

6 Sweetpotato processing and utilisation

6.1 The nutritional value of sweetpotato

6.1.1 Sweetpotato as an energy source

The human body needs energy to work and play. Energy comes from the nutrients in the foods that are eaten. The main nutrients that give energy are carbohydrates, protein and fat. Energy is measured in kilocalories (kcal), calories or kilojoules (kj), and 1 kilocalorie = 4.2 kilojoules.

With the exception of cassava (590 kj), sweetpotato (465 kj) is a higher source of energy than other root and tuber staples including potato (335 kj), yam (434 kj) and taro (432 kj). The starch making up sweetpotato dry matter, is easily digestible and therefore a useful ingredient in the preparation of good weaning meals.

The table below shows that both sweetpotato roots and vines are good sources of energy. A wide range of nutrients including carbohydrates, vitamins, minerals and proteins are present in varying levels in the different sweetpotato varieties and plant parts.

An example of chemical composition and nutritive value of sweetpotato roots and vines

Sweetpotato plant part	Dry Matter (%)	Crude Protein (%)	Ether Extract (%)	Crude Fibre (%)	Nitrogen Free Extract (%)	Total Ash (%)	Calcium (%)	Phosphorous (%)	Metabolisable Energy (kcal/kg)
Root	18.64	0.81	0.19	0.87	16.02	0.75	0.07	0.03	957
Vine	9.21	1.42	0.25	1.92	4.50	1.13	0.14	0.06	303

6.1.2 Vitamins in sweetpotato

Vitamins are the biochemical “nuts and bolts” that enable the proteins, carbohydrates, and fats of body tissues to function as a coordinated unit. They are essential components that the body cannot make but can only get from nutrients in food. Every year 97% of the bodies blood cells are completely replaced, even the structure of DNA of the genes is reconstructed entirely from the nutrients one eats. The quality of those nutrients determines the quality of the renewed cell structure, the level at which it can function, and its resistance to disease. Renewal is slow and steady. The blood cells take three months for complete renewal and many cells of the muscles and organs take six months. The matrix of the bones takes about a year. Therefore improved nutrition through supplementation takes time, as we have to wait until the nutrients are built into the body structure for their benefits to show.

Sweetpotato roots have been shown to contain substantial amounts of ascorbic acid (vitamin C), moderate quantities of thiamin (vitamin B₁), riboflavin (B₂) and niacin, some pantothenic acid (B₅), pyridoxine and its derivatives (B₆), folic acid and have also been reported to contain satisfactory quantities of tocopherol (vitamin E). One of the major contributions, which sweetpotato could make to health, and welfare of mankind is that of supplying carotenoid, vitamin A (Retinol) precursors. Vitamin A deficiency is currently one of the major health problems facing many developing countries.

More than 90 countries worldwide have a public problem concerning clinical and/or sub-clinical vitamin A deficiency. FAO reports indicate an improving trend of vitamin A content in the diet for most developing countries in the last 20 years, with the notable exception of sub-Saharan Africa. In general, populations in eastern and southern African countries have a low availability of vitamin A in their diets and some indications show that the overall vitamin A

supply is actually decreasing in East Africa. Those most severely affected are young children and pregnant and lactating women.

In general vitamin A intake is often inadequate because of the seasonality of food sources, the early abandonment of exclusive breast feeding, and traditions of not giving vitamin A-rich food to young children. Over the past 25 years, public health agencies have addressed vitamin A deficiency by providing children with vitamin capsules that contain mega-doses of Vitamin A. The strategy has helped millions, but has proven expensive and - despite the best efforts of those involved - has left hundreds of thousands of children at risk. As a complement to vitamin supplements, health experts have experimented with different methods that address the problem through diet. Many types of fruits and vegetables, as well as meat and milk, are rich in Vitamin A or beta-carotene, and, if consumed in sufficient quantity can eliminate or greatly reduce the impact of vitamin A deficiency. Most foods that are rich in Vitamin A, however, are too expensive for African consumers, are only seasonally available, or are unpalatable to young children. The exception is sweetpotato.

Vitamin A is essential for normal vision, skin and mucous membranes, cell growth, reproduction and immunity to diseases such as measles, malaria and diarrhoea. Retinol, named after the retina of the eye, is fat-soluble, meaning that it works in the lipids (fats) in the body. It also makes the visual purple of the eyes, essential for night vision. The best food sources of vitamin A are liver and fish liver oils, which are very expensive for the rural poor. The best sources of beta-carotene are carrots, green vegetables and orange-fleshed sweetpotato. Effective vitamin A supplements contain 5,000-10,000 I.U. per day as retinal or palmitate but vitamin A can build up in the fats to become toxic at or above an intake of 25,000 I.U. per day. Beta-carotene is a natural precursor of vitamin A and so the human body can transform it into vitamin A as required. Unlike vitamin A, large amounts of beta-carotene show little toxicity, apart from turning the skin yellow.

