Adequacy of Traditional Methods for Drying Sweet Potato in Uganda

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Abstract

Indigenous methods for processing sweetpotato in North Eastern Uganda consist in crushing the storage roots, and sun drying them on rocky surfaces or courtyards smeared with cow dung. To improve the quality and sanitation of the product, the International Potato Center (CIP) has been evaluating, at the village level of Soroti, Uganda, the use of a hand-operated slicer and drying of the sweetpotato slicers on raised stands. Sweetpotato roots from orange-fleshed variety Naspot 5 were processed, and the dried slices from CIP's sites compared to those produced using local traditional methods and laboratory controlled methods from the Department of Food Science, Makerere University, for the nutrient content, microbial quality, and foreign substance contents. Microbial analysis revealed that the total plate count of micro-organisms exceeded the safety level of 5.3 log cfu/g for the samples traditionally processed. This was also true for the coliform contents (2.8 log MPN/g), while the counts for yeast and moulds (2.7 log cfu/g) remained far below the recommended safety levels. The samples processed using traditional methods had high levels of foreign substances ranging from 0.2 to 1%, and showed considerable browning. The difference in nutrient contents was, however, not significant among different samples.

Introduction

Sweetpotato is an important crop in Uganda and much of the densely populated mid-elevation region surrounding Lake Victoria in eastern Africa (Bashaasha et al., 1995, Hall et al., 1998, Scott et. al., 1999). Millions of farmers produce the crop primarily for home consumption and to a lesser extent for commercial sales in local or urban markets. The increasing importance of sweetpotato in the Lake Victoria region and

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elsewhere in sub-Saharan Africa is largely attributable to the crop's relatively high productivity across a range of environments, and its short cropping season (Hagenimana and Low, 2000). Periodic droughts and the rising costs of grain production have also contributed to the increasing importance of sweetpotato both for food security and income generation.

In Uganda, sweetpotato is mainly marketed in the fresh form, and is eaten boiled, steamed or roasted. Fresh sweetpotato is bulky with moisture content over 65% (Hagenimana et al., 1998) and quite perishable due to water loss and rots (Gatumbi et al., 1994). However, in some drier areas, such as north-eastern Uganda and the Lake Zone of Tanzania where sweetpotato is a major crop, slicing or crushing with a wooden implement or stone and sun-drying of sweetpotato on flat rocky surfaces or courtyards smeared with cow dung, are widely practised by local people to produce a dried food product that can be stored for some months. This indigenous product (*inginyo*) is ground into flour and mixed with sorghum, millet or maize to produce staple dishes. Although dried sweetpotato products are very important in local diets where they are produced, there is little commercial trade in these products. The quality of sweetpotato flour produced at the household level is generally very low, due to low levels of food sanitation used in the processing and handling.

CIP's effort on sweetpotato research and development in sub-Saharan Africa are aimed at enhancing the role of sweetpotato for both food security and income generation for small poor farmers in the region. The effort is interdisciplinary, involving crop production (plant breeding, plant health) postharvest and socio-economic research. In Uganda, this work is concentrated in Soroti and surrounding Districts, where sweetpotato production is important and the potential for expanded production and processing are high. New varieties, including orange-fleshed varieties with high dry matter are being introduced in the area (Hagenimana and Low, 2000).

To improve the quality and technology of producing affordable dried sweetpotato products at the village level, production of dried sweetpotato was technically evaluated in three villages of Soroti District considering the steps of washing, use of the sweetpotato slicer, adjustment of drying, milling and storage to local conditions, and quality control of the dried product. The product was compared for the nutrient content, microbial quality, and foreign substance contents to that produced using local traditional methods and laboratory controlled methods.

Materials and Methods

Dried sweet potato samples processed using traditional methods were obtained from 23 farmers in Gweri sub-county, Soroti District in January 2000. They were mainly processed by crushing scrapped storage roots with a wooden implement or stone and sun-dried on flat rocky surfaces or courtyards smeared with cow dung. Sweetpotato processing usually takes place at the beginning of the dry season.

Samples from CIP's sites were processed using the flow diagram for producing dried sweetpotato chips and flour as described by Hagenimana et al. (1999). Roots were cleaned and trimmed, washed, sliced using an improved hand-operated slicer, and then sun-dried on raised stands for 48h.

Besides, fresh roots were collected from 23 farmers in Soroti and processed in the laboratory of the Faculty of Agriculture, Makerere University.

Total protein, fat, fibre and ß-carotene contents were determined by methods of AOAC (1990). Starch and sugar contents were determined using the Anthrone method as described by Clegg (1956). Microbial quality, yeasts and moulds were estimated by the total plate count (TPC), total coliforms were determined by the most probable number (MPN) as described by Bainbridge et al. (1997). Foreign materials were determined by physical separation, while the colour was estimated by Lovibond tintometre.

