Tropical Root Crops

PRODUCTION AND USES IN AFRICA

Proceedings of the 2nd International Symposium on the National Society for Root Crops —

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The International Society for Tropical Root Crops — Africa Branch was created in 1978 to stimulate research, production, and utilization of root and tuber crops in Africa and the adjacent islands. The activities include encouragement of training and extension, organization of workshops and symposia, exchange of genetic materials, and facilitation of contacts between personnel working with root and tuber crops. The Society’s headquarters are at the International Institute of Tropical Agriculture in Ibadan, Nigeria, but its executive council comprises eminent root and tuber researchers from national programs throughout the continent.

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TROPICAL ROOT CROPS: PRODUCTION AND USES IN AFRICA
ABSTRACT

A mixture of original research, updates on procedures, literature reviews, and survey reports, this document resulted from the second symposium of the International Society for Tropical Root Crops — Africa Branch, with 77 participants from 16 countries. The focus was cassava, yams, cocoyams, and sweet potatoes, from the perspectives of breeders, agronomists, soil specialists, plant pathologists, entomologists, nutritionists, food technologists, etc. Learning from past successes and failures, many of the researchers directed their efforts toward problems obstructing progress in reaching improved production and use of root crops and attempted to view, realistically, the context in which their results would be applied.

RÉSUMÉ

Résultats de recherches récentes, mises à jour sur les méthodes de recherche, revues de publications et rapports de sondages sont contenus dans ce document issu du Deuxième symposium de la Société internationale pour les plantes-racines tropicales — Direction Afrique, qui a réuni 77 participants de 16 pays. Des communications sur le manioc, le taro, le yam et la patate douce ont été présentées par des phytosélecteurs, des agronomes, des pédologues, des phytopathologistes, des entomologistes et des spécialistes de la nutrition et des aliments, entre autres. Tirant leçon de leurs succès et de leurs échecs, beaucoup de ces chercheurs ont dirigé leurs efforts vers la solution des problèmes qui entravent l'augmentation de la production et de la consommation des plantes-racines et ont tenté de considérer d'un œil réaliste le contexte qui sera celui de l'application de leurs recherches.

RESUMEN

Una mezcla de investigaciones originales, actualizaciones de procedimientos, reseñas de literatura e informes de encuestas, este documento es el resultado del segundo simposio de la Sociedad Internacional de Raíces Tropicales, Filial Africana, que contó con 77 participantes de 16 países. El simposio se centró en la yuca, el tóaro, el cocoyam y las batatas, desde la perspectiva de los fitomejoradores, los agrónomos, los especialistas en suelos, los patólogos vegetales, los entomólogos, los nutricionistas, los tecnólogos alimenticios, etc. A partir de los éxitos y fracasos anteriores, muchos de los investigadores encaminaron sus esfuerzos hacia los problemas que obstaculizan el avance para lograr una producción y un uso mejorados de las raíces y trataron de obtener una visión realista del contexto en que los resultados pueden ser aplicados.
TROPICAL ROOT CROPS: PRODUCTION AND USES IN AFRICA

EDITORS: E.R. TERRY, E.V. DOKU, O.B. ARENE, AND N.M. MAHUNGU

PROCEEDINGS OF THE SECOND TRIENNIAL SYMPOSIUM OF THE INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS — AFRICA BRANCH HELD IN DOUALA, CAMEROON, 14 – 19 AUGUST 1983
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MINERAL CONTENT OF YAM TUBERS: RAW, BOILED, AND AS FLOUR

A. BELL

The zinc, copper, iron, manganese, magnesium, calcium, and total phosphorus content of 20 yam varieties belonging to 7 edible species, i.e., *Dioscorea rotundata*, *D. cayenensis*, *D. alata*, *D. esculenta*, *D. liebrechtsiana*, *D. schimperiana*, and *D. dumetorum*, was determined. The tubers were analyzed before and after being boiled and being converted into flour. The mineral composition of the tuber after treatment varied little from that before treatment. The greatest loss recorded was in magnesium and phosphorus as a result of boiling the peeled tuber.

The calcium, phosphorus, and iron content of yams has been discussed by several authors, including Winton and Winton (1935); Intengan et al. (1954); Platt (1962); Ingram et al. (1962); Oke (1965); and Pele and Le Berre (1966). More recently, Baquar and Oke (1977) reported the phosphorus, calcium, magnesium, potassium, sodium, zinc, copper, manganese, and iron levels found in 58 cultivars representing 6 yam species consumed in Nigeria.

