), smoking, chronic sunlight exposure, nutritional deficiencies, and blue/green eyes. As standard for macular degeneration therapies are limited, costly, and often associated with undesirable pathological side effects, the role of nutrition in protecting against degenerative diseases is under intensive scientific investigation. Lutein (3,3'-dihydroxy- α -carotene) has been identified as a dietary component that can delay the onset of age-related macular degeneration (AMD). Major sources of lutein are green vegetables and marigold flower. Sweetpotato roots are known for their high content of β -carotene. However, sweetpotato leaves are often considered to have no economical value and are discarded following sweetpotato harvest. From their research they found that Lutein concentration in sweetpotato leaves were: 54 mg/100 g (Beauregard); 60-68 mg/100 g (Tanzania/Kenya/Osukut); 53 mg/100 g (94-96); 34 mg/100 g (Jonathan); and 42-46 mg/100 g (Webaligae). These values rank sweetpotato leaves second in lutein content after marigold flowers, and number one among edible vegetables.

In addition, the information provided by USDA SR-21 shows that the sweetpotato leaf is low in Saturated Fat and Sodium, and very low in Cholesterol. It is also a good source of Protein, Niacin, Calcium and Iron, and a very good source of Dietary Fiber, Vitamin A, Vitamin C, Thiamin, Riboflavin, Vitamin B6, Folate, Magnesium, Phosphorus, Potassium and Manganese.

(<http://nutritiondata.self.com/facts/vegetables-and-vegetable-products/2664/2#ixzz1uyfrdSXq>; read on 15 May 2012)

FLOUR PROCESSING

The schematic sweetpotato flour processing can be seen in Fig 1 below.



It is noted that drying is a critical process, more than the other traditional methods of processing (i.e. boiling and steaming). Indeed, the removal of water affects the internal cell structure of the vegetable food leading to higher losses of micronutrients such as pro-vitamin A (Bechoff, 2010).

Drying technologies suitable for farming areas should have a low initial capital cost; be easy to construct with available natural materials and be easy to operate and maintain (Chua and Chou 2003). There are two types of dryers, artificial and natural (solar or sun). Artificial drying can be conducted in a cabinet or tunnel dryer where air is heated by a fuel or electricity but is expensive. Solar and sun dryers are environmentally friendly systems with low operating costs. However, open air sun drying involves a number of risks for product quality, including dust, insects, mammals, rain, and pro-vitamin-A-damaging ultra violet (UV) sun radiation because of poor control over environmental factors. Clean smooth raised platforms, blackened surfaces (Fig 3) that absorb solar radiation more efficiently, or woven mats and mesh trays that facilitate the air movement around the product are recommended for farmers and producers. The lowest cost-models of dryers are passive direct solar dryers of using natural convection. The simplest one is the tent dryer (Fig 4) (Bechoff, 2010).



Fig 2. Chipping machine (curtsy of Ms Michiela)



Fig 3. Air Sun drying method that is recommended (photo taken at Soroti Sweetpotato Producers Association (SOSPPA) in Uganda by Erna Abidin in September 2011).

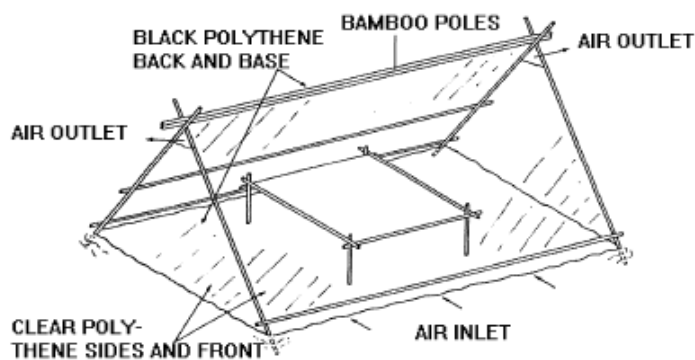


Fig 4. Tent dryer (source: Intermediate Technology Development Group (ITDG), 1988)

