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Effect Of Processing, (Boiling, Frying and Roasting) On The Nutrient, Antinutient And Phytochemical Composition Of Two Varieties Of Cocoyam (*Colocasia Esculenta*)

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ABSTRACT

The importance of food processing in enhancing nutrients contained in foods, cannot be overemphasized. The study evaluates the effect of different processing methods (boiling, frying and roasting), on the nutrient, antinutrient and phytochemical compositions of two varieties of cocoyam, (Colocasia antiquorum and Xanthosoma sagittifolium). Anti-nutrients are chemical compounds evolved by plants for their defence, among other biological functions. Anti-nutrients reduce the maximum utilization of nutrients (especially proteins, vitamins and minerals), thus preventing optimal exploitation of the nutrients present in food and decreasing the nutritive value. Cocoyam (Colocasia esculenta) is a non-indigenous species, widely grown in the subtropical parts of Africa, as a traditional food crop. Cocoyam makes a significant contribution to the diet of local people in Nigeria, where it is easily available. Cocoyam varieties (X.sagittifolium and C.antiquorum), were harvested from the farm, cleaned and divided into three equal parts, (those to be boiled, fried and roasted). Thereafter, were subjected to different processing techniques before analysis. Standard assay methods were used to analyse for antinutrients, nutrients and phytochemical composition. The proximate and mineral composition of the Cocoyam varieties revealed improved values in some nutrients. Phosphorus improved (from 52.36mg/g to 65.39mg/g) Calcium (21.mg/g to 26.02mg/g), sodium (41.66 to 52.34mg/g), magnesium (11.66mg/g to 13.4mg/g), iron, (from 2.72mg/g to 5.72mg/g). The different processing methods used, especially boiling, had a diverse effect in reducing the levels of tannin, phytate, oxalate, phenols, cyanogens, saponins, flavonoids and alkaloids in relation to the other processing methods. Boiling for 30minutes was also found to be highly effective in reducing the anti-nutrient content in both varieties of cocoyam. (Tannin reduced from 0.62mg/100g to 0.15mg/100g; Phytate, from 1.83mg/100g to 0.12mg/100g and Oxalate, from 2.99mg/100g to 0.13mg/100g respectively). Alkaloid concentration decreased from 1.44mg/100g to 0.10mg/100g. Processing was

effective in substantially reducing the cyanogens to low levels, from 1.44mg/100g (in raw Xanthosoma sagittifolium) to 0.07mg/100g (in boiled). The result of the study showed that some, nutrients contained in food crops, could be improved and made more available to the body, through the application of some processing methods.

Keywords; Processing, Antinutrients, Phytochemical, Cocoyam, Nutrients.

INTRODUCTION

The food we eat gives our bodies the 'information' and the materials they need to function properly. If we don't get the right food and the right information at the proper time, our metabolic processes suffer and our health declines (West *et al.,2007*). If we consume excess food that gives our bodies the wrong instructions, we could become overweight, undernourished and could be at risk for disease conditions such as arthritis, diabetes, and heart disease. Summarily, what we eat determines our health.

The nutrient present in a food enables the cells which are present in our bodies to perform their necessary functions (Ali *et al.,* 2006). Nutrients are the nourishing substances in food that are essential for growth, development and maintenance of the body functions (Troncoso et al.,2007). However, endogenous toxic factors, characteristic of plant materials can also affect the content of nutrients. These toxic factors act as anti-nutrients and adversely affect the organism. Anti-nutrients are chemicals which have been evolved by plants for their defence, among other biological functions. Anti-nutrients reduce the maximum utilization of nutrients (especially proteins, vitamins and minerals), thus preventing optimal exploitation of the nutrients present in food and decreasing the nutritive value (Ugwu and Oranye, 2006). Anti-nutrients vary in chemical structures, ranging from amino acids to proteins; from simple amines to a1kaloids, glycosides and many phenolic compounds. The biological effects of all these chemicals are diverse and complex. When man ingests plant foods to meet nutritional needs, a wide variety of these non-nutrient phytochemicals are ingested at the same time.

