CHAPTER 8

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The United Nations Millennium Project established the Task Force on Hunger in 2002, with a mandate to develop a strategy to reduce world hunger by 50% in 2015. In their report, many previous attempts to eliminate world hunger cut the world's proportion of hungry people from 33 percent to 18 percent over the past 40 years. Yet, 852 million people still go to bed hungry every night (UN Millennium Project, 2005). In South Africa, however, despite the fact that the country 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). In view of this, there is a need to reduce hunger in South Africa and the continent of Africa which is most hit by hunger.

Unlike maize (*Zea mays*) and potato (*Solanum tuberosum*) which are the main staples in the country, cocoyams are not well known in South Africa. Even though cocoyam tubers are cooked and eaten in similar manner to potatoes (van Wyk, 2005), cocoyam cultivation and consumption in the nation still remain at subsistence level especially among black and Indian populations in KwaZulu Natal Province. Compared with conventional root and stem tuber crops like sweet and landrace potatoes, there is a dearth of information on scientific research carried out on cocoyam in South Africa (Lewu *et al*., 2009). Thus, there is a need for a systematic study and documentation of research findings on the nutritional values, antinutritional properties as well as the toxicity of different accessions of cocoyams growing in South Africa. Studies like this may, thus, encourage the consumption of cocoyam and also popularize the crop as an additional tuber crop to potato in South Africa.

The tubers of *C. esculenta* and *S. tuberosum* found in the markets of South Africa were investigated for their nutritional values and antinutritional factors for the basis of comparison. The results of the proximate analysis revealed that there was no difference in the carbohydrate, caloric and crude protein contents of cocoyam and potato. 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 which is typical of most root and stem tuber crops (Alexandratos, 1995; Eka, 1998). Thus indicating the potential of these tubers in meeting the energy requirement of the consumer. On the other hand, while cooking the tubers improved the availability of moisture, crude protein, fibre and lipid contents, the ash content became reduced in the tubers of both crops due to cooking.

Analysis of the compositions of the two crops indicated that potassium is the most abundant mineral in cocoyam and potato tubers. 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, a significant increase in iron was observed for cocoyam. Boiling also lowered magnesium, potassium and copper contents in both tuber species. Other workers (Bradbury and Holloway, 1988; FAO, 1990) have also reported that cooking may reduce the nutritional value of root crops as a result of losses and changes in nutrients during cooking.

When cocoyam and potato tubers were further analysed for antinutritional factors, oxalate and phytate contents were found to be higher in cocoyam when compared with potato

whether cooked or uncooked. However, there was no significant difference in the tannin contents of the two tubers. Generally, cooking remarkably reduced the antinutrient contents of both tubers. Similar observation had earlier been reported by several authors (Osisiogu *et al*., 1974; Iwuoha and Kalu, 1995; Agwunobi *et al*., 2000).

The study then proceeded to investigate seven accessions (UFCe1 - UFCe7) of raw and cooked *C. esculenta* tubers for their proximate, mineral and antinutrient contents. It was discovered that cooking the tubers enhanced the carbohydrate, energy and protein levels in the samples. However, the ash and crude fibre contents of the accessions decreased after cooking. In all, accession UFCe7 had the highest moisture, ash, protein, crude fibre and crude lipid contents, while its carbohydrate and energy contents were the least.

Results of the mineral composition and anti-nutritional factors in seven accessions of cooked and uncooked tubers of this crop showed a general decrease in the levels of the mineral elements in the cooked samples, especially phosphorus, calcium, potassium and zinc. However, there was no difference in magnesium, sodium and copper contents after boiling. Potassium and magnesium contents were reasonably high. Sodium, calcium and zinc were also present in significant amounts while copper was in trace amounts. Manganese could not be detected in all the accessions studied while iron was sparingly detected only in cooked accessions UFCe2, UFCe3 and UFCe5. The results further portray the accessions as good sources of potassium, magnesium, sodium and calcium. Boiling markedly reduced the level of the anti-nutritional factors calcium oxalate, phytate and tannins, thereby improving the food quality. These results further support the findings of earlier workers (Osisiogu *et al*.,

1974; Iwuoha and Kalu, 1995; Noonan and Savage, 1999; Agwunobi *et al*., 2000) who observed reduction of the antinutrients present in different parts of some root and tuber crops after cooking. Wide variations were observed in the proximate, mineral and antinutrient composition values of the accessions studied which could be attributed to differences in the genetic background, climate, season and the agronomic factors during cultivation (Onwueme, 1982).

The leaves of the seven accessions of cocoyam, being edible as leafy vegetables, were also analysed for their nutritive value. The results of the proximate composition indicated that cooking these vegetables could result in the reduction of ash, carbohydrate and caloric contents in all the accessions with the exception of UFCe4 where the caloric content increased after cooking. On the other hand, cooking significantly increased the levels of the crude protein, fibre and lipid contents of all the accessions studied with the exception of UFCe5 and UFCe6 with reduction in their crude lipid contents after cooking. In all, moisture, protein and fibre contents were high in these vegetables while carbohydrate was low. The low level of carbohydrate in the leaves of the accessions studied could be attributed to the high deposition of carbohydrate in the tuberous root of the species. However, studies have shown that the leaves are consumed for their mineral and other nutrient contents (Duru and Uma, 2002). This species may also be a good compliment to its tuber which is low in protein (FAO, 1990).

