CHAPTER 2

Comparative assessment of the nutritional value of commercially available cocoyam and potato tubers in South Africa
# CHAPTER 2

**COMPARATIVE ASSESSMENT OF THE NUTRITIONAL VALUE OF COMMERCIALLY AVAILABLE COCOYAM AND POTATO TUBERS IN SOUTH AFRICA**

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COMPARATIVE ASSESSMENT OF THE NUTRITIONAL VALUE OF COMMERCIALY AVAILABLE COCOYAM AND POTATO TUBERS IN SOUTH AFRICA

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ABSTRACT

Potato (Solanum tuberosum) is a popular staple food in South Africa while cocoyam (Colocasia esculenta) remains unpopular and not well known outside KwaZulu-Natal Province where it is cultivated mainly for subsistence. A comparative study of the nutritional compositions of commercially available tubers of both crops in South Africa was carried out. The results showed that the tubers of the two crops were high in carbohydrate and energy but low in lipid content. Although potato was significantly higher in moisture and ash than the tubers of cocoyam, carbohydrate, caloric and crude protein contents were not significantly different (P<0.05) in both tubers. While boiling improved the availability of crude protein, fibre and lipid contents for both species, it reduced the ash contents in the tubers of both crops. Manganese levels were not detectable, while iron contents were appreciably high, but magnesium and copper contents were in the average range in both tubers. While cooking reduced iron level in potato (11.20 to 9.95 mg/100g DM), a significant increase in iron was observed for cocoyam (9.08 to 13.87 mg/100g DM). Cooking significantly lowered magnesium, potassium and copper contents in both crops. Oxalates and phytate contents were significantly higher in cocoyam when compared with potato. Cooking remarkably reduced the antinutrient contents of both tubers.

PRACTICAL APPLICATIONS

This study provides evidence that commercially available cocoyam (Colocasia esculenta) and potato (Solanum tuberosum) in South Africa have very close nutritional values. Cocoyam compared favourably with potato and even excelled in some nutrients. Thus, cocoyam consumption could be encouraged and popularized as an additional tuber crop.
Keywords: Antinutrients, crude fibre, crude protein, Colocasia esculenta, Solanum tuberosum, cocoyam, potato, proximate and mineral compositions, oxalate, tannins.

INTRODUCTION

Potato (Solanum tuberosum L.) is a starchy tuberous crop which is mostly grown in temperate climates (Hawkes, 1978). Although it is a temperate crop, it is grown in various climates from the tropics to the sub-polar regions and comprises a major food crop in many countries (Wright and Stark, 1990). Potato is the world’s most widely grown tuber crop, fifth largest and most widely distributed food plant (Beukema and Van der Zaag, 1990; Alleman et al., 2004). It is also an important food crop in South Africa. Only one botanical species of potato (Solanum tuberosum) exists, but with thousands of varieties worldwide (Burton, 1989; Chase 1989).

On the other hand, cocoyam [Colocasia esculenta (L) Schott] which is widely cultivated in the tropical and subtropical areas, is a relatively neglected crop in South Africa, even though the relative price per kilogram of the tubers of these two crops are about the same.

Cocoyam is an ancient crop grown for its edible corms, cormels, leaves and other traditional uses by subsistence farmers (Miyasaka et al., 2003; Ekanem and Osuji, 2006). There are two edible species of cocoyam, C. esculenta also known as Taro and Xanthosoma sagittifolium (L) Schott which is commonly referred to as Tannia. Both are generally cultivated for their enlarged underground starch-rich corms and cormels (tubers). The dietary importance of these crops has led several workers to evaluate the chemical composition of their tubers (Wills et al., 1983; Bradbury and Holloway, 1988). Although cocoyams are neglected tuber crops in many parts of the world, their nutritional value is high. They contain digestible starch, good quality protein, vitamin C, thiamin, riboflavin, niacin and high scores of proteins and essential amino acids (Onayemi and Nwigwe, 1987).
Around 300,000 metric tonnes of potatoes are produced annually (FAO, 1985) in about 95 countries, with a total value of around $US 13 billion (Horton and Fano, 1985). Unlike potato, cocoyam has not fully entered the international trade market. Nigeria is the world’s leading producer of cocoyam accounting for about 40% of total production (Eze and Okorji, 2003). However, Onwueme, (1991) noted that the global average yield is only about 6,000 kg/ha.

