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Chemical Studies of the Peel of *Xanthosoma sagittifolium* (Tannia Cocoyam)

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Abstract: The peels of *xanthosoma sagittifolium* (Cocoyam) which is locally called 'kunkoro' in 'Nupe' land from four farms; randomly sampled to represent the four geographical areas in Bida, Niger State of Nigeria, were analyzed for their nutritive and anti-nutritional contents using standard analytical methods. The nutritive content of the peel and its effect on the period of sampling was also investigated, as a first step in their possible modification for use as animal feed. The results obtained show that samples collected during dry season contained more nutrients (proteins, lipid, etc.) than those collected during the wet season. Macro-minerals (Na, K, Ca and P) being the highest while the micro-mineral nutrients such as Mg, Zn, Fe and Cu etc were found to be generally lower than the dietary mineral requirement for animal feeds. The protein content of the peel ranged between 6.30-17.6%, while fibre and carbohydrate contents were 10.7-19.7% and 41.2-46.0% respectively. The lipid content was generally low and ranged between 0.70-2.14%. The peels collected during dry season contained lower concentration of phytate which ranged between (1.26-1.43%), hydrogen cyanide (3.17-3.20%), soluble oxalate (1.18-1.69%) and tannin (1.43-8.24%) than the peels collected during wet season, with the exception of sample CYD. These anti-nutritional factors in all the cocoyam peel studied were generally low, yet critical to the safety of the consumer as it affects bioavailability of some essential minerals. The proximate analysis of the peels suggests that they could serve as supplementary sources of essential nutrients for livestock production, especially with their low levels of anti-nutritional factors.

Key words: *Xanthosoma sagittifolium*, nutritional and anti-nutritional factors, minerals

INTRODUCTION

Humans and animals require food to carry out basic functions of life. A balanced food must provide all necessary nutrients for energy, bodybuilding, maintenance and regulation of body processes (Bogden and Klevay, 2000). Plants are the ultimate source of food in nature and of all the food crops of the tropical world, few are guite ubiquitous as root and tuber crops. Cocoyam for instance, are among the yielding crops in relation to energy and minerals (Degras, 1993).

Cocoyam (*xanthosoma* spp.) is a stem tuber that is widely cultivated in both the tropical and subtropical regions of the world. Among several species of xanthosoma (tannia) that originated from America, xanthosoma sagittifolium is mostly grown in West Africa (Ihekoronye and Ngoddy, 1985) and are important crop in Hawaii, Japan, Egypt, Ghana and Nigeria.

The quantity of grains in tropical Africa is not sufficient to feed the increasing human population. For instance, in Nigeria, there is an alarming rate of population growth of both human and livestock which include goats, sheep, poultry etc (FAO, 1985). Food security for these teeming millions of people and their domestic animals should be of immense concern to the authorities as most staple food for humans also serves as livestock feeds, thereby exalting serious competition between human and livestock for these scarce food items which could be avoided if alternatives, less competitive, feed ingredients were used to feed animals.

Also, in Nigeria, the most important factor militating against rapid development in livestock production is the increasing unavailability and high cost of conventional feeds (Sonaiya and Omale, 1977). This has threatened the potential for increasing animal feed production which is in short supply. The use of local by-product that is consumed by man has been the subject of cost oriented study by nutritionists over the years.

Tannia cocoyam is a less well known source of energy, whose peel is not in great demand for human food which is an advantage in using it as a feed for livestock. The protein content of tannia cocoyam is higher than that of other tuber crops (Hussain *et al*., 1984). It is also found to have contained more amino acids than cassava, yam or sweet potatoes (Standal, 1983). The starch content of cocoyam is readily digestible because of its small particle size (Hussain *et al*., 1984).

Tuber crops are useful source of good quality starch for man and livestock. It is however, considered

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uneconomical to feed cocoyam for instance to livestock but their peels which are often discarded, for livestock to eat. Yam peel has been seen to contain more mineral nutrients than its tissue, including protein (Yahaya *et al*., 2007). Apart from the domesticated species, some wild species form a dependable standby in time of famine or scarcity. Among the nutritional requirements, the need for energy is most paramount and an animal fuel consists largely of carbohydrate, protein and fat (Agwunobi *et al*., 2002). Consequently, since cocoyams are consumed by humans, thereby leaving large quantity of the peels as refuse in homes, hotels etc to constitute serious environmental problem, these when pooled together can be a potential source of energy for livestock. Cocoyam peel is an agro-waste and is one of such non-conventional feed sources that could be used to replace maize for instance as source of energy and minerals for animal diets. The peels which is a skin and thin outer cortex of their tubers that represent a major waste during processing constitutes about 10-13% of the tuber which were randomly taken from different farms of the four villages within 25km-radius of Bida town, in Niger State of Nigeria. All samples were collected between February 2009 and January 2010.

