

EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO



TOPIC 9

Processing and Utilisation

Reaching Agents of Change Training of Trainers (ToT) manual

October 2018



Everything You Ever Wanted to Know about Sweetpotato. Topic 9 - Processing and Utilisation

Reaching Agents of Change ToT Training Manual

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ISBN: 978-92-9060-502-7

DOI: 10.4160/9789290605027T9

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Produced by International Potato Center (CIP)

Correct citation for the entire manual:

Stathers, T., Low, J., Mwanga, R., Carey, T., McEwan, M., David, S., Gibson, R., Namanda, S., McEwan, M., Malinga, J., Ackatia-Armah, R., Benjamin, M., Katcher, H., Blakenship, J., Andrade, M., Agili, S., Njoku, J., Sindi, K., Mulongo, G., Tumwegamire, S., Njoku, A., Abidin, E., Mbabu, A., Mkumbira, J., Ogero, K., Rajendran, S., Okello, J., Bechoff, A., Ndyetabula, D., Grant, F., Maru, J., Munyua, H., Mudege, N., Muzhingi, T. (2018). Everything You Ever Wanted to Know About Sweetpotato: Reaching Agents of Change ToT Manual. International Potato Center, Lima, Perú.
<https://hdl.handle.net/10568/98341> 12 vols., 664 p. (see table on page iii)

Production Coordinator

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Design and Layout

SONATA Learning
Movin Were, Cartoons
Communications and Knowledge Resources Center, Covers

Printing

Clean Tone (Nairobi, Kenya)

Press run: 500

December 2018

CIP thanks Bill and Melinda Gates Foundation for funding the production of this manual.

CIP also thanks all donors and organizations which globally support its work through their contributions to the CGIAR Trust Fund.

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<http://www.cipotato.org/contact/>

ISBN: 978-92-9060-502-7

TITLE OF TOPIC	DOI	CITATION
Topic 1: Facilitating Training Sessions. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T1	Stathers, T., Low., J., E., Mbabu, A., Maru, J., Munyua, H., 2018. Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 1: Facilitating Training Sessions. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 95 p.
Topic 2: The Origin and Importance of Sweetpotato. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T2	Stathers, T., Low., J., 2018. Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 2: The Origin and Importance of Sweetpotato. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 26 p.
Topic 3: Sweetpotato Varietal Selection and Characteristics. Reaching Agents of Change Training of Trainers (ToT) manual	10.4160/9789290605027T3	Stathers, T., Carey, T., Mwanga, R., Njoku, J., Malinga, J., Tumwegamire, S., Andrade, M., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 3: Sweetpotato Varietal Selection and Characteristics. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 47 p
Topic 4: Nutrition and Orange-fleshed Sweetpotato. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T4	Stathers, T., Ackatia-Armah, R., Grant, F., Muzhingi, T., Benjamin, M., Katcher, H., Blakenship, J., Low., J., Maru, J., Munyua, H., Mudege, N., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 4: Nutrition and Orange-fleshed Sweetpotato. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 107 p
Topic 5: Sweetpotato Seed Systems. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T5	Stathers, T., McEwan, M., Gibson, R., Mwanga, R., Carey, T., Namanda, S., Low., J., Ogero, K., Rajendran, S., Agili, S., Abidin, E., Malinga, J., Andrade, M., Mkumbira, J., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 5: Sweetpotato Seed Systems. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 118 p
Topic 6: Sweetpotato Production and Management. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T6	Stathers, T., Mwanga, R., Carey, T., Njoku, J., Malinga, J., Njoku, A., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 6: Sweetpotato Production and Management. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 33 p
Topic 7: Sweetpotato Pest and Disease Management. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T7	Stathers, T., Gibson, R., Namanda, S., 2018. Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 7: Sweetpotato Pest and Disease Management. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 37 p
Topic 8: Harvesting and Post-Harvest Management. Reaching Agents of	10.4160/9789290605027T8	Stathers, T., Sindi, K., Bechoff., A., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 8: Harvesting and Post-Harvest Management. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 33 p

TITLE OF TOPIC	DOI	CITATION
Change Training of Trainers (ToT) manual.		
Topic 9: Processing and Utilisation. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T9	Stathers, T., Stathers, T., Sindi, K., Bechoff., A., (2018). Bechoff., A., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 9: Processing and Utilisation. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 42 p
Topic 10: Marketing and Entrepreneurship. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T10	Stathers, T., Low., J., Sindi, K., Ndyetabula, D., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 10: Marketing and Entrepreneurship. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 41 p
Topic 11: Gender and Diversity Aspects. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T11	Stathers, T., David., S., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 11: Gender and Diversity Aspects. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 31 p
Topic 12: Monitoring, Learning, and Evaluation of Sweetpotato Projects. Reaching Agents of Change Training of Trainers (ToT) manual.	10.4160/9789290605027T12	Stathers, T., Mulongo, G., Low., J., Mbabu, A., Rajendran, S., Okello, J., Sindi, K., Mudege, N., Maru, J., (2018). Everything You Ever Wanted to Know about Sweetpotato: Reaching Agents of Change ToT Manual. Topic 12: Monitoring, Learning, and Evaluation of Sweetpotato. International Potato Center. Nairobi (Kenya). ISBN 978-92-9060-502-7. 54 p

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Acknowledgements

This manual and the supporting training materials were developed by Tanya Stathers working closely with the following resource people on the different topics: Topic 1: Jan Low, Hilda Munyua, Adiel Mbabu, Joyce Maru Topic 2: Jan Low; Topic 3: Ted Carey, Robert Mwanga, Jude Njoku, Silver Tumwegamire, Joyce Malinga, Maria Andrade; Topic 4: Robert Ackatia-Armah, Fred Grant, Margaret Benjamin, Heather Katcher, Jessica Blakenship, Jan Low, Netsayi Mudege, Joyce Maru, Hilda Munyua; Topic 5: Margaret McEwan, Richard Gibson, Robert Mwanga, Ted Carey, Sam Namanda, Jan Low, Kwame Ogero, Srini Rajendran, Erna Abidin, Joyce Malinga, Sammy Agili, Maria Andrade, Jonathan Mkumbira; Topic 6: Ted Carey, Robert Mwanga, Jude Njoku, Joyce Malinga, Anthony Njoku; Topic 7: Richard Gibson, Sam Namanda; Topic 8: Aurelie Bechoff, Kirimi Sindi; Topic 9: Aurelie Bechoff, Kirimi Sindi; Topic 10: Jan Low, Kirimi Sindi, Daniel Ndyetabula; Topic 11: Sonii David; Topic 12: Godfrey Mulongo, Jan Low, Adiel Mbabu, Srini Rajendran, Julius Okello, Joyce Maru . Luka Wanjohi, Eric Muthuri and Frank Ojwang have provided invaluable support throughout the process.

This team has brought together and shared their many years of experience of working with sweetpotato systems and farmer learning processes across Sub-Saharan Africa to compile this *Everything You Ever Wanted to Know about Sweetpotato* resource. None of this experience would have been gained without the partnership of many sweetpotato farmers and other stakeholders (extensionists, national researchers, traders, transporters, NGO staff, nutritionists, media and donors) across the region. We thank you, and hope that this resource can in return offer you support in your sweetpotato activities.

The photographs used throughout this manual come from a wide range of places and we thank Margaret McEwan, Jan Low, Richard Gibson, A. Frezer, Erna Abidin, Aurelie Bechoff, Keith Tomlins, Sam Namanda, J. O’Sullivan, Gabriela Burgos, Tanya Stathers, Olasanmi Bunmi, Benson Ijeoma, Grant Lee Neurenberg, Sammy Agili, Jentezen Franklin, Kwame Ogero, the late Constance Owori, Ted Carey, Robert Mwanga, Ana Panta, Kirimi Sindi, Frank Ojwang, CIP digital archive, Centre for Behaviour Change and Communication, G. Holmes, B. Edmunds, and Nicole Smit for kindly sharing them. Most of the cartoons used in this manual were drawn by Movin Were.

This manual was originally produced as part of the Reaching Agents of Change project in 2013 and updated by the Building Nutritious Food Baskets project in 2017/2018 – both projects funded by the Bill & Melinda Gates Foundation.

Acronyms and Abbreviations

Als	Adequate Intakes
AVRDC	The World Vegetable Centre
BNFB	Building Nutritious Food Baskets
CBO	Community Based Organisation
CIP	International Potato
DAP	Days After Planting
DFE	Dietary Folate Equivalents
DONATA	Dissemination of New Agricultural Technologies in Africa
DVM	Decentralised Vine Multipliers
dwb	Dry Weight Basis
FAO	Food and Agriculture Organisation of the United Nations
FW	Fresh Weight
HH	Household
HKI	Helen Keller International
IBPGR	Bioversity International
IPM	Integrated Pest Management
IPPM	Integrated Pest & Production Management
K	Potassium
LGA	Local Government Areas
M&E	Monitoring and Evaluation
MAP	Months After Planting
m.a.s.l.	Metres Above Sea Level
Mm	Mass Multiplication
MSC	Most Significant Change
N	Nitrogen
NARO	National Agricultural Research Organisation
NGO	Non-Government Organisations
NHV	Negative Horizontal Ventilation
NRI	Natural Resources Institute
OFSP	Orange-fleshed Sweetpotato
P	Phosphorous
PMCA	Participatory Market Chain Approach
PMS	Primary Multiplication Site
PPP	Public Private Partnership
PVC	Polyvinyl Chloride
QDPM	Quality Declared Planting Material

QDS	Quality Declared Seed
RAC	Reaching Agents of Change
RAE	Retinol Activity Equivalents
RCT	Randomised Control Trial
RDA	Recommended Daily Allowances
RE	Retinol Equivalents
REU	Reaching End Users
RH	Relative Humidity
SASHA	Sweetpotato Action for Security and Health in Africa
SMS	Secondary Multiplication Site
SP	Sweetpotato
SPCSV	Sweetpotato Chlorotic Stunt Virus
SPFMV	Sweetpotato Feathery Mottle Virus
SPKP	Sweetpotato Knowledge Portal
SPVD	Sweetpotato Virus Disease
SSA	Sub-Saharan Africa
ToT	Training of Trainers
TMS	Tertiary Multiplication Site
Tshs.	Tanzanian Shillings
TSNI	Towards Sustainable Nutrition Improvement
UNICEF	United Nations Children's Fund
USD	United States Dollar
Ushs.	Ugandan Shillings
VAD	Vitamin A Deficiency
WAP	Weeks After Planting
WHO	World Health Organisation
WTP	Willingness to Pay

Foreword

During the past decade, interest in sweetpotato in Sub-Saharan Africa (SSA) has expanded, the number of projects utilizing sweetpotato has increased, and the demand for quality training resources, training development practitioners and farmers has subsequently risen. Sweetpotato scientists at the International Potato Center and national research centres often received these requests and frequently held 1-3 day training sessions, drawing on whatever training materials they had or could quickly pull together.