Some peculiar similarities found in cocoyam and potato includes the presence of antinutritional factors (Morris and Lee, 1984; Noonan and Savage, 1999; Friedman, 2006) which are potentially toxic compounds when the tubers are consumed. However, the food quality could be enhanced by cooking prior to consumption which reduces the level of toxicity. Both the leaves and tubers of cocoyam are edible while the leaves of potato are toxic because of the high levels of glycoalkaloids present in the stem, leaves and sprouts (Olsson 1996). Another limitation to the use of these two crops is the problem of enzymatic browning when the tubers are peeled or sliced (Duangmal and Apenten, 1999).

Potato and cocoyam both have low shelf life in storage at ambient temperature except when stored under low temperature. Cold storage aims at preserving the physical appearance of the tubers by controlling sprouting, rotting and loss in weight. Storage at higher temperatures may be satisfactory, except that this induces sprouting (Burton, 1989). Unlike potato, post harvest technology for cocoyam is very limited, thereby contributing minimally to food security.

Both tubers are grown mainly for food, therefore, can be eaten boiled, fried, baked or prepared as flour, chips, porridge or pottage. Cocoyam can also be pounded into paste and consumed with soup. Cooked tubers can be eaten alone or with stew, and can also be used as soup thickeners. They could as well find uses as animal feed and as industrial raw materials. In addition to being good sources of
nutrients, potato and cocoyam have some medicinal properties (Saldanha, 1995; Lachman et al. 2000).

Agronomically, potato exhibits a growing period of about four months, shorter than many other root crops. Ideal soil for potato production is deep, well-drained and friable soil (Thornton and Sieczka, 1980). The crop cannot tolerate frost, is sensitive to soil water deficit and optimum soil pH required for good growth is 3.7 (Vayda, 1994). Potato can multiply either sexually or asexually (vegetatively), however, vegetative propagation is most common. Cocoyam thrives better on a well drained sandy loamy soil. It produces optimum yields when planted in fertile soil with a good water retention capacity. In the wet tropics, and in the absence of irrigation, planting is generally done at or shortly before the beginning of the rainy season. As flowering and seed production rarely occurs, cocoyam is propagated by setts. Most cocoyam varieties mature in about 8-12 months after planting (Igbokwe, 1983).

Despite the fact that South Africa is regarded to be self-sufficient in food and even able to export some food items, hunger and malnutrition are still common in many rural and urban areas (Van den Heever, 1995). Unlike Asia, the Pacific and other African countries, where cocoyam is a commercialized staple (Miyasaka et al., 2003); the crop is not commercially popular in South Africa. Though several landraces of the crop have been cultivated in some remote parts of KwaZulu-Natal Province for centuries where they are collectively called Amadumbe, cocoyams are not well known like maize (Zea mays) and potato which are the main staples in the country. Rather, the crop is cultivated in association with other subsistence food crops like sweet potatoes, landrace potatoes and green beans mainly for subsistence. The species is considered as food for the poor and the commercial farmers have not shown much interest in the crop. Consequently, there is very little information on scientific research carried out on cocoyam in South Africa compared with conventional root and tuber crops like sweet and landrace potatoes. There is, therefore, the need for a
systematic investigation on the nutritional values of cocoyam in South Africa by comparing this species with potato based on their nutritional values and anti-nutritional factors.

The objective of the present study was to highlight the relative food value and antinutrient constituents in cocoyam compared with commercially available potatoes in South Africa. This study will further elucidate the effect of cooking on the nutritive value and the antinutritional factors contained in the tubers of *C. esculenta* and *S. tuberosum* found in the markets of South Africa.