Stir-Frying Method

Multiple studies have shown better absorption of the beta-carotene from sweetpotatoes when fat-containing foods are consumed along with the sweetpotatoes. (It doesn't take much fat for this better absorption to take place—only 3-5 grams). What fat makes possible is the conversion of beta-carotene into a special form called micellar form. Micelles are specialized collections of molecules that allow fat-soluble substances (like beta-carotene) to move around comfortably in non-fat environments (like our water-based bloodstream). They can also make it easier for fat-soluble

substances to get absorbed from our digestive tract. Among several studies that have shown the benefits of a fat-containing meal for absorption of beta-carotene from sweetpotato foods, one study has shown that stir-frying in oil is one specific cooking technique for sweetpotatoes that can enhance the bioavailability of their beta-carotene. It's interesting to note that the sweetpotato stir-fry in this study used a very low stir-frying temperature of 93°C and that only 5 minutes of stir-frying were required to achieve the beta-carotene bioavailability benefits (source: <http://www.whfoods.com/genpage.php?tname=foodspice&dbid=64>; world Healthy Foods: Sweetpotato; 2001-2012, the George Mateljan Foundation).

DISHES FROM OFSP STORAGE ROOTS



Fig 5. Stir-fry – sweetpotato chips. Right: the TA chief from Bembeke and the Minister from Ireland, Mr. Jo Costello are tasting the sweetpotato chips (curtesy of Erna Abidin, 2012)





Fig 6. A variety of multi-mix meals prepared by Malawians during several events (curtesy of Erna Abidin, 2010-2011)

DISH FROM SWEETPOTATO LEAF



Fig 7. Sweetpotato leaf with peanut sauce, fried with onion and tomato, fried with onion, tomato, chilli and kapenta and sweetpotato leaf with peanut sauce prepared by Victoria Hotel (curtsey of Erna Abidin, 2011 and 2012)

REFRESHMENT AND SNACKS



Fig 8. Sweetpotato juices from leaves and roots and sweetbeer ("thobwa")



Fig 9. Golden buns and golden cake



Fig 10. Mandazi, muffins, golden bread from sweetpotato and golden doughnut



Fig 11. A delicious mandazi is eaten by this cute little girl (left) and a plate of African muffins

STAPLE FOODS



Fig 12. Boiled sweetpotato roots, chapatti and nsima from OFSP. Left: sweetpotato soup



Fig 13. Porridge for infants – testing porridge during practical at Kachele Club on 27 June 2012

SESSION 2: Practical

Preparing Juice from roots and leaves, doughnut, golden bread, cake and sweetpotato relish

| | |
|----------------------------|--|
| Time | 240 minutes |
| Learning Objectives | <ul style="list-style-type: none"> Participants will gain knowledge and skills on how to prepare a variety of foods and drinks from sweetpotato |
| Preparation | <ul style="list-style-type: none"> Read through the session and familiarize yourself with the process and activities Prepare the budget and purchase the ingredients Type the ingredients and its budget for being distributed to participants Copy the recipes for participants |
| Materials | <ul style="list-style-type: none"> Sweetpotato leaves and roots Knives, basins, plates, stove, oven/village modified oven, buckets, firewoods/charcoal, mortal Ingredients Recipes |

Activity 1: Preparing sweetpotato juice from leaves and roots

- Divide the participants into small groups and delegate multitasks
- Distribute the sweetpotato juice recipes (from roots and leaves)

Activity 2: Preparing golden bread or buns

- Divide the participants into small groups and delegate multitasks
- Distribute and explain the recipe

Activity 3: Preparing golden doughnut

- Divide the participants into small groups and delegate multitasks
- Distribute and explain the recipe

Activity 4: Preparing cakes

- Divide the participants into small groups and delegate multitasks
- Distribute and explain the recipe

Activity 5: Preparing Sweetpotato Relish

- Divide the participants into small groups and delegate multitasks
- Distribute and explain the recipe



Pictures above are an example of the equipments that are usually used in a village for preparing the OFSP products, including a modified oven: a pot covered by an iron sheet with some charcoals on it (photo taken in Kasungu – under FAO, on 27 May 2012, by Erna Abidin)

FACILITATOR RESOURCE

The following recipes have been used for training the trainers in Malawi. However, to enrich the knowledge on a variety of recipes, it is advised to find it in the internet. One of the useful link is as follows: <http://sweetpotatoknowledge.org/use-consumption/training-and-communication/recipe-booklets/sweetpotato-recipes.pdf/view>

A hard copy of the recipe book that is available in the link above mentioned will be provided by the Rooting out Hunger project. Each copy is given to every district where the training is taking place.