The Reaching Agents of Change (RAC) project in 2011 changed that situation. Jointly implemented by the International Potato Center (CIP) and Helen Keller International (HKI), RAC sought to empower advocates for orange-fleshed sweetpotato (OFSP) to successfully raise awareness about OFSP and mobilize resources for OFSP projects. RAC also sought to build the capacity of public sector extension and non-governmental organizational personnel to effectively implement those projects to promote the dissemination and appropriate use of vitamin A rich, orange-fleshed sweetpotato. The Building Nutritious Food Basket (BNFB) is a three-year project (November 2015 to October 2018) that followed on from the RAC project. The project is implemented in Nigeria and Tanzania and funded by the Bill & Melinda Gates Foundation. The goal of the project is to accelerate and support scaling up of biofortified crops for food and nutrition security and to help reduce hidden hunger by catalyzing sustainable investment for the utilization of biofortified crops (OFSP, PVA maize, high iron beans and vitamin A cassava) at scale. BNFB develops institutional, community and individual capacities to produce and consume biofortified crops. The objectives of the project are to strengthen the enabling environment for increased investments in biofortified crops and to develop institutional and individual capacities to produce and consume biofortified crops.

RAC/BNFB goal of developing and revising the Training of Trainers (ToT) manual on *Everything You Ever Wanted to Know about Sweetpotato* was to see *sustained* capacity for training senior extension personnel about the latest developments in sweetpotato production and utilization in each of the major sub-regions of SSA: Eastern and Central Africa, Southern Africa, and West Africa. Hence, CIP identified local institutions to work with in Mozambique, Tanzania, and Nigeria to host an annual course entitled: *Everything You Ever Wanted to Know about Sweetpotato*. The course has progressed from initially having CIP scientists working closely with national scientists to implement it, to national scientists and partners independently organising and conducting the course. In subsequent years, institutions in Burkina Faso, Ethiopia, Ghana, Malawi and others have been capacitated in conducting the course.

In developing the course content, a long-time collaborator of CIP, Tanya Stathers of the Natural Resources Institute (NRI), University of Greenwich, worked with CIP Scientists to review the existing training material, added in new knowledge from sweetpotato scientists and practitioners, and designed the course with a heavy emphasis on learning-by-doing. The CIP personnel who contributed to the development of the initial manual include, (Robert Mwanga, Ted Carey, Jan Low, Maria Andrade, Margaret McEwan, Jude Njoku, Sam Namanda, Sammy Agili, Jonathan Mkumbira, Joyce Malinga, Godfrey Mulongo), Adiel Mbabu and HKI nutritionists (Margaret Benjamin, Heather Katcher, Jessica Blankenship) and an HKI gender specialist (Sonii David) as well as NRI colleagues (Richard Gibson, Aurelie Bechoff, Keith Tomlins). Some of the materials were adapted from the DONATA project training materials, the Reaching End Users project and many others. After practitioners had used the course and the manual, a review was held in 2012 and the manual and course were subsequently updated, and a standard set of accompanying Power Point presentations created. In 2017-2018, the Building Nutritious Food Baskets project led a further review of the manual working closely with Tanya Stathers, the above mentioned CIP teams again plus Robert Ackatia-Armah, Kwame Ogera, Srinji Rajendra, Julius Okello, Fred Grant, Joyce Maru, Hilda Munyua and Netsayi Mudege to update the content of topics 3, 4, 5, 12 and 13 which cover: sweetpotato varietal selection; nutrition; seed systems; monitoring, learning and evaluation; and using the 10 and 5 day ToT course.

This manual is designed to potentially serve a wide variety of audiences (nutritionists and agronomists, policymakers, extension workers, community development workers, leaders of farmer organizations, farmers etc.). Not all the materials will be relevant to all audiences, but facilitators can adapt the content to their audience and facilitation best practices. To ensure sustainability and wide reach; a cascading approach in the delivery of training is recommended; where key experts (agriculturalists, nutritionists, health workers, marketing and gender experts) will attend more detailed ToT workshops. The experts trained will then become primary facilitators and drive the agenda for OFSP. This group will in turn deliver shorter version courses and step-down the training to various levels of audiences (secondary and tertiary) – based on needs identified. This trend will continue until the training cascades down to “farmer trainers” who finally train the end users in their communities.

The original version of the manual has also been translated into Swahili, French, Portuguese, and Amharic are available online at <https://www.sweetpotatoknowledge.org/learn-everything-you-ever-wanted-to-know-about-sweetpotato/> with the intension of translating the revised chapters as soon as resources permit. We envision the course to continue to be improved as new knowledge comes in. In this way, we expect the vibrant and knowledgeable sweetpotato community of practice to continue to grow in the coming years. The *Everything You Ever Wanted to Know about Sweetpotato* course will help us to achieve the major objectives of the Sweetpotato Profit and Health Initiative (SPHI). Launched in October 2009, the SPHI seeks to improve the lives of 10 million sub-Saharan African families in 16 countries by 2020 through the diversified use of improved sweetpotato varieties.



Jan W. Low, Leader of the Sweetpotato for Profit and Health Initiative, International Potato Center
October 2018, 2nd edition.

How to Use This Guide

This guide was designed to be used in two ways:

- As self-study material, or
- As a facilitator's guide for classroom training sessions

For each topic we have provided:

- A handbook (this volume)
- A PowerPoint presentation, and
- A handout for classroom training participants

If you plan to deliver this as classroom training, then we would encourage you to read the **Facilitator's Guide** (separate volume) prior to planning your lessons.

Introduction: Processing and Utilisation

Topic Objectives

Upon completing this module, participants should be able to:

- Describe the best methods to preserve beta-carotene during sweetpotato processing.
- Compare the use, storage timing, and nutritional content of the most widely used forms of processed sweetpotato.
- Tell how processed sweetpotato is used to improve household nutrition.
- List and describe sweetpotato recipes.
- Explain industrial sweetpotato processing.
- Describe the use of sweetpotato (roots and foliage) as animal feed.
- Explain how to create high quality silage.
- Discuss gender and diversity issues around sweetpotato processing and utilisation.
- Design and lead learning-by-doing activities around sweetpotato processing and utilisation.

Synopsis

Topic 9 focuses on the many delicious, nutritious and potentially profitable food products can be prepared from orange-fleshed sweetpotato. The use of sweetpotato as animal feed is also discussed.

Unit 1 – How to Process Orange-Fleshed Sweetpotato, Retain the Beta-Carotene Content and Add Value

Objectives

By the end of this unit, you should be able to:

- Identify the sweetpotato processing practices that best preserve beta-carotene.
- Describe the processes of boiling, steaming, roasting, and drying sweetpotato root.
- Discuss the pros and cons of peeling sweetpotato.
- Tell how to improve beta-carotene retention within each processing method.
- List the three primary orange-fleshed sweetpotato (OFSP) products.
- Explain how to add nutritional value to a variety of foods using processed OFSP.

Key Points

- **Sweetpotato loses essential beta-carotene both in storage and in processing.**
- **Roasting sweetpotato is the best method for retaining beta-carotene. Sun-drying is the most destructive; between them, listed from best to worst, are boiling, frying, and steaming.**
- **With all methods of preparation, less is more: do not overdry, over steam, etc. Sometimes OFSP must be sun-dried for the off-season but using thin slices that can be dried quickly reduces nutrient loss.**
- **Peeling sweetpotatoes is optional; the peel contains dietary fibre, and not peeling saves labour.**
- **Long storage destroys beta-carotene, even if it is preserved during processing.**
- **If carefully processed, flour made with OFSP adds significant amounts of Vitamin A to many foods, such as doughnuts, breads, and porridges. A single OFSP chapati can provide a child with a full day's Vitamin A.**
- **Sweetpotato foliage can also add nutrition to a variety of dishes and condiments.**

How to Process Orange-Fleshed Sweetpotato, Retain the Beta-Carotene Content, and Add Value

Orange-fleshed sweetpotato (OFSP) is usually cooked before being consumed. Traditional methods of preparing OFSP in Sub-Saharan Africa include boiling, steaming, roasting and drying (see table below).

Traditional Methods of Preparing Orange Fleshed Sweetpotato

Boiling

- Use clean water.
- Wash sweetpotato roots.
- Peel the roots (optional); the peel has lots of dietary fibre.
- Boil the sweetpotato roots until they are soft.



Steaming

- Use clean water.
- Wash the sweetpotato roots.
- Peel the roots (optional).
- Wrap them in banana leaves.
- Steam them over boiling water until they are soft.



Roasting

- Wash the sweetpotato roots and wipe them to remove moisture.
- Either wrap the sweetpotato roots in banana leaves and place them in the ashes of a fire until they are cooked or place on a grill above charcoal.
- Sweetpotato roots can also be roasted in an oven.