**MATERIALS AND METHODS**

**Collection and Preparation of Tuber Samples**

The tubers of *Colocasia esculenta* variety *esculenta* (white-fleshed) and those of *Solanum tuberosum* - potato (the long-oval with shallow eyes, white skin and flesh) used in this study were purchased from a fruits and vegetables store in King William’s Town in the Eastern Cape, South Africa. The tubers were hand peeled with a kitchen knife, washed in distilled water, sliced with a knife into thin pieces of about 2 mm thick and air-dried on trays for 20 min. Eight hundred grams (wet weight of peeled tubers) of each tuber was used. Each sample was then separated into two equal portions (400 g each). A portion each of cocoyam and potato was separately cooked by boiling in about 3.5 L of distilled water for 20 min. and later air-dried as before. Both the cooked and uncooked portions of the crops were further dried in an oven at 60°C to constant weights. The dried samples were separately milled using a Fritsch pulverisette 14® Rotor-Speed mill (Fritsch GMBH, Laborgeraetebau, Germany), kept in well labelled air-tight containers and later stored in the refrigerator for analysis. All reagents used for these analyses were of analytical grade.
Chemical Analyses

The moisture, ash, crude lipid and crude fiber contents of both cocoyam and potato samples were determined according to the standard method of the Association of Official Analytical Chemists (AOAC, 1984).

Crude protein (N x 6.25) was determined by micro-kjeldahl method (Okalebo et al., 2002). Carbohydrate content was obtained by subtracting the total ash content, crude lipid, crude protein and crude fibre from the total dry matter (Oyeleke, 1984). The caloric value of each sample was calculated using Atwater factor method \([(4 \times \text{crude protein}) + (9 \times \text{crude lipid}) + (4 \times \text{carbohydrate})]\) as described by Ihekoronye and Ngoddy (1985). A mixture of concentrated H₂SO₄, a catalyst (selenium), salicylic acid and hydrogen peroxide were used for sample digestion and subsequently, total nitrogen, phosphorus, calcium, magnesium, sodium, potassium, zinc, copper, iron and manganese in the digests were determined.

The mineral element composition was determined using the Unicam Solaar Atomic Absorption Spectrophotometer (AAS) – (Model 969 Mk II; Unicam Ltd., Cambridge, UK). Potassium, sodium, magnesium and calcium contents were determined by reading their absorbance at 766.5, 589.0, 285.2 and 422.7 nm wavelengths respectively while the copper, manganese, zinc and iron contents were measured at 324.8, 279.5, 213.9 and 248.3 nm wavelengths respectively. Total phosphorus was obtained using the ascorbic acid blue colour procedure of Okalebo et al., (2002) by reading the absorbance at a wavelength of 880 nm on a Helios Gamma spectrophotometer (Thermo Spectronic; Helios Gamma, UK). The calcium oxalate content was determined using the method of Ukpabi and Ejidoh (1989). Tannins were determined by the method of Markkar et al. (1993), while phytate was determined using Wheeler and Ferrel (1971) method. The phytate content was calculated from the
iron determinations, using a 4:1 iron-to-phytate molecular ratio.

**Statistical Analysis**

All determinations were replicated thrice. A completely randomized two-way (2 x 2) factorial experiment was used. The data obtained were subjected to analysis of variance (ANOVA) using SAS (SAS Institute Inc., 1999) package. The main factors tested were tuber species (at two levels; potato and cocoyam) and cooking (also at two levels; cooked and uncooked). The means were separated using the DUNCAN Multiple Range Test, SAS (1999).

**RESULTS AND DISCUSSION**

**Proximate Composition**

The carbohydrate, caloric and crude protein contents were not significantly different in both tubers (Table 1). However, moisture and ash contents of potato were higher than that of cocoyam. The results further showed that the tubers of the two crops were high in carbohydrate and energy but low in lipid content. On the other hand, while cooking improved the availability of moisture, crude protein, fibre and lipid contents, the ash content was significantly reduced in the tubers of the two crops.

The high moisture contents obtained for cocoyam and potato in this study explains why post-harvest loss due to spoilage is always high for these tubers, since high moisture content enhances microbial attack. In comparison, potato contained more moisture than cocoyam. The observed increase in moisture in the cooked samples could be linked to the boiling effect that probably softened the tissue, thereby increasing water absorption and water-retention capacity of the tubers due to
increased permeability of the cell membrane to water (Mbajunwa, 1995). These results agree with the 63-85% reported for taro and tannia by Bradbury and Holloway (1988) and 76.94% for potato (Yildirim and Tokuşoğlu, 2005).