Processing is expected to inactivate these anti-nutritional factors and increase the availability of bioactive compounds. However, the health risk to consumers of large quantities of residual anti-nutrients cannot be ruled out. Cocoyam (Colocasia esculenta) is widely grown in the sub-tropical parts of West Africa as a traditional food crop. Cocoyam is not extensively commercialized at present but is mostly grown in rural areas or on small farms in most parts of Africa.

Like most root crops, Cocoyam is high in carbohydrate content with low levels of protein and lipids. Preliminary screening of Cocoyam revealed the presence of some anti-nutrients (substances in the food of plant origin that interfere directly with the absorption of nutrients), and phytochemicals (bioactive, non-nutrient plant compounds in fruits, vegetables, staples, grains, and other plant foods that have been linked to reducing the risk of chronic diseases). Processing (boiling, frying and roasting) of Cocoyam reduces the content of these anti-nutritional factors (amylase inhibitor, trypsin inhibitor, oxalate, alkaloids, saponin, phytate etc.). In Nigeria, the underlying courses of malnutrition are poverty, inadequate food production, inadequate food intake, ignorance and uneven distribution of food, poor processing method, poor preservation techniques, and improper preparation of foods, food restrictions, taboos, poor sanitation. It is also

common knowledge that several indigenous plant food in Nigeria are now going extinct because they are no longer been consumed by most people (El-Niely, 2007). Underutilization of indigenous food in Nigeria could be attributable to the fact that information on their nutritional and functional properties are lacking. This work, therefore, aims at evaluating the effects of different processing methods (boiling, frying and roasting) on the nutrients, antinutrient and phytochemical composition of two species of cocoyam (X. sagittifolium and C.

antiquorum) and use the beneficial result in tackling some of the problems of malnutritional diseases which are among the leading course of death in Nigeria (Agbor-Egbe, 2006). DESCRIPTION OF COCOYAM (Colocasia esculenta).

Cocoyam (colocasia esculenta) belongs to the genus Colocasia, within the subfamily Colocasioideae of the monocotyledonous family Araceae. Taro or cocoyam is the common name for edible aroids which are important staple foods in many parts of the world (Chay-Prove and Goebel, 2004). Perez and Delahaye, 2007 identified two major botanical varieties:

i) Colocasia esculenta (L.) Schott var. sagittifolium;
ii) Colocasia esculenta (L.) Schott var. antiquorum.

They also observed that the Colocasia esculenta var. sagittifolium is made up of a central corm, bulky and cylindrical in shape, with not many cormels, whereas Colocasia esculenta var. antiquorum has several large cormels arising from a small, central, globe-shaped corm.

Cocoyams are grown for local consumption in West Africa and their corms and cormels are used in the same manner as yams or potatoes for local dishes (Polomy, 1997).

Considered traditional African fare, the tubers are used in the same way as potatoes: fried as chips, mashed or barbequed whole (African affair, 2005). The young Cocoyam (or taro) leaves can also be used as a vegetable (Aregheore and Perera, 2003): they are boiled for 15 minutes like spinach and are utilized as a supplement to maize. The leaves may be used in making salad. The Indian delicacy puripatha, often created in Durban, South Africa, is wrapped in Cocoyam leaves.

Liener (2001) observed that taro (or cocoyam) is one of the only major staple foods where both the leaf and underground parts are used and have equal importance for human consumption. The excellent digestibility (98.8%) of the small starch grains of taro suggests an efficient release of nutrients during digestion and absorption of this food (Liener, 2001).

