Nutritional and antinutritional characteristics of Anchote (Coccinia abyssinica)

Habtamu Fufa Aga and Kelbessa Urga Badada

Abstract: The whole and peeled samples of anchote (Coccinia abyssinica) were analyzed for their nutrient and antinutrient contents. The protein, starch, total sugars, reducing sugars, vit-A, and vitB contents were higher in peeled anchote than in whole anchote samples. The phosphorous, potassium, sodium, calcium, magnesium, iron, zinc and copper contents of whole and peeled anchote were determined and peeling of anchote reduced the contents of calcium, potassium, phosphorous, iron and magnesium by 5%, 8%, 16%, 16%, and 19%, respectively. The phytic acid, oxalic acid and tannin contents of whole anchote were higher than those which were peeled by 20%, 22% and 29.6%, respectively. There were no detectable trypsin inhibitor activity in both samples of anchote. Oxalic acid in both anchote samples exists as insoluble oxalate and no water soluble oxalate was detected. As it is observed from the analysis made, anchote contained good nutrient composition with a good supplements of vitamins and minerals. Its antinutritional contents are probably of little nutritional significance and they may be still minimized or destroyed during cooking processes. [Ethiop. J. Health Dev. 1997;11(2):163-168]

Introduction
A knowledge of the chemical composition of foods is essential in most quantitative studies of human nutrition and it is demanded for better and more up to date information about the chemistry of food (1).

A number of edible tubers, roots and corms form an important part of the diet of many people in different parts of the world but their nutrient composition is not fully studied or not studied at all. These food crops are usually easy to cultivate and give high yields per hectare; they contain large quantities of starch and are easily obtainable source of food energy (2). Anchote (Coccinia abyssinica) is the root crop of the Cucurbitaceae family (3), indigenous to Ethiopia. It is widely cultivated for food in the western and south western regions of the country.

The total yield of anchote is 150-180 quintals/hectare, which is in the range of the total yield of sweet potato and potato (4). Anchote is propagated exclusively from seeds and harvested in 4 months. Anchote can be safely stored under the ground, which thus gives added food security to the population in times of main crop failures. Like many other roots, anchote is rarely eaten raw. It undergoes some form of processing and cooking before consumption. The roots are cleaned superficially, or peeled with knife and then cooked in boiling water or grated. Cooked anchote is served usually with kochkocha, a fermented side-dish prepared from ground green pepper with green leafy varieties of spices like coriander (Coriandrum sativum), sweet basil (Ocimum basilium), ginger (Zingiber officinale), garlic and salt. Anchote when sliced, dried in the sun and ground, its flour remains in good conditions for a long time. The flour is used to prepare a soup when boiled with bone-marrow from animals. Such soup is particularly served to patients with broken or fractured bones or sick people. A stew locally called anchote Ittoo is prepared on festive occasions solely from sliced anchote with sufficient butter. Traditionally, it is believed that anchote heals broken or fractured bones, helps sick people to recuperate and makes lactating mothers healthier and stronger.
Characteristics of Anchote

Starchy roots and tubers like potato and sweet potato contain antinutritional factors like tannin, trypsin inhibitors, phytic acid and oxalic acid (5, 6, 7). The presence of antinutritional factors in the foods (raw or cooked products) reduces the bioavailability of nutrients and also the food qualities (8). Usually the consumers peel out the skin of anchote and use the rest. Some studies, however, showed that the crude protein content of sweet potato skin is 50-90% higher than that of the bulk of the root (6).

The purpose of this work was to determine and characterize the nutritional and antinutritional contents of whole and peeled anchote and to compare the nutritional contents of anchote with some other starchy roots (9), whose nutritional composition is already studied.

Methods

Sample preparation: Freshly harvested anchote samples were obtained from a farmer near Nekmte, Wollega, Ethiopia and transported to the institute in polyethylene bags. The tubers were washed to remove all soil. The peeled and the whole tubers were sliced and bulked separately. All the samples were shredded using a blender and were stored at -20°C.

Reagents: All reagents used were of analytical grade.

Chemical analyses: Moisture content was measured by drying to a constant weight the shredded samples at 90°C (10). For chemical analyses the bulk of the shredded anchote was freeze dried using a Labconco freeze drying system (Labconco, USA) and was ground to a fine powder using a cyclotec sample mill (Tecator, Sweden). This ground material was stored in bottles and used in all analyses.