The total carotenoid content of sweetpotato has been found to range from 0 to >20 mg/100g of fresh weight, which would be equivalent to 0 to 60 mg/100g of dry weight. It is likely that cultivars with medium to high levels contain most of their carotenoids in the form of beta-carotene. Therefore, expression of total carotenoids as beta-carotene entails little error when levels are high. Sweetpotato roots can be used in main meals as a staple, co-staple, vegetable or dessert, or as a savoury or snack. Therefore, it may be compared in terms of vitamin contents, with other roots and tubers, with other staples and with some commonly consumed vegetables and fruits. The comparative advantage of sweetpotato cultivars with medium to high beta-carotene contents can be clearly seen in the table below. The other root and tuber staples are invariably lacking or extremely low in beta-carotene resulting in negligible quantities of retinal equivalents. The only starchy staple, apart from sweetpotato, with a significant amount of beta-carotene is the plantain. Cereals, with the exception of some varieties of yellow maize, have no provitamin A activity. The only commonly consumed vegetable, which has a high carotene content, comparable to that of carotene-rich sweetpotato is the carrot. Pumpkins have a similar content to moderate-carotene sweetpotato. Even tomatoes, which many consumers consider to be high in provitamin A activity, are much lower in biologically active carotenoids than many cultivars of sweetpotato. The carotene content of dark yellow or orange-fleshed sweetpotato is very high and at least comparable to that of carotenoid-rich fruit such as mangoes.

Vitamin A levels of common foods in East Africa (average per 100g edible portion)

Source	Beta-carotene (g) equivalent of different foods						
	Fresh and ripe	Boiled	Skin boiled	Green boiled	Dried	Porridge	Leaves
Sweetpotato	0->20,000		0->20,000		7,820		2,700
Carrots	12,000						
Mango	355-13,000						
Pumpkin	1,500						
Papaya	205-1,500						
Plantain	390-1,035			345			
Tomato	600						
Yam (Dios. sp)		108					5,535
Cassava		0-20					8,280
Maize		240				0	
Banana	200						
Pepper (green)	200						
Taro/ Cocoyam		43					
Potato		0-trace					
Rice (white)		0					
Sorghum						0	
Beans		trace					
Cabbage	trace						

Unlike water-soluble B vitamins and ascorbic acid, vitamin A is stored in the liver when more is eaten than can be immediately utilized. In this respect, sweetpotato with high levels of beta-carotene eaten in large quantities could supply more than the daily requirement for vitamin A and hence enable consumers to build up reserves to tide them over periods when they either do not wish, or are unable, to eat carotene-rich vegetables. Thus, 200g of sweetpotato containing 7500ug/100g beta-carotene would provide an adult man or woman with the recommended amount of vitamin A for 3 or 4 days, respectively, and a child for 5-6 days (assuming a cooking loss of 20%). However, evidence from the Philippines shows that an adequate fat intake is also necessary to ensure proper utilization of beta-carotene. The increased consumption of carotene-containing sweetpotato roots in vitamin A deficient areas or of pale-fleshed types in areas of vitamin A sufficiency would also ensure the increased intake of other essential vitamins such as ascorbic acid.

Comparison of sweetpotato root flesh colour and vitamin A supply

Age/ sex	Vit-A requirement (µg RE)	Average amount (g) of fresh sweetpotato roots required to supply the daily requirements of pro-vitamin A				
		TIS (White)	25 34	Tanzania (Yellow)	Kakamega (Orange)	Japanese (Deep Orange)
1 day to 3 years	400	3636		265	78	35
4 to 6 years	500	4545		331	97	43
7 to 10 years	700	6364		463	136	61
Females over 10 yrs	500-850	7273		530	156	69
Males over 10 years	500-600	9091		662	194	87

Total carotenoids in processed products of orange fleshed sweetpotato cultivar CIP420027 as compared to those of wheat flour

Product forms	DM (%)	Total carotenoids (mg beta-carotene equiv./ 100 g product)
Fresh sweetpotato root	21.6	4910.3 ± 126.3
Sweet potato boiled and mashed	18.9	3408.2 ± 34.6
Sweetpotato flour	88.7	3929.4 ± 28.4
Chapattis from sweetpotato flour	68.6	2281.8 ± 19.2
Chapattis from wheat flour	69.0	110.5 ± 7.3
Mandazis from sweetpotato flour	66.2	2119.3 ± 82.8
Mandazis from wheat flour	68.3	109.1 ± 2.7
Buns from sweetpotato flour	70.3	2228.4 ± 45.6
Buns from wheat flour	69.3	117.2 ± 6.0