3. Results and Discussions

3.1. Chemical Analysis

In accordance with previous studies, this investigation revealed that sweet potato is a good source of nutrients (table 1), such as carbohydrates and proteins (Woolfe, 1992) and that some varieties can supply appreciable amounts of the ß-carotene (Ameny and Wilson, 1997). In processing sweet potato, indigenous methods and CIP technology showed no significant differences with respect to the nutrient content and ß-carotene content, but minimal variations on the aspects of moisture, ash and sugar. The fact that the ß-carotene content in all samples turned out to be low (< 3 mg / 100 g) compared to fresh sweet potato tubers (4 mg / 100 g) (Diop, 1998) implies that the challenge to preserve ß-carotene would still remain common to all technologies, thereby taking into consideration that this important constituent degrades when exposed to sunlight.

Table 1: Results of the Chemical Analysis

	Sample No.	% Ash	ß-Carotene (mg/100g)	% Sugar	% Starch	% Fat	% Protein	% Dry matter	% Fibre
Samples processed on courtyards	**1**	3.42	2.77	1.33	40.0	0.54	4.1	96.0	1.4
	2	3.15	2.64	1.21	68.2	0.77	3.5	97.0	2.2
	3	3.03	1.30	1.20	66.4	0.90	2.9	97.4	0.6
Samples processed on rock surfaces	**4**	2.80	1.29	1.65	74.0	0.60	3.3	97.7	3.0
	5	3.17	2.19	1.51	76.5	0.77	3.1	97.2	2.6
	6	3.40	2.77	1.34	54.2	0.75	3.2	97.2	0.6
Samples processed at the CIP site	**7**	3.23	2.7	1.26	57.2	0.7	3.2	97.8	2.6
	8	3.21	2.46	1.22	57.4	0.81	3.1	98.0	1.8
	9	3.25	2.7	1.30	57.0	0.59	3.4	97.6	1.6
Samples processed in the University Laboratory	**10**	2.63	2.7	1.43	40.0	0.92	2.5	93.8	2.4
	11	2.58	2.55	1.39	32.1	0.79	2.6	93.7	1.6
	12	2.69	2.7	1.47	46.0	0.68	2.7	93.9	2.0
Mean		*3.04*	*2.39*	*1.35*	*55.7*	*0.74*	*3.1*	*96.4*	*1.8*
Standard deviation (S.D)		*0.29*	*0.53*	*0.13*	*14.1*	*0.11*	*0.42*	*1.6*	*0.75*
Standard Error(SE)		*0.08*	*0.15*	*0.03*	*4.0*	*0.03*	*0.12*	*0.4*	*0.21*

3.2. Microbial Analysis

The examination of the microbial quality of the products processed by using different technologies (table 2) showed significant differences in total plate count of micro organisms.

The difference with respect to TPC and coliforms was minimal within the traditional technologies (rock and courtyard processing), when further microbial analysis on the products was performed a year later. TPC counts of 8.8 and 11.2 log cfu/g were obtained in products from rock surface and courtyards respectively (Table 3), compared to TPC counts of 3.61 log cfu/g in sweet potato processed in the previous year at the CIP site (Table 2), these results show a continued degeneration of microbial quality. This drop in quality (high number of counts) for traditional technologies exceed the accepted safety levels of 2×10^5 cfu/g (5.3 log cfu/g) reported by Andrews (1992) and Van Hal (2000). Similar conclusions can also be drawn for the counts of coliforms (Table 2 and 3).

Table 2: Results of the Microbial Analysis

	Sample No.	TPC (total plate count) of micro organisms (log cfu/g)	Count for yeast and moulds (log cfu/g)	Coliforms (log MPN/g)
Samples processed on courtyards	**1**	4.27	2.41	2.85
	2	4.95	2.63	2.72
	3	6.64	2.82	3.07
Samples processed on rock surfaces	**4**	5.57	2.27	2.34
	5	6.01	3.31	3.1
	6	5.27	2.88	2.89
Samples processed at the CIP site	**7**	3.61	1.63	2.52
	8	3.64	1.65	1.85
	9	3.65	1.46	1.75
Samples processed in the University Laboratory	**10**	3.73	1.33	1.7
	11	3.56	1.33	1.36
	12	3.78	1.40	1.32

Table 3: Mean counts of micro organisms and coliforms

(a) Crushed sweet potato from courtyard

Total plate count (log cfu/g)	Coliforms (log cfu/g)
11.2	7.5
8.8	7.8
8.6	5.0
11	7.6
7.9	4.0
7.9	7.5
8.5	5.0
8.9	4.8

(b) Crushed sweet potato from rock

Total plate count (log cfu/g)	Coliforms (log cfu/g)
6.1	4.6
6.3	4.3
7.0	5.1
7.3	5.7
7.2	6.7
7.4	6.5
8.6	6.1
8.8	5.9
7.5	5.1

3.3. Physical Analysis

The presence of foreign substances such as faecal droppings of ruminant animals was prominent in products processed by using traditional technologies (Table 4) while in the CIP and laboratory products, they were hardly measurable and hence not reported. Among the traditional technologies the percentage value for the foreign substance from courtyards appeared to exceed that from the rock surface.