These vegetables were further investigated for mineral and antinutritional factors and the cooked vegetables showed appreciable variation in their mineral contents. Cooking brought about a decrease in phosphorus, potassium and zinc contents in the vegetative parts (leaves)

of the seven accessions. Similar observation was reported by Mepba *et al*. (2007) for *C. esculenta* and some vegetables where blanching and cooking caused significant reductions in the levels of some mineral elements. In contrast, cooking appears to increase the iron levels in all the samples. Generally, cooking did not have any significant effect in the level of the calcium, magnesium, sodium and copper for most of the accessions. However, the manganese levels in four (UFCe1, UFCe2, UFCe4 and UFCe5) of the accessions tested in the study were reduced with boiling. Potassium and magnesium contents were reasonably high with potassium being the most abundant mineral element in the accessions studied and this conforms with early findings of Ejoh *et al.* (1996). The results further indicated that the leaves of the accessions are good sources of potassium, magnesium, sodium and calcium.

Boiling remarkably reduced the level of the anti-nutritional factors, thereby improving the food quality of all the leaf accessions tested in this study. Boiling for 5 min led to 16 - 78% drop in oxalate level, 28 - 61% in tannin and 17 - 41% reduction in phytate contents in some of the accessions. Other workers (Reddy *et al*., 1982; Vijayakumari *et al*., 1997; Saikia *et al*., 1999; Badifu, 2001; Onu and Madubuike, 2006; Savage and Dubois, 2006; Oscarsson and Savage, 2007) also reported similar observations.

In vivo study on the toxicity/safety of *C. esculenta* used for the current study revealed that; feeding of rats *ad libitum* for four weeks on the various accessions of cooked *C. esculenta*-based diet produced varying alterations in the concentrations of serum liver and kidney functional endpoints of rats. These accessions selectively altered the biochemical indices of liver and kidney function in weanling rats. The animals maintained on UFCe4 produced the

highest (38.89%) alteration in the functional indices investigated whereas the UFCe2 altered the least number (16.67%) of the parameters. The implication of this is that feeding of animals with some accessions of *C. esculenta* growing in Kwazulu-Natal Province of South Africa may alter some of the liver and kidney functional indices of weaning rats. This is also supported by the findings of Afolayan and Yakubu (2009). These alterations suggest that the accessions of *C. esculenta* could adversely affect the normal hepatorenal functioning of the animals.

Conclusions and recommendations

- Cocoyams (*C. esculenta*) are not well known in South Africa compared with potato (*Solanum tuberosum*) which is a main staple in the country, even though cocoyam tubers are cooked and eaten in a similar manner to potatoes.
- This study provides evidence that commercially available cocoyam and potato tubers used for this study have very close nutritional values. Cocoyam compared favourably with potato and even excelled in some nutrients.
- The tubers of accession UFCe7 of *C. esculenta* were better in ash, crude protein, crude fibre and crude lipid contents but with higher moisture content. Based on this study, accession UFCe7 could be recommended as being richer in protein and fibre contents but should not be stored for long after harvesting to minimize rotting.
- No tubers of the seven accessions studied proved to be outstandingly better than the others based on their mineral compositions. However, in terms of antinutritional

factors, UFCe1, UfCe3 and UfCe7 had the least amounts of oxalate, tannins and phytate in their cooked states.

- The findings also revealed that cooking may increase the protein, fibre and lipid contents of the leaves of *C. esculenta* while at the same time, cooking may also decrease the mineral, carbohydrate and caloric contents of the leaves of the accessions. The leafy vegetable may therefore, be recommended as a cheap source of plant protein.
- The current study has shown that boiling the leaves of *taro* prior to consumption is an effective way of reducing the antinutrient contents of the leaves of the plant.
- None of the accessions (leaf samples) studied proved to be outstandingly better than the others based on their mineral compositions and anti-nutritional factors.
- Since accessions of this leafy vegetable contain substantial amount of minerals, hence, it can contribute significantly to the nutrient requirements of humans. These accessions could therefore be recommended as a cheap source of nutrients in South Africa especially as a vegetable for the consumption of *pap*; a common staple of South Africans.
- Cooking improved the nutritive value as a result of the reduction in antinutrient levels, thereby improving the food quality in potato and both the tuber and leaves of cocoyam species used for this study. At the same time, cooked samples 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 these crops are being cooked for consumption.
- *In vivo* toxicity/safety evaluation of cooked accessions of *C. esculenta* produced selective alterations in the concentrations of serum liver and kidney functional

endpoints of rats. These alterations suggest that the accessions of *C. esculenta* could adversely affect the normal hepatorenal functioning of the animals.

- The animals maintained on UFCe4 produced the highest alteration in the functional indices investigated while the least number of the parameters were altered by UFCe2. Based on this, UFCe2 may be recommended for consumption because it poses the least level of toxicity risk.

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