In common with other dark green leafy vegetables, sweetpotato leaves are rich sources of vitamin A carotenoids, chiefly beta-carotene. As far as comparisons with other tropical leafy vegetables are concerned, sweetpotato leaves generally appear to be of medium provitamin A content, being superior to cabbage and taro leaves, but containing only about half the quantity in cassava leaves. Their adoption as a back garden crop, harvested continuously, could help to make them available even to those without land to cultivate. The average riboflavin content of sweetpotato leaves compares favourably with that of cow's milk (0.19), beef (0.24), chicken meat (0.16) and fish (0.07). Sweetpotato leaves are also moderately good sources of other B vitamins, namely thiamin, niacin and pyridoxine. Although sweetpotato leaves have greater quantities of ascorbic acid, it is likely to be leached into the cooking water and destroyed by heat.

Comparison of the vitamins in sweetpotato leaves and tender tips with other vitamin A leafy vegetables sources in East Africa (per 100g raw)

Leaves	Beta-carotene Equiv. (µg) (pro vitamin A)	Thiamin mg) (vitamin B1)	Riboflavin (mg) (vitamin B2)	Niacin (mg) (vitamin B3)	Pyridoxine (mg) (vitamin B6)	Folic acid mg) (B vitamin)	Ascorbic acid (mg) (vitamin C)
Sweetpotato leaves	2700	0.13	0.35	0.9	0.21	88	41-103
Sweetpotato tender tips	2290-7050		0.29-0.41	0.9			32-136
Amaranthus	6545	0.04	0.22	0.7		85	23
Cassava	8280	0.16	0.32	1.8			82
Kale	1200	0.04	0.14	0.5			40
Taro	5535	0.13	0.34	1.5	0.19	163	63
Cabbage	trace	0.06	0.05	0.6	0.15	26	40

6.1.3 Protein

Protein is an essential part of our diet. Proteins are complex substances found in many foods and made up of thousands of small units called amino acids. The different amino acids that make up proteins are important for growth, tissue repair and replacement. Meat and fish are good sources of protein. However we can also obtain protein from eating pulses, cereals, dairy products, nuts and some vegetables, including sweetpotato. However sweetpotato has a relatively low protein content and boiling of sweetpotato roots eliminates the trypsin inhibitor content before roots are consumed thus protein supplementation is needed for sweetpotato root-based diets.

Sweetpotato leaves (with about 3% protein on fresh weight basis) contain approximately twice the amount of protein as the same weight of roots. If sweetpotato is grown for its leaves, or both its roots and leaves, it produces much higher yields of protein per unit area than if only the roots are utilised. It was shown that for three cultivars, an average of only 26.25 g protein/plant was produced by the roots alone when the vines were not topped, whereas a total of

81.4 g protein/ plot (67.1 g from tips and 14.3 g from the roots) was produced when roots and tips were harvested, tips being removed weekly. The leaves also have moderate to good quantities of all the essential amino acids, although different varieties of sweetpotato are likely to vary widely in the amino acids they contain.

6.2 Sweetpotato processing

Sweetpotato is mainly consumed as fresh boiled roots. However, in some parts of East Africa sweetpotato is traditionally processed into dried chips and/or flour to preserve the roots for household food security and to a lesser extent for sale in rural markets.

Besides permitting better preservation, the drying and processing of sweetpotato into dried chips and flours offers other opportunities such as:

- facilitating storage and transport;
- reducing bulkiness and losses due to high perishability of fresh roots (if roots are left in the ground further weevil attack can occur, this damage increases the risk of other pathogens getting in and destroying the roots);
- increased shelf life;
- greater nutritive value due to the fact that as a great part of the water content is removed, the carbohydrates, pectin, proteins, oils and mineral salts are concentrated in the tissues of dried food products;
- creating new income opportunities for farmers such as new markets and new sources of income
- changing some of the negative attitudes about sweetpotato consumption, and enabling them to see sweetpotato as an important commercial crop with a diverse range of uses, and consumers

Although sweetpotato flour has great potential for use as an ingredient in many marketable products, traditional processing methods of sweetpotato, which involve exposing peeled, sliced and unwashed slices directly to sun present certain problems, including:


- high dependency on climatic conditions (if its going to rain product has to be gathered up and taken to a dry, safe place)
- high manual labour requirements for peeling, slicing, spreading out to dry, turning the product during drying, guarding product from hungry livestock, moving product if weather changes etc
- difficulties in maintaining hygienic conditions can lead to products becoming contaminated by micro-organisms and dust
- lack of control of enzymatic oxidative browning and other reactions leading to discoloured and/or strong smelling sweetpotato flour
- lack of uniformity in terms of chip size

Some of the factors commonly mentioned as affecting the quality of dried chips include: appearance; size of slices; uniformity and intensity of colour; defects such as skin planks; presence of contaminants.