Ash contents of both tubers appear to be close with mean values of 3.65-4.09% and 3.93-4.58% for cocoyam and potato respectively, although potato had significantly higher values whether cooked or uncooked. However, the ash levels in the two tubers were reduced in the course of the cooking which could be attributed to the solubilization and leaching of nutrients into the processing water (Mbajunwa, 1995; Adeyemi et al., 2000). This implies that the mineral contents preserved in the species have been reduced. The findings of this study are comparable to a mean range of 4.60-7.78% ash contents reported for three cocoyam cultivars in Nigeria (Njoku and Ohia, 2007).

Cooking resulted in more availability of protein in this work. This might be due to breakage of the tannin-protein complex as a result of cooking. Tannins have been reported to form complexes with protein thereby limiting protein availability (Eka, 1985). The crude protein contents of cocoyam and potato seem close, though higher for potato, but not significantly different from cocoyam values. However, crude protein content may range widely depending on the genotype and growing conditions (Debre and Brindza 1996). These results compare well with the crude protein content reported for yams by early workers (Agbor-Egbe and Treche, 1983; Afoakwa and Sefa- Dedeh, 2001). Root and stem tuber crops including potato and cocoyam are generally low in protein, hence, food products from these crops should be supplemented with other high protein products for balanced nutrition (Bradbury, 1988).

Cocoyam had higher fibre content than potato which confirms that it is a good source of fibre compared with other root and tuber crops especially potato (Bradbury and Holloway, 1988). The high fibre content of cocoyam highlights its superiority with regard to protection against some health
problems. The observed increase in the crude fibre content may be due to the gelatinisation and retro degradation of the starch that occurred during cooking process which could change part of the starch into non-degradable polysaccharides (resistant starch) (Unlu and Faller, 1998).

Interestingly however, cooking increased the lipid contents of the tubers (Table 1). The higher fat contents in the cooked samples could possibly be due to increased extractability of the more polar lipid or lipids that are bound to other macroconstituents in the tissue. This does not pose a problem since the results presented these tubers as being low in crude lipid, even when cooked. This was further supported by the findings of Mondy and Mueller (1977), that all root crops exhibit very low lipid content. Onyeneho and Hettiarachchy (1993) obtained values ranging from 0.17 to 0.21% in six potato varieties.

Cocoyam and potato samples were high in carbohydrate; this agrees with the fact that tuber and root crops are generally rich in carbohydrates (Eka, 1998), hence, their high caloric values. The caloric values obtained for these two crops were slightly higher than that of cassava, irish potato, sweet potato, yam, and taro (INCAP-ICNND, 1961; Brabury and Holloway, 1988; Souci et al., 1994).

**Mineral Composition**

The mineral compositions of these tubers are presented in Table 2. The results indicated that potassium is the most abundant mineral in these tubers with mean values ranging from 716.91 to 901.28 mg/100g and from 757.68 to 895.04 mg/100g for cocoyam and potato respectively. High dietary potassium in humans plays a protective role against hypertension, stroke, cardiac dysfunctions, renal damage, hypercalciuria, kidney stones, and osteoporosis (Demigne et al., 2004).

In this study, when compared with the Recommended Dietary Allowance (RDA) (Ostrowska et al.,
the mean value range for zinc (1.08-2.52 mg/100g) was low, copper (0.23-1.24 mg/100g) was average, iron (9.95-13.87 mg/100g) was high, potassium (716.91-757.68 mg/100g) was low, sodium (42.46-80.85 mg/100g) was low, Magnesium (89.68-128.35 mg/100g) was average, calcium (22.77-30.73 mg/100) was low, and phosphorus (42.60-45.89 mg/100g) was low for cooked cocoyam and potato tubers.

Although cocoyam was significantly higher in calcium and sodium while potato was higher in magnesium, the two tubers may be considered as moderate sources of magnesium and copper, while their calcium and sodium levels are low. The manganese contents of the two tubers were below detectable levels. Mean values for zinc was also relatively low in both crops but the iron contents were appreciably high. With respect to cocoyam, cooking brought about a significant increase in the availability of iron. On the other hand, though the level of zinc in cocoyam increased after boiling, the zinc content in the cooked tubers was not significantly different from the uncooked. This indicates that zinc, which is an essential trace mineral required for the metabolic activity of body enzymes was preserved even after cooking.