I. SWEETPOTATO BUNS

INGREDIENTS:

| | |
|---------------------|----------------|
| ❖ Sweet potato mash | 1 cup |
| ❖ Bread flour | 3 cups |
| ❖ Sugar | 1 table spoon |
| ❖ Salt | pinch |
| ❖ Yeast | 1.5 teaspoons |
| ❖ Oil/fat | 3 table spoons |
| ❖ Water | adequate |

PROCEDURE:

1. Take 1 teaspoon of sugar in a cup, add 1.5 table spoon of warm water and leave to rise
2. Put mashed sweet potato in mixing bowl and sift in the dry ingredients
3. Add oil/fat and rub it till crumbles.
4. Add risen yeast, salt, improver and mix
5. Add water and knead till done to required texture.
6. Roll into a ball, knead the dough till smooth
7. Divide the dough into equal small balls and roll out to make desired shapes.
8. Grease a ban pan and place in small balls and cover it with plastic bag, allow it to rise.

II. SWEETPOTATO CAKE

INGREDIENTS

| | |
|----------------------|----------------|
| ❖ Sweet potato flour | 1cup |
| ❖ Wheat flour | 3cup |
| ❖ Eggs | 4 |
| ❖ Margarine | 5 tea spoons |
| ❖ Baking powder | 3 table spoons |
| ❖ Lemon/vanilla | 1 tea spoon |
| ❖ Sugar | 3 table spoons |
| ❖ Milk | adequate |

PROCEDURE:

1. Put margarine and sugar into a mixing bowl and mix them well
2. Beat the eggs and add to the bowl
3. Grate lemon rind and add to the bowl and mix
4. Sieve sweet potato flour, wheat flour and baking powder together and then add milk

5. Add little water and vinegar to the mixture should to make a good paste, it should be watery or hard
6. Grease baking pan and pour in contents
7. Bake in oven for 30 minutes or till brown
8. Serve

III. SWEETPOTATO RELISH (“Mtolilo”)

INGREDIENTS

| | |
|-------------------------------|----------------|
| ❖ Tenderly sweetpotato leaves | 1kg |
| ❖ Onions | 2 medium |
| ❖ Tomatoes | 4 medium |
| ❖ Flavor | 4 medium |
| ❖ Oil/fat | 4 table spoons |
| ❖ Salt | 1 table spoon |
| ❖ Warm water | half container |

PROCEDURE:

1. Clean leaves by removing dirty
 2. Prepare the onions and tomatoes and slice into separate dishes
 3. Shred the leaves
 4. Wash twice in warm water to remove the ant-nutrients
 5. Heat the oil and fry onions till they start to brown
 6. Add tomatoes and let cook for while
 7. Add the vegetables and let cook for 5 minutes
 8. Add the flavor and stir the contents and let cook till done
 9. Serve with bananas or nsima or rice as desired
- *The flavor can be ground nuts paste, lemon etc.

IV. JUICE FROM ORANGE-FLESHED SWEETPOTATO STORAGE ROOTS

INGREDIENTS:

- ❖ 3 Cups full mashed sweetpotato roots
- ❖ 1000 ml water
- ❖ 500g sugar
- ❖ 2 Table spoons grated lemon rind and juice
- ❖ Orange or pine apple

PROCEDURE:

1. Wash flesh sweet potato roots and peel
2. Mash to a fine mixture
3. Put the mashed potato over a sieve
4. Pour warm water over the mashed potato
5. Add grated lemon rind and juice in the sieved potato juice
6. Add in orange or pine apple extracts as an essence
7. Add in sugar
8. Put over fire to mix for 10 minutes.
9. Sieve to remove other debris
10. Distribute and refrigerate to serve cold

V. JUICE FROM SWEETPOTATO LEAVES

INGREDIENTS:

- ❖ 3 hand full tender sweetpotato leaves
- ❖ 1000 ml water
- ❖ 500g sugar
- ❖ 2 table spoons grated lemon rind and juice
- ❖ Orange or pine apple

PROCEDURE:

1. Boil the tender leaves till colour change
2. Remove from fire and sieve out juice
3. Add in grated lemon rind and juice as a colour neutralizer
4. Add in orange or pine apple extracts as an essence
5. Add in sugar
6. Put over fire to mix for 10 minutes.
7. Sieve to remove other debris
8. Distribute and refrigerate to serve cold

