Proximate Composition and Carotene Content of Three Cultivars of Xanthosoma Sagittifolium

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Abstract: Three cultivars of Xanthosoma sagittifolium: White (XCw), Red (XCr), and Yellow (XCy) fleshed were studied for their proximate composition and carotene content. The proximate composition showed that the moisture content was highest in XCr (12.50%) followed next by XCy (11.25%) and 10.00% in XCw. Fat content was 0.55% in both XCy and XCr but 0.25% in XCw. Crude protein composition was 4.21% in XCw 5.10% in XCr and 3.71% in XCy, showing that the red cultivar in higher in protein content. Carbohydrate content was high in all three cultivars – XCw (79.49%), XCy (79.14%) and XCr (76.75%). β-Carotene content of 1920µg/100gm, 16µg/100g and 8µ/100g was obtained from XCy, XCr and XCw respectively and the vitamin A equivalent of 3200i.u, 26.67i.u and 13.33i.u from XCy, XCr and XCw respectively. Thus, result indicated that the colour pigments in these cultivars were mainly-carotene. Since the yellow-fleshed cultivar is rich in carotene leading to good source of vitamin A, it means that the yellow cultivar can support good nutrition as far as energy and vitamin A is concerned.

Keyword: Proximate composition, carotene content, Xanthosoma sagittifolium

I. Introduction

Xanthosoma species commonly called new cocoyam, one of the two principal genera of aroid root crops belonging to the taxonomic family of Araceae is a native of Tropical America. First cultivated into the pre-Columbian times Thompson and de Wet (1983), it was later introduced into W. Africa around 1840s (Coursey, 1968). They are either eaten roasted, boiled, fried or milled to flour after drying and are popularly called cocoyam due to their resemblance to colocasia. In W. Africa, they are preferred to colocasia as they are more suitable for making ‘fufu’, a very popular food originally made from yam. In Ghana, the young leaves and corms are parts of the staple diet.

A herbaceous perennial, Xanthosoma has a corm in the form of a rhizome from which cormels sprout and is propagated vegetatively. Coursey (1968) and Oguntona and Akinyele (1995) investigated and gave the approximate composition of tubers as: water 70–77%, carbohydrate 17-26%, protein 1.3-1.7%, fibre 0.6-1.9% Ash 0.6-1.3%, Fat 0.2-0.4% as well as several minerals and vitamins.

The taxonomy of Xanthosoma spp is unclear. Cultivated varieties have been allocated to X. atrovirens, X. caracu, X. violaceum and X. sagittifolium. In Nigeria three cultivars of X. sagittifolium have been identified, i.e. white fleshed, red-fleshed and yellow-fleshed respectively. However, these three cultivars have suffered low esteem and social problems leading to discouragement in further research on them.

Nwana and Onochie (1979) identified social problems as a great obstacle to further development on cocoyam processing resulting into lack of encouragement and support. This is reflected in these varieties being poorly documented crops in which basic information about their role within West African farming system is scarce (Knipscheer and Wilson, 1981 and Onayemi and Nwogwe, 1987).

These limitations are due to lack of proper knowledge of the true values of these cultivars. The future of these cultivars to become foods of exceptional value because of their pigment characteristics and nutritional properties lies in the application of technology to diversify their use and promotion of more intensive consumption in peoples diet in tropical regions.

The objective of this study therefore was to evaluate the proximate composition and carotene content of white-, red-and yellow-fleshed Xanthosomasagittifolium.

II. Materials and methods

The cocoyams (Xanthosoma species) were collected from National Root Crops Research Institute, Umudike. This ensured proper history and classification of the samples to be taken. It also created an opportunity for continuous collection of the same species and varieties without mixing them up.

Three cultivars of Xanthosomasagittifolium were collected and named as follows;
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(i) White – fleshed (XCw)
(ii) Red – fleshed (XCr)
(iii) Yellow – fleshed (XCy)

Nature of Material
The cocoyams used were under 7 month’s cultivation. They were preferred to remain underground and collected according to need until the next farming season. The ones collected were fresh and free from injuries.

Laboratory Storage
The cocoyam corms collected were stored at a cool, dry and airy section of the laboratory and samples were gradually drawn for experiments when needed.

Proximate analysis
The moisture content, crude protein, fat content, crude fibre and total ash were determined by the methods of AOAC (1990). All analysis in this section was expressed on dry weight basis.

Moisture determination
The moisture content was determined by the moisture vacuum oven method in which 2g of each samples was weighed into a dried metallic crucible of known mass and dried at a temperature of 105±1°C, with drawn into a desiccator to cool, weighed, then reheated, cooled and reweighed and reheated. The process was repeated until a relatively constant mass was obtained. Drying was performed in duplicated and the average values recorded. The differences in masses before and after drying were recorded as moisture content.

Ash determination
The ash basic method was used. Here, 5g of sample was weighed into an ashing dish which has been ignited, cooked in desiccator and weighed soon after attaining room temperature. The sample inserted into the furnace at about 550±1°C until a light grey as resulted to a constant weight. The sample was cooled in a desiccator and weighed. The mass of residual incinerate was calculated as ash content.