Different sweetpotato varieties will have different dried chip and flour properties such as taste and colour, and farmers might like to test several different varieties in order to choose which variety to plant for the different products.

Improved processing methods have been developed to help overcome some of the problems associated with traditional methods, in order to produce sweetpotato flour with improved odour, colour and nutritional quality. However the cost of the improved methods is higher than that of the traditional methods, and therefore might be more suited to use by farmer groups working together.

The steps to follow to obtain quality dried chips and flour are as follows:

- Selection of raw material* Select only healthy roots for drying
- Cleaning, peeling and trimming* Any soil on the roots must be removed before the root is peeled using a clean kitchen knife.
Any damaged parts of the root should be trimmed off and destroyed.
- Washing* A drum washer has been developed to help at this stage. The drum washer consists of a 200 litre oil drum mounted on a horizontal axle. The drum is cut lengthwise to provide a door which can be opened and closed during loading and washing of the roots respectively. Inside the drum are brushes which are fixed on a horizontal axle. A handle is fixed on the axle to rotate the drum and wash the roots. At one end of the drum an opening can be made to drain the dirty water after washing. The drum can be used to wash 40 kg of sweetpotato in 10 minutes using 30 litres of clean water. If drums are not available a large saucepan could be used.
- Slicing/ chipping* After washing, the sweetpotato roots are pre-dried in a clean place in the sun for about 10 minutes to remove the surface water. A manual or mechanical chipper/ slicer is then used to cut the sweetpotato roots into uniform pieces of about 5 mm thick.
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- A photograph showing several people, including men and women, gathered around a green manual slicer. They are in the process of slicing sweetpotato roots. The slicer is a mechanical device with a hopper for the roots and a cutting mechanism. Shredded sweetpotato chips are visible on a surface in front of the machine. The setting appears to be outdoors in a rural or agricultural area.
- Soaking* Slices are soaked in clean water for 90 minutes. The volume of water used is twice the weight of the slices and is just enough to cover all the slices.
- Drying* The slices are then either sun dried on a raised tray for approximately 4-6 hours if weather conditions are suitable, or in a conventional dryer using firewood or charcoal as fuel. The drying tray should be raised off the ground to prevent dust and dirt contaminating the chips. If the drying process is not thorough, the chips will be prone to mould attack during storage. The drying rate will depend on the thickness of the slices, rate of turning chips as they dry and the amount of sliced chips placed on the tray.
- Grinding* The dried sweetpotato chips can now be milled into flour.
- Sorting* The dried sweetpotato chips can be sorted for uniformity before packaging or further processing, if this might affect the quality, intended use or price.
- Packing and storage* Sweetpotato flour can be safely packed and stored in polythene bags as well as baskets and tins. Sweetpotato chips can be stored in clean sisal or polypropylene sacks, granaries, and polythene bags. The use of black packing material (e.g. two black linings inside a sisal sack) helps to minimise the loss of vitamin A (which can be degraded through exposure to ultraviolet light) during storage. Care should also be taken to keep the products in a cool, dry,

well ventilated location. Wooden pallets/ platforms can be used to stack the packed sweetpotato products on, to prevent moisture being absorbed from the floor. Regular monitoring of the stored products should be undertaken to build up knowledge about the products shelf life under the site specific storage conditions and to prevent large infestations of insects or rodents developing. See sections 5.4 and 5.5 for more information on storage. Packages should be labelled to trace the origin (farmer/ producer) of the roots and the chip processor. If compositional or nutritional information is needed this will require that a sample of the dry sweetpotato chips are analysed to give a representative content per consignment or batch.

The following parameters should be monitored to achieve and maintain high quality dried sweetpotato chips, especially when they are being bulked from different production batches: moisture content (preferably less than 10-15%); appearance/ colour; absence of undesirable odours; hygiene standards and cleanliness of chips; absence of contaminants (e.g. soil, insects; human hair etc); uniformity of shape; nutritive value (e.g. beta-carotene content).

6.3 Processed products of sweetpotato

Traditional methods of processing sweetpotato have been limited to washing, peeling and boiling. Boiled sweetpotato is also mixed with cooked beans and maize, mashed and consumed as a complete meal. Some households simply wash and boil then peel as they consume. Other households wash, roast then consume. In some communities like the Teso, they wash, peel, cut into small pieces add lemon or tamarind juice, dry in the sun and mill with sorghum into flour used in making porridge. In Busia some farmers make chips, sun dry, store and later