Several factors influence the nutritional content of food. These include the genetic make-up of the plant, the soil in which it is grown, use of fertilizer, prevailing weather, maturity at harvest, packaging, storage conditions and method utilized for processing (Moller and Seigler, 2003). The primary purpose of processing is to render food palatable and develop its aroma, but it has inevitable consequences on the nutritional value of foods. Washing and peeling result in the loss of many water-soluble vitamins since these are more concentrated in the peel and outer layers. With careful control of the processes, nutrient losses can be minimized without affecting palatability. The term "food processing" covers an enormous field, from simple boiling to the use of irradiation. The types of cooking methods differ in countries around the world and also vary with the ethnic background of the family. Processing (cooking) can be both beneficial and detrimental to the

nutrient composition of foods. It is known that processing techniques may decrease the food value of some nutrients (Nestares et al., 1996): for example, there is some inevitable leaching of nutrients into the cooking water during processing. The cooking water may or may not be discarded, depending upon cultural and personal preference. On the other hand, processing may enhance the nutritional quality of food by reducing or destroying the anti-nutrients present in it, as well as increasing the digestibility of proteins and starches. Elimination or inactivation of anti-nutritional compounds is necessary to improve the nutritional quality and effectively utilize human foods to their full potential.

MATERIALS AND METHODS



Fig.1.Colocasia antiquorum (Ede-ndia)



Fig.2.Xantosoma sagittifolium (Ede-ji)

Materials

Two varieties of cocoyam commonly consumed were freshly harvested from the local farm in Owerri, Imo State, Nigeria. The samples were Elephant ear cocoyam and wild taro cocoyam with common names as Ede-ndia and Ede-Ji. Their botanical names being *Colocasia antiquorum and Xanthosoma sagittifolium*

Preparation of materials

Tubers with little or no skin wounding were selected. Non-edible portions, unwanted wastes like sand and portion of compost from the farm were removed from the sample. The samples were then divided into three equal parts, about 500g each (those to be boiled, fried and roasted).

Processing techniques

Boiling

Cocoyam samples, made up of the two varieties were first cleaned, peeled and washed thoroughly before boiling separately in clean water, on a stove for 30 minutes. After which they were drained off excess water and kept aside for further processing.

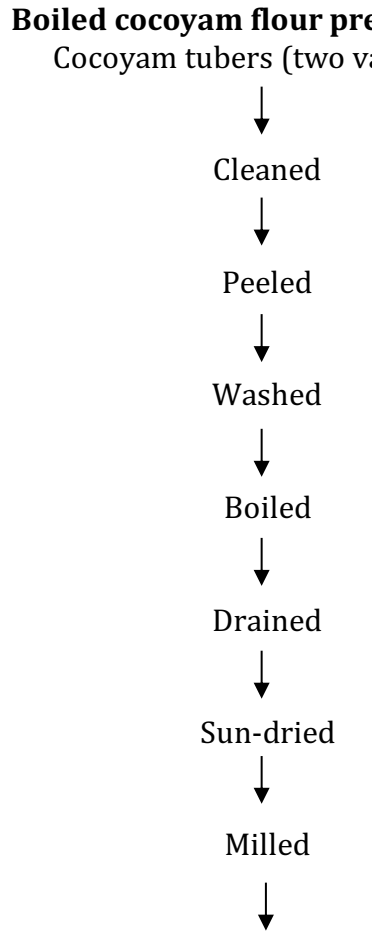


Fig.1: Flow Chart for boiled cocoyam flour preparation

Frying

Cocoyam samples, made up of the two varieties were cleaned, peeled, sliced into flat round chips, washed thoroughly and then deep-fried separately, in domestic cooking oil for 15 minutes.