Drying

- Wash sweetpotato roots and wipe or pre-dry them in the sun to remove external moisture.
- If possible use a chipper or a slicer to cut the roots into thin pieces that dry fast. Alternatively, roots can be sliced by hand, but bigger pieces will take longer to dry.
- Spread the pieces on a clean surface (for example, a black plastic sheet or a mosquito mesh) and leave it in the sun until dry (do not dry on the ground, as the roots can get contaminated with dirt). The total drying time should not exceed 3 days.
- Pack the dried pieces in opaque bags and seal them. Store in a clean, cool and dry place with limited sunlight.
- Mill the dried pieces into flour.



During the preparation of OFSP, some of the micronutrients that it contains such as beta-carotene can be lost (by washing) or destroyed (by cooking, sun exposure, long-term storage). Processes causing the least to the greatest beta-carotene loss in OFSP roots are roasting > boiling > frying > steaming > sun-drying.

How to Retain the Beta-Carotene Content?

- **Process quickly:** beta-carotene degrades when exposed to long preparation times and high temperatures. Don't overboil, over steam, over-roast or overdry your OFSP.
- **Process with the skin:** peeling is not a necessary stage of preparation as the peel can be removed after cooking or when it is dried. Not peeling the roots before processing will save time. If the OFSP is properly washed and clean, it is not necessary to peel it. Leaving the skin on the sweetpotato root can help retain more of the beta-carotene and other vitamins during processing.
- **Do not store the processed OFSP for long periods.** Beta-carotene is degraded during storage of the processed product. Dried OFSP that is stored for more than 1 month starts to lose its beta-carotene. The longer the dried product is stored the more the beta-carotene is destroyed. If dried OFSP needs to be stored, it should be in a cool and dried place and in opaque packaging (so sun-light cannot destroy the beta-carotene in the product).



How to Add Value?

In addition to the traditional preparations described above, there are multiple novel ways of preparing OFSP to add value to it. In order to tackle vitamin A deficiency and increase consumption of OFSP, the CIP and HarvestPlus Challenge project have developed various recipes with OFSP.

There are three primary products from OFSP that can be used as ingredients for a range of recipes:



Fresh-grated sweetpotato



Boiled and mashed sweetpotato often referred to as puree



Sweetpotato flour

These three primary products can replace some of the wheat flour in commonly consumed food products. They can be incorporated into bread, bakery products such as mandazi (traditional doughnut), chapati, cakes, biscuits, croissants, pies etc. Consuming two OFSP mandazi is equivalent to $\frac{3}{4}$ of the vitamin A daily intake requirement for a child. Consuming one OFSP chapati is equivalent to 100% of the vitamin A daily requirement for a child.

In addition, sweetpotato flour can be mixed with other flours (roasted soybean, roasted maize, millet, cassava, Amaranthus) to produce composite flour that can be used to make porridges. These porridges can be consumed by children. Consuming one mug of porridge containing 30% OFSP would provide a child with about 20% of his/her vitamin A daily nutritional requirement. Other products from OFSP include sweetpotato jam, ketchup etc. In addition to these products, the sweetpotato leaves can also be used to prepare relish. *Recipes* are provided in Unit 4 below.



*Mandazi from OFSP: wheat
(30:70) flours*



*Porridge from OFSP:
soybean: maize
(30:35:35) flours*



*Ingredients for sweetpotato
jam*



*Relish made from
sweetpotato leaves*

Review Question

1. What are some of the ways to retain beta-carotene during OFSP processing?
2. What are the three primary products of OFSP?

Unit 2 – Sweetpotato Flour Versus Grated Sweetpotato or Sweetpotato Puree

Objectives

By the end of this unit, you should be able to:

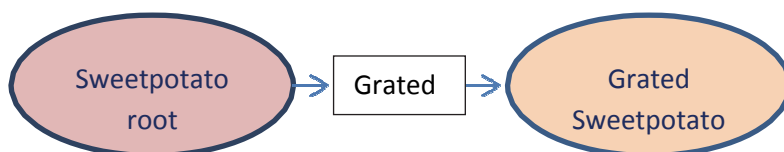
- Compare the processes used to make sweetpotato flour, grated sweetpotato, and sweetpotato puree.
- List the uses of these different sweetpotato forms.
- Discuss the pros and cons of each form, particularly when used in baked goods.

Key Points

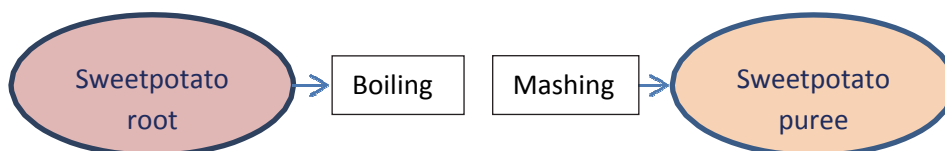
- **Grated sweetpotato is a relatively simple product, as it requires only grating the rinsed fresh root. Sweetpotato puree requires two steps (boiling and mashing), while sweetpotato flour requires chipping, drying, storing, and milling.**
- **Much beta-carotene is lost in the lengthy process of making and storing sweetpotato flour. However, since the flour has a low water content, the vitamin A it contains is concentrated. Therefore, it is sometimes more nutritious than less processed forms of sweetpotato.**
- **Sweetpotato flour can replace 25-50% of the wheat flour in recipes for many profitable and nutritious bakery products without changing the texture of the product.**
- **Sweetpotato puree (mash) can also be used in baking, but its high-water content means the recipes must be altered, and the baked goods' taste and texture may change.**

Sweetpotato Flour Versus Grated Sweetpotato or Sweetpotato Puree

Grated sweetpotato is made from raw and grated (shredded) sweetpotato:

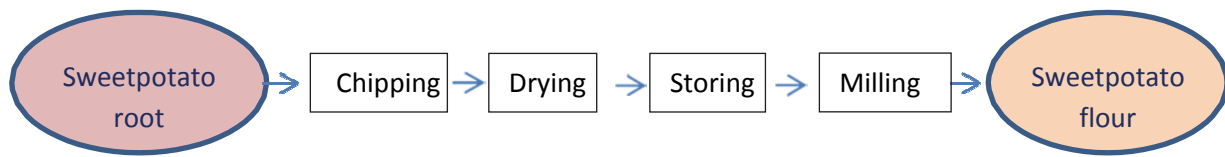


Sweetpotato puree is made from boiled and mashed sweetpotato:





Sweetpotato flour is made from dried and milled sweetpotato:



Making sweetpotato flour is a more complex and longer process than making grated sweetpotato or puree. The disadvantage of flour preparation is that the beta-carotene can be easily lost during the process. This is particularly true if the product is stored for some time. The drying process also has greater labour and equipment (a dryer) requirements than the boiling process. Good drying conditions as well as qualified personnel/ processors are necessary to perform the operations.

On the other hand, sweetpotato flour has some advantages over grated sweetpotato or puree: since the water is removed from the product, it is then lighter, making transport and storage easier.

Additionally, the beta-carotene content is more concentrated in a product that contains little water, and in some cases, higher contents of beta-carotene can be achieved. In addition, sweetpotato flour can be easily incorporated into products that usually use wheat flour. Sweetpotato flour can favourably replace 25-50% of the wheat flour used in several high-value bakery product recipes for biscuits, croissants and doughnuts. The use of mashed and boiled sweetpotato (puree) requires changing the proportions of other ingredients when making baked products and the dough is more difficult to work with for processors. The final products made with a mixture of wheat flour and sweetpotato puree have a different texture from the original products made with only wheat flour, whilst those products made by substituting sweetpotato flour for some of the wheat flour do not differ. The changed texture might affect the taste, and consumer preference. However, in our experience, most consumers prefer the taste and appearance of the product containing the sweetpotato puree over the product with only wheat flour.

Bread and mandazi have been successfully made from composite flours of OFSP and wheat (~20%/80%). The price of the different flours determines how cost effective this is. Raw and grated OFSP roots or puree may be preferred for bread making when the price of flour is high. Porridge prepared from OFSP-sorghum (70%/30%) composite flour (similar to *atap*) had high beta-carotene levels.

When the traditional Ugandan cassava flour and banana pulp deep fried pancake (Kabakagala) was made using sweetpotato flour instead of cassava flour it attracted significant consumer interest.

While attempts in Kenya to prepare the staple dish Ugali (normally made from maize or sorghum flour) from sweetpotato flour, led to complaints that the product was too sweet. Most new products need some promotional activities to help develop market demand for them. These aspects are discussed in the topic, Marketing and Entrepreneurship.

The substitution of wheat flour, either with fresh grated OFSP, boiled and mashed OFSP or OFSP flour, is gaining a foothold in the snack product market in East Africa. However, the profit is dependent on the relative cost of sweetpotato roots or flour to wheat flour and the degree of substitution. It takes 4-5 kilograms of fresh sweetpotato roots to make a kilogram of flour; while just 1.25 kilograms of fresh roots to make a kilogram of puree. For example, in Rwanda, bread is being made using up to 30% sweetpotato puree, mandazi up to 40% sweetpotato puree, and biscuits up to 45% sweetpotato puree.

There are pros and cons for the use of 'fresh and grated', 'boiled and mashed (puree)' and 'dried and milled (flour)' sweetpotato products and each case should be considered individually in order to find the most practical and economically feasible way of using the sweetpotato. For some recipes you will want to use varieties with high dry matter content, and for others such as weaning foods varieties with low dry matter content are more suitable.

Review Question

1. While sweetpotato flour has several advantages that sweetpotato puree and grated sweetpotato do not, what are some disadvantages?

Unit 3 – Using Sweetpotato to Add Nutritional Value at the Household Level

Objectives

By the end of this unit, you should be able to:

- Explain why rural households should consider adding more sweetpotato products to their diet.
- Suggest how sweetpotato can be incorporated into foods.
- Name the three types of food that children, infants, and adults should have at every meal.

