Process of producing sweetpotato flour

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1. Raw material

Sweetpotato roots can be a raw material for processing flour. The main characteristics of the fresh roots are summarised in Table 1.

Table 1. Characteristics of fresh sweetpotato roots, variety Tanzania.

Skin colour	White
Fresh colour	Yellow
Moisture content (%)	67
Dry matter content (%)	33
Starch content (%)	23.5
Dry starch extracted (g/100 g fresh root)	17.0
Total sugars content (%)	3.3
Total protein content (%)	1.65
Lipid content (%)	0.3
Ash content (%)	1.0
Total fibre (NSP + lignin) (%)	3.0
Vitamin & other components (%)	0.3

NSP-Non Starch Polysaccharides

2. Yield in dried sweetpotato chips and flour

Our calculations showed that the yield in dried chips for the variety Tanzania was 30% while that of flour was 27% at the village level processing. The residual moisture content in dried chips and flour was 11%.

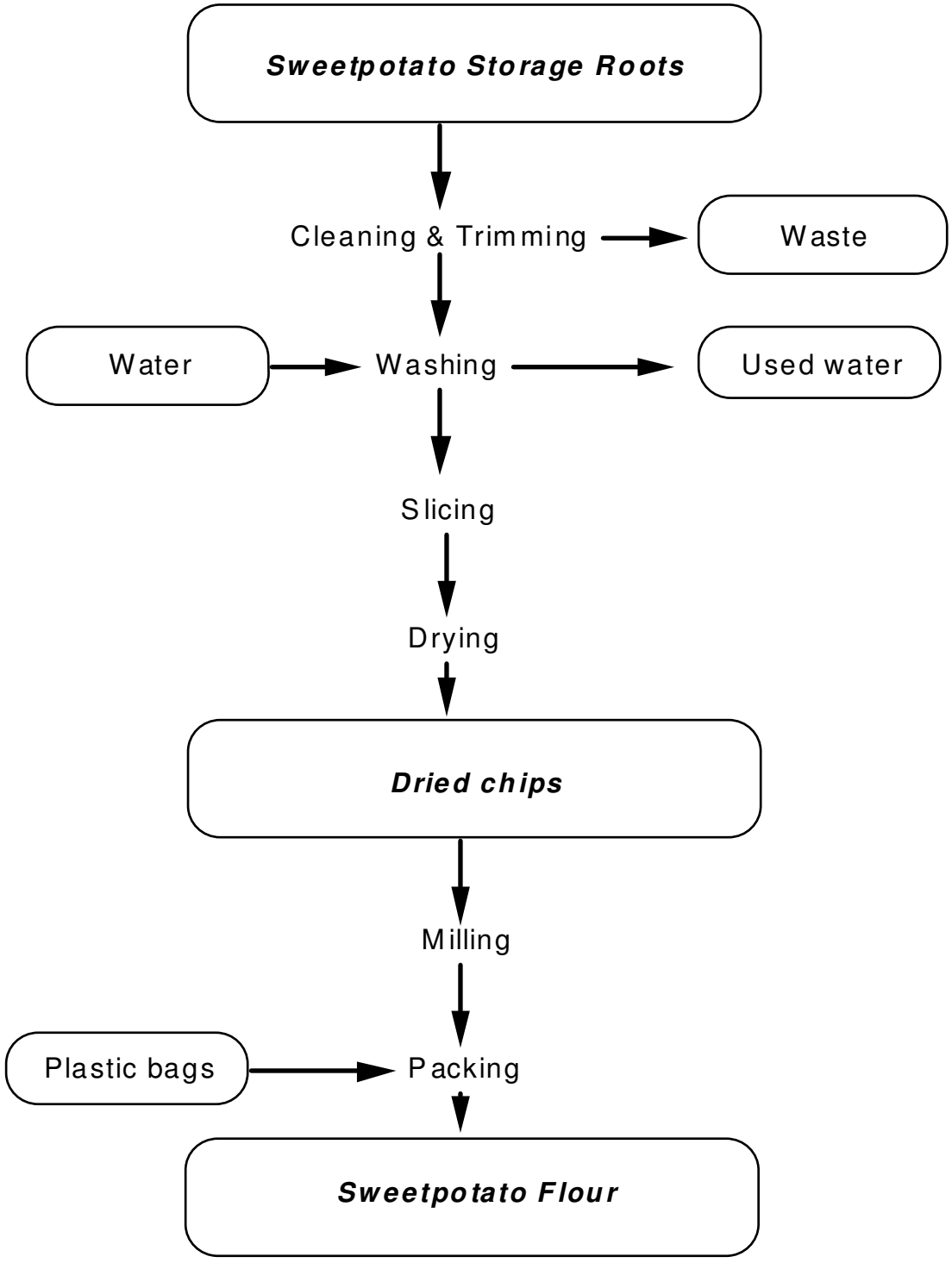

Fig. 1. Process of producing dried sweetpotato slices and flour

3. Processing of sweetpotato flour

The processing schema is shown in the Figure 1.