The calorie factors used in calculating the food energy were based upon the physiological energy factors (11). Nitrogen was determined by the macro-kjeldahl method of AOAC (12). Values for protein content were computed from the nitrogen content and multiplied by a conversion factor of 6.25. Fat was determined by Soxhlet method (13). Crude fibre and ash were determined according to AOAC methods (14).

The values for carbohydrate given were as "total carbohydrate by difference", that is the sum of the figures formed from moisture, protein, ash and fat subtracted from 100. Total sugars other than starch were extracted in ethanol by reflux method and were determined by the method of Dubois, et al (15). Reducing sugars were determined colorimetrically by the method of Nelson (16). Starch was determined by Anthrone method (17).

Phosphorous in anchote samples was determined by the method of Fiske and Subborw (18). The iron in anchote samples was determined according to the AOAC method (19). Potassium and sodium contents of anchote were determined by flame photometer (20). Calcium, magnesium, zinc and copper were determined by atomic absorption spectrophotometer (21).

Ascorbic acid was determined colorimetrically (22). Vit-A was determined by a chemical procedure, according to Gyorgy (23). The conversion factors used for the calculation of retinol and β-carotene from International Unit were as follows: one International Unit is equivalent to 0.3 µg of retinol or, 0.6 µg β-carotene (24). Riboflavin was determined by a fluorometric method (25). The trypsin inhibitor activity was evaluated by AOCS method (26). N-benzoyl-DL-arginine-p-nitroaniline (BAPNA) was used as the trypsin substrate. Phytic acid was determined by sensitive methods for the rapid determination of phytate (27) from standard curve. The condensed tannin were assayed colorimetrically by the method of vanillin hydrochloride described by Price et al. (28) using catechin as a standard. The tannin content was expressed as catechin equivalents. The total oxalic acid and soluble oxalic acid were determined according to AOAC method (29).

Data analysis: Tests were replicated three times. Data were subjected to analysis of variance (ANOVA). Differences were considered statistically significant at p<0.05.
Results
All data obtained from analyses of the dry samples are presented on a fresh weight basis. The protein, carbohydrate, total sugars, and reducing sugars contents of peeled samples were significantly higher than the whole samples. The moisture and fat of whole samples were significantly (p<0.01) higher than the peeled samples. Starch is the main component of the total carbohydrate followed by total and reducing sugars.

Table 1: Proximate composition and carbohydrate contents of anchote in 100 gram edible portion\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>peeled anchote</th>
<th>Whole anchote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture, %</td>
<td>68.8±0.44</td>
<td>73±0.52</td>
</tr>
<tr>
<td>Energy, Kcal</td>
<td>117.5±0.54</td>
<td>103.5±0.45</td>
</tr>
<tr>
<td>Protein, g</td>
<td>3.9±0.2</td>
<td>3.00±0.14</td>
</tr>
<tr>
<td>Ash, g</td>
<td>1.7±0.10</td>
<td>2.0±0.15</td>
</tr>
<tr>
<td>Fat, g</td>
<td>0.12±0.01</td>
<td>0.17±0.02</td>
</tr>
<tr>
<td>Crude fibre, g</td>
<td>1.5±0.12</td>
<td>1.6±0.13</td>
</tr>
<tr>
<td>Carbohydrate, g</td>
<td>25.5±0.48</td>
<td>22.5±0.45</td>
</tr>
<tr>
<td>Starch, g</td>
<td>20.4±0.44</td>
<td>17.5±0.98</td>
</tr>
<tr>
<td>Total sugars, g</td>
<td>4±0.14</td>
<td>3.12±0.17</td>
</tr>
<tr>
<td>Reducing sugars, g</td>
<td>2.38±0.1</td>
<td>1.8±0.08</td>
</tr>
</tbody>
</table>

\(^a\) The reported values are means ± SD of six samples of each of peeled and whole anchote.

The results for the mineral and vitamin content of anchote samples are given in Table 2. There is a significant difference between the peeled and whole sample contents (P<0.001) except for sodium, zinc and copper. The calcium, phosphorous, iron and potassium contents of whole anchote were higher than the peeled samples. Peeling of anchote results in 5% loss of calcium, 8% loss of potassium, 16% loss of phosphorous 16% loos of iron and 19% loss of magnesium. The concentrates of vitamin A and riboflavin are higher in the peeled root than in the whole root while the vit-C contents is higher in whole anchote than in the peeled one.