Key Points

- **Sweetpotato adds vitamins A, C, and several B vitamins to many dishes. Sweetpotato dishes that also include groundnuts supply protein and fats as well.**
- **Sweetpotato should be prioritised as a breakfast food, as it is more nutritious and filling than wheat bread.**
- **The leaves of the sweetpotato plant are valuable as a dietary vegetable and can be fried with groundnuts, tomatoes, and onions.**
- **At 6 months, infants can be given sweetpotato as a weaning food.**
- **Infants and adults should consume three types of food at each meal: an energy food (fat and carbohydrate), a protective food (micronutrients), and a body building food (proteins).**

Using Sweetpotato to Add Nutritional Value at the Household Level

For rural households, emphasis should be put on including sweetpotato particularly orange-fleshed sweetpotato (OFSP) in their existing diet if it is not already being eaten several times a week. For example, if the household cooks a stew, sweetpotato chunks can be added to the stew. In many countries, there is a traditional sweetpotato with groundnut dish. This is a really healthy food, especially when made with OFSP roots, as they contain vitamins A, C, and several B vitamins and minerals (see the topic, Nutrition) and the groundnuts have protein and fat. The use of OFSP roots as a breakfast food should be promoted as it is much more nutritious than bread and much more filling. Children can carry boiled or baked OFSP roots to school as a healthy snack. Better-off households may be making bakery products in which OFSP roots can become an ingredient. Boiled, fried, and baked sweetpotato can be rotated on the weekly menu, diversifying how it is prepared, often leads to increased frequency of consumption.

Families should also be encouraged to select young and tender sweetpotato leaves for use as a vegetable. These may be cooked in the same way other popular African leafy vegetables such as *Amaranthus* are cooked. They can also be prepared by frying with a little oil, and then cooked with tomatoes and onions for a few minutes, adding pounded groundnuts if they are available (see the next unit, *How to Cook Delicious Sweetpotato*).

When infants turn 6 months of age, sweetpotato can be one of the first complementary weaning foods they receive. Unfortunately, in most SSA countries young children are given thin, runny porridges of just maize meal or cassava meal. Infants have small stomachs, and need them filled frequently with nutrients, not with water. We need to encourage care givers of infants to prepare *enriched* porridges. An enriched porridge is thick – it does not fall off the spoon easily. An enriched porridge contains each of the following types of food, mashed before adding them to the porridge:

1. A source of energy (carbohydrates and fats): e.g. sweetpotato, maize, wheat, cassava,

potato and fats/oils (groundnuts, vegetable oil, coconut, avocado) – just a little oil packs a lot of energy.

2. A protective food (vitamins and minerals): e.g. orange-fleshed sweetpotato (vitamins A, C), mango and other fruits and vegetables like pumpkin and dark green leaves; eggs, milk.
3. A body building food (proteins): e.g. beans, eggs, milk, meats, chicken, fish, sesame, groundnuts, some insects.

In fact, all family members should eat from each of these three food groups at each meal. To be healthy, people must eat *enough* food and the *right* foods. Orange-fleshed sweetpotato roots provide both energy and vitamins, and so they are superior to cassava tubers, which are just a source of energy only. Sugar is *not* a good food for infants and should *not* be added to porridges; young children should *not* be given sugary drinks. Use fruits and orange-fleshed sweetpotato to add a sugary taste to children's foods.

Review Questions

1. What are some of the nutritional benefits of sweetpotato for rural households?
2. What are the advantages of enriched porridges?

Unit 4 – How to Cook Delicious Sweetpotato Recipes

Objectives

By the end of this unit, you should be able to:

- Name the healthiest and less healthy ways of eating sweetpotato.
- Explain how to make sweetpotato porridge, mandazi, chapati, mshenye, crisps, drop scones, buns, and other baked goods and dishes, with or without the addition of other flours and cereals.

Key Points

- **A small amount of oil in sweetpotato increases beta carotene (Vitamin A) absorption.**
- **Boiled or baked sweetpotato dishes are more nutritious than deep fat-fried sweetpotato foods.**
- **Sweetpotato should be mixed in varying proportions with different flours for the best results in various recipes**

How to Cook Delicious Sweetpotato Recipes

A wide range of delicious recipes can be made using sweetpotato. The following pages contain recipes for a selection of popular recipes. However, it should be remembered that the healthiest way to eat your orange-fleshed sweetpotato is to boil and mash it and add just a teaspoon of oil to increase vitamin A absorption. Deep fat fried products (chips, crisps) are much less healthy than boiled or baked products.

Quantity conversions are given in later in this Unit; however, due to varying cup sizes in the different places these recipes have originated from, it is not advisable to convert the measurements in these recipes.

Sweetpotato Porridge

Ingredients

- 1 heaped tablespoon sweetpotato flour
- 4 heaped tablespoons millet, sorghum, cassava or maize flour
- 1 heaped tablespoon soya flour
- 1 small lemon
- 2 tablespoons sugar
- 6 cups water

Procedure

1. Bring five cups of water to boil.
2. Mix the cereal/root crop flours with the soya flour and make a paste with the remaining one cup of water.
3. Pour the paste into the boiling water and keep stirring to prevent lumps.
4. Squeeze the juice of the lemon into a cup while the pot continues to boil for 20 minutes.
5. The cooked product should jell.
6. Remove from fire; add the lemon juice and sugar.
7. Cool, then serve warm. Milk can be added if desired.

Other popular formulations of composite flours for making porridge are:

Sweetpotato-maize-soybean (30:35:35);

Sweetpotato-maize-amaranthus (30:35:35),

Sweetpotato-maize-groundnut (25:50:25);

Sweetpotato-millet-soybean (35:30:35);

Sweetpotato-millet-amaranthus (35:30:35);

Sweetpotato-millet-groundnut (30:40:30);

Sweetpotato-soya (50:50).



Preparing porridge from OFSP:soybean:maize (30:35:35) flour, Kawanda, Uganda – Feb. 2010



Sweetpotato Mandazi

Ingredients

- ½ cup sweetpotato mash or sweetpotato flour (30%)
- 2 cups wheat flour (70%)
- 2 tablespoons sugar
- Pinch of salt
- 2 cups cooking oil
- 1 tablespoon baking powder
- Adequate lukewarm water



Procedure

1. Put the sweetpotato mash in a mixing bowl and sift in the dry ingredients.
2. Add water and mix into a dough.
3. Knead the dough well while adding 2 tablespoons of oil.
4. On a floured surface, roll the dough to about 1 cm thickness.
5. Cut into desired shapes.
6. Deep fry while turning till golden brown.
7. Remove from oil, drain and serve warm or cold.



Sweetpotato-Soya Chapati

Ingredients

- 1 cup grated, boiled and mashed sweetpotato or sweetpotato flour
- 2 cups wheat flour
- 1 cup soya flour
- 1 teaspoon salt
- Adequate lukewarm water
- ½ cup oil

Procedure

1. Mix the dry ingredients together in a bowl.
2. Add the grated sweetpotato and mix.
3. Add 1 tablespoon of oil and mix well.
4. Add the lukewarm water to the mixture in the bowl and knead till a stiff smooth paste is formed.
5. Divide the dough into 8-10 equal balls.
6. On a lightly floured surface roll one ball at a time.
7. Fold each ball at a time to form a strip.
8. Coil each strip to form a circle and put aside for 20 minutes.
9. On a floured surface, roll out each coiled circle into a thin circular sheet.
10. Grease a shallow frying pan.
11. Fry each circular sheet on both sides till golden brown; make sure both sides are greased.
12. The resulting chapatti can be served with stew or sauce or tea.





Sweetpotato "Mshenye"

Ingredients

- 10 medium-sized sweetpotato roots
- 2 cups maize kernels
- 4 cups beans/cowpeas or greengrams
- Salt to taste
- Adequate water

Procedure

1. Sort maize and beans and pre-soak for 6-8 hours.
2. Boil the maize and beans till almost cooked.
3. Remove any soil from the sweetpotato roots and peel them.
4. Wash and slice the sweetpotato roots.
5. Add the sliced sweetpotato roots to the maize and beans and let cook.
6. When sweetpotato roots are soft and maize and beans are well cooked, mash them.
7. Add salt to taste and serve as balls or a mound heaped on a plate.



Sweetpotato Crisps

Ingredients

- 6 medium-sized sweetpotato roots
- 2 cups oil
- Salt and red pepper to taste
- 2 containers water for preparing the roots

Procedure

1. Remove soil from roots and then peel and place the roots in clean water.
2. Slice roots into very thin pieces using a knife or the larger blade of a grater.
3. Drain off the water.
4. Heat the oil and deep fry till the crisps start to turn golden brown.
5. When golden brown remove and drain.
6. Add salt and red pepper to taste; serve warm or cold.



Sweetpotato Doughnuts

Ingredients

- ½ cup grated sweetpotato root
- 2 cups wheat flour
- 1 teaspoon yeast
- 2 tablespoons sugar
- Pinch of salt
- 2 cups oil
- 1 tablespoon cooking fat
- 2 teaspoons grated lemon peel
- Adequate lukewarm water
- Optional - milk/egg



Procedure

1. Put yeast and 1 tablespoon of sugar into a cup.
2. Add 3 tablespoons of warm water and leave for 10 minutes to rise.
3. Put the grated sweetpotato into a mixing bowl and sift in the dry ingredients.
4. Add in the grated lemon peel and mix.
5. Rub in the cooking fat and then add the risen yeast and mix.
6. Add water and knead into a dough.
7. On a floured surface, roll the dough slightly.
8. Make the dough into a ball and return to mixing bowl.
9. Cover the mixing bowl with wet warm cloth and leave to dough to double in size. Placing the bowl in the sun for 10 minutes helps it rise.
10. Re-knead the dough after doubling and roll onto a floured surface.
11. Cut into desired shapes and deep fry till golden brown.



Sweetpotato Crackies

Ingredients

- 1 cup sweetpotato flour or 1½ cups sweetpotato mash
- 2 kgs (~10 cups) wheat flour
- 3 teaspoons salt
- 5 small pieces garlic
- 12-15 pieces local green hot pepper local or 3 pieces exotic green hot pepper
- 0.8 litres sunflower oil
- Lukewarm water



Procedure

1. Sift all dry ingredients in a mixing bowl.
2. Add sunflower oil.
3. Knead to form a smooth dough, till it leaves the bowl clean.
4. Add a little lukewarm water and keep mixing until hard and smooth. Cover it immediately

- with a clean cotton cloth.
5. Cut and make into small balls, roll them till flat and transparent. Add juice from crushed green hot peppers depending on the consumer's preference.
 6. Heat oil and fry the flat crackies in it, when lightly brown remove them from the oil, drain the oil and let cool in a covered container.