VI. ONE POT DISH (OFSP MIXED WITH MEAT / EGGS/ SMALL FISH / LEGUMES)**INGREDIENTS:**

- ❖ Boiled sweetpotato
- ❖ Meat
- ❖ Eggs
- ❖ Fish
- ❖ Legumes
- ❖ Salt
- ❖ Tomato
- ❖ Onion
- ❖ Sweetpotato leaves

PROCEDURE:

Mix boiled sweetpotato and cooked meat in one pot
 Add fried onion and tomatoes and salt to taste and let it simmer
 -You can follow the same procedure when preparing small fish, legumes
 -For eggs you can scramble eggs or boil and add fried sweetpotato leaves

Note:

- I. You may serve this as a complete dish.
- II. Peel and cut into sizeable pieces and put in a basin of water to avoid darkening of the sweetpotato
- III. You can use any type of fish available dry or fresh

VII. MOFFIN**INGREDIENTS:**

- ❖ 5 ripe bananas
- ❖ 4 medium OFSP roots
- ❖ 2 cups maize flour or sweetpotato flour or mashed
- ❖ 1tea spoons salt
- ❖ Cooking oil

PROCEDURE:

1. Boil the roots until tender
2. Mash boiled sweetpotato roots to a fine mixture
3. Measure 2 cups mashed sweetpotato to one cup of maize flour and peeled bananas and mix with the motor
4. Add half teaspoon salt and sugar if so desired
5. Pound until smooth mixed
6. Take a mixture like a ball and put in a plastic till you make a flat shape
7. Fry Moffins in a pan or pot till brown and you can serve it as a snack

VIII. CHINCHINS:**INGREDIENTS**

- ❖ 4 tomatoes
- ❖ 2 eggs
- ❖ 2 onions
- ❖ OFSP roots
- ❖ 2 cups wheat flour
- ❖ 1 tea spoons salt
- ❖ 1 teaspoon pepper (chilies) powder
- ❖ Cooking oil



chinchins

PROCEDURE:

1. Boil sweetpotato roots until tender
2. Mash boiled sweetpotato roots till mixture
3. Measure 2 cups mashed sweetpotato one cup wheat flour, 2 eggs, tomato and onion in a motor
4. Add one teaspoon pepper
5. Add one teaspoon salt
6. Pound until they mix well
7. Wash hands and make small balls
8. Put in a pot of boiling oil to fry till golden brown and serve as a snack.

IX. MANDASI**INGREDIENTS:**

- | | |
|---------------------|----------------|
| ❖ Sweet potato mash | 1 cup |
| ❖ Bread flour | 2 cups |
| ❖ Sugar | 3 table spoon |
| ❖ Salt | pinch |
| ❖ Yeast | 2 teaspoons |
| ❖ Oil/fat | 3 table spoons |
| ❖ Water or milk | adequate |

PROCEDURE:

1. Mix all dry ingredients together
2. Add milk or water little by little till you make a dough
3. Roll into a ball, knead the dough till smooth
4. Make small balls and roll into a desired shape
5. Let the balls risen a little while before you start frying
6. Deep fry mandasi till golden brown

7. Serve as a snack

X. OFSP PORRIDGE

INGREDIENTS:

- ❖ Sweet potato mash
- ❖ Maize flour (m'gaiwa)
- ❖ Salt
- ❖ Sweetpotato leaves
- ❖ Cooking oil/groundnuts/ milk

PROCEDURE:

1. Boil and mash sweetpotato
 2. Boil water (any amount as desired)
 3. Mix sweetpotato mash and maize flour in the ratio of 2 sweetpotato mashed:1 m'gaiwa (maize flour)
 4. Let the porridge simmer when the porridge is cooked add pounded sweetpotato hand full leaves you add milk or eggs or cooking oil or groundnuts flour as desired and let it simmer
 5. Serve whilst hot
- Note:** Complete six food group porridge recommended for children and pregnant mothers.