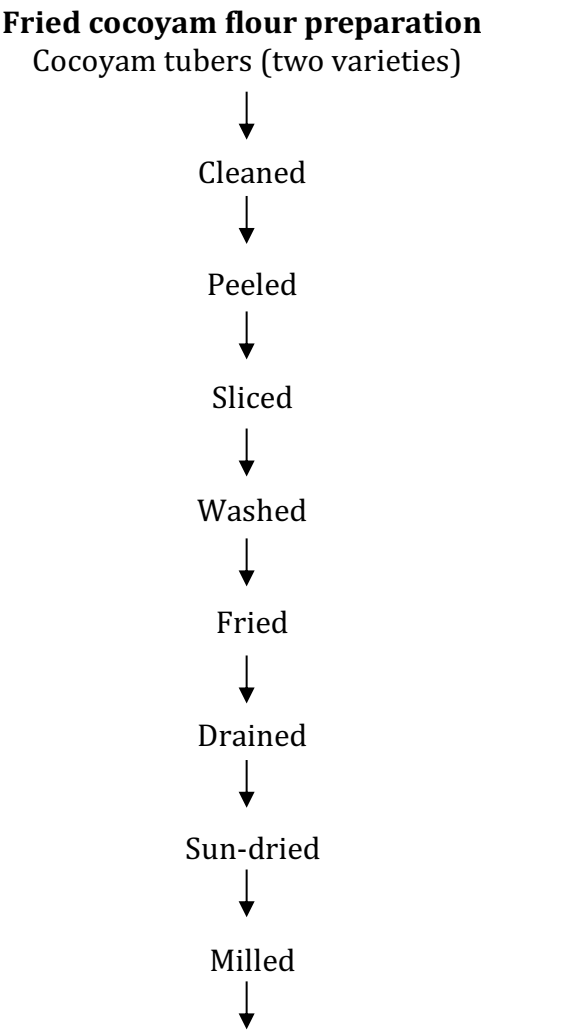


Fig.2: Flow Chart for fried cocoyam flour preparation

Roasting

Cocoyam samples, made up of the two varieties were cleaned, cut into smaller sizes and roasted separately, in a baking pan in an oven for 30 minutes at 180°C until done and well cooked. The covering back was peeled, sun-dried and milled into flour. It was thereafter, packaged for onward analysis.

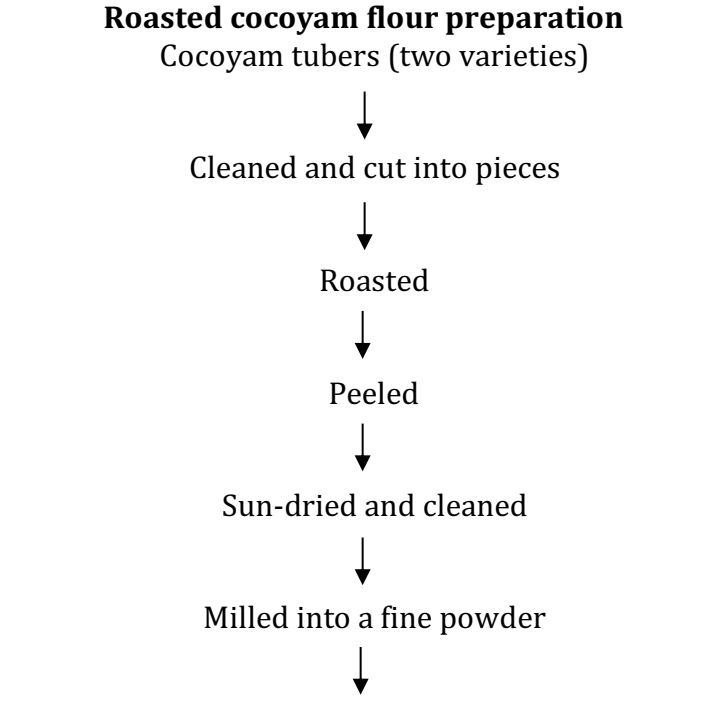


Fig.3: Flow Chart for fried cocoyam flour preparation

RESULTS

Table 1: Proximate composition of two varieties of Cocoyam (*Colocasia esculenta*)