3.1. Cleaning and Trimming

This operations aim to remove soil and other foreign material from the sweetpotato root surface, portion damaged by weevils or other pests, and any other unwanted portions of the roots. Damaged portions tend to brown during the course of flour processing ..Cleaning and trimming is manually done using knives.
In the processing of flour using sweetpotato, experiments have shown there is no need of peeling since the root skin is extremely thin and has a very minor influence on the colour and final composition of the product.

3.2. Washing & Brushing

The washing and brushing steps are the most critical in the production of sweetpotato flour. The washing of the roots should be exhaustive. The quality of the end product-flour - depends on how the washing has been conducted. The brushing is also a relevant step because it reinforces the removal of the soil and an important portion of the skin, especially when red skin coloured sweetpotato roots are being processed into flour. It has been noted that the skin has a protective effect on the water diffusion from the roots towards the surface, and consequently slices having a portion of the skin take a long time to dry and their structure becomes harder and not breakable. During the brushing, the protective role of the peel against capillary water diffusion to the surface is slowed down.
At least, three batches of water are required: the first for pre-washing when soil and other impurities are removed. Roots should be submerged in water so that impurities which adhere to the skin can be freed. The second washing is for cleaning and brushing concomitantly with removal of possible damaged portions of the roots escaped from the previous step. The third washing is for fine cleaning with A very clean water.
The sun pre-drying of clean and washed roots is desirable. It reduces the moisture at the surface of the roots and improves the cleanliness of the end product.

3.3. Slicing

The sweetpotato slicing separates roots into small physical sizes and increases their drying surface. It is currently done manually and stainless knives are recommended to avoid undesirable browning reactions. The slicing sweetpotato roots is a tedious exercise, but it has been observed that the slicing or chipping gives a sweetpotato flour of high quality colour. The sweetpotato grating induces a lot of enzymatic browning reactions and the fresh grated product is quickly subjected to an undesirable spontaneous fermentation. Sweetpotato balanced chemical composition makes fresh sweetpotato a suitable medium for the growth of a wide range of micro-organisms and other agents involved in the deterioration of the fresh roots.

3.4. Drying

Many different techniques exist to carry out the drying of food products such as : traditional solar drying, technical solar drying or drying using sophisticated industrial equipment. Our context is of traditional solar drying. The traditional drying is the exposition of sweetpotato chips directly to the rays of the sun on a drying surface, and water is capillarly transported to the slice surface where it vaporises. So, thin slices will dry very fast.
The sun drying presents certain difficulties such as: there is too much dependence on climatic conditions (it is sometimes necessary to gather up the product in case of rain), there is a need for manual labour to move the product during the drying time, there is difficulty in maintaining hygienic conditions.
The dry season is a must to avoid moving of the product, especially for the first drying day. The second drying day, chips could be moved at least twice a day until they are completely dried.
The approximate drying time of sweetpotato chips is from two to four days and the residual humidity should be between 10 and 12%. The water activity should be around 0.4. Dried chips from Tanzania sweetpotato variety are breakable, with a whitish colour and the dry matter of 89%.
It is recommended to pack the sweetpotato dried chips immediately after the drying to avoid any risk of rehydratation.

3.5. Milling

For grinding, any hammer mill can be used. It is desirable to pass twice the dried material in the mill should a finer flour is desired. The residual humidity in the dried slices should be between 10 and 12%. Over drying of slices produces a lot of dust and loss of material during the milling. It is recommended to grind sweetpotato dried chips immediately after drying to avoid any risk of rehydratation. Flour from Tanzania sweetpotato variety is yellowish and suitable for a dry matter of 89%.