Few studies provide the mineral composition of ready-to-eat yams, i.e., either the cooked or converted product. Composition tables of the Food and Agriculture Organization of the United Nations (FAO 1970) give the levels of calcium, phosphorus, iron, and some vitamins in yam flour along with the overall composition but do not supply any further details on the species used. The purpose of this study is to report the mineral composition of 20 edible yam varieties in raw, boiled, or converted form.

MATERIALS AND METHODS

Twenty cultivars from seven edible yam (*Dioscorea* spp.) species were studied. They included *D. rotundata* (3), *D. cayenensis* (3), *D. alata* (5), *D. esculenta* (3), *D. liebrechtsiana* (2), *D. schimperiana* (1), and *D. dumetorum* (3).

All the tubers, with the exception of *D. alata* specimens provided by the Njombe agricultural station in December 1981, were supplied by the Ekona agricultural station in October–December 1980. The tubers were grown without fertilizers and harvested at maturity, i.e., after 9 months. They were then conveyed to Yaounde within a day and kept at ambient temperature for a maximum of 3 weeks (1 week for *D. dumetorum*).

Four identical groups of tubers were made up from the one lot, each tuber being cut lengthwise. The first group was reserved for raw product analyses, the second for analyses on the boiled product, and the third and fourth for flour tests (Table 1). Each type of preparation was repeated at least three times. Except for the dried chips used for preparing the flour, the raw and treated tubers were vacuum-dried in the oven at 45°C. They were then ground to pass through a 1-mm-mesh sieve. Dry

Table 1. Methods of preparation for analyses of mineral content of yam.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Mean time for 1 kg tuber (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pealed and boiled</td>
<td>97</td>
</tr>
<tr>
<td>Unpeeled <em>D. dumetorum</em>, quartered and boiled</td>
<td>97</td>
</tr>
<tr>
<td>Preparation of the flour</td>
<td>Peeled, sliced, and washed in boiling water</td>
</tr>
<tr>
<td>Oven-dried</td>
<td>65</td>
</tr>
</tbody>
</table>

1 Centre for Nutrition, General Delegation for Scientific and Technical Research, Yaounde, Cameroon.

*aOvernight.*
matter and mineral content determinations were carried out in two trial samples. The mineral content was determined from the hydrochloric extract of ashes obtained by incinerating the tubers at 450°C for 48 h. The determinations carried out were:
- Calcium by flame photometry;
- Total phosphorus by the Vanadate colorimetric method (Stuffins 1967);
- Iron by the O-phenanthrolene method; and
- Copper, manganese, magnesium, and zinc by atomic absorption spectrophotometry.

Duncan's multiple range test (1955) was used to analyze the significance of variations in mineral content observed after boiling and conversion into flour in relation to values recorded in the raw product.

**RESULTS AND DISCUSSION**

The mineral content of yams varies (Table 2) according to species. Yams may supply a sub-

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### Table 2. Mineral content of yam tubers: raw, boiled, and as flour.a