The results further revealed that cocoyam and potato tubers contain significant amount of mineral nutrients like potassium, magnesium, sodium and calcium, whose salts regulate the acid-base balance of the body (Njoku and Ohia, 2007). Consumption of such micronutrient-rich foods helps in building a strong immune system, thereby helping the body to absorb, utilize and digest nutrients.

Generally, cooking significantly reduced magnesium, potassium and copper contents in both crops. While cooking reduced iron level in potato, the same was not true for cocoyam. Boiled cocoyam could therefore serve as better source of iron than potato. This means that consumption of cooked cocoyam may increase the blood level and may therefore be recommended as a good food for anemic patients.
Antinutrient Contents

The results of antinutrients analysis indicated that oxalate and phytate contents were significantly higher in cocoyam than potato whether cooked or uncooked, while there was no significant difference in the tannin contents of the two tubers (Table 3). Oxalates and phytate contents were significantly higher (673.98 and 87.48 mg/100g DM) in raw cocoyam when compared with potato (261.60 and 37.56 mg/100g DM). Cooking significantly reduced the levels of the antinutrients in both tubers.

The mean values for calcium oxalate was reduced by about 50% in both cocoyam and potato after boiling in water for 20 min. This is an indication that oxalate has a hydrothermal ability which may be due to the dual effect of leaching and thermal degradation. This is beneficial because oxalic acid and its salts can have deleterious effects on human nutrition and health, particularly by decreasing calcium absorption and aiding the formation of kidney stones (Noonan and Savage, 1999). Osisiogu et al. (1974) observed that boiling cocoyams for 15 min brought about considerable reduction in the irritant effect. In another study, boiling for 60 min completely removed the irritant effect (Iwuoha and Kalu, 1995), indicating that irritation and itching caused by the acridity factor may not be observed when cocoyam is thoroughly cooked (Agwunobi et al., 2000). The oxalate content of the uncooked cocoyam is comparable to the reported values for sweet potato and taro (Bradbury, 1988; Holloway et al., 1989 and Iwuoha and Kalu, 1995). It is also documented that oxalate content varies with species and cultivars (Osisiogu et al., 1974).

Tannin contents were higher in uncooked cocoyam but these were drastically reduced by 55% in cocoyam while 45% reduction was observed in potato after boiling. Tannins affect nutritive value of food products by forming a complex with protein, thereby inhibiting digestion and absorption. The reduction in the tannin contents of the two tubers indicates that boiling could decrease the tannic acid
in root and tuber crops.

Phytate is widespread in roots and tubers (McCance and Widdowson, 1935). This is a well known antinutrient of plant food. It decreases the bioavailability of nutritionally significant mineral elements. Like oxalates, phytate can bind essential minerals to form insoluble or indigestible complexes, thereby preventing their absorption (Davis and Olpin, 1979). The values obtained for phytate in this study were lower than 624 mg, 855 mg and 637 mg per 100g of phytate reported for cassava, cocoyam and yam respectively (Marfo and Oke, 1988). In many cases, phytic acid content may vary depending on the crop variety, climatic conditions, location, irrigation conditions, type of soil, and the growing season of the plant (Deshpande et al., 1982).

In conclusion, it is evident from these results that cooking improved the nutritive value as a result of the reduction in antinutrient levels, thereby improving the food quality in both species. At the same time, cooked tubers also suffered loss of some nutrients with respect to the proximate and mineral compositions. However, supplementation from other food sources that are rich in these nutrients is necessary when cocoyams and potatoes are being cooked for consumption.

The study provides evidence that these two crops have a very close nutritional potential. Cocoyam compared favourably with potato and even excelled in some nutrients. Thus, cocoyam consumption should be encouraged and popularized as an additional tuber crop to potato in South Africa. The results of this study will help to document the nutritional composition of cocoyam available in the nation, where, to the best of our knowledge, no such data are available.

ACKNOWLEDGMENTS

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REFERENCES


BEUKEMA, H.P. and VAN DER ZAAG, D.E. 1990. Introduction to potato production. PUDOC,


CHASE, R.W. 1989. North American Potato Variety Inventory. Certification Section Potato Association of America, Orono, Me., USA


taro (*Colocasia esculenta*) and potato (*Solanum tuberosum* var. Romano). Food Chem. 64, 351-359.