reconstitute by adding water then boil and consume. Sweetpotato can also be processed by washing the roots and grating. The grated product is dried and then milled and added to other flours to make composites. The grated sweetpotato can also be added to other foods in fresh form during cooking. Enriched weaning flour can be made from mixing sweetpotato, soyabeans and sorghum or millet flour into a porridge. Fried products like mandazi, chapatti, doughnuts etc can be made using a combination of sweetpotato and wheat flour thereby reducing the production costs. Wheat flour can also be mixed with sweetpotato flour, gratings or mash to bake products like cakes, bread, scones, buns, etc. All the above products can be made using orange-fleshed sweetpotato to increase the beta-carotene content of diets, particularly of children. Sweetpotato roots can also be washed, boiled, mashed and mixed with other ingredients for baking and/or frying. Sweetpotato leaves can be processed by cleaning, shredding, washing twice in warm water and cooking. The sweetpotato leaves are delicious when made into a vegetable dish popularly known as relish. The addition of flavour, soya flour, milk, or groundnut paste enhances the palatability of the relish. A huge number of products can be made from sweetpotato; many of them are described below.

6.3.1 Equipment

The following is a list of equipment that can be used to make the recipes given in this chapter, if you don't have all the equipment to hand, be creative and try to think about what you could use instead.

- Cooking range/ fire, preferably an improved charcoal stove
- Fuel/ firewood
- Water
- Cooking pans with lids
- Chapatti pan
- Chapatti rolling board and pin
- Mixing bowls
- Deep frying pan
- Wooden cooking stick
- Wooden cooking spoon
- Table spoons
- Tea spoons
- Kitchen knives
- Noodle machine
- Draining spoon
- Trays
- Cups and mugs
- Plates
- Baking tins
- Kitchen grater
- Sieves
- Basins
- Working surface that is raised
- Chopping board

The food items are bought according to the selected products to be made. After cooking is complete products can be placed in a central point on plates and taste tests carried out by all participants.

6.3.2 Favourite sweetpotato recipes

Sweetpotato porridge

Ingredients:

Sweetpotato flour	1 heaped table spoon
Millet flour	4 heaped table spoon
Soya flour	1 heaped table spoon
Lemon	1 small
Sugar	2 table spoons
Water	6 cups

Procedure:

1. Bring five cups of water to boil.
 2. Mix the flours 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. Make juice from the lemon while pot continues to boil for 20 minutes.
 5. The cooked product should jell
 6. Remove from fire add lemon juice and sugar.
 7. Cool, then serve warm.
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Sweetpotato products

		
<i>Sweetpotato boiled roots</i>	<i>Sweetpotato composite flour</i>	<i>Sweetpotato porridge</i>
		
<i>Sweetpotato relish</i>	<i>Sweetpotato chapattis</i>	<i>Sweetpotato doughnuts</i>
		
<i>Sweetpotato juice</i>	<i>Sweetpotato buns</i>	<i>Sweetpotato crisps</i>
		
<i>Sweetpotato crackies</i>	<i>Sweetpotato cake</i>	<i>Sweetpotato soap</i>

Sweetpotato crisps

Ingredients:

Sweetpotato roots	6 medium
Oil	2 cups
Salt	to taste
Water	2 containers

Procedure:

1. Remove soil from roots and peel as you place in clean water.
2. Wash off any soil.
3. Slice into very thin pieces using a knife or larger blade of grater.
4. Drain off the water.
5. Heat the oil and deep fry till starting to brown.
6. When brown remove and drain.
7. Salt and serve warm or cold.

Sweetpotato chips

Ingredients:

Sweetpotato roots	6 medium
Oil	2 cups
Salt	to taste
Water	2 containers

Procedure:

1. Remove soil from roots
 2. Peel and wash and place in clean water
 3. Chip into desired shapes
 4. Heat oil and deep fry the chips.
 5. When starting to brown, remove and drain oil.
 6. Salt and serve warm or cold.
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Sweetpotato “Mshenye”

Ingredients:

Sweetpotato roots	10medium
Maize	2 cups
Beans	4 cups
Salt	to taste
Water	adequate

Procedure:

1. Sort maize and beans and pre-soak for 6-8 hours.
 2. Boil the maize and beans till almost cooked.
 3. Remove soil from sweetpotato roots and peel.
 4. Wash and slice the sweetpotato roots into desired shapes.
 5. Add the sliced sweetpotato roots to the maize and beans and let cook.
 6. When sweetpotato roots are soft and maize and beans well cooked mash.
 7. Add salt to taste and serve as balls heaped on plates.
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Sweetpotato relish

Ingredients:

Sweetpotato leaves	1 kg
Onions	2 medium
Tomatoes	4 medium
Flavour	4 tablespoons
Oil/Fat	4 tablespoons
Salt	1 tablespoon
Warm water	½ container

Procedure:

1. Clean leaves by removing dirty and very old ones.
 2. Prepare the onions and tomatoes and slice into separate dishes.
 3. Shred the leaves.
 4. Wash twice in warm water to remove the anti-nutrients.
 5. Heat the oil and fry onions till they start to brown.
 6. Add tomatoes and let cook for a while.
 7. Add the vegetables and let cook for 5 minutes
 8. Add the flavour and stir the contents and let cook till done.
 9. Serve with bananas/ugali or kaunga, sima or nshima/rice.
- *The flavour can be alternated with milk, groundnut paste, coconut milk, soya flour etc.
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Sweetpotato mandazi

Ingredients:

Sweetpotato mash	½ cup
Wheat flour	2 cups
Sugar	2 table spoons
Salt	pinch
oil	2 cups
Baking powder	1 table spoon
Lukewarm water	adequate

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.
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Sweetpotato soya chapatti

Ingredients:

Grated sweetpotato	1 cup
Wheat flour	2 cups
Soya flour	1 cup
Salt	1 teaspoon
Lukewarm water	adequate
Oil	½ cup

Procedure:

1. Mix dry ingredients together in a bowl.
 2. Add the grated sweetpotato and mix.
 3. Add 1 tablespoon of oil to the flour and mix well.
 4. Add the water to the mixture in the bowl and knead till stiff smooth paste is formed.
 5. Divide the dough into 8-10 equal balls.
 6. On a 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 coil into a thin circular sheet.
 10. Grease a shallow frying pan.
 11. Fry each circular sheet on both sides till golden brown.
 12. Ensure to grease both sides.
 13. The product is the chapatti and can be served with stew or sauce or tea.
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Sweetpotato doughnuts

Ingredients:

Grated sweetpotato	½ cup
Wheat flour	2 cups
Yeast	1 teaspoon
Sugar	2 tablespoon
Salt	pinch
Oil	2 cups
Milk/Egg	optional
Cooking fat	1 tablespoon
Lukewarm water	adequate

Procedure:

1. Put yeast and 1 tablespoon sugar in a cup.
 2. Add 3 tablespoon 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. Rub in the cooking fat and then add the risen yeast and mix.
 5. Add water to the mixture and knead into a dough.
 6. On a floured surface, roll the dough slightly.
 7. Make dough into a ball and return to mixing bowl.
 8. Cover the mixing bowl with wet warm cloth and leave to double.
 9. Re-knead the dough after doubling and roll onto a floured surface.
 10. Cut into desired shapes and deep fry till golden brown.
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Sweetpotato soya crackies

Ingredients:

Sweetpotato flour	1 cup
Wheat flour	2 cups
Blue band	2 table spoons
Eggs	3
Salt	1 table spoon
Spices	1 table spoon
Oil	2 cups
Baking powder	2 tea spoons

Procedure:

1. Sift all dry ingredients in a mixing bowl.
 2. Add blue band and rub in.
 3. Whisk the eggs and add to the contents in the bowl.
 4. Knead to a smooth dough, if hard add a little warm water.
 5. Pack dough in noodle machine.
 6. Heat oil and drop contents in machine by turning the handle round.
 7. Cut contents from machine with a knife to reduce the size.
 8. Let cook till brown
 9. Remove and drain oil and let cool in a covered container.
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Sweetpotato onion bites

Ingredients:

Sweetpotato mash	1 cup
Wheat flour	2 cups
Baking powder	3 tsp
Chilli pepper	3/4 tsp
Salt	1 tsp
Spring onion leaves	1/2cup
Water	
Cooking fat	1 tsp

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 a little water 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
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Sweetpotato strips

Ingredients:

Sweetpotato flour	1 cup
Soya flour	1/2 cup
Wheat flour	2 cups
Cooking fat	4 table spoons
Eggs	1
Sugar	3 table spoons
Oil	2 cups
Baking powder	3 tea spoons

Procedure:

1. Sift all dry ingredients in a mixing bowl
 2. Add cooking fat and rub in.
 3. Beat eggs and add to the bowl and mix.
 4. Add a little warm water and knead to smooth dough.
 5. Roll dough on floured surface to 1centimeter.
 6. Cut small strings from rolled dough.
 7. Heat oil and drop in the strings and let cook.
 8. When brown remove and drain.
 9. Keep in covered container to prevent hardening.
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Sweetpotato bread

Ingredients:

Grated sweetpotato	½ cup
Wheat flour	2 cups
Yeast	1 teaspoon
Sugar	1 tablespoon
Salt	pinch
Luke warm water	adequate
Oil	2 tablespoons

Procedure:

1. Mix yeast and sugar in a cup.
 2. Add 3 table spoons of water to the cup and leave to rise.
 3. For quick rising cover cup with a warm cloth and put in 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 to double size.
 10. Bake in oven at 200°C (400°C) for 15 - 20 minutes.
 11. Remove and allow to cool and then wrap.
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Sweetpotato buns