Sweetpotato Drop Scone Style Pancakes

Ingredients

- 1 ¼ cups sweetpotato mash
- 1 ½ cups wheat flour
- 3 ½ teaspoons baking powder
- 1 teaspoon salt
- ½ teaspoon ground nutmeg
- 2 eggs, beaten
- 1 ½ cups milk
- ¼ cup butter, melted



Procedure

Sieve all the dry ingredients into a mixing bowl.

1. Combine the remaining ingredients, and then add them to the flour mixture.
2. Melt a small knob of butter in a frying pan.
3. Drop tablespoons of the batter into the hot frying pan.
4. Fry, turning the pancakes over once, until browned on both sides.



Golden Bread Sweetpotato Buns

Ingredients (for 44 small buns)

- 3 cups (each 300ml) or 950g of boiled and mashed orange fleshed sweetpotato (cooked and peeled before mashing);
OR re-hydrate 350g of dried orange-fleshed sweetpotato chips (to re-hydrate, soak the chips in water for 20 minutes then boil until soft enough to mash)
- 1.5kgs (~7½ cups) wheat flour
- 2 tablespoons of yeast
- ½ teaspoon of improver (a product sold especially for bread making) – *optional*
- 1 teaspoon salt (use as little as possible as it makes the buns rise less)
- 1 litre of water (approximate)



Procedure

1. Begin warming the oven to 180°C (350°F) or light the charcoal in the charcoal oven.
2. Wash 5 medium sized roots of orange fleshed sweetpotato and cook them in boiling water.
3. Peel and mash the cooked roots.

4. Mix together the wheat flour, yeast, improver and salt.
5. Add the mashed sweetpotato to the flour mixture and mix again.
6. Add half the water and knead well for 5-10 minutes.
7. Continue adding water little by little, while continuing to knead the dough until it does not stick to your hands.
8. Make the dough into the buns of the size you want. It is not necessary, nor desired to let the dough rise before shaping it into buns.
9. Cover the buns with a clean cotton cloth and leave to rise for 25 minutes in a warm place, for example in the direct sunlight outside.
10. Sprinkle a small amount of wheat flour on the surface of the baking tray/sheet, before placing the raw buns on top.
11. Bake in a hot oven at 180°C (350°F) for about 15-20 minutes or until they are golden brown.



Sweetpotato Bread

Ingredients

½ cup grated sweetpotato
 2 cups wheat flour
 1 teaspoon yeast
 1 tablespoon sugar
 Pinch of salt
 2 tablespoons oil
 Adequate lukewarm water or milk



Procedure

1. Mix yeast and sugar in a cup.
2. Add 3 tablespoons of water or milk to the cup and leave to rise.
3. To quicken the rising process, cover cup with a warm cloth and put in the sun for 5 minutes or 10 minutes at room temperature.
4. Mix grated sweetpotato with other dry ingredients in a mixing bowl.
5. Add the yeast mix and water into mixing bowl.
6. Knead into dough and add the oil to make it smooth.
7. Divide into two parts.
8. Grease bread tins and shape each dough and place in tin.
9. Leave to rise until it has doubled in size.
10. Bake in oven at 200°C (400°F) for 15 - 20 minutes.
11. Remove and allow to cool and then wrap.



Sweetpotato Onion Bites

Ingredients

1 cup
sweetpotato
mash
2 cups wheat
flour
3 teaspoons baking powder
 $\frac{3}{4}$ teaspoons
chilli pepper
1 teaspoon salt
 $\frac{1}{2}$ cup spring
onion leaves
1 teaspoon
cooking fat
Water



Procedure

1. Sift all dry ingredients in a mixing bowl. Pound the onions.
2. Add the sweetpotato mash and cooking fat and mix well to a dough.
3. Add water a little at a time and knead to a light texture, let it relax for 10-15 minutes.
4. Heat oil in a pan.
5. Make small sized balls and drop them into the hot oil.
6. Cook till brown drain and serve.



Sweetpotato Fiossis

Ingredients

300g wheat flour
50g margarine
200g sweetpotato puree
65g sugar
2 eggs
Oil for frying
2 teaspoons baking powder

Procedure

1. Beat the margarine and sugar together.
2. Add the eggs and then the sweetpotato puree, keep mixing.
3. Gradually add the flour and baking powder, keep mixing.
4. Knead the dough well until it stops sticking to your hands.
5. Roll small pieces of the dough into little sausage shapes and then tie each in a loose knot or bow
6. Fry in oil (not too hot).

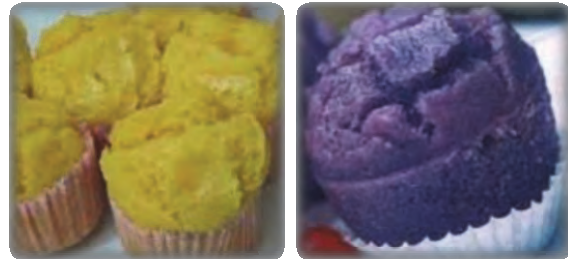




Sweetpotato Steamed Cup Cakes

Ingredients

- 2 medium-sized roots of orange or purple fleshed sweetpotato
- 2 ½ cups wheat flour
- 1 tablespoon yeast
- ½ cup sugar
- 1 egg
- 100 ml (~ ½ cup) coconut milk (coconut cream)
- ¼ tablespoon salt
- 5 tablespoons water



Procedure

1. Steam the sweetpotato roots, then peel and mash them and set aside in a bowl.
2. Add 5 tablespoons of water and 1 tablespoon of yeast to 50g of wheat flour and stir it until smooth. Set aside for 20 minutes.
3. Add the sugar, egg, salt, and remaining 200g of wheat flour to the bowl of mashed sweetpotato roots, stir while adding the coconut milk little-by-little into the bowl.
4. Pour the contents of the two bowls in together, mix very well and then leave the mixture to rise for 45 min.
5. Boil water in a steam-pot.
6. Place the paper cup cases into the cups of the baking tray, spoon the batter carefully into each cup case until they are each about ¾ full.
7. Place the baking tray in the steam-pot.
8. Wrap the lid of the pot with a tea-cloth to prevent steam from condensing and dripping on the cupcakes, and then close the lid very tightly. Let the cakes steam for 20 minutes.
9. Remove the cupcakes from the baking tray and allow to cool.



Sweetpotato Cake

Ingredients

- 1 cup sweetpotato mash
- 3 cups wheat flour
- 4 eggs
- 5 tablespoons margarine/ sunflower oil
- 3 teaspoons baking powder
- 1 medium lemon
- 3 tablespoons sugar
- Adequate water or milk



Procedure

1. Sift all dry ingredients in a bowl. Add the sweetpotato mash and 4 tablespoons of margarine

and rub in.

2. Beat the eggs and add to the bowl and mix well.
3. Grate lemon rind and add to the bowl and mix.
4. Make juice from the lemon and add to the contents in the bowl and mix well.
5. If consistency is not runny, add a little water or milk.
6. Grease baking pan and pour in contents.
7. Bake in oven at 175°C (360°F) for 30 minutes or till golden brown.
8. Alternatively bake on an open-fire (see tips on open-fire baking below).



Tips on Open-Fire Baking

Method 1

1. Pre heat the charcoal stove /jiko.
2. Grease a heavy pan with a lid, pour the mixed dough contents into the pan then cover the pan with the lid.
3. Remove fire from stove and place on the lid evenly.
4. Leave very little fire in the fire – box/stove and cover with ash.
5. Place covered pan with fire on the lid onto the ash covered stove.
6. Keep the fire on the lid burning by adding twigs for 2 minutes.
7. Let cook for another 30 – 40 minutes depending on type of charcoal.
8. Remove the lid with fire/coals on it, test cake with a knife by piercing it in the middle.
9. If done knife should come out dry - if not done knife will be wet with uncooked contents, the cake should also be starting to come away from the sides of the pan.
10. If done remove and cool cake on rack. If not done return and replace lid with fire for a while.

Method 2

Alternatively, some people use two pans to bake a cake over a fire. One large, thick base and walled pan with a lid (which becomes the oven), the other a smaller cake pan, which is greased and then the cake mixture is poured into it.

1. Allow the wood to burn down and then use the coals to bake with.
2. Place your large (oven) pan just above the coals (if it gets too hot the cake can burn). You will then need to place a metal riser or some dry stones (N.B. – not wet stones from the river as they may explode in the oven due to their contained moisture!). Put the stones inside the large pan (oven) to enable the smaller pan to be raised off the base so that hot air can circulate around it.
3. Place the cake pan with the mixture in it into the larger (oven) pan, and let it cook for 20 minutes.
4. Then take the larger (oven) pan off the coals/fire and put it aside and place the coals instead on to its lid. Cook for a further 20 minutes, and then lift the lid and test whether the cake is ready (e.g. the knife comes out clean and not covered in uncooked ingredients).
5. When the cake is ready, remove the cake pan from the larger (oven) pan and let it cool.



Liberian Sweetpotato Pone

Ingredients

- 3 cups grated raw sweetpotato roots
- 1 cup molasses or 1 cup dark cane syrup
- 2 teaspoons ground ginger
- 2teaspoons baking powder
- 1 teaspoon salt
- 1/3 cup vegetable oil

Procedure

1. Combine all ingredients in a saucepan and simmer slowly, stirring constantly, for 10 minutes.
2. Pour into a well-greased 9-inch baking pan.
3. Bake at 170°C (325°F) for 30 minutes, stirring it up every 5 minutes for the first 20 minutes.
4. Smooth down the top and allow to brown.
5. Cut into squares and serve either hot or cold.