IGBOKWE, M.C. 1983. Growth and development of *Colocasia* and *Xanthosoma* spp. Under upland


SAS. 1999. SAS (Statistical Analysis System) user’s guide: statistic. SAS Institute, NC.


Am. Potato J. Suppl. 57, 1-36.


Table 1. Proximate composition of cocoyam (*Colocasia esculenta*) and potato (*Solanum tuberosum*) tubers. Data are in $X \pm S.D.$

<table>
<thead>
<tr>
<th></th>
<th>Composition (% dry matter)</th>
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<tr>
<td></td>
<td>Moisture</td>
<td>Ash</td>
<td>Crude Protein</td>
<td>Crude Fibre</td>
<td>Crude Lipid</td>
<td>Carbohydrate</td>
<td>Caloric value</td>
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<tr>
<td>Cocoyam</td>
<td></td>
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<tr>
<td>Uncooked</td>
<td>66.62±1.01(^b)</td>
<td>4.09±0.07(^a)</td>
<td>6.40±1.10(^b)</td>
<td>1.83±0.04(^b)</td>
<td>0.78±0.07(^a)</td>
<td>86.58±1.69(^a)</td>
<td>378.93±10.39(^a)</td>
</tr>
<tr>
<td>Cooked</td>
<td>68.10±0.87(^a)</td>
<td>3.65±0.02(^b)</td>
<td>8.96±0.38(^a)</td>
<td>2.49±0.04(^a)</td>
<td>1.04±0.07(^a)</td>
<td>83.66±0.31(^a)</td>
<td>380.67±0.33(^a)</td>
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<tr>
<td>Potato</td>
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<tr>
<td>Uncooked</td>
<td>81.53±1.39(^a)</td>
<td>4.58±0.02(^a)</td>
<td>10.34±0.57(^a)</td>
<td>1.64±0.13(^a)</td>
<td>0.24±0.03(^b)</td>
<td>83.21±0.46(^a)</td>
<td>376.30±0.43(^b)</td>
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<td>Cooked</td>
<td>80.72±0.56(^a)</td>
<td>3.93±0.05(^b)</td>
<td>10.41±0.8(^a)</td>
<td>1.66±0.16(^a)</td>
<td>1.40±0.04(^a)</td>
<td>82.60±0.69(^a)</td>
<td>384.66±0.98(^a)</td>
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<td>Tuber x Cooking</td>
<td></td>
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<td>method</td>
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<tr>
<td>LSD Uncooked:</td>
<td>1.0104</td>
<td>0.1745</td>
<td>4.1405</td>
<td>0.4084</td>
<td>0.2254</td>
<td>3.4144</td>
<td>26.782</td>
</tr>
<tr>
<td>LSD Cooked:</td>
<td>0.7701</td>
<td>0.0625</td>
<td>2.5222</td>
<td>0.4262</td>
<td>0.0861</td>
<td>2.0325</td>
<td>1.6193</td>
</tr>
</tbody>
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*Significantly different ($P<0.05$) from the other tuber having the same treatment within the same column. Values with different letters within the same column shows significant difference among treatments of the same tuber. LSD = Least Significant Difference.
* = $P<0.05$; ** = $P<0.01$; *** = $P<0.001$; NS = not significant.
Table 2. Elemental composition of cocoyam (*Colocasia esculenta* (L.) Schott) and potato (*Solanum tuberosum* L.) tubers. Data are in $\bar{X} \pm S.D.$

