A COMPARATIVE STUDY ON THE $\beta$-CAROTENE CONTENT AND ITS RETENTION IN YELLOW AND ORANGE FLESHED SWEET POTATO FLOURS

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Abstract

Sweet potato (Ipomoea batata) is very important staple food crop in Rwanda. Orange fleshed sweet potatoes believed to contribute to the prevention of vitamin A deficiency (VAD) disease are being introduced into the country. Hence 25kgs of freshly harvested orange fleshed sweet potato (Cacearpedo) and 25kgs of yellow sweet potato (Kwezikumwe) were harvested in ISAR farm and used for the study. They were selected, washed, peeled, trimmed, soaked into Sodium metabisulfite (3g/l of water) to prevent browning reaction then conventional partial sun drying. The dried orange fleshed and yellow sweet potato slices were milled using hammer mill to get flour and 10kg of flour was obtained (5kgs of YSPF and 5kgs of OFSPF). The flour was packaged in double plastic bags, brown papers and polyethylene bags packaging materials and stored in a cool dark place at ambient temperature. This study was conducted with the aim of comparing the $\beta$-carotene content, retention and the shelf life of the orange fleshed and yellow sweet potato flours. According to the results obtained during analysis of selected nutrients (carbohydrate, crude protein, crude fibre, crude fat, total ash, total reducing sugar, vitamin C and moisture content) showed that the OFSP had higher $\beta$-carotene content with difference of 99.4% and retention of 91.8% during flour production. The losses in vitamin C were observed for both varieties 4.5; 0.02% and 23; 0.1% in OFSP and YSP dried chips and flours respectively.

Key words: $\beta$-carotene, shelf-life, conventional partial sun drying, sweet potato slices (orange fleshed and yellow), spectrophotometer.

1. INTRODUCTION

Sweet potato (Ipomoea batatas) is one of the world’s important food crop and is a major food crop in developing countries (Woolfe, 1992). Sweet potato ranks as the world’s seventh most important food crop after wheat, rice, maize, potato, barley, and cassava (CIP, 2000; FAO, 2002). Sweet potato is mainly produced in marginal soils in low-input subsistence farming systems of developing countries where it is a major food crop and it is consumed in large quantities (Woolfe, 1992; Grüneberg et al., 2005) and an important staple food crop in Rwanda. It is quickly becoming an important supplementary staple in Eastern and Southern part of the Africa continent (Tumwegamire, 2004). The importance of sweet potato in daily Rwandan diets has to be underlined and sweet potato is one among the two most important crops: common beans and sweet potato, that help so much in the traditional foods of many Rwandese (Tardif et al., 1998 and Ndirigwe, 2006).

This crop is cultivated throughout the country mainly by peasant farmers, and is especially important in the densely populated areas of the plateau of Rwanda (Mid altitude) (Ferris et al., 2000). Rwanda is the third largest producer in East Africa and also has the second highest per capita consumption of sweet potato in Africa (FAO, 2007). Over 98% of the farmers in Rwanda grow sweet potato primarily for household consumption (Njeru et al., 2007) and the average sweet potato yield in Rwanda is 5.9 tonnes/ha while the global yield is 9.7 tonnes/ha (FAO, 2007).

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In Rwanda there are white and yellow sweet potatoes. These varieties which are known to be low yielding, no resistant to a big range of pests and diseases varieties and poor in beta carotene a precursor of vitamin A. Eight exotic varieties already tested in sub Saharan countries, which are high nutrient value (yellow and orange fleshed sweet potato varieties enriched in beta –carotene: a precursor of vitamin A which intervenes in eyesight) were introduced in Rwanda for yield performance evaluation hence the farmers do not know among yellow sweet potatoes and orange fleshed sweet potatoes which have high beta- carotene content, retention during processing and storing.

In Rwanda people cultivate both white and yellow sweet potatoes) varieties. Orange fleshed sweet potato (OFSP) is a new variety and is not yet grown in all parts of Rwanda. The yellow sweet potatoes are available in the market during harvesting period. But both due to their high water content (83%) they pose the problems of storage due to their high perishability. Therefore they are eaten fresh in the form of boiled, steamed and fried for a short period after harvest. Hence processing into flour, packaging and storing would help to increase the shelf life of sweet potato. It can be used to develop composite flour and added to several products viz., bread, cake, doughnuts, amandazi, waffle’s etc. This will help to increase the β-carotene intake in a community and prevent the VAD (Vitamin A Deficiency) in the long run because the VDA disease is prevalent in Rwanda. This study will provide more information to the farmers, consumers about processing technology, the variety possessing high beta- carotene content ,retention during processing and storing, it also show the packaging material appropriately for packaging and storage stability of sweet potato flour, where the storage stability was done during 4months in a cool dark place at ambient temperature.