The calcium to phosphorous ratio is 2.8 to 1 and 3 to 1 in whole and peeled samples, respectively and the potassium to sodium ratio is 41 to 1 and 37.5 to 1 in whole and peeled anchote samples, respectively.

The content of antinutritional factors of anchote samples are given in Table 3. Peeling of whole anchote results in significant decreases of phytic acid, tannin and oxalic acid contents. The process of peeling removes 20%, 22% and 29.6% phytic acid, oxalic acid and tannin, respectively. Oxalic acid in anchote exists as insoluble oxalate and no water soluble oxalate content was detected. The trypsin inhibitor activity was not detected in both anchote samples.

Table 2: Mineral and vitamin contents of anchote in 100 gram edible portion\(^b\)

<table>
<thead>
<tr>
<th></th>
<th>peeled anchote</th>
<th>whole anchote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorous, mg</td>
<td>103.5±3.98</td>
<td>123±4.5</td>
</tr>
<tr>
<td>Potassium, mg</td>
<td>610.4±3.8</td>
<td>663.46±7.2</td>
</tr>
<tr>
<td>Sodium, mg</td>
<td>16.3±0.2</td>
<td>16±1.2</td>
</tr>
<tr>
<td>*Calcium, mg</td>
<td>327±10</td>
<td>344±13</td>
</tr>
<tr>
<td>Magnesium, mg</td>
<td>124±6</td>
<td>80±4</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>4.6±0.2</td>
<td>5.5±0.4</td>
</tr>
<tr>
<td>Zinc, mg</td>
<td>1.8±0.2</td>
<td>1.8±0.2</td>
</tr>
<tr>
<td>Copper, mg</td>
<td>0.5±0.02</td>
<td>0.4±0.02</td>
</tr>
<tr>
<td>Vit-A, µg</td>
<td>53.3±1.47</td>
<td>45±1.6</td>
</tr>
<tr>
<td>Vit-B₂, mg</td>
<td>0.08±0.003</td>
<td>0.06±0.002</td>
</tr>
<tr>
<td>Vit-C, mg</td>
<td>8±0.4</td>
<td>9.56±0.37</td>
</tr>
</tbody>
</table>
Characteristics of Anchote

Discussion

Anchote contained 3.9 g protein in 100 g of peeled samples and whole samples contained 3.0 g/100 g. The protein content of whole anchote is 2 times higher than the values reported for potato and sweet potato (9). The crude protein content of peeled samples of anchote was higher than that of the whole samples. This may indicate that there is a high protein content in the bulk of the root than in the skin part of it. This result is in contrary with the results of crude protein content of sweet potato (6) in which its skin contained more protein than the bulk of the root.

Anchote exhibits a low lipid content. These may be mainly structural lipids of the cell membrane which enhance cellular integrity, offer resistance to bruising and help to reduce enzyme browning. Since anchote is low in lipid, it may not be rich source of fat soluble vitamins. However, the vitamin A and riboflavin content of anchote are much higher than those in white fleshed sweet potato, potato and cassava (9). Due to its good vitamin-A content, consumption of anchote may help to reduce the problem of vitamin-A deficiency in these regions. Vit-C content of whole anchote is 10 mg in 100 g serving and thus anchote may help to make dietary iron soluble and more bioavailable.

Table 3: Antinutritional contents of anchote in 100 gram edible portion.

<table>
<thead>
<tr>
<th>Antinutritional components</th>
<th>peeled anchote</th>
<th>whole anchote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytic acid, µg</td>
<td>199.8±10.3</td>
<td>249.6±10.1</td>
</tr>
<tr>
<td>Tannin, µg</td>
<td>445.4±10.4</td>
<td>632.5±15.7</td>
</tr>
<tr>
<td>Oxalic acid, mg</td>
<td>7.1±1.3</td>
<td>9±1.2</td>
</tr>
<tr>
<td>Trypsin inhibitor, TIU</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

The ratio of potassium to sodium makes anchote particularly valuable in the diets of people who have to restrict their sodium intake. The calcium to phosphorous ratio is 3.0 in peeled anchote, which is similar to some infant foods in some countries, where less phosphorous is recommended than calcium (30).