MATERIALS AND METHODS

Materials: Cocoyam samples were washed thoroughly with tap water to remove the adhering sand and rinsed with distilled water. After air drying, the peeling process was done such that only the outer rind (without any edible pulp) is carefully removed from all the samples. All the peels are labeled and oven dried at 60°C, for 4 days and then at 110°C for 24hr until constant weight is obtained and then ground to powder in a porcelain mortar and pestle. Each sample was separately stored in a plastic bottle and kept in a desiccator until required for analysis.

Methods

Elemental analysis: The peel sample solution was prepared by digesting 1g of the oven-dried powder with a mixture of $HClO_4$ (60-62%, 1cm^3), HNO_3 (69.7%, 5cm^3) and H_2SO_4 (98%, 0.5cm^3) in a kjeldahl digestion tube. Digestion was initially at low heat until the brown fumes had escaped and heating continued until all the solid dissolve and the appearance of white fumes emerge. After cooling, the digest is transferred into 100cm^3 volumetric flask and made up to the mark with distilled water. Flame Emission Spectroscopy (FES), using Jenway flame photometer model PFP7 fitted with either a Na or K filter and an air-propane flame, was used to determine the Na and K contents of the solutions, using appropriate working standard solutions. Phosphorus was determined using standard colorimetric procedure (Allen *et al*., 1974). Blank solutions were prepared as appropriate. Working standard solutions were prepared for Ca, Mg, Cu, Fe and Zn. The metal concentration in the solution was determined by Atomic Absorption Spectrometer (Pye Unicam, Model AA 969) atomic absorption spectrometer.

Proximate analysis: The samples were analyzed for proximate composition (moisture content, crude fat, crude protein, crude fiber and total carbohydrate). The micro kjeldhal procedure was used for the determination of protein while the Schweider and Flat procedure was used for the determination of carbohydrate. Crude fat was estimated by the method described by Osborn and Voogt (1978).

Hydrogen cyanide determination: Cyanide content was assayed using the method developed by Ikediobi (Ikediobi *et al*., 1980). Cyanide solution was extracted from 2g of ground sample with 15ml of 0.1M sodium phosphate buffer (pH 6.8) with thorough shaking using a mechanical shaker for 3mins. The mixture was then centrifuged and the resulting supernatant removed by filtration. To 0.4ml of the extract was added 1.6ml of 0.1M sodium phosphate buffer to give a total volume of 2ml and 4ml of alkaline pickrate solution. The tube was stoppered and incubated in a water bath at 95°C for 5mins. This was allowed to cool to room temperature and the absorbance of the deep orange solution was read in a spectrophotometer at 490nm.

Phytate determination: The (Reddy and Love, 1999) method was adopted. Each ground sample (4g) was soaked in 100ml of 2% hydrochloric acid for 5hrs and filtered. The filtrate (25cm^3) was placed in a conical flask and 5cm^3 of 0.3% Ammonium thiocyanate solution was added. The mixture was titrated with standard iron (III) chloride solution until a brownish-yellow colour persisted for at least five minutes.

Determination of tannin: The tannin extract was prepared by weighing 0.2g of the sample into 100cm^3 conical flask, 50cm^3 of distilled water was added and boiled for 1hr, filtered and the solution was made to the volume on cooling. Aliquot of both tannic acid and the sample were prepared respectively. 2.5cm^3 of Folin-Denis reagent was added to each followed by 10cm^3 of the 17% sodium carbonate solution and was diluted appropriately and was then placed in a water bath at 25°C for 20mins. These was determined colorimetrically at 760nm using spectronic 20.

Determination of oxalate: Oxalate content of the sample was determined by titrimetric method proposed by Dye (1956), 2g of ground sample was used for extraction purposes. The aliquot of the extract was added 20cm^3 of 6M hydrochloric acid and evaporated to half its volume

and then filtered. To the filtrate was added 3 drops of methyl red indicator and concentrated ammonia until solution turned faint yellow. The resultant solution was then heated at 90°C with 10cm^3 of 5% (w/v) calcium chloride to precipitate the oxalate and subsequently filtered off. The residue was then washed into a beaker using hot 25% (v/v) sulphuric acid solution and diluted. This was warmed to 90°C and titrated while hot with 0.01M potassium permanganate solution.