Baked Sweetpotato Wedges with Chicken Wings

Ingredients

- 2 large sweetpotato roots
- 1 tablespoon olive oil
- 12 pieces of chicken wings
- 1 tablespoon oil
- 1 teaspoon chilli flakes
- Juice of 1 lime
- 2 tablespoons African dark honey
- Salt, black pepper, thyme and chilli powder to taste

Procedure

1. Wash and cut the sweetpotato roots into wedges.
2. Toss the sweetpotato wedges with olive oil, salt, thyme and chilli. Set aside.
3. Combine the chicken wings with salt, black pepper and oil.
4. In a different bowl, combine the chilli flakes, dark honey and lime juice. Set aside.
5. Arrange the chicken and potatoes on an oiled tray; bake for 25 minutes at 180C (350F).
6. Remove the tray from the oven and turn the sweetpotato wedges over.
7. Add the precooked chicken wings to honey mixture and coat them generously.
8. Return the chicken wings to the baking tray, and spoon over any of the left-over honey sauce.
9. Return the tray to the oven and bake for another 15 minutes.





Sweetpotato Jam

Ingredients

- 3-4 medium Sweetpotato roots
- 1 kg sugar
- Juice of 1 lemon or orange (as a preservative and for taste)
- 1 cup water

Procedure

1. Peel sweetpotato roots and boil till soft, then mash while still hot.
2. Prepare syrup by mixing 1 cup of water to 1 kg of sugar, then boil while mixing with a wooden spoon.
3. Add the mash to the boiling syrup and allow it to simmer until the jam becomes amber in colour.
4. Remove from heat, taking care not to let it burn. Mix in the lemon/orange juice.
5. Bottle, seal and label the jam.



Sweetpotato Juice

Ingredients

- 4 cups sugar
- 8 medium sized boiled peeled sweetpotato roots
- Juice from 5 lemons or 3 teaspoons of citric acid
- 5 litres boiled and cooled water
- 1 drop of fruit flavouring (optional) or add tamarind or passion or orange or pineapple to taste

Procedure

1. Boil water and sugar and then leave to cool. Mash boiled sweetpotato or blend, mix the product with the boiled water and then sieve/ filter.
2. Add lemon juice or citric acid and fruit flavour if desired and mix well.
3. Pour into a jug, chill if possible and serve cold as fresh juice.



Relish from Fresh Sweetpotato-Cocoyam Leaves

Ingredients

- 4 handfuls (~200g) sweetpotato leaves (note: the leaves of some sweetpotato varieties are tastier than others)
- 10 small leaves (~200 g) cocoyam leaves
- level tablespoons (~60 g) roasted groundnut paste
- 2 level teaspoons salt
- ½ litre water



Procedure

1. Break the middle portion of cocoyam leaves to separate from the middle veins of the leaves.
2. Mix the tender cocoyam leaves with sweetpotato leaves and put in the sun to wilt.
3. Wash the wilted vegetables and cut into smaller pieces.
4. Boil water and place the cut pieces of vegetables into boiling water to cook.
5. Add salt when vegetables are almost ready.
6. Mix the groundnut paste with a little cold water until a smooth flowing paste is formed.
7. When the vegetables are ready, add the groundnut paste mixture to the vegetables and simmer for about 5 minutes.



Liberian Sweetpotato Leaves (Potato Greens)

Ingredients

- 4 cups (pressed down) fresh sweetpotato leaves
- 2 onions, chopped
- 1 lb (450g) beef, cut into small pieces
- 1 medium sized dried fish
- Some pieces of chicken
- Salt
- Bullion (stock) cubes
- 1 ½ cups palm oil
- Dried shrimp (optional)
- 1 or 2 pods hot pepper (optional)



Procedure

1. Season the beef and chicken using chopped onion, bullion (stock) cubes, pepper and salt. Allow to sit for some time.
2. Make a seasoned soup with the beef, chicken, dried fish and dried shrimp. Boil the meat first until it is tender before adding the other ingredients.
3. Remove the stems and wash the sweetpotato leaves two or three times. Cut or shred the leaves very finely.
4. Add the sweetpotato greens to the soup and let it cook slowly until almost all the liquid (soup) has dried out.
5. Add palm oil and let simmer until all the soup has dried.
6. Serve with rice or cassava.



Filipino Sweetpotato Leaves (Kamote Tops)

Ingredients

- 1 medium bunch of sweet potato leaves, trimmed
- 5 cups water
- 2 medium tomatoes, sliced or quartered
- 1 medium onion, minced
- 1 thumb-sized piece of ginger, minced
- Juice of 1 lemon
- 1 tablespoon olive oil
- 3 tablespoons soy sauce



Procedure

1. Combine the ginger, lemon juice, olive oil and soy sauce in a small bowl.
2. Boil water in a pan, add the sweetpotato leaves and blanch for 30 seconds. Drain. Transfer to a serving dish.
3. Pour the lemon juice mixture over the blanched sweetpotato leaves, add the tomato slices and onions, and mix well. Serve with piping-hot rice.



Green Leaves of Sweetpotato With Groundnuts

Ingredients

- 3 large bunches of fresh sweetpotato leaves (stalks removed)
- 1 onion (cut into half-moon)
- 3 very ripe medium sized tomatoes
- 2 cups groundnuts (pounded into flour)
- 6 cups water
- Pinch of salt



Procedure

1. Wash the sweetpotato leaves well and put in a pan with the tomato sliced into small pieces, chopped onion and 1 cup of water. Cook on a low heat.
2. Add the groundnut flour to 5 cups of water and then strain the mixture using a sieve/colander.
3. When the sweetpotato leaves, tomato and onion are cooked pour the peanuts in and cook until the peanuts are well cooked. Eat as a snack or with maize or cassava or rice.

Conversion Table

If you wish to convert the quantities suggested in these recipes into alternative measurement systems, you can use the table below to help. However, please note that many of these recipes have been developed in rural villages where the 'cup' measurement is not the standard 'recipe cup' measurement (e.g. a 'village' cup of water may range between 200 and 300ml of water). It is therefore not advisable to convert the recipes' quantities. If all the ingredients are measured using the same cup, the proportions will remain correct no matter what size the cup is.

Conversion of Standard Recipe Cups to Grams (Note: Please Read the Above Paragraph)

Ingredient	Cups (standard recipe cup)*	Grams or Litres
Wheat flour - white	1	100g
Sugar – caster	1	225g
Sweetpotato mash	1	200g
Sweetpotato root sliced	1	150g
Water	1	230 ml (just less than a ¼ litre)

**Note: the cups used in rural villages may differ in size, and therefore it is best just to measure all ingredients using one cup and not to try and convert cup measurements into grams.*

Review Questions

1. What is the healthiest way to eat sweetpotato?
2. What is the least healthy way to eat sweetpotato?

Unit 5 – Large-Scale Commercial Processing of Sweetpotato Products

Objectives

By the end of this unit, participants should be able to:

- List the sweetpotato products that show the most commercial promise in SSA.
- Name varieties of processed sweetpotato foods that are popular in different areas around the globe.

Key Points

- **Several promising processed sweetpotato foods now being produced in SSA.**
- **China produces a wide variety of sweetpotato foods and novelties on a large scale.**
- **Sweetpotato French fries are commercially produced in bulk in the USA.**



Large-Scale Commercial Processing of Sweetpotato Products

Currently, the orange-fleshed sweetpotato products with the most commercial potential being produced in Sub-Saharan Africa are:

1. Fried products, such as chips, crisps, chapatis, and doughnuts
2. Baked products, such as breads and biscuits
3. Juice

Pointers for when it makes sense to develop a processed product are described in the topic, Marketing and Entrepreneurship.

In Rwanda, the sweetpotato Superfoods project is working with large-scale processors to produce orange-fleshed sweetpotato biscuits and mandazi, and attractive product packaging.



Sweetpotato biscuits and mandazi being produced in a factory in Rwanda, and nicely packaged sweetpotato products being promoted at a trade fair.

China produces a wide range of commercial sweetpotato products.



Sweetpotato noodle extrusion, sheeting noodle production line, packaged sweetpotato noodles for cooking



Factory producing, and packaging instant noodles made from sweetpotato



Cornflake breakfast cereal made from sweetpotato and corn flakes, sweetpotato snacks and crackers



Sweetpotato dumplings, crackers made from purple fleshed sweetpotato, sweetpotato candy, noodles

Sweetpotato is regularly processed packaged into ready to cook french fries (chips) in the USA.



Different sweetpotato varieties in a supermarket, production of sweetpotato French fries, packaged chips

Review Questions

1. What are some of the sweetpotato products produced in SSA?
2. What are some of the sweetpotato products produced in other countries?

Unit 6 – Sweetpotato as Animal Feed

Objectives

By the end of this unit, participants should be able to:

- Explain the potential for sweetpotato use in animal feed products in Sub-Saharan Africa (SSA).
- Describe the best ways to use sweetpotato roots and vines to fulfil livestock nutritional needs.
- Explain how to create high-protein silage by fermenting sweetpotato foliage.
- List the steps needed to build an improved plastic tube silo.

Key Points

- **In many parts of the world, sweetpotato is widely used as animal feed, while in SSA sweetpotato is reserved for human consumption. This represents an opportunity for feed improvement in SSA.**
- **Sweetpotato roots and vines both make nutritious feed for livestock, although roots are usually fed only to pigs, although they also make good feed for other animals such as broiler chickens.**
- **Sweetpotato vine can be cut and dried for hay or used as silage.**
- **Roots should be cooked or dried before feeding to help with nutrient absorption.**
- **Sweetpotato vines have far more protein than roots, but amino acids can be added to pellet feeds based on sweetpotato root.**
- **Different planting methods are used to emphasize production of sweetpotato foliage for animal feed.**
- **Fermenting vines creates a very high protein feed for cattle and pigs at a low cost, especially if ensiled with chicken manure.**
- **Containers such as polythene bags and plastic tube silos can be constructed to provide anaerobic (no oxygen) conditions for fermenting feed.**

Sweetpotato as Animal Feed

In Sub-Saharan Africa, sweetpotato is almost entirely used for feeding humans, contrary to other regions of the world, such as Asia, where more than half of the sweetpotato produced is used for animal feed or industrial processes.