Crude fat determination
A 2g sample was wrapped in a filter paper and gradually lowered in the thimble which was fitted to a flask containing the solvent, petroleum ether (boiling pt. 60 - 80°C). The round – bottomed flask, in a soxhlet extraction unit, was slowly heated for 5h. The filter paper with the spent (defatted) flour sample was removed from the extractor and the refluxed solvent distilled out and recovered. The filter paper containing the spent flour sample was dried at 85°C for 3h, cooled and weighed. The difference in mass was recorded as crude fat (AOCS 1990).

Crude fibre determination
Sample (2g) was digested with 200ml 1.25%H₂SO₄ solution under reflux for 30min boiling. The digest was allowed to cool before filtration, with butcher funnel equipped with muslin cloth secured with elastic band. The residue was washed with hot water until washing were no longer acid. The charge was then digested with 200ml of 1.25% NaOH solution under reflux for 30min boiling. The digest was cooled, filtered, washed thoroughly with hot water, the 1% HCl acid, hot water and then with petroleum ether. Residue was scooped into a clean, dry and weighed porcelain dish, dried in the oven at 85°C to a constant mass. The dish with its content was placed inside muffle furnace at 550°C for 4h, withdrawn, cooled in desiccator and weighed. Difference in mass was recorded as crude fibre.

Crude protein determination
This was determined by the semi-microkjeldahl method in which 0.2g of sample was digested with 2ml of concentrated sulphuric acid in the presence of 0.8g of catalyst mixture (400g sodium sulphate, 16g hydrated copper sulphate and 3g selenium dioxide).

The digest was distilled with 15ml of 40% NaOH into 10ml of 2% Boric acid. The filtrate was then titrated again 0.02N HCl and the average of three readings was recorded.

\[ P = 100 \left( \frac{abc}{d} \right) \]

\[ a = \text{titre value of acid (HCl) used} \]
b = nitrogen equivalent per ml of acid (0.00 1408)
c = protein factor (6.25)
d = weight of sample used
e = % crude protein (N x 6.25)

Carbohydrate Determination
This component was determined by difference. This approach was adopted on the premise that vitamins and minerals occurred in negligible quantities. The moisture, ash, fat, fiber and protein contents were summed up and subtracted from 100% to obtain the value for carbohydrate content.

Carotene Content Determination Of The Cocoyam Varieties
The carotene content was determined by the method of Stewarte et al., (1984).

Sample Preparation
Each corm was washed with tap water, peeled and cut crosswise into tussle blocks and the pieces were thoroughly mixed to ensure homogeneity.

Carotene Analysis
The carotene was extracted using wet tissues. A portion of 4g was weighed from the homogenized representatives of the sample in a beaker. The sample was then transferred to a mortar and grinded with 50ml cold acetone. The homogenate was filtered with suction through a butcher funnel. Mortar, pestle, and residue were washed with acetone receiving washing in the funnel. The filtrate was made up to 100ml with acetone (85%) and refluxed for 30mintes with 2g Barium hydroxide. The resultant filter through a separating funnel and residue was washed with acetone. A 50ml portion of diethyl ether was added into acetone and the mixture was allowed to stand so as to let the two phases to separate. The lower aqueous acetone Phases was discarded and the diethyl ether was washed with 20ml portion of distilled water to remove acetone completely and the washing were discarded. The extra was now filtered through anhydrous Sodium Sulphate (Na₂SO₄) to dry. The optical density of standard and samples were measured using filter photo colorimeter at 420nm. A calibration curve was prepared for the standard and used to obtain β-carotene in the samples. The quantities obtained were converted into vitamin A equivalent using the relationship.

III. Results And Discussion

Proximate Composition
The results of the proximate analysis on the three cultivars of Xanthosoma sagittifolium were presented in table 1. All results were based on dry weight basis.

There was generally no significant difference in proximate composition between the cultivars. However, the results showed that the three cultivars of Xanthosoma studied are carbohydrate based food, generally low in protein and oil, with a bit high moisture content.

The samples showed a bit elevated moisture content between 10.00% for white-fleshed, 11.25% for yellow-fleshed to 12.50% for red-fleshed. The relative elevated moisture content of cocoyam was also reported by Coursey(1968), Onwueme (1978) and (Oguntona and Akinyele, 1995), as responsible for the major drawback in the utilization potential of the products as high moisture content causes problems with food storage at ambient temperature.

The crude fat content of the samples were very low with the red and yellow fleshed having the highest amount of 0.55% each and the least amount of 0.25% in the white-fleshed. This qualified cocoyam as a low fat crop. Other lesser known low fat tubers include Yam, Cassava and potato.

The carbohydrate content in the red-fleshed cultivars is quite high (76.75%), though it increased to 79.14% and 79.49% for yellow-fleshed and white-fleshed cultivars respectively. Cocoyam could be regarded as a high carbohydrate crop alongside with other tuber crops like Yam and cassava with carbohydrate content of 86.0% and 93% respectively (Oguntona and Akinyele, 1995).