XI. SWEET BEER

INGREDIENTS:

- | | |
|--------------------------|---------------------------------------|
| ❖ Sweet potato flour | 2 cup or flour from sweetpotato peels |
| ❖ Maize flour | 1 cups |
| ❖ Fermented millet flour | Half cup |
| ❖ Sugar | adequate |
| ❖ Water | adequate |



Sweetpotato peels

PROCEDURE:

1. Put some water in a pot, allow the water to boil but not too much
2. Add 1 cup of maize flour and 2 cups of sweetpotato flour mix well using a cooking stick
3. Stir frequently to avoid burnt, when the porridge is well cooked, allow the porridge to cool before you put fermented millet flour and boil again until done

XII. OFSP CHIPS

INGREDIENTS:

- ❖ Sweet potato roots adequate
- ❖ Cooking oil 1litre
- ❖ Salt 2tablespoons

PROCEDURE:

1. Peel and wash sweetpotato roots and cut into sizeable slices
2. Put the slices in a bucket of water to avoid darkening of the slices
3. Deep fry as chips

Note: can be served with cabbage salads and beef or chicken if so desired

XIII. OFSP AFRICAN CAKE/ TRADITION CAKE

INGREDIENTS:

- ❖ Maize flour
- ❖ Banana
- ❖ Salt
- ❖ Sugar
- ❖ Mashed sweetpotato
- ❖ Warm water or milk or cooking oil
- ❖ Soda

PROCEDURE:

1. Pound banana and mix all dried ingredients in the ratio 1 maize flour: 1 sweetpotato mash add warm water or milk and soda mix thoroughly till you make a light porridge
2. Smear margarine or cooking oil on a bottom of cooking pot and pour the porridge into the pot
3. Take charcoal on top and bottom of the cooking pot and bake till cooked
4. Serve as snack

XIV. OFSP CHAPATTI

INGREDIENTS:

- ❖ Mashed sweetpotato
- ❖ Bread flour
- ❖ Salt
- ❖ Cooking oil

PROCEDURE:

1. Mix mashed sweetpotato with bread flour in the ratio of 2:1 (1 part mashed sweetpotato : 2 parts bread flour)
2. Add salt and a table spoon f cooking oil
3. Make a dough

4. Make small balls and roll on a flat surface till you make a flat shape and put in frying pan
5. Take off chapatti when it is cooked and serve with any relish as desired.

XVI. FUTALI

INGREDIENTS

- ❖ Sweetpotato roots boiled
- ❖ Salt
- ❖ Groundnut flour or tomato

PROCEDURE:

Add groundnut flour to boiled sweetpotato and salt and let it simmer

Note: you may also use tomato

References

- Bartley, G.E., and P.A. Scolnik 1995. Plant carotenoids: pigments for photoprotection, visual attraction, and human health. *The Plant Cell* 7: 1027-1038.
- Bechoff, A., M. Poulaert, K.I. Tomlins, E. Westby, G. Menya, S. Young and C. Dhuique-Mayer 2011. Retention and bioaccessibility of B-Carotene in blended foods containing orange-fleshed sweetpotato flour. *J. Agric. Food Chem.* 59 (18): 10373–10380
- Bechoff, A. 2010. Investigating carotenoid loss after drying and storage of orange-fleshed sweetpotato. PhD thesis. University of Greenwich. UK. 330pp.
- Bengtsson, A., A. Namutebi, M.L. Alminger and U. Svanberg 2008. Effects of various traditional processing methods on the all-trans-b-carotene content of orange-fleshed sweet potato. *Journal of Food Composition and Analysis* 21: 134-143.
- Bouis, H. 2002. Plant breeding: A new tool for fighting micronutrient malnutrition. The American Society for Nutritional Sciences. *Journal of Nutrition* 132: 491–494S.
- Chua, K.J. and S.K. Chou 2003. Low-cost drying methods for developing countries. *Trends in Food Science and Technology* 14: 519-528.
- Desai, D.P. 2008. Understanding the genetic basis of storage root formation along with starch and betacarotene biosynthesis and their inter-relation in Sweetpotato (*Ipomoea batatas* LAM.). PhD. Thesis. Universität für Bodenkultur, Wien. 153pp.
- Doering W. von E., C. Sotiriou-Leventis and W.R. Roth 1995. Thermal interconversions among 15-cis, 13-cis, and all-trans-b-carotene: kinetics, Arrhenius parameters, thermochemistry, and potential relevance to anticarcinogenicity of all-trans-b-carotene. *Journal of American Chemical Society* 117: 2747-2757.
- FEWS NET 2011. Household food security for the poor begins to deteriorate as maize prices rise in southern district markets. Malawi Food Security Outlook Update September 2011. USAID. Farming Early Warning System Network (FEWS NET), 3 pp.
- Galston, A.W., P.J. Davies and R.L. Satter 1980. The life of the green plant. Prentice Hall Inc. New Jersey. 464pp.
- Haskell, M.J., K.M. Jamil, F. Hassan, J.M. Peerson, M.I. Hossain, G.J. Fuchs and K.H. Brown 2004. Daily consumption of Indian spinach (*Basella alba*) or sweet potatoes has a positive effect on total body vitamin A stores in Bangladeshi men. *American Journal of Clinical Nutrition* 80: 705-714.
- Hotz, C., C. Loechl, A.d. Brauw, P. Eozenou, D. Gilligan, M. Moursi, B. Munhaua, P.v. Jaarsveld, A.