	Moisture Content (%)	Dry Matter (%)	ASH (%)	Crude Protein (%)	FAT (%)	Crude Fibre (%)	Carbohydrate (%)
Raw *Xanthosoma sagittifolium*	68.⌈p;0op 46 ± 0.05	31.54 ± 0.05	3.87 ± 0.04	6.71 ± 0.01	0.64 ± 0.01	2.43 ± 0.02	31.07 ± 0.02
Raw *Colocasia antiquorum*	67.22 ± 0.31	32.37 ± 0.24	3.61 ± 0.01	6.83 ± 0.01	0.66 ± 0.02	2.35 ± 0.01	31.99 ± 0.02
Boiled *Colocasia antiquorum*	69.77 ± 0.09	30.23 ± 0.09	3.07 ± 0.01	5.11 ± 0.01	0.46 ± 0.02	1.74 ± 0.02	20.75 ± 0.02
Boiled *Xanthosoma sagittifolium*	70.56 ± 0.16	29.43 ± 0.16	3.04 ± 0.02	5.42 ± 0.01	0.55 ± 0.02	1.66 ± 0.02	19.89 ± 0.01
Fried *Xanthosoma sagittifolium*	34.68 ± 0.09	65.31 ± 0.09	2.92 ± 0.01	5.14 ± 0.02	21.69 ± 0.12	4.40 ± 0.02	26.29 ± 0.01
Roasted *Xanthosoma sagittifolium*	63.29 ± 0.72	36.71 ± 0.72	3.15 ± 0.01	4.87 ± 0.04	0.75 ± 0.01	2.15 ± 0.02	17.77 ± 0.02
Roasted *Colocasia antiquorum*	62.49 ± 0.01	35.51 ± 0.01	3.11 ± 0.01	4.66 ± 0.04	0.71 ± 0.01	2.21 ± 0.02	18.45 ± 0.02
Fried *Colocasia antiquorum*	35.50 ± 0.14	64.50 ± 0.14	2.96 ± 0.10	5.18 ± 0.01	20.56 ± 0.12	3.84 ± 0.02	26.82 ± 0.03

Data presented as the mean ± standard deviation obtained from duplicate reading. Different letters indicate significant statistical difference ($p < 0.05$).

Analysis of the table reveals that there was a significant difference ($p<0.05$) in the moisture content of the investigated starchy staples, which on average ranged between (34.68 and 70.56%)

The ash content of the two species of cocoyam (colocasia esculenta) tubers ranged between (2.92 and 3.87%) of the dry weight material. The mean ash content for raw (x. sagittifolium and C. antiquorum were (3.87 and 3.61%). The ash content of these cocoyam varieties is significant in that it contains nutritionally important minerals. The crude protein content of raw and processed cocoyam (colocasia esculenta) tubers was found to range between (4.66 and 6.83%).

Table 2: Mineral composition of two varieties of cocoyam (colocasia esculenta) tubers

	Phosphorus (mg/100g)	Sodium (mg/100g)	Potassium (mg/100g)	Calcium (mg/100g)	Zinc (mg/100g)	Iron (mg/100g)	Magnesium (mg/100g)
Raw Xanthosoma sagittifolium	$52.67^{g} \pm 0.09$	$42.61^{f} \pm 0.12$	$654.57^{b} \pm 0.24$	$23.17^{d} \pm 0.60$	$2.32^{c} \pm 0.02$	$2.72^{d} \pm 0.02$	$11.66^{d} \pm 0.04$
Raw Colocasia antiquorum	$52.36^{g} \pm 0.16$	$41.66^{g} \pm 0.08$	$661.79^{a} \pm 1.42$	$21.77^{c} \pm 0.09$	$2.81^{b} \pm 0.04$	$2.92^{d} \pm 0.02$	$11.96^{d} \pm 0.49$
Fried Xanthosoma sagittifolium	$58.72^{d} \pm 0.02$	$44.71^{d} \pm 0.12$	$578.41^{c} \pm 0.64$	$25.69^{b} \pm 0.12$	$1.63^{d} \pm 0.02$	$5.72^{a} \pm 0.16$	$13.42^{b} \pm 0.59$
Fried Colocasia antiquorum	$56.63^{e} \pm 0.12$	$45.49^{c} \pm 0.15$	$580.27^{c} \pm 0.04$	$26.02^{a} \pm 0.73$	$1.70^{d} \pm 0.02$	$5.72^{a} \pm 0.02$	$13.52^{a} \pm 0.10$
Boiled Xanthosoma sagittifolium	$62.77^{b} \pm 0.04$	$49.20^{b} \pm 0.84$	$586.35^{c} \pm 0.07$	$24.54^{c} \pm 0.33$	$2.69^{b} \pm 0.12$	$3.17^{c} \pm 0.01$	$12.72^{c} \pm 0.16$
Boiled Colocasia antiquorum	$65.39^{a} \pm 0.12$	$52.34^{a} \pm 0.08$	$585.0^{c} \pm 0.42$	$23.54^{d} \pm 0.28$	$2.22^{a} \pm 0.08$	$3.26^{c} \pm 0.02$	$12.88^{c} \pm 0.02$
Roasted Xanthosoma sagittifolium	$60.53^{c} \pm 0.05$	$43.61^{e} \pm 0.15$	$593.50^{c} \pm 1.55$	$24.76^{c} \pm 0.09$	$2.54^{b} \pm 0.01$	$3.85^{b} \pm 0.01$	$13.64^{a} \pm 0.22$
Roasted Colocasia antiquorum	$54.53^{f} \pm 6.95$	$44.66^{d} \pm 0.08$	$560.41^{d} \pm 0.09$	$25.36^{b} \pm 0.08$	$2.61^{b} \pm 0.02$	$3.91^{b} \pm 0.01$	$13.84^{a} \pm 0.08$