Whole anchote contained 344 mg calcium and 5.50 mg iron in a 100 g serving, respectively. The calcium and iron content of whole anchote are 26 and 5 fold higher than potato, 10 and 2.8 fold higher than sweet potato and 7 and 4.6 fold higher than taro (9). The phosphorous and potassium are also higher than those of potato, sweet potato and taro (9). The recommended magnesium daily intake in most countries is 128 mg for children 1-2 years, 280 mg for women and 350 mg for men (31) and anchote (peeled) contains 124 mg in 100 g edible portion. The recommended daily intake for zinc content in most countries is 3.9 mg for infants and 7.4 mg for children (31) and anchote (peeled) contained 1.8 mg in 100 g edible portion. Thus, a serving of 100 gm per day can fulfil most of the daily requirements of these nutrients.

The carbohydrate content of anchote contributed the major part to its energy since it contained large quantities of starch, which is 22-25%. The peeled anchote contained more carbohydrate than the whole anchote.

Table 4: Some nutrient composition of anchote and other roots and tubers (9) in 100 gram edible portion.

<table>
<thead>
<tr>
<th>Sample</th>
<th>protein</th>
<th>CHO</th>
<th>Ca</th>
<th>Fe</th>
<th>P</th>
<th>Vit-A</th>
<th>Vit-C</th>
<th>Vit-B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>gm</td>
<td>gm</td>
<td>mg</td>
<td>mg</td>
<td>mg</td>
<td>mg</td>
<td>µg</td>
<td>mg</td>
<td>mg</td>
</tr>
</tbody>
</table>
There is no detectable trypsin inhibitor activity in both peeled and whole samples of anchote, whereas, several species of heat-stable proteinase inhibitors have been purified from extracts of potatoes and cumulatively they can compromise over 15% soluble proteins of mature tubers (7) and this may indicate the good quality of protein from anchote than from potatoes. Trypsin inhibitors, when ingested by man in significant amounts, disrupt the digestive process and may lead to undesirable physiological reactions (32).

The phytic acid content of anchote is low (Table 3) relative to cereals, in which phytic acid is a major portion of phosphorus and occupies 60-80% of the total phosphorus of the grain (7) and thus, those minerals liable to interaction by dietary phytic acid are more available in anchote than those in cereals. This is especially important for iron, which has been found to be 100% available in banana which contained no phytic acid (33). Recently, it has been reported that cassava, cocoyam and yam contain 624, 815, and 637 mg of phytates per 100g, respectively (34) and these are significantly higher than those in anchote. The nutritional significance of phytate in the diet of man has assumed great importance in recent years because of its implication in the mineral deficiency so prevalent in those parts of the world, that are reliant on cereal protein (33). The tannin content obtained in peeled and whole anchote samples are 0.445 mg and 0.632 mg, respectively. The toxicity effects of the tannin may not be significant in anchote since the total acceptable tannic acid daily intake for a man is 560 mg (35). Tannins also form insoluble complexes with proteins and the tannin-protein complexes may be responsible for the antinutritional effects of tannin containing foods (36). However, since the tannin content of anchote is very low compared to its protein content, its antinutritional effect may be insignificant.

Anchote contains 8.3, 10.8 and 161 times less oxalic acid compared to sweet potato, potato and carrot (37), respectively. Oxalic acid inhibits the absorption of calcium by forming insoluble calcium oxalate (24). But there may be also the possibility of bacterial degradation which may occur in intestine, making the calcium available from calcium oxalate (38). The water-soluble oxalate was not detected in both the peeled and whole anchote samples. The water-soluble oxalates are comparatively more toxic as they form insoluble salts with calcium and magnesium rendering these metals unavailable from other sources of food in the digestive tract (39).

Since the amount of calcium and iron in whole grains and cereals are not easily available owing to the presence of high phytates and other components of dietary fibre (24), the contribution of anchote to iron and calcium needs may be essential to the areas where the staple food is based on whole grains and cereals. Anchote may also play a vital role in supplying the calcium requirements of infants and children of this country where milk and milk products are not easy to come by.

As shown in this study anchote has got a good nutrient composition with a good supplement of vitamins and minerals and its antinutritional contents are probably of little nutritional significance and they may be still minimized or destroyed during cooking process. The study of its amino acid balance is warranted, which may enhance its supplementary quality with other food items. If appropriately supplemented with cereals or legumes, anchote processed into flour may be used as a supplementary food for infants, young children and lactating mothers.

Acknowledgement
This study was funded by the former Ethiopian Nutrition Institute.
References