Both sweetpotato roots and vines are good materials for animal feed. The roots provide energy derived from starch while vines provide protein and fibre. It is recommended that sweetpotato forage should either be wilted or dried if intended for provision of basal diet to the animals. Roots are generally fed to pigs while the vines are feed for a variety of animals, including goats, pigs, cows, chickens and rabbits.

To process and preserve sweetpotato animal feed, farmers commonly chop the roots and dry them as chips and cut the vines and dry them as hay. The high-water content of the roots and vines also makes the crop suitable for silage, which can be less labour intensive than chopping and drying sweetpotato roots. The vines left in the field after harvest and the peelings left from processed roots can be useful feed components but are often left as waste. Dual purpose sweetpotato varieties with high root and vine yields can help address both household and livestock nutrition; although care needs to be taken not to harvest the vines too frequently or the root yields become so reduced that

the duality is lost. Compared to many browse/ multipurpose trees and shrubs, sweetpotato vines have a fast rate of re-growth.



Pig eating OFSP roots



Chickens eating OFSP roots

Using Sweetpotato Roots as Animal Feed

Use of the root for feeding pigs is well developed in much of Asia, but not yet exploited in Sub-Saharan Africa. Pigs can convert the low-value sweetpotato into highly desired meat and/or marketable commodities, and simultaneously provide manure for maintaining soil fertility or biogas production. However, improvements in pig nutrition need to be combined with improvements in pig husbandry and health to reduce pig diseases.

The roots can also be used as an ingredient for broiler chickens (in the finisher as opposed to the starter diets) and rabbit feeds, and they can replace maize in many feeds.

A few considerations need to be kept in mind when using **sweetpotato roots** as animal feed:

Trypsin Inhibitors

Some sweetpotato roots, depending on the variety, possess chemicals that inhibit the digestive enzyme trypsin. This leads to reduced nutrient absorption from the sweetpotato roots and other feeds consumed at the same time. Cooking or drying the sweetpotato roots before feeding them to animals, breaks down the trypsin inhibitor and prevents this problem. Varieties with low trypsin inhibitor activity should be selected, or the roots should be dried or cooked before feeding them to livestock. However, this cooking obviously has associated labour and fuel costs.

Starch Digestibility

The starch of some sweetpotato varieties is difficult to digest and absorb. Slicing and drying the roots seems to break down the starch structure and improve the digestibility.

Starch Content

For animal feed it is better to choose roots of sweetpotato varieties that are high in starch content and lower in yield than those that are low in starch but high in yield. Low starch content means high water content in the roots and pigs can become bloated if the root moisture content is too high.

Low Protein Content

Unlike the vines, the roots contain insignificant levels of protein (~1.3% 10% on a dry weight basis). This can pose a major constraint to pig growth in a sweetpotato-based diet. Farmers can overcome this by supplementing the feed with rice bran, fish meal, soy beans or residue, sweetpotato leaves or cassava leaves, or commercial supplements. Farmers in Asia commonly allow the pigs to forage for additional protein from soil fauna, particularly earthworms.

In China they have been working on developing dry pellet feeds that use sweetpotato as the major ingredient instead of maize. They added amino acids, minerals, vitamins and a protein concentrate, and increased feed efficiency and reduced the feed/kg weight gain cost by 15-20%.

Using Sweetpotato Vines as Animal Feed

When using **sweetpotato vines** as animal feed, it is good to consider the following factors:

Vine Production

If vines are the objective of production, the sweetpotato can be planted on flat fields at a spacing of 30-40 cm between plants and 40-50 cm between rows. Planting too close limits the efficiency of photosynthesis. Depending on the rainfall levels, vines can be harvested 30-45 days after planting and every 15-25 days after that. The optimal way to cut multiple vines is to cut 1-2 of the longest branches of each plant leaving about 10 cm for resprouting. In Vietnam they developed a cheap vine- chopping machine to reduce the hours spent cutting vines prior to ensiling them.

Vine Feed

Vines can be fed fresh, dried, fermented, or made into silage. The most common practice is to feed fresh vines during harvest season (if sweetpotato is grown for roots or root/vine), but if the vines are dried and stored as hay or made into silage after harvest the feeding period can be prolonged. In Uganda it was found that vines harvested during the wet season recorded significantly higher crude protein, fibre and acid contents. Processing and preserving the vines allows farmers to use them as feed for an extended period.



Drying

- Some farmers like to cut the vines before drying because the dried vines are difficult to cut, while others hang the whole vines on trees, fences, walls or other structures that are strong and high enough to support the vines.

Fermentation

- Fermented vines are favoured by pigs and provide protein at the lowest cost. The feed is made from a mix of chopped vines, rice bran, and salt and is ready to be fed after 10 days of fermenting.



Feeding goats and pigs with sweetpotato vines

Silage

- This method is less common, but it provides several advantages: the silage can be stored for use during times when feed is limited; and cost-wise vines are much cheaper during the harvest season, so they can be ensiled then, avoiding the need to purchase them during the off-season when vines are expensive. If the ensiling involves a fermentation process the nitrogen can be converted into protein which increases the nutritional value and feed efficiency. In this case, vines are firmly pressed into a tank with a layer of salt placed on top before covering the tank. Sweetpotato forage can be ensiled in earth pits lined with either banana leaves or polythene sheeting. Polythene bags could also be used to ensile sweetpotato vines and a brochure describing how to make an improved sweetpotato silage tube can be found on the Sweetpotato Knowledge Portal (www.sweetpotatoknowledge.org). In order to prepare good quality silage from sweetpotato vines, the following principles should be considered.
 - An anaerobic condition should be maintained by compressing the forage material in silos to expel air.
 - Ensiled sweetpotato vines should be chopped into small pieces (2 – 5 cm).
 - Additives that supply carbohydrates such as sweetpotato roots, molasses or fresh sugar cane juice should be included. If making 100 kg of silage we need to add 2-5 kg of molasses or fresh sugar cane juice or 10–20% sweetpotato roots on fresh weight basis of ensiled forage material.
 - Trials in Vietnam looked at the nutritional value of different ensiled mixtures of sweetpotato vines, corn, cassava meal, rice-bran, sun-dried chicken manure, and salt. Vines ensiled with chicken manure have higher protein; dry matter and ash contents and were nutritionally more cost effective.

Good quality sweetpotato vine silage will be brownish green in colour. It will have a pleasant aroma (fruit smell) and can be fed free of choice to the animals.

An Improved Method for Making Sweetpotato Silage

Well-made sweetpotato silage is a wholesome and nutritious feed for all classes of cattle and pigs. Sweetpotato silage is made by anaerobic (in the absence of air) fermentation of chopped vines and roots of non-commercial value and can be stored as a feed for up to a year. This can help to avoid periods of feed shortages, and to maintain good milk and meat production levels during the dry season.

Silage can be made with either just the chopped vines or a combination of chopped vines and roots and is an excellent complement to grass feeds. Starter ingredients such as molasses can improve the fermentation process and nutrient content.

Use of sweetpotato silage can increase milk yields by 15-20%, as well as meat production, but amongst farmers in Sub-Saharan Africa there is limited knowledge or use of sweetpotato silage. The following information is taken from a new brochure on 'Making high quality sweetpotato silage'.

One of the challenges farmers face when making sweetpotato silage is that of excess water accumulating at the bottom of the silage container and resulting in spoilage. This challenge led to the development of the improved plastic tube silo.

Making Silage

Step A. Sealing the tube and making an internal drainage pipe

Open the silage tube up fully. At one end pleat the tubing, and twist together and tie firmly with rope. Turn the tubing inside out, so the tied end is on the inside.

Make 2 holes (2.75 diam.) on each side of the drainage pipe, one 4cm from the end A on both sides, and one 20cm from end B on one side and 22 cm on the other side.

Heat the nail and make small holes every 1cm along the PVC pipe (just between the larger holes), and the rubber tubing. Thread the rubber tube through the PVC pipe.



Step B. Fitting and fixing the drainage pipe

Make a 3.5cm diam. Hole at the side of the tube about 43cm from the tied knot.

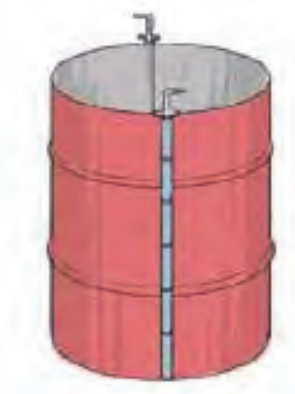
Place the drainage pipe inside the base of the tube silo, so it protrudes ~ 20 cm out through the newly made hole in the tube. Tightly tie the plastic tube around the drainage pipe. Fit a tap or soft piece of wood at the end of the protruding drainage pipe.



Step C. Making a compacting drum

Remove the top and bottom of each drum to make it hollow. Then cut the oil drum longitudinally in half. Have a welder fix joints along each long edge and fit a long rod through them to hold the two sides together. He/she will need to cut out a place on one side for the drainage pipe to protrude through.

Find a shady place to make and store the silage. Move the drum there and place the tubing inside it letting the excess tube length fold over the sides of the drum.



Step D. Preparing, filling and managing the silo

Chop the sweetpotato vines and roots into pieces not more than 2.5cm long. Mix the 10kg of molasses with 2 to 3 times as much water until the mixture flows easily.

Fill the tubing by adding alternate layers of chopped vines and roots (~20cm deep) and the molasses/water mix (sprinkle until thoroughly wet on top). Compact each layer before adding the next layer. When full, bunch tubing together and remove all excess air, tie the plastic tubing, and place heavy stones on top. Remove the compacting drum. Anchor filled tube with 3 poles with ropes between them to prevent collapse. Open drainage tap daily for 5 days, then every 4-5 days.

Fermentation is usually complete after 30 days.