The colour of the products varied: The traditionally processed products tended more to red orange while the products from the CIP site and the laboratory tended more to yellow-orange. This difference is basically due to the progress of enzymatic browning. At CIP, tubers are normally immersed in water before slicing (Hagenimana, personal communication) in order to minimise the browning process.

Since dark colour and the presence of foreign material is associated with poor quality, the sweet potato processed by using traditional technologies will most likely face reduced marketability.

Table 4: Foreign substance (%)

Inginyo from Rock surface	*Inginyo* from Court yard
0.13	1.70
0.16	1.90
0.21	0.87
0.21	0.82
0.30	0.47
0.24	0.47
0.32	—
0.07	—
Mean 0.21	*Mean 1.03*
SD 0.08	*STD 0.6*

4. Conclusion and Recommendations

The fact that the nutrient content of traditionally processed potato products is not significantly different from that of products processed by using CIP technologies clearly implies that there is no need to abandon traditional processing methods, but just need to modify them by integrating some elements of CIP technology for greater achievement. This is of particular importance for the rural poor who live on marginal soils and lack economic occupations to earn money to spend on energy foods.

The integration of CIP technologies would lead to organised flow processing and thus process control, guaranteeing quality products with a higher marketability. Moreover, the integration of CIP methods would free labour - a very important component in rural communities particularly for women who are the ones most involved in processing and preparation of food, gathering fire wood and raising children.

In light of the results of this study and the financial and technological restraints (e.g. the lack of electricity) in rural areas and communities, the following improvements appear to be appropriate, feasible and sustainable:

- In order to enhance efficient cleaning of the tubers and the use of manual slicers, the farmers should be encouraged to grow varieties with tubers that have a smooth surface and regular shape.
- Before processing, the tubers should be washed in order to reduce the amount of foreign material (esp. sand) in the potato product. In order to save water, the washing should be done in two or three different tubs representing different stages of cleaning. Enzymatic browning could easily be controlled by soaking the sweet potato in water afterwards. This would enable the farmers to produce flour of light colour and thus contribute to higher marketability of local products.
- Instead of crushing the potato root with a wooden implement (most common traditional technology), a simple mechanical slicer with preferably several blades should be used for processing. The technology currently used could be improved by introducing bigger slicers not propelled by handles but cogwheels of a bicycle, thereby benefiting from transmission and momentum at the same time. This would not only shorten the time of processing, but also that of drying since the tool enables the farmers to produce very thin slices. The most suitable location for the slicer would be a central place where clean water is available.
- In order to avoid faecal contamination of the potato product during drying, a raised drying stand should be constructed since this excludes stray animals from walking into the products. Besides such a preferable wooden stand helps to reduce the amount of foreign elements (esp. sand) in the potato product. The stand should be constructed in an airy place and be equipped with a roof protecting the potato products from rain as well as from sunlight in order to preserve the content of residual ß-carotene.
- In order to avoid moulds on the processed potato, farmers should be encouraged to ensure airy stocking and regular turning of the product.
- Sensitisation of the local communities can best be achieved by training one educated person per community and send them back to their communities during harvesting such that they can instruct their people in the local language. In order to reach the rural population not only intellectually, but also emotionally, it might be worth thinking of

convincing local drama groups to stage a piece of drama highlighting the benefits of CIP technologies.

- Besides focusing on dried sweet potato production, attention could also be drawn to the possibility of processing flour based products of sweet potato such as *mandazi* (doughnuts) and *chapati* (unleavened bread) thus promoting a diverse opportunity for marketing.

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Table 7. Some characteristics of sweet potatoes dried by using different techniques

Sample Source	Moisture, %	Ash, %	Crude Protein, %	Total sugars, %	% starch	Foreign substances	Log cfu/g flour	Minimum acceptable	(MPN) of coliforms, log/g	Coliforms, min. acceptable
Laboratory slices	6.2	2.60	2.6	1.40	39.4	?	3.7	?	1.50	?
Slices from CIP site	2.2	3.20	3.2	1.30	57.2	?	3.6	?	2.00	?
Inginyo from courtyard	3.1	3.20	3.5	1.20	58.2	?	5.3	?	2.90	?
Inginyo from rock	2.6	3.10	3.2	1.50	68.2	?	5.6	?	2.80	?