Data presented as the mean ± standard deviation obtained from duplicate reading. Different letters indicate significant statistical difference ($p < 0.05$).

A variation in mineral distribution was noted between varieties, the composition and concentration levels of these nutrients varied significantly ($p<0.05$) among cultivars.

Potassium was the most abundant macromineral (664.57 and 661.79mg/100g) of dry matter in the raw tubers. Phosphorus was the second most common mineral and varied between (52.36 and 65.39mg/100g of dry matter. An appreciable amount of sodium (52.34mg/100g) of dry matter and calcium (23.54mg/100g) of dry matter was also noted.

With regards to micronutrients, iron was the most abundant in both varieties with (5.72mg/100g) of dry matter as the mean value for the raw tubers. Zinc content ranged between (2.69 and 3.22mg/100g) of dry matter in the raw tubers. The concentration of iron and zinc was the lowest of minerals observed in the varieties studied.

Table 3: Mean anti-nutrient /phytochemical composition of two varieties of cocoyam (colocasia esculenta) tubers.

	Tannin (mg/100g)	Phytate (mg/100g)	Oxalate (mg/100g)	Phenol (mg/100g)	Cyanogen (mg/100g)	Saponin (mg/100g)	Alkaloid (mg/100g)
Raw Xanthosoma sagittifolium	0.62±0.03^{a}	1.83±0.04^{a}	2.83±0.02^{a}	0.35±0.01^{a}	1.44±0.01^{a}	0.57±0.04^{a}	1.44±0.05^{a}
Raw Colocasia antiquorum	0.57±0.01^{b}	1.78±0.01^{a}	2.76±0.05^{a}	0.30±0.00^{b}	1.40±0.02^{a}	0.56±0.01^{a}	1.43±0.01^{a}
Fried Xanthosoma sagittifolium	0.43±0.02^{d}	0.28±0.01^{c}	2.97±0.02^{b}	0.26±0.02^{c}	0.86±0.03^{b}	0.31±0.02^{b}	0.37±0.01^{b}
Fried Colocasia antiquorum	0.48±0.01^{c}	0.31±0.01^{c}	2.93±0.01^{b}	0.26±0.02^{c}	0.83±0.02^{b}	0.29±0.01^{b}	0.35±0.02^{e}
Boiled Xanthosoma sagittifolium	0.19±0.01^{f}	0.16±0.01^{c}	0.13±0.01^{d}	0.03±0.00^{f}	0.07±0.01^{d}	0.09±0.00^{d}	0.14±0.01^{e}
Boiled Colocasia Antiquorum	0.15±0.01^{H}	0.12±0.01^{d}	0.16±0.02^{d}	0.03±0.00^{f}	0.07±0.00^{d}	0.08±0.00^{d}	0.10±0.01^{e}
Roasted Xanthosoma sagittifolium	0.17±0.01^{g}	0.19±0.01^{c}	2.96±0.02^{c}	0.14±0.01^{e}	0.24±0.01^{c}	0.15±0.01^{c}	0.21±0.02^{d}
Roasted Colocasia antiquorum	0.22±0.01^{e}	0.26±0.01^{c}	2.99±0.01^{c}	0.18±0.01^{d}	0.28±0.02^{c}	0.18±0.01^{c}	0.27±0.03^{c}

Data presented as the mean ± standard deviation obtained from duplicate readings.
Different letters indicate significant statistical difference ($p < 0.05$).