Statistical analysis: Means were compared using student t-test and the level of significant difference was determined at $p<0.05$.

RESULTS AND DISCUSSION

The moisture content of the peel samples collected during wet season were considerably high with sample CYC and CYB having 77.1 and 82.7%, respectively (Table 1). Similar results were reported for Colocasia esculenta (Agwunobi *et al*., 2002).

The protein content for all the samples, with the exception of sample CYD shows the peels to be fairly rich in protein. These values are similar to those of maize and higher than those reported for other root and tuber crops, including yam and cassava peels (Gbolade *et al*., 2003; Bradbury and Holloway, 1988; Ravindran and Blair, 1991). Cocoyam peel sample CYA (14.4±0.37%), CYB (15.3±0.24%) and CYC (17.6±0.26%) are similar to the values of crude protein obtained for D. Cayanensis (Shewry, 2003; Anugwa and Okorie, 1994). There is a significant difference ($P<0.05$) in the protein content of the peels collected all seasons, up to 95% level of confidence.

The level of total carbohydrate, obtained by difference, ranged from 41.2 to 46.0%. These values when compared are higher during wet season with the exception of sample CYB, this may be partly due to storage which decreases the concentration of carbohydrate by the subsequent utilization of sugar and starch by spoilage micro-organism. The carbohydrate content of the peel analyzed in this study compares favourably with Diocorea domentorum pax (45.2%) and even higher than cocoyam taro (32.9%), (Afoakwa and Sefa-Dedeh, 2001). The high value of carbohydrate content in the present work may be due to low fat. It was observed that there was no significant difference in the fiber content for most of the sample except cocoyam peel CYD which showed low value when compared to other samples.

The elemental analysis showed that in all samples analyzed, potassium was the most abundant mineral constituting one third (1/3) of the total ash content with sample CYB containing higher amount of Potassium (49166.0), calcium (2122.5), phosphorus (2115.0); while sample CYC contained higher amount of sodium (7933.3), magnesium (15.36) and Copper (1.77). These elements are essential for growth, production of bones, teeth and hormones (Reddy and Love, 1999). The healthy functioning of the body organs depends on the essential elements and too little of it can lead to deficiency disease and too much of any can be toxic (Schauss, 1995).

In Table 3, the concentration of some anti-nutritional factors is presented. The level of the Phytate determined in sample CYC was the highest among the four peel samples. However, this was comparatively lower than those reported in some Diocorea alata tissue (Doessien and Ifon, 1992). There was no significant difference ($P>0.05$) in the phytate level of the peels. A phytate diet of 1-6% over a long period of time decreases bioavailability of minerals in monogastric animals (Thompson, 1993). Similarly, high dietary phytate is reported to cause growth reduction (O'Dell and Savage, 1960), affect food value by binding and making mineral ions unavailable to the consumer, affect the homeostasis of Zinc and iron, inhibit enzymatic

Table 1: Proximate composition of cocoyam peel (%) on dry weight basis

Component	CYA	CYB	CYC	CYD
Moisture	72.6±6.24	77.1±2.77	82.7±2.36	70.7±0.26
C. Protein	14.4±0.37	15.3±0.24	17.6±0.26	6.30±0.21
C. Fiber	18.8±0.08	17.7±0.14	19.7±0.18	10.7±0.16
C. Lipid	2.05±0.04	1.95±0.04	2.14±0.04	0.70±0.06
Carbohydrate	41.2±0.30	45.5±0.15	41.4±0.59	46.0±0.20

Values are Mean±SD of triplicate determination. Levels of significant (student t-test) $p<0.05$

Table 2: Essential elements of the peel of xanthosoma sagittifolium (mg/kg) on dry weight basis

Component	CYA	CYB	CYC	CYD
Na	7500±300	7166±305.5	7933.3±1527	2140±2.680
K	18000±500	49166±2020.7	38000±500	9022±0.86
Ca	1787.3±0.50	2122.5±0.02	176.2±0.02	172.5±0.53
P	1874±3.47	2115±30.4	1725.4±2.87	544.0±3.80
Mg	10.80±0.54	12.08±0.69	15.36±0.17	4.35±0.14
Cu	1.07±0.13	0.75±0.08	1.77±0.15	0.44±0.02
Fe	1.24±0.01	1.16±0.02	0.96±0.04	0.31±0.03
Zn	0.29±0.11	0.19±0.01	0.07±0.01	0.33±0.03