1.2. OBJECTIVES OF THE STUDY :
The following are the objectives of the study.

2. To process flour from yellow and orange fleshed sweet potatoes
3. To assess selected nutrients viz., (carbohydrate, crude protein, crude fibre, crude fat, total ash, total reducing sugar, vitamin C and moisture content) in yellow and orange fleshed sweet potato.
4. To compare the β-carotene content in orange fleshed sweet potatoes (OFSP) and Yellow sweet potatoes (YSP).

Methodology:
Fresh sweet potatoes (yellow – Cacearpedo variety and orange fleshed – Kwezikumwe) of 25 Kg each were harvested from ISAR farm in the morning and were packaged using the plastic bags to avoid excessive loss of moisture and transported to ISAR Post Harvest Unit for processing viz., drying and milling. The flour was packed in double plastic bag in order to avoid moisture migration and contamination and was transported to the KIST Lab for nutrient analysis and storage studies.

Both sweet potatoes were subjected to several pre-treatment operations such as sorting and grading, washing, peeling and trimming, slicing, soaking in sodium meta-bisulphite (3g/l of water to prevent browning reactions and drying. Drying was done by conventional partial sun drying method for 72 hours. They were milled into flour in a hammer mill. The flour was weighed (500g) and packed into double plastic bags (DPB), brown paper (BP) bags and polythene bags (PB) and kept for storage studies. The rest were subjected to nutrient analysis. Proximate content viz., moisture content, ash, carbohydrate, protein, fat, crude fiber, total reducing sugars, vitamin C and β carotene were analyzed as outlined in Official Method of Analysis of AOAC International (2005).

4.1. PROCESSING OF FLOURS FROM FRESH OFSP (Cacearpedo) AND YSP (Kwezikumwe) ROOTS: 
Freshly harvested OFSP (Cacearpedo) and YSP (Kwezikumwe) were obtained from ISAR farm harvested in the morning and 60kgs of fresh samples were used 30kgs of OFSP and 30kgs of YSP where 60kgs were obtained. The OFSP and YSP went through the following Unit operations: Selection, sorting, washing, peeling/trimming,
weighing, slicing, soaking, drying, milling and packaging of flours in double plastic bags. Peeling and trimming brought a loss of 10kgs (16.6%) while milling further reduced its weight to 10kgs (83.3%).

4.2. COMPARISON OF SELECTED NUTRIENTS IN OFSP AND YSP

The proximate composition viz. Carbohydrate, protein, fat, ash, moisture content and fiber were analyzed. Also the total reducing sugar, β-carotene and vitamin C content were analyzed. The results obtained are presented in table 1 below.

Table 1: Comparison of selected nutrients content in fresh, dried chips and processed flours from OFSP and YSP

<table>
<thead>
<tr>
<th>S No</th>
<th>Nutrients (%)</th>
<th>Fresh</th>
<th>Dried chips</th>
<th>Sweet potato flour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carbohydrate</td>
<td>OFSP</td>
<td>YSP</td>
<td>OFSP</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>7.65</td>
<td>8.7</td>
<td>64.8</td>
</tr>
<tr>
<td>2</td>
<td>Protein</td>
<td>2.5</td>
<td>1.9</td>
<td>5.2</td>
</tr>
<tr>
<td>3</td>
<td>Fat</td>
<td>1.15</td>
<td>0.6</td>
<td>2.1</td>
</tr>
<tr>
<td>4</td>
<td>Fiber</td>
<td>3.4</td>
<td>5.3</td>
<td>4.12</td>
</tr>
<tr>
<td>5</td>
<td>Total ash</td>
<td>4.7</td>
<td>3.5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Moisture content</td>
<td>81</td>
<td>80</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>Total Reducing Sugar</td>
<td>6.73</td>
<td>6.83</td>
<td>6.78</td>
</tr>
<tr>
<td>8</td>
<td>Vitamin C*</td>
<td>50.17</td>
<td>39.7</td>
<td>47.9</td>
</tr>
<tr>
<td>9</td>
<td>β-carotene</td>
<td>8.75</td>
<td>0.045</td>
<td>8.04</td>
</tr>
</tbody>
</table>

*Mg/100g

Moisture content: Studies by Wenkam, N. S. (1983) indicated that fresh sweet potato had a moisture content of 87.8%. In the present study the moisture content in the fresh sample was 81 and 80% in OFSP and YSP respectively. This was reduced during conventional partial sun drying by 64% and 65% in fresh OFSP and YSP samples to the dried sweet potato chips and flours respectively.

Carbohydrate: Wenkam, N.S. (1983) further quoted that fresh sweet potato contained 27% of carbohydrates. The result obtained in this study showed that carbohydrate content was 7.65% and 8.7% in fresh samples of OFSP and YSP respectively. But on drying they increased to 64.8% and 73.6% in OFSP and YSP dried sweet potato both in the chips and flours respectively. Drying brings about concentration of the nutrients.