3.6. Packing and Storage

After the grinding, pack and seal immediately to avoid rehydratation and insect infestation. Materials with little permeability to water vapour, such as cellophane, polyethylene or polypropylene should be used. The decision on packaging material is based on transportation requirements and storage time. As soon as the product is placed in its package it should be sealed immediately, removing as much air as possible from inside the package. This is to avoid direct exposition of the product to the surrounding air and to minimise any insect attack. The packed products should be stored in a fresh, dry, and preferably dark place until it is shipped to the consumer.

Table 2. Production costs for sweetpotato dried chips and flour in Soroti/Uganda (UShs)

Items	Cost/unit	Unit	Total
Sweetpotato roots (120 kg)	5500	8.33	45815
Cleaning & trimming roots (labour)	700	3	2100
Washing water (100 L)	50	10	500
Washing tools	9800	0.1	980
Washing & brushing (labour)	700	4	2800
Slicing tools	1000	0.1	100
Slicing (labour)	700	5	3500
Drying*	1000	2	2000
Total costs (dried chips)			57795
Yield in dried chips (Kg)			295.5
Production cost/Kg dried chips (UShs)			*195.6*
Milling	400	15	6000
Packaging	560	5	2800
Yield in flour (Kg)			286
Total costs (flour)			66595
Production cost/Kg flour (UShs)			*232.8*

4. Calculation of Sweetpotato Flour Production Costs

4.1. Needs and costs of flour processing equipment

We are talking about the production of sweetpotato flour in rural area at the village level. The hand chipping of roots is a traditional technology and only requires a knife. However, the operation is perillous and accidents of fingers cut or injured often occur. The way the operation is currently done needs a lot of improvements and a hand chipper machine can get it easier and rapid done and ensure the sanitation of the dried product.
Water is scarce when the sun drying is suitable, and the food sanitation is a crucial step in marketing. An investment in a 200-L jerrycan/household is desirable.
The sun drying is usually done on rocks, and on cleaned surfaces and covered by dried cow dung etc. The dried product is always in contact with soil and dust, and would not necessarily meet the basic hygienic requirements of urban foods. A training of farmers in general sanitation of dried roots, and use of local available material such as mats to avoid direct contact of chips with soil could improve the sanitation aspect of the end product.
The milling would be done in local hammer mills and the packaging is a must to improve the transportation of the product to urban areas.

4.2. Cost of raw material

The schema of the technological process of the figure 1 indicates the sweetpotato flour processing requires only roots and water.
Roots. Prices of fresh sweetpotato roots vary from 4,000 to 7,500 Ushs/bag of 120 Kg in areas surrounding Soroti.
Water. Water is another important ingredient in sweetpotato flour processing. Due to its multiple uses (washing & cleaning) in the process of slices dehydration, an important quantity of that liquid is necessary. Potable water is used in the processing dried chips for cleaning the fresh roots and ustensils. Roots should be washed in potable water to eliminate surface impurities and make the drying process more effective. In case of any doubt regarding the potability of water, the last is made potable using chlorides. The adequate concentrations of chlorine in water should be 3 to 5 ppm of free chlorine (for 1000 L of water use 3 to 5 g of Na hypochlorite)
Energy. There is no cost related to energy because the sun drying is involved. The cost appearing in Table 2 is for night watching of drying material.

4.3. Transport cost

The transport of raw material at the village level does not require any extra cost.

4.4. Storage cost

Packing and flour storage would require the plastic bags. One plastic bag, size 20 X 24, gauge 200, suitable for packing and storage of flours costs 2.4 Kshs (about 45 Ushs). The loss during the grinding was estimated at 3% of the weight of dried sweetpotato chips.

4.5. Profitability

Sweetpotato dried chips or flour are not currently traded off on food markets surrounding Soroti Trading Center. However, sweetpotato flour is home made in each household and used alone or in mixture with sorghum or finger millet to process local bread called "*atapa*". According to information collected from farmers and agricultural extension service in Soroti, the price of a 120-Kg bag of fresh sweetpotato (variety Tanzania) varies between 4,000 Ushs and 7,500 UShs at the farm gate, where drying is supposed to be taking place. The Table 2 suggests that the production cost of a kilogramme of sweetpotato flour would fluctuate between Ushs 183.1 and 291.1. The cost of production was 233 UShs/Kg of sweetpotato flour when the study was being conducted, which can be reasonably traded off at Ushs 300. That price can highly compete with wheat flour (traded at 750 UShs/Kg), maize flour (400 UShs/Kg), cassava (300-350 Ushs/kg), millet flour (400-500 Ushs) in Soroti and Kampala.