Step E. High quality silage

Well prepared silage is bright or light yellow-green in colour, with a strong smell similar to that of fermented milk and a firm texture. Poor quality silage smells like rancid butter or ammonia.

The tube silo should be in the shade and protected from rodents.

After removing some silage for feeding animals, make sure you re-tie the tube tightly without trapping air inside.



Review Questions

1. How could nutrient value of the sweetpotato as animal feed be improved?
2. What are the different ways vines could be used as animal feed?

Unit 7 – Gender and Diversity Aspects of Sweetpotato Processing and Utilisation

Objectives

By the end of this unit, participants should be able to:

- Discuss gender and diversity issues regarding sweetpotato processing and utilisation.
- Explain the link between local culture and food preference.

Key Points

- **Nutritional requirements vary by age and gender as well as workload.**
- **Some preparations of sweetpotato are more appealing to one group or individual than to another.**
- **Nutritional and processing information needs to be shared with all parties in a community, whatever their level or type of involvement in processing and food preparation.**

Gender and Diversity Aspects of Sweetpotato Processing and Utilisation

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in the Topic on Gender and Diversity Aspects. Key gender and diversity issues relevant to sweetpotato processing and utilisation include:

- Nutritional requirements including vitamin A requirements and dietary preferences vary by age, sex and workloads. Some recipes will be more appealing to certain groups; it is important to find out about the local food culture and see how new nutritious recipes could be combined with it.
- Attention needs to be given not only to imparting appropriate and practical information to those who will be involved in preparing the food (mothers, women), but also to those who control access to the raw materials and food and who influence consumption patterns (grandmothers, husbands, wives, traders, community leaders). Timing, duration, location, delivery language, approach and participant composition of training events also need to be considered to ensure certain groups are not unintentionally prevented from accessing it.
- Attention needs to be paid to postharvest gender roles and how processing may impact on them, including appropriateness of equipment and whether the introduction of machines affect gender roles and income benefits in any way.

Activities

These learning-by-doing activities will provide hands-on discovery opportunities for participants.

Activity 9.1 Substituting Sweetpotato for Wheat Flour in Chapati Recipes

Objective

Participants will know how to incorporate sweetpotato (particularly the vitamin A rich OFSP) into popular recipes that normally only use wheat flour

Time

2 hours 5 mins

Materials

Per small group:

- Sauce pan;
- Charcoal or gas stove;
- Frying pan;
- Cutting board;
- 1 litre lukewarm boiled water;
- Rolling pin;
- Grater;
- Fruit squeezer;
- Food containers;
- Bowls;
- Plates;
- Knives;
- Flip chart;
- Marker pens;
- Masking tape;
- Recipe:
 - 2 kg wheat flour
 - ½ kg OFSP
 - ½ kg boiled OFSP
 - ½ kg OFSP flour
 - One cup vegetable oil
 - Salt.

Advanced Preparations

Obtain sufficient OFSP for each small group to have ½ kg of it. If you will be short of time, the OFSP for the boiled & mashed recipe could be pre-boiled so that the participants just mash them and then incorporate them into the recipe.

Suggested Steps

1. If equipment allows break the participants into groups of 5 people. Explain to them that they are going to prepare chapatis using a range of different recipes that incorporate sweetpotato. First each group will prepare a typical chapati using just wheat flour. Then they will make chapatis using orange-fleshed sweetpotato flour, they can decide whether to use:

raw and grated OFSP; or boiled and mashed OFSP; or OFSP flour in their recipe. Ask the group what benefits there might be from using OFSP as a substitute for wheat flour in recipes (e.g. cost, nutritional, taste, ease of access etc.)?

- The different options are written up on a flip chart so that the groups can decide which they will make. The facilitator must ensure that there is a good spread of the different recipes, and that not all groups are using OFSP, as the aim is to get them to practice and compare the different chapati recipes. If there is time, each group could test 2 or 3 of the different sweetpotato chapati recipes. Remind them that they must wash their hands before preparing or eating any food.

Wheat flour chapati	Orange-fleshed Sweetpotato Chapati Options		
	OFSP raw & grated	OFSP boiled & mashed	OFSP flour
100% wheat flour	50% raw & grated OFSP /50% wheat flour	50% boiled & mashed OFSP /50% wheat flour	30% OFSP flour/70% wheat flour
500 g wheat flour	250g grated OFSP 250g wheat flour	250g boiled & mashed OFSP 250g wheat flour	150g OFSP flour 350g wheat flour

Procedure

- First mix dry ingredients together in a bowl, then add any grated or mashed sweetpotato (depending on which recipe you are using), and mix. (500g of flour makes ~5 large chapatis).
- Add 1 tablespoon of oil and mix well.
- Add the lukewarm water little by little to the mixture in the bowl and knead till a stiff smooth paste is formed.
- Divide the dough into 5 equal sized balls.
- On a floured surface roll one ball at a time.
- Put aside for 20 minutes
- Fold each ball at a time to form a strip.
- Coil each strip to form a circle
- On a floured surface, roll out each coil into a thin circular sheet.
- Grease a shallow frying pan.
- Fry each circular sheet on both sides till golden brown, make sure both sides are greased.
- Taste.
 - Ask them to individually rank the products by preference (4=most preferred, 1=least preferred).
 - Discuss the different products: cross-compare the chapatis made with OFSP flour; raw & grated OFSP and boiled & mashed OFSP and the chapatis made from 100% wheat flour. Ask them to explain why they chose their preferred product, (probe if necessary with questions about colour, taste, texture, nutritional aspect, easiness to make, cost etc...).
 - In their small groups ask them to discuss the marketing issues associated with the different products? Quality and storage issues of these products? Any ideas for new OFSP products that they could develop? Then bring these points into a short whole group discussion.

Activity 9.2 Making Sweetpotato Juice

Objectives

Participants will know how to process sweetpotato into juice

Time

45 mins

Materials

- 4 cups of sugar;
- 8 medium sized boiled peeled sweetpotato roots;
- 3 teaspoons of citric acid OR juice from fruits like oranges or pineapples;
- 5 litres of cooled boiled water (for flavouring add tamarind, passion, pineapple or orange juice);
- Sieve;
- Pans;
- Fruit squeezer;
- Wooden spoon;
- Jug;
- 5 * 1 litre clean empty bottles;
- Fridge to chill the juice in.

Advanced Preparations

Organise cooking ingredients, equipment and facilities. Obtain sufficient OFSP. If you will be short of time the OFSP can be pre-boiled so that the participants just mash them and then incorporate them into the recipe.

Suggested Steps

1. Work in small groups, as long as you have sufficient equipment for each group to use, e.g. pans. Note the above quantities of ingredients will produce about 5 litres of juice.
2. Boil water and sugar and then leave to cool.
3. Mash boiled sweetpotato or blend, mix the product with the boiled water and then sieve/ filter.
4. Add citric acid/ lemon juice and fruit flavour if desired and mix well.
5. Pour into a jug, chill if possible and serve cold as fresh juice.

Activity 9.3 Making Sweetpotato Fiossis

Objective

Participants will know how to process sweetpotato into fiossis.

Time

45 mins

Materials

- Fridge to chill the juice in;
- 300g (2-2 ½ cups) wheat flour
- 50g margarine;
- 200g (1 – 1 ½ cups) sweetpotato puree
- 65g (¼ cup) sugar;
- 2 eggs;
- Oil for frying;
- 2 teaspoons baking powder.



Advanced Preparations

Organise cooking ingredients, equipment and facilities. Obtain sufficient OFSP, and pre-boil them so that the participants just mash them and then incorporate them into the recipe.

Suggested Steps

1. Work in small groups, as long as you have sufficient equipment for each group to use.
2. Beat the margarine and sugar together.
3. Add the eggs and then the sweetpotato puree, keep mixing.
4. Gradually add the flour and baking powder, keep mixing.
5. Knead the dough well until it stops sticking to your hands.
6. Roll small pieces of the dough into little sausage shapes and then tie each in a loose knot or bow.
7. Fry in oil (not too hot).
8. Share with the rest of the group.

Answers to Review Questions

Unit 1

1. What are some of the ways to retain beta-carotene during OFSP processing?
 - *Process quickly, process with skin, do not store for long periods.*
2. What are the three primary products of OFSP?
 - *Fresh-grated, boiled or mashed, flour.*

Unit 2

1. While sweetpotato flour has several advantages that sweetpotato puree and grated sweetpotato do not, what are some disadvantages?
 - *The process of converting sweetpotato into flour is lengthier and more complicated. Beta-carotene is easily lost in the process.*

Unit 3

1. What are some of the nutritional benefits of sweetpotato for rural households?
 - *OFSP roots contain vitamins A, C, and several B vitamins; Sweetpotato dishes that also include groundnuts supply protein and fats as well; OFSP is more nutritious and filling than bread; Children can carry boiled or baked OFSP to school healthy snack.*
2. What are the advantages of enriched porridges?
 - *Source of energy – carbohydrates and fats; Protective food – vitamins and minerals; Body building food – proteins.*

Unit 4

1. What is the healthiest way to eat sweetpotato?
 - *Boil and mash*
2. What is the least healthy way to eat sweetpotato?
 - *Deep fat fried*

Unit 5

1. What are some of the sweetpotato products produced in SSA?
 - *Fried products: Chips, crisps, chapatis, doughnuts; Baked products: Breads, biscuits; Juice.*
2. What are some of the sweetpotato products produced in other countries?
 - *China: Noodles, Cornflake cereal, Dumplings, Crackers; Rwanda: Biscuits, Mandazi; USA: French fries, Packaged chips.*

Unit 6

1. How could nutrient value of the sweetpotato as animal feed be improved?
 - *Roots should be cooked or dried before feeding; Vines contain more protein than roots; Different planting methods are used to emphasise production of sweetpotato foliage for animal feed.*
2. What are the different ways vines could be used as animal feed?
 - *Fresh, Dried, Fermented, Made into silage.*

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The many recipes in this topic have been collected from a wide range of people and places – thank you for sharing them with us all.

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