Crude protein of 3.71% in the yellow-fleshed, 4.21% in the white-fleshed and 5.10% in the red-fleshed rated the crop as a better source of protein when compared with the value of 2.58% in Yam reported by (Oguntona and Ainyele, 1995 and Onyenuga, 1968). Considering the result, one feels that, for cocoyam to adequately supply human life their nutrient needs, they must be enhanced with foods that are high in protein quality and quantity. Such foods include leguminous crops like cowpea and other varieties of beans.
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The cultivars have ash contents of 5.0% for white-fleshed, 4.6% for yellow-fleshed and 4.5% for red-fleshed. The crude fibre content was 1.05% for white-fleshed, 0.75% for yellow-fleshed and 0.70% for red-fleshed. The ash content for food reflects its mineral element composition. Subsequently, mineral element of a food varies with the locality or soil type and virtually reflects the influence of the environments in which it was grown (Onyeiketel., 1995).

Crude fibre is the insoluble and combustible organic residue remaining after severe acid and base hydrolysis, while dietary fibre include those plant constituent which are resistant to digestion by human gastrointestinal system (Stare and McWilliam, 1977). However, high fibre content is believed to have some adverse effect on mineral element in the body (Kesleyetal., 1978).

Carotene Content Of Xanthosoma species

The carotene content of white-, red- and yellow-fleshed cultivars of xanthosoma were presented in table 2. The table showed a low content of 8.0µg/100g and vitamin A equivalent of 13.33i.u in the white-fleshed (XCr), 16µg/100g and vitamin A equivalent of 26.67i.u in the red-fleshed (XCr) and a high carotene content of 1920µg/100g and vitamin A equivalent of 3200i.u in the yellow-fleshed cultivars. This follows the report given by (Onwueme, 1978 and Mercadante and Rodriguez-Amaya, 2007). This might suggest that the red and yellow distinctive colour in the xanthosoma cultivars is due to the presence of carotene.

Carotenoids contributed significantly to the body’s total potential vitamin A intake (stare and McWilliams, 1977). A daily allowance of 2500µ.u was recommended for children under 6 years as stated by Singh, (2002). The importance of vitamin A has been so highlighted in recent times by WHO and this has led to the launching of special programs to incorporate rich sources of vitamin A into diets for children and adults (FAO, 1997). The value obtained from yellow-fleshed cultivar is well adequate in meeting this allowance.

IV. Conclusion And Recommendation

The results obtained from this work have shown that the white – red – and yellow-fleshed cultivars of Xanthosoma species contain little quantities of major nutrients like protein and oil but high in carbohydrates. Based on their proximate composition it could be referred to as high energy root crop like yam, cassava and potato and the distinctive colours in the cultivars could be due to the presence of β-carotene. This is the main provitamin A, which is a very important nutrition factor to prevent children from xerophathalmia (Nobert, 1976; Sommer et al 1983 and Sommer, 1997). Thus, from the studies, it is believed that the yellow-fleshed cultivar (XCy) has great nutritional values that could be harnessed to meet nutritional needs (energy and vitamin A) and be used in the formulation of various foods.

References

Table 1: Proximate Analysis of cocoyam (Xanthosoma) species (dry weight basis).

<table>
<thead>
<tr>
<th>Cocoyam specie</th>
<th>Moisture %</th>
<th>Protein%</th>
<th>Fat%</th>
<th>Fibre%</th>
<th>Ash%</th>
<th>*Carbohydrate %</th>
</tr>
</thead>
<tbody>
<tr>
<td>XCw</td>
<td>10.00±0.2</td>
<td>4.21±0.5</td>
<td>0.25±0.05</td>
<td>1.05±0.3</td>
<td>5.0±0.1</td>
<td>79.49%</td>
</tr>
<tr>
<td>XCy</td>
<td>11.25±0.2</td>
<td>3.71±0.5</td>
<td>0.55±0.05</td>
<td>0.75±0.2</td>
<td>4.6±0.1</td>
<td>79.14%</td>
</tr>
<tr>
<td>XCr</td>
<td>12.50±0.2</td>
<td>5.10±0.6</td>
<td>0.55±0.05</td>
<td>0.70±0.2</td>
<td>4.5±0.1</td>
<td>79.75%</td>
</tr>
</tbody>
</table>

Note * By difference
Values were obtained in triplicate and the mean values recorded except for moisture content which was in duplicate and average value recorded.

Table 2: The β-carotene content in the Xanthosoma cultivars and the potential vitamin A equivalent

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Carotene content (µg/100g)</th>
<th>Vitamin A equivalent (LU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>XCw</td>
<td>8.0</td>
<td>13.33</td>
</tr>
<tr>
<td>XCr</td>
<td>16.0</td>
<td>26.67</td>
</tr>
<tr>
<td>XCy</td>
<td>1920.0</td>
<td>3200</td>
</tr>
</tbody>
</table>

Note: Values were obtained in duplicate and the average values recorded.

1 international unit of vitamin A = 0.344 µg of vitamin A acetate
International unit of vitamin A = 0.6µg of β-carotene