The result showed the presence of tannin activity in varying levels, ranging from (0.15 to 0.62 mg/100g). On processing, the tannin content reduced drastically in the boiled colocasia antiquorum variety (0.15mg/100g) followed by the roasted Xanthosoma spp. (0.17mg/100g).

The highest losses of oxalate (a decrease from 2.96 to 0.13mg/100g) were observed when cocoyam (x. sagittofolium) sample was boiled and (a decrease from 2.99 to 0.16mg/100g) when cocoyam (colocasia antiquorum) samples were boiled. When the samples were fried and roasted, there was an increase in the oxalate content: 2.97mg/100g, 2.95mg/100g, 2.99mg/100g and 2.96mg/100g) respectively.

The reduction for phenol was highest during boiling (0.03 and 0.03mg/100g) for the two varieties of cocoyam respectively.

DISCUSSION

Like all tubers, cocoyam tubers in this study have high moisture content especially in the boiled (70.56%) while the fried recorded (34.68%). This is reflected in results reported for Cocoyam(Colocasia esculenta) in the Pacifics, where moisture content ranged between 63 and 85% (Bhandari and Kawabata,2006). The ash contents in this study were higher than the values reported for other cultivated Cocoyam (Colocasia esculenta) species (Huang et al., 2007).

Differences in the ash contents of cocoyam corms might be related to their species, fertility, geographical sources or planting periods (Bhandari and Kawabata, 2004).

The variations in the mean values of the protein content of the different varieties were distinct. 6.8% in (*colocasia antiquorum)* and 6.71% in (*Xanthosoma sagittifolium)*, All the tubers had a protein content of < 7%, as is generally the case with most starchy root crops. Environmental factors such as duration of the growing season, length of daily rainfall, light intensity and temperature, as well as agronomic factors such as plant density, wild plants or soil fertility, can influence protein content (Rosenthal and Berenbaum, 2001)

Cocoyam is mostly consumed with vegetables, a practice that undoubtedly complements the poor protein content of the tuber. The fat content ranged from 0.64 to 0.66% in the unprocessed tubers. As was expected, the fried tubers had a higher level of fat (20.56 to 21.69%) than the raw tubers or those cooked (0.46 to 0.75%). The starch levels of the different cocoyam corms indicated that Cocoyam tubers store a high level of starch, ranging between 17.77 and 31.99%. These starch levels are similar to those, between 19.2 and 26.1%, recorded for Cocoyam (Colocasia esculenta) by Huang et al,.2000).

The good levels of starch in cocoyams mean that these tubers can be used in the preparation of foods which prevents allergic diseases. It can as well be used to prepare infant meals and for patients with chronic liver problems, peptic ulcers and inflammatory bowel disease (Shahidi and Naczk, 2004). The mineral profile of the Cocoyam varieties, improved with processing, (Iron, 2.2 to 5.2mg/100g, calcium 21.77 to 26.02mg/100g, sodium, 41.66 to 52.34mg/100g, zinc 2.32 to 2.69mg/100g and magnesium 11.66 to 13.84mg/100g). It is apparent that the variety of Colocasia esculenta is rich in mineral nutrients, especially in potassium (from 560.41 to 661.9mg/100g) and phosphorus, (from 52.36 to 65.39mg/100g). It is thought that potassium might play an important role in the control of hypertension and in lowering the risk of strokes (NRC 1989).

Anti-nutrients are known to reduce the availability of nutrients to animals and humans (Rackis et al., 2006). The higher the concentration of the metabolites, the greater the risk they pose to the health of the consumer.