Protein: Reports by Villareal et al., (1979) indicated that protein content in fresh sweet potato was 2.8%. As presented in table 1, the protein content was 2.5 and 1.9% in OFSP and YSP fresh samples respectively. The results further revealed that the OFSP had more protein content than YSP and this was increased from 2.5 to 5.2% and 1.9 to 2.4% in OFSP and YSP fresh, and dried sweet potato chips and this remain the same after flours processing. The results showed that the protein content was high in dried sample than in fresh because of the removal of moisture content by conventional partial sun drying.

Fat: Paul and Southgate (1979) revealed that the fat content in fresh sweet potato was 0.6%. The study revealed that the fat content was 1.15% and 0.6% in OFSP and YSP fresh samples respectively and this showed that the results were similar to that obtained by Paul and Southgate, (1979). On drying it was found that fat increased

from 1.15% to 2.1% and from 0.6% to 0.7% in OFSP and YSP dried chips and this remained the same during flour processing. The increase can be attributed to the concentration of fat due to the removal of moisture.

**Total ash:** Goodbody S., (1984) reported the total ash content in fresh sweet potato as 1.7%. But in this study it was found to be as high as 4.7% and 3.5% in OFSP and YSP fresh samples. The ash content reduced from 4.7% to 4% and from 3.5% to 3% in OFSP and YSP dried sweet potato chips. However, it remained the same in the processed flour. The reduction can be attributed to the minerals lost during peeling and soaking as minerals such as iodine are concentrated in peels.

**Fiber:** In a study by Oomen and Gruber (1978), the fiber content in fresh sweet potato was 3.9%. The results obtained in this study revealed that fiber content was 3.4% and 5.3% in fresh samples of OFSP and YSP respectively. On drying fiber increased from the fresh sweet potatoes to the dried Sweet potato chips from 3.9% to 4.12% and 5.3% to 6.09% in OFSP and YSP respectively. But in the processed it was found to be slightly reduced from 4.12% to 4% and 6.09% to 5% in OFSPF and YSPF respectively.

**Total reducing sugar:** Picha D., (1985) stated that the total reducing sugar in fresh sweet potato was 7.84% and the results obtained in this study showed that the total reducing sugar was 6.73% and 6.83% in fresh OFSP and YSP respectively. The results further indicated that both varieties contained almost the same amount of total reducing sugar. This indicated that the results were related to the study of Picha D., (1985). Further processing viz., drying and processing of flour did not alter the total reducing sugar content.

**Vitamin C:** Studies have indicated that the vitamin content in yellow and Orange fleshed fresh sweet potatoes were found to be 37mg/100g FAO, (1970). The results obtained in this study showed that the vitamin C was 50.17mg/100g and 39.7mg/100g in OFSP and YSP fresh samples respectively. These were reduced from 50.17 mg/100g to 47.9 mg/100g and 47.89mg/100g and 39.7 mg/100g to 30.15 and 30.13mg/100g in OFSP and YSP dried chips and flours respectively, the losses were 4.5 ; 0.02% and 23 ;0.1% in OFPS and YSP dried chips and

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flours respectively. The losses observed in analysis result from peeling, cutting, soaking and drying because Vitamin C is heat sensitive and water soluble.

β-carotene content: Burgos G. et al., (2001) opined that the β-carotene content varied in the intensity of colouration of the sweet potatoes. They further indicated that the β-carotene content ranged from 0.0 to 0.4 mg/100g in cream coloured sweet potatoes to 4.29 mg / 100g to 18.55mg/ 100g in deep orange coloured sweet potatoes. This study revealed that β-carotene content in fresh OFSP was 8.75 mg/100g and dried sweet potato chips had 8.04mg/100 and this remained the same after flour processing. While in fresh YSP the β-carotene was 0.05 and 0.04mg/100g dried sweet potato chips respectively. It was also unaltered in the flour. Further analysis showed that there was a loss of 8.1% in OFSP and 11% in YSP. This may be caused by the exposure of samples to oxygen during different unit operations viz., peeling, cutting and drying because β-carotene is sensitive to heat and oxygen. Therefore the use of conventional partial sun drying and hammer mill for dried sweet potato chips and flours had retention of 88.8 % and 91.8% in YSP and OFSP respectively. This vividly explains that the OFSP that had higher β-carotene retention than YSP due to high concentration of orange pigment present in OFSP as reported by Simon et al., (1993) and that the carotenoids, especially concentration of β-carotene, was responsible for the orange flesh color. The two unit operations i.e., conventional partial sun drying and milling (using a hammer mill) operations indicated a β-carotene retention at 92% and 89% in OFSP and YSP dried sweet potato chips and flours respectively.

5.1. Conclusion:
This research demonstrated that OFSP were high in beta-carotene content than YSP. There were losses in beta-carotene for both varieties due to heat during drying while vitamin C was reduced during peeling, cutting and drying. Conventional partial sun drying (CPSD) was found to be the most useful method for beta-carotene retention because there is no direct heat which destroys the beta-carotene and the most for food preservation by
reducing microbial contamination. This study concluded that the OFSP were higher in beta-carotene content than YSP.

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