- Carriquiry, J.V. Meenakshi 2011. A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. *British Journal of Nutrition*: 1-14
- ITDG 1988. Intermediate Technology Development Group. Practical answers to poverty. Drying of Foods. NRI. Technical Brief. NRI, UK.
- Jaarsveld Pv, M. Faber, S.A. Tanumihardjo, P. Nestel, C.J. Lombard, A.J. Benade 2005. Beta-carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *The American Journal of Clinical Nutrition* 81:1080-1087.
- Jayne, T, M. Villareal, M. Pingali, G. Hemrich 2004. Interactions between the agricultural sector and the HIV/AIDS pandemic: Implications for agricultural policy. In *International Development Working Paper*. pp. <http://www.aec.msu.edu/agecon/fs2/index.htm>. East Lansing, Michigan.
- KHACHATRYAN, A., R. R. Bansode, D. R. Labonte, and J. N. Losso (2003). Age-related macular degeneration (AMD) is a pathological condition with real cure. Institute of Food Technologists (IFT) Annual Meeting, Chigago, USA.
(http://ift.confex.com/ift/2003/techprogram/paper_20401.htm)
- Kósambo L., E.E. Carey, A.K. Misra, J. Wilkes and V. Hagenimana 1998. Influence of age, farming site, and boiling on pro-vitamin A content in sweet potato (*Ipomoea batatas* (L.) Lam.). *Journal of Food Analysis* 11: 305-321.
- Low, J.W., M. Arimond, N. Osman, B. Cunguara, F. Zano, D. Tschirley 2004. A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique. *J Nutr* 137:1320-1327.
- Low, J.W., J. Lynam, B. Lemaga, C. Crissman, I. Barker, G. Thiele, S. Namanda, C. Wheatley, M. Andrade 2009. Sweetpotato in Sub-Saharan Africa. In: G. Loebenstein and G. Thottapilly (eds.). *The Sweetpotato*, pp. 359-390. Springer Science+Business Media B.V., Dordrecht. The Netherlands.
- Mulokozi, U. and G. Svanberg 2003. Effect of traditional open sun-drying and solar cabinet drying on carotene content and vitamin A activity of green leafy vegetables. *Plant Foods for Human Nutrition* 58: 1–15.
- Schutter de, O. 2011. A Special Rapporteur on the right to food. This special report was submitted to Human Rights Council, United Nations General Assembly on 26 December 2011, 22pp.
- Simonne, A.H., S.J. Kays, P.E. Koehler and R.R. Eitenmiller 1993. Assessment of β -carotene content in sweetpotato breeding lines in relation to dietary requirements. *Journal of Food Composition and Analysis* 6: 336-345.
- Tumuhimbise, G.A., A. Namutebi and J.H. Muyonga 2009. Microstructure and *in vitro* Beta-carotene bioaccessibility of heat process orange-fleshed sweetpotato. *Plant Food Hum Nutr* 64: 312-318.
- Vishnevetsky, M., M. Ovadis and A. Vainstein 1999. Carotenoid sequestration in plants: the role of carotenoid-associated proteins. *Trends in Plant Science* 4: 233-235.
- Woolfe, J.A. 1992. Sweetpotato: an untapped food resource. Cambridge, UK: Cambridge Univ. Press and the International Potato Center (CIP).