The Levels of phytate in the studied Cocoyam were seen in the ranges of 1.83 – 0.12mg/100g relatively lower than the safe limit (22.10mg/100g) (WHO, 2003) but higher, compared to those found by Huang et al. (2007) in Taro. Phytates are inositol hexaphosphoric acids which form complexes with salts like calcium, zinc, magnesium, iron and render them unavailable for absorption and utilization by the body. Generally, the phytic-acid content in these samples is lower than those of other tropical root crops, including yam (Makoi et aI.2007) and cassava (Maga, 2001). Phytate lowers the availability of many other necessary dietary minerals (Siddhmaju and Becker, 2002). Therefore, the reduction of phytate in the Cocoyam tubers is expected to enhance the bioavailability of proteins and dietary minerals. There is current support for the supposition that, reduced levels of phytate may enhance health through antioxidant and anti-carcinogenic activity (Hagerman and Butler, 2001).

The total oxalate content of the corms in this study showed variation in plants (0.13 to 2.99 mg/100g). Oxalate levels were lower than the oxalate contents of some tropical foods investigated

by Hook et al. (2001), who reported the oxalate content of the tubers of four different cultivars of Cocoyam (Colocasia esculenta) grown in Fiji, to range from 6.5 mg/100g fresh weight (FW) to 9.3 mg/100 g for the giant swamp.

Dietary oxalates have been known to form a complex with calcium, magnesium and iron and inhibit their absorption by humans. Oxalate causes calcium deficiency both in man and in non-ruminants. At a high dose of 1g – 2g of body weight, it is toxic to the kidney and heart, (Obiakor, 2014). Considerable loss in oxalate content, (0.13mg/100g) occurred with boiling the Xanthosoma sagittifolium variety. Boiling may cause considerable cell rupture and facilitate the leakage of soluble oxalate into cooking water (Albihn and Savage, 2001). On the other hand, when the samples were roasted and fried, there was a slight increase in oxalate content (2. 97 and 2. 96mg/100g) for fried and roasted Xanthosoma sagittifolium, and (2.93 and 2.99mg/100g) for fried and roasted Colocasia esculenta respectively. This apparent improvement could be related to the relative increase in dry matter, as Cocoyam is roasted. Oxalate is broken down at 200^0C, but this temperature is rarely reached when roasting or frying. The level of phenolic compounds in plant sources depend on factors such as cultivation techniques, cultivar, growing conditions and ripening process, among others (Naczk and Shahidi, 2004). The reduction during boiling was the highest (0.03 and 0.03%) of the X.sagittifolium and C.antiquorum tubers respectively and may be attributed to leaching out of the phenol into the cooking medium under the influence of the concentration gradient (Uzogara et al., 2000).

The cyanogen levels for Cocoyam tubers are higher than HCN levels for potato and sweet potato (0.005 mg/loo g and 0.004 mg/100 g respectively), as well as for yam (0.06 mg/loo g) (Noman et al., 2007).

The reduction of hydrogen cyanide through boiling maybe because free cyanide and bond cyanide are both water-soluble and, hence, may be leached out during boiling. The results indicated that the cyanogen levels found in the processed and unprocessed tubers studied were satisfactorily below the safety level for cyanide poisoning. For humans, the lethal dose of HCN taken by mouth is estimated to be only 0.5 to 3.5mg/kg body weight (Bhandari and Kawabata, 2006). Irrespective of the relative decrease in the cyanogen content during processing, the amount remaining might be slightly toxic to people who consume high quantities of Cocoyam tubers.

In this study, the saponin level of the cocoyam varieties was in the ranges of 0.08 -0.57mg/100g, lower than the maximum permissible limit of 48.05mg/100g, according to (WHO 1999).

CONCLUSION

Cocoyam (Colocasia esculenta) is an important staple food for various populations (Huang et al., 2007). The different cooking methods studied had diverse effects on reducing the levels of the tannin, phytate, oxalates, phenols, cyanogens, saponins, flavonoids and alkaloids.

Boiling appeared to be the most effective processing method to reduce most anti-nutrients in Cocoyam tubers. The reduction of anti-nutrient to tolerable levels on processing the foodstuff enhances the nutritional value of Cocoyam tubers. Thus, it may be stated from the results of this study that the anti-nutritional factors, though present in raw tubers, should not pose a problem to human.

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