Ingredients:

Sweetpotato mash	1 cup
Wheat flour	3 cups
Sugar	2 tablespoons
Salt	pinch
Yeast	1½ teaspoons
Oil/Fat	3 tablespoons
Water	adequate

Procedure:

1. Put yeast with 1 teaspoon sugar in a cup,
 2. Add 2½ tablespoons of warm water and leave to rise.
 3. Put the mashed sweetpotato in a mixing bowl and sift in the dry ingredients
 4. Add oil/fat and rub in till it crumbles.
 5. Add risen yeast and mix.
 6. Add water and knead till done to required texture.
 7. Roll into a ball, put into mixing bowl and cover with wet cloth or put into an oiled poly bag and let double.
 8. Knead the doubled dough.
 9. Divide dough into equal small balls and roll out to make desired shapes.
 10. Put in oiled baking pan and leave at room temperature for 10 minutes.
 11. Bake for 20 minutes at 170°C or 350°F or till crust is golden brown.
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Sweetpotato cake

Ingredients:

Sweetpotato mash	1 cup
Wheat flour	3 cups
Eggs	4
Blue band	5 tablespoons
Baking powder	3 teaspoons
Lemon	1 medium
Sugar	3 table spoons

Procedure:

1. Sift all dry ingredients in a bowl.
2. Add the sweetpotato mash and 4 tablespoons of blue band and rub in.
3. Beat the eggs and add to the bowl and mix well.
4. Grate lemon rind and add to the bowl and mix.
5. Make juice from the lemon and add to the bowl contents and mix well.
6. If consistency not runny, add a little water.
7. Grease baking pan and pour in contents.
8. Bake in oven at 175°C (360°F) for 30 minutes or till brown.
9. Alternatively bake on open fire (see tips on open-fire baking below)

Tips on open-fire baking

1. Pre heat the charcoal stove /jiko, Kenya Ceramic Jiko (KCJ) or maendeleo stove.
 2. Grease a heavy pan with lid.
 3. Pour mix dough contents into the pan.
 4. Cover the pan with lid preferably heavy chapati pan.
 5. Remove fire from stove and place on the lid evenly.
 6. Leave very little fire in the fire – box and cover with ash.
 7. Place covered pan with fire on the ash covered stove.
 8. Keep fire on lid burning by adding twigs for 2 minutes
 9. Let cook for another 30 – 40 depending on type of charcoal used minutes.
 10. Remove lid with fire, test cake with knife by piercing in the middle.
 11. If done knife should be dry - if not done knife will be wet with uncooked contents.
 12. If done remove and cool cake on rack.
 13. If not done return and replace lid with fire for a while then remove.
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Sweetpotato biscuits

Ingredients:

Sweetpotato mash	1 cup
Wheat flour	2 cups
sugar	3 table spoons
salt	pinch
Blue band	3 table spoons
Baking powder	1 tsp
water	2 cups

Procedure:

1. Sift the dry ingredients in a mixing bowl.
 2. Add the blue band and rub in till the mixture crumbles.
 3. Add water, knead to a stiff paste
 4. Roll out on a floured board.
 5. Cut into shapes and arrange on a greased baking pan.
 6. Prick with a fork to prevent dough from rising.
 7. Bake for 15 minutes at 175°C (350°F) or until evenly brown.
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Sweetpotato pineapple upside down

Ingredients:

Sweetpotato flour	1
Wheat flour	3
Eggs	4
Blue Band	5 tablespoons
Baking powder	3 teaspoons
Sugar	3 table spoons
Pineapple	1 small ripe

Procedure:

1. Sift all dry ingredients in a mixing bowl.
 2. Cream the blue band and sugar in a small bowl.
 3. Break eggs one at a time and pour into cream mixture.
 4. Mix well then pour in the dry ingredients and fold in, to give a runny mix.
 5. If hard add water or milk to make mixture runny and smooth.
 6. Clean the pineapple and peel. Slice pineapple into 1 inch thick.
 7. Grease baking tin and arrange the pineapple slices in.
 8. Pour cake mix into tin and bake in oven at 176°C (360°F) for 30 minutes or till brown.
 9. Remove and turn contents into a plate or small tray.
 10. Serve as dessert/ sweet.
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Sweetpotato pie

Ingredients:

Sweetpotato flour	1 cup
Wheat flour	2 cups
Fat	8 table spoons
Salt	to taste
Rice	2 cups
Dhania	1 bunch
Minced beef	½ kg
Egg plants	1 large
Onions	1 medium
Tomatoes	2 medium
Mixed spices	1 teaspoon
Milk	1 cup
Egg	1

Procedure:

1. Prepare dhanias, onions and tomatoes and cut into separate containers.
 2. Fry onions with 2 table spoons of oil.
 3. Add tomatoes, let cook then add dhanias.
 4. Add minced beef and let cook for 20 minutes
 5. When about ready add mixed spices and let cook for another 10 minutes.
 6. Sort rice, wash once and bring 4 cups of water to boil.
 7. Pour rice into boiling water, add a little salt then cook for 15 mins. or till there is no water.
 8. Clean egg plants and cut into slices.
 9. Use 2 tablespoons of fat to shallow fry the slices, and arrange in a greased baking tin.
 10. Pour the rice on the arranged egg plants.
 11. Pour the beef on the rice and evenly distribute.
 12. Melt the remaining fat, reduce heat.
 13. Fold the mixed flour into the melted fat, a little at a time.
 14. Add milk to flour - fat mix and continue till all flour is used.
 15. The mixture should spread when poured.
 16. Pour the mixture onto the beef and spread evenly.
 17. Beat the egg and spread on the pastry.
 18. Bake in oven at 170°C (350°F) for 30 minutes.
 19. Remove and serve as complete meal.
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Sweetpotato juice

Ingredients:

Sugar	4 cups
Boiled peeled sweetpotato roots	8 medium sized roots
Citric acid/ lemon juice	3 teaspoon/ 5 fruits
Water boiled and cooled	5 litres
Fruit flavouring (optional)	1 drop or add tamarind to taste

Procedure:

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

Farmers from Abuket FFS in Soroti, Uganda developed and trialled number of different sweetpotato flours for use in various products, details of which are given below.

Sweetpotato flour for making Atap (local bread)

Sweetpotato flour with optional additives of tamarind juice, lemon juice or dried powder made from sun dried slices of unripe mangoes

Sweetpotato composite flour for making Atap (local bread)

Mix sweetpotato flour with cassava and sorghum flour at weight ratios of 2:2:1. As above it can be enhanced with optional additives.

Sweetpotato composite flour for making porridge

Mix sweetpotato flour with maize flour at a weight ratio of 2:1. As above it can be enhanced with optional additives.

Sweetpotato soap

This recipe is still under development, to date the following ingredients have been used to produce a soap, however it does not yet produce enough lather.

Ingredients:

Sodium hydroxide

Sweetpotato residue (dregs left after squeezing mash sweetpotato roots for juice)

Salt

Animal fat

Lemon & Eucalyptus leaves

Optional: colouring

6.4 Sweetpotato as animal feed

Both sweetpotato roots and vines are good materials for animal feed. The roots provide energy derived from starch while vines provide protein and fibre. The value of sweetpotato vines as animal feed is attributed to high yield, palatability and crude protein content. Crude protein content of sweetpotato vines varies among varieties and stage of growth at time of harvest. Normally, dry matter content of fresh vines is low suggesting that consumption of fresh forage as basal diet for animals could be limited by high intakes of water in the material. 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. A few considerations need to be kept in mind when using roots as pig feed:

- *Trypsin inhibitors:* Some sweetpotato roots, depending on the variety, possess chemical compounds that inhibit the important digestive enzyme trypsin. When a trypsin inhibitor is present, nutrient absorption from sweetpotato roots or other feeds consumed simultaneously is significantly reduced. Trypsin inhibitors can be broken down in high heat, thus, farmers generally cook sweetpotato roots before feeding to pigs. Unless the specific variety has been screened for trypsin inhibitors and proves to be free of them, it is a good practice to cook the roots.
- *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 and rate of absorption, although this practice is only feasible when weather conditions permit.
- *Starch yield (starch content multiplied by storage root yield):* For the purpose of animal feed, given the same starch yield per hectare, it is better to choose varieties that are high in starch content and lower in yield, than those low in starch but high in yield. Low starch content means high water content in the roots. Pigs can become bloated if the root moisture content is too high.

By the same token, 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 cms for resprouting.

- *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), and to dry the vines or make silage after harvest.
 - 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.
 - Silage: this method is less common, but also an option for storage. 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 sheet. The dimensions of pits vary depending on the amount of forage available for ensilage. Polythene bags could also be used to ensile sweetpotato vines. In order to prepare good quality silage from sweetpotato vines, the following principles should be considered.
 - Anaerobic condition should be maintained by compressing the forage material in silos to expel air.
 - Ensiled sweetpotato vines should be chopped. Chopping of sweetpotato vines into small pieces (2 – 5 cm) can be done by using either machetes or stationary forage chopper.
 - Additives that supply carbohydrates such as sweetpotato roots, molasses or fresh sugar cane juice should be included. If a farmer is making 100 kg of silage he/she must add 2-5 kg of molasses or fresh sugar cane juice or 10–20% sweetpotato roots on fresh weight basis of ensiled forage material.

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