Values are Means±SD of triplicate determination. Levels of significant (student t-test) $p<0.05$

Table 3: Anti-nutritional composition of the peel of xanthosoma sagittifolium (%) on DW basis

Component	CYA	CYB	CYC	CYD
Cyanide	3.17±0.15 x 10-5	3.20±0.10 x 10-5	4.70±0.61 x 10-5	2.70±0.03 x 10-5
Oxalate	1.18±0.07 x 10-5	1.69±0.03 x 10-5	2.63±0.09 x 10-5	0.74±0.03 x 10-5
Tannin	8.24±0.02 x 10-5	1.43±0.01 x 10-5	1.84±0.04 x 10-5	0.66±0.05 x 10-5
Phytate	1.43±0.04 x 10-5	1.26±0.04 x 10-5	2.83±0.09 x 10-5	0.52±0.04 x 10-5

Values are Mean±SD of triplicate determination. Levels of significant (student t-test) p<0.05

digestion of proteins and cause rickets in young animals (Marfo *et al*., 1990). Therefore, the low level of phytate in the peel samples would be nutritionally advantageous.

The hydrogen cyanide varied between 2.70% in sample CYD and 4.70% in sample CYC. There is no significant difference observed in the cyanide composition of the peels (P>0.05). From the present study, cyanide composition is found to be low, giving the fact that the toxic level in raw foods is 0.5-3.5mg/kg dry weight (Montgomery, 1980), its toxicity could occur due to accumulation of the substance over a period of time. These values are less than those reported for cassava peel (Obioha and Anikwe, 1982). The side effect of cyanide includes pancreatic diabetes; vitamin B12 deficiency and decrease in mineral uptake (Makkar and Beekar, 1998) and testicular lesions have been observed in some ruminant animals that consumed cassava with low values of cyanide (Okolie and Osagie, 1999).

The concentration of Oxalate in the peels ranged between 0.74% in sample CYD to 2.63% in sample CYC. The values reported in this study are less than the toxic range of 2-5mg/kg dry weight. Toxicity occurs only when the excess oxalate ions react with calcium of the fluid, thereby rupturing the renal tubules which reduces the excretory ability of the kidney, although ruminant animals are more effective in dealing with oxalate problems by producing the insoluble salts in the gastrointestinal track (Radeleff, 1962). Oxalate can upset the calcium-phosphorus ratio of the body fluid when combined with calcium as calcium oxalate.

A tannin range of 0.66-8.24% was determined in the peel samples used in this study. The concentrations of tannins in the samples were altogether comparatively lower than those that other workers have reported on (Doessien and Ifon, 1992; Obioha and Anikwe, 1982). Although, the low value of tannin may make it susceptible to bird predation and insect attack (Schultz and Baldwin, 1982). The renewed interest in dietary tannin is due to evidence of adverse effects. For instance, high tannin content can depress growth and feed efficiency. It also lowered palatability of feeds due to the bitter astringent taste (Makkar and Beekar, 1998). Statistical analysis indicates that there was no significant difference (P>0.05) in the tannin composition of the peels from different location.

This study confirms that the Xanthosoma Sagittifolium peel of Bida, in Niger State of Nigeria, encourages their use as supplementary Protein, Calcium, Phosphorus, Potassium, Sodium and energy sources for animal nutrition. The low anti-nutritional factors also support the nutritional value of the peels.

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REFERENCES

Afoakwa, E.O. and S. Sefa-Dedeh, 2001. Chemical Composition and Quality Changes Occurring in Dioscorea dumentorum pax tubers after harvest. Food Chem., 75: 85-91.

Agwunobi, L.N., P.O. Angwukam, O.O. Cora and M.A. Isika, 2002. Studies on the use of Colocasia esculenta (Taro cocoyam tissue) in the Diets of Weaned Pigs. Trop. Anim. Health Prod., 34: 241-47.

Allen, E.S., H.M. Grimshaw, A. Parkinson and C. Quarmby, 1974. Chemical Analysis of Ecological Materials. Blackwell Scientific, Publications Oxford London, pp: 69-89.

Anugwa, F.O.I. and A.U. Okorie, 1994. Nutrient Digestion and Nitrogen Utilization by Growing Pigs Fed Varying Levels of Sun-dried yam tissue of Dioscorea cayenensis. Nig. J. Nutr. Sci., 5: 129-135.

Bogden, J.D. and L.M. Klevay, 2000. Clinical Nutriyion of the essential Trace Elements and Minerals. 1st ed. New Jessey, Humana Press.