<table>
<thead>
<tr>
<th>Composition (mg/100g dry matter)</th>
<th>Phosphorus</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Sodium</th>
<th>Potassium</th>
<th>Iron</th>
<th>Copper</th>
<th>Manganese</th>
<th>Zinc</th>
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<tr>
<td>Cocoyam</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncooked</td>
<td>38.45±1.16$^b$</td>
<td>34.62±0.37$^a$</td>
<td>114.89±2.41$^a$</td>
<td>63.42±0.74$^b$</td>
<td>901.28±6.36$^a$</td>
<td>9.08±0.54$^b$</td>
<td>2.53±0.28$^a$</td>
<td>nd</td>
<td>2.39±0.15$^a$</td>
</tr>
<tr>
<td>Cooked</td>
<td>42.60±1.15$^a$</td>
<td>30.73±2.40$^a$</td>
<td>89.68±1.03$^b$</td>
<td>80.85±1.61$^a$</td>
<td>716.91±7.13$^b$</td>
<td>13.87±0.48$^a$</td>
<td>1.24±0.15$^b$</td>
<td>nd</td>
<td>2.52±0.33$^a$</td>
</tr>
<tr>
<td>Potato</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncooked</td>
<td>44.97±1.17$^a$</td>
<td>15.29±0.71$^b$</td>
<td>145.49±4.16$^a$</td>
<td>50.61±0.93$^a$</td>
<td>895.04±3.36$^a$</td>
<td>11.20±0.61$^a$</td>
<td>5.17±0.16$^a$</td>
<td>nd</td>
<td>3.15±0.15$^a$</td>
</tr>
<tr>
<td>Cooked</td>
<td>45.89±1.33$^a$</td>
<td>22.77±1.60$^a$</td>
<td>128.35±1.54$^b$</td>
<td>42.46±1.01$^b$</td>
<td>757.68±3.70$^b$</td>
<td>9.95±0.33$^a$</td>
<td>0.23±0.04$^b$</td>
<td>nd</td>
<td>1.08±0.05$^b$</td>
</tr>
</tbody>
</table>

**Tuber x Cooking method**

<table>
<thead>
<tr>
<th></th>
<th>Phosphorus</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Sodium</th>
<th>Potassium</th>
<th>Iron</th>
<th>Copper</th>
<th>Manganese</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncooked</td>
<td>0.8318</td>
<td>1.84</td>
<td>14.3</td>
<td>4.0799</td>
<td>22.306</td>
<td>2.5131</td>
<td>1.0798</td>
<td>---</td>
<td>0.6762</td>
</tr>
<tr>
<td>Cooked</td>
<td>6.1487</td>
<td>7.2</td>
<td>5.8255</td>
<td>3.549</td>
<td>9.8391</td>
<td>1.3169</td>
<td>0.3382</td>
<td>---</td>
<td>0.7479</td>
</tr>
</tbody>
</table>
*Significantly different \( (P<0.05) \) from the other tuber having the same treatment within the same column. Values with different letters within the same column shows significant difference among treatments of the same tuber. nd= not detected. LSD = Least Significant Difference.

* = \( P<0.05 \); ** = \( P<0.001 \); NS = not significant.
Table 3. Antinutrient composition of cocoyam (*Colocasia esculenta*) and potato (*Solanum tuberosum*) tubers. Data are in $\overline{X} \pm S.D.$

<table>
<thead>
<tr>
<th>Composition (mg/100g dry matter)</th>
<th>Calcium oxalate</th>
<th>Tannin</th>
<th>Phytate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocoyam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncooked</td>
<td>673.98±23.03*^a</td>
<td>4216.00±455.67^a</td>
<td>87.48±1.36*^a</td>
</tr>
<tr>
<td>Cooked</td>
<td>342.70±15.19^b</td>
<td>1938.33±302.00^b</td>
<td>72.46±0.88^b</td>
</tr>
<tr>
<td>Potato</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncooked</td>
<td>261.60±16.72^a</td>
<td>4001.33±189.87^a</td>
<td>37.56±0.10^a</td>
</tr>
<tr>
<td>Cooked</td>
<td>146.91±15.93^b</td>
<td>2179.00±124.86^b</td>
<td>24.99±1.14^b</td>
</tr>
</tbody>
</table>

Tuber x Cooking method

<table>
<thead>
<tr>
<th>LSD:</th>
<th>***</th>
<th>NS</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncooked</td>
<td>42.557</td>
<td>1602.3</td>
<td>3.6268</td>
</tr>
<tr>
<td>Cooked</td>
<td>77.303</td>
<td>812.25</td>
<td>0.6459</td>
</tr>
</tbody>
</table>

*Significantly ($P<0.05$) different from the other tuber having the same treatment within the same column. Values with different letters within the same column shows significant difference ($P<0.05$) among treatments of the same tuber. LSD = Least Significant Difference. * = $P<0.05$; *** = $P<0.001$; NS = not significant.