<table>
<thead>
<tr>
<th>Species</th>
<th>Zn (ppm)</th>
<th>Cu (ppm)</th>
<th>Fe (ppm)</th>
<th>Mn (mg/100 g)</th>
<th>Mg (mg/100 g)</th>
<th>Ca (mg/100 g)</th>
<th>P (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D. rotundata</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Bonakanda (R971)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Boiledb</td>
<td>18.2</td>
<td>6.2</td>
<td>12.6**</td>
<td>10.4</td>
<td>41.9**</td>
<td>23.0</td>
<td>121**</td>
</tr>
<tr>
<td>Flour</td>
<td>21.6**</td>
<td>5.8**</td>
<td>14.0**</td>
<td>11.0</td>
<td>45.3**</td>
<td>19.9*</td>
<td>122**</td>
</tr>
<tr>
<td>Ogoja (R670)</td>
<td>12.2</td>
<td>4.4</td>
<td>11.4</td>
<td>6.9</td>
<td>49.9</td>
<td>25.4</td>
<td>71</td>
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<td>Oshie (R871)</td>
<td>11.1</td>
<td>4.4</td>
<td>11.6</td>
<td>13.1</td>
<td>51.9</td>
<td>30.1</td>
<td>81</td>
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<tr>
<td>Boiled</td>
<td>11.8**</td>
<td>3.4</td>
<td>15.4**</td>
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<td>38.6**</td>
<td>14.6</td>
<td>79*</td>
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<tr>
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<td>10.5</td>
<td>3.3</td>
<td>18.7</td>
<td>3.6</td>
<td>37.4**</td>
<td>13.4</td>
<td>82</td>
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<td>Beep (C 1870)</td>
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<td>3.9</td>
<td>50.6*</td>
<td>18.4</td>
<td>79*</td>
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<td>8.6*</td>
<td>4.0*</td>
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<td>52.5</td>
<td>19.5</td>
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<td>Bafang (C 269)</td>
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<td><strong>D. alata</strong></td>
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<tr>
<td>Pacala station (A 1372)</td>
<td>11.3</td>
<td>4.8</td>
<td>11.6</td>
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*continued*
but higher manganese
lower with
D. cayenensis
Species Zn Cu Fe Mn Mg Ca P
D. liebrechtsiana
Ebolowa (L 170–L 270) 10.1 3.5 16.0 1.5 47.2 18.1 96
Boiled 12.4** 3.4 13.5** 1.3 38.9** 17.8 82**
Ebolowa (L 170) 12.9 3.6 26.9 1.8 44.3 19.3 81
Ebolowa (L 270) 8.7 3.4 10.5 1.5 48.6 17.5 103
D. schimperiana
Dschang 21.0 6.5 21.3 33.8 86.0 47.7 125
D. dumetorum
Jakiri (D 569) 24.4 6.3 26.4 13.5 75.0 42.9 211
Boiled 26.8** 5.6** 146.2** 21.2** 70.1** 41.1 190**
Flour 24.3 6.3 24.1** 13.5 76.2 39.8 195**
Local 19.7 5.6 32.7 23.7 90.4 78.5 218
Boiled 24.9** 5.4 84.4** 31.0** 85.4** 85.1* 218
Flour 21.9** 5.7 29.3** 23.9 87.2* 77.8 194**
Muyuka (D 2075) 13.4 3.7 27.9 16.5 74.2 35.8 199
Boiled 15.0* 3.4 50.0** 19.7** 67.9** 43.4** 191
Flour 14.9* 3.5 34.7** 18.4* 66.7* 33.5 200

Table 2 continued

Table 3. Average mineral supply per 200 g* of yam (% of adult requirements) (Passmore et al. 1974).

<table>
<thead>
<tr>
<th>Species</th>
<th>Zn</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Mg</th>
<th>Ca</th>
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<td>12</td>
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<td>8</td>
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<tr>
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<td>18</td>
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<td>14</td>
<td>4</td>
<td>20</td>
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<tr>
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<td>13</td>
<td>13</td>
<td>4</td>
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<tr>
<td>D. dumetorum</td>
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<td>11</td>
<td>13</td>
<td>24</td>
<td>12</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>

*Estimate of average daily consumption per person, based on yam-production data for Cameroon (Minagri 1976).
based on only a small number of varieties, taro (or old cocoyam) seems to be even richer than yam in magnesium, zinc, and copper.

In the boiled, peeled product, the greatest loss recorded was for magnesium and phosphorus, which decreased by an average of 10% (Table 2).

Variations in the calcium and copper content were generally low and insignificant. Manganese and zinc levels were higher than in the raw yam, but differences, except in the case of zinc in some varieties, were slight. Differences in iron levels showed greater inconsistency. There was little mineral loss in boiled, unpeeled, and quartered D. dumetorum tubers but some increase in iron, manganese, and zinc levels (Table 2). With this preparation, variations were comparable with those recorded when yams were peeled, then boiled. Losses however, were slighter (Table 2). This is not surprising, as the first step in converting yams into flour consists of washing peeled, sliced tubers in boiling water. There was a considerable increase in iron and manganese levels, but in the case of manganese, the difference between the raw and prepared products was generally not significant. These increases were probably a reflection of contamination from the metal trays used during drying.

**Conclusions**

As a result of yam's manganese, phosphorus, copper, iron, and magnesium content, it could provide a substantial portion of the mineral requirements in western Africa where daily consumption may exceed 1 kg/person. Boiling and conversion into flour only slightly affect the mineral composition of yams. Studies are necessary, however, to determine the biological availability of these minerals before and after conversion in areas where the yam constitutes the staple food.

I wish to thank the agricultural research centres at Ekona and Njombé for supplying the yam tubers analyzed. My thanks also go to Abona and B. Hagbe for their valuable technical assistance.