Bradbury, J.H. and W.D. Holloway, 1988. Chemistry of tropical root crops: significance for nutrition and agriculture in the Pacific (ACIAR Monograph No., 6: 68-76). Canberra, Australia: Australian Centre for International Agricutural Research.

Degras, L., 1993. The yam: A tropical root crop (2nd Edn.), London, Macmilan Press Ltd.

Doessien, E.I. and E.T. Ifon, 1992. Chemical Evaluation of Some Antinutritional Constituents in four species of yam. Trop. Sci., 32: 115-119.

Dye, W.B., 1956. Studies on Halogeton glomerulus. Weeds., 4: 50-60.

FAO, 1985. Proceedings of the World Food Survey Conference. World Health Organization Technology, Series, Rome, Italy.

Gbolade, A.A., B.B. Hankova and C.Y. Erhun, 2003. Callus Induction and Morphogenesis in Dioscorea Dumentorum for Steroid Production. Nig. J. Nat. Prod. and Med., 7: 32-36.

Hussain, M., G. Norton and R.J. Neale, 1984. Composition and nutritive value of cormel colocasia esculenta L. J. Sci. Food Agric., 35: 112-117.

Ihekoronye, A.I. and P.O. Ngoddy, 1985. Cocoyams. In: Integrated food science and Technology for the tropics. Macmillan, London, UK, pp: 280-281.

Ikediobi, C.O., G.O.C. Onyia and C.E. Eluwah, 1980. A Rapid and Inexpensive Enzymatic Assay for Total Cyanide in Cassava (Manihot esculenta crantz) and Cassava Products. Agric. Biol. Chem., 44: 2803-2809.

Makkar, H.P.S. and K. Beekar, 1998. Plant toxins and detoxification methods to improve feed quality of tropical seeds. Asian-Aust. J. Anim. Sci., 12: 467-480.

Marfo, E.K., J.S. Idowu and O.L. Oke, 1990. Effect of local food processing in phytate levels in cassava, cocoyam, yam, maize, sorghum, rice, cowpea and soybean. J. Agric. Food Chem., 38: 1580-1585.

Montgomery, R.D., 1980. Cyanogens in toxic constituents of plant foodstuffs. 2nd Edn., Liener, I.E. (Ed.), Academic press, New York, pp: 143-16025.

O`Dell, B.L. and J.E. Savage, 1960. Effect of Phytic Acid on Zinc Bioavailability. Proc. Soc. Exp. Biol. Med., 103: 304-304.

Obioha, F.C., and P.C.N. Anikwe, 1982. Utilization of Ensiled and Sundried Cassava Peels by Growing Swine. Nutr. Rep. Int., 26: 961-972.

Okolie, N.P. and Osagie, 1999. Liver and Kidney Lesions and Associated enzyme changes Induced in Rabbits by Chronic Cyanide Exposure. Food Chem. Toxicol., 37: 745-750.

Osborne, D.R. and P. Voogt, 1978. The analysis of nutrients in foods. New York, Academic Press, Pages: 251.

Radeleff, R.D., 1962. Veterinary Toxicology. Lea and Febiger Philadephia, pp: 50-83

Schultz, J.C. and I.T. Baldwin, 1982. Protective Effect of Tannins in Sorghum. Scinece, Washington DC, 217: 149.

Ravindran, V. and R. Blair, 1991. Feed Resources for Poultry Production in Asia and the pacific. I. Energy sources. World`s Poult. Sci. J., 47: 213-231.

Reddy, M.B. and M. Love, 1999. The Impacts of Food Processing on the Nutritional Quality of Vitamins and Minerals. Adv. Exp. Med . Biol., 459: 99-106.

Schauss, A., 1995. (White papers) Minerals. Trace Elements and Human Health. Life Science Press: Tacoma, W.A., pp: 2-23.

Shewry, P.R., 2003. Tuber Storage Proteins: A Review. Annal. Bot., 91: 755-769.

Sonaiya, E.B. and T.A. Omale, 1977. Cassava Peels for Finishing Pigs. Nutr. Rep. Int., 16: 479-486

Standal, B.R., 1983. Nutritive value of Taro. A review of colocasia esculenta and its potential. pp: 141-145.

Thompson, L.U., 1993. Potential health benefits and problems associated with antinutrients with foods. Food Res. Intl., 26: 131-150.

Yahaya, I.A., A.J. Nok and J.J. Bonire, 2007. Nutrional and antinutritional Assessment of the peel of Dioscorea alata. Chem. J., 4: 65-69.