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Antinutrient Compositions of Nine Cocoyam Varieties grown in Port Harcourt, Rivers State

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Abstract

Colocasia esculenta (L.) Schott belonging to the Araceae plant family is an important tuber food crops in Rivers State. The antinutrient compositions of cocoyam grown in Port Harcourt is understudied due to lack of scientific researches, hence this study aims at investigating the antinutrient compositions of cocoyam varieties. This study was carried out at the Research plot, Department of Plant Science and Biotechnology, Rivers State University, Rivers State. Nine varieties (NXe001, NXe002, NXe003, NCe004, NCe005, NCe006, NCe007, NCe008, NCe009) of cocoyam were gotten from National Root Crops Research Institute (NRCRI) Jos, Nigeria and sown into polyethene bags field with 20kg loam soil and allowed to grow for 6 months. Cultural practices were done at intervals when necessary. Antinutrient analysis of harvested corms for phytate, tannin, oxalate, saponin, alkaloid, glycosides, flavonoid, phenolics, amino acids and fatty acids was done using the methods described by Association of Analytical chemists (AOAC). Phytate, tannin and oxalate were revealed to be highest (5.13±0.00; 14.75±0.00 and 18.86±0.00) in NCe008 and lowest (3.47±0.00; 9.98±0.00 and 12.77±0.00) in NCe004 respectively. Saponin content was more (9.54±0.00) in NCe008 than other varieties with NXe001 recording lowest (6.08±0.00). alkaloid content amongst all varieties had highest content (9.75±0.00) and lowest (1.00±0.00) in NCe007 and NCe006 respectively. Highest (2.51±0.00) and lowest (1.35±0.00) values of glycoside content was recorded from NXe002 and NCe009. Flavonoid content was lowest (35.35±0.04) in NCe009 and highest (44.39±0.00) in NCe008 compared to all varieties studied. Phenolics revealed that NXe002 and NCe004 as the highest (103.7±0.00) and lowest (52.06±0.00) values. Amino acid content amongst all varieties shows that NCe008 had highest (7.97±0.00) contents and lowest (3.25±0.00) contents recorded in NCe005. Fatty acid content was recorded to be highest (1.96±0.00) and lowest (0.67±0.00) in NXe002 and NCe007 respectively. The result reveals that cocoyam corms contain bioactive compounds which are effective against numerous health related risk factors which can help to develop cocoyam food products and to promote productivity and utilization by encouraging its sustainable use and thus can rival other conventional vegetables normally consumed in Nigeria.

Keywords: Araceae, Cocoyam, Corms, Antinutrients, Bioactive compounds

Introduction

Colocasia esculenta (L.) Schott, commonly known as cocoyam or taro, is an edible, highly nutritious and an underutilized crop that belongs to the family, *Araceae*. About 30 – 40 species of taro have been identified but only 5 – 6 species produce edible parts (Manjushri, 2021). Cocoyamis grown primarily for their edible starch storage, corms and cormels called tubers, and secondarily as a leafy vegetable (Aregheore& Perera, 2003).

Nutritional value is the main concern when a plant is considered as food source. However,endogenous toxic factors characteristic of plant material can also affect the content ofnutrients. These toxic factors act as anti-nutrients and adversely affect the organism. Antinutrientsare chemicals which have been evolved by plants for their own defence, amongother biological functions. Anti-nutrients reduce the maximum utilization of nutrients(especially proteins, vitamins and minerals), thus preventing optimal exploitation of thenutrients present in a food and decreasing the nutritive value (Ugwu and Oranye, 2006).

These anti-nutrients limit the digestion and absorption of nutrients and result in reduced bioavailability of nutrients and flatulence production (Medoua *et al.*, 2007). Technological processes (for example, cooking) partially eliminate most anti-nutrients so that their acute toxicity is, as a rule, mild (Adeparusi, 2001; West *et al.*, 2007). Medicinal uses of Cocoyamare limited but include applying grated corms for boils, snakebites, and rheumatism in Gabon; consuming boiled young leaves for hypertension and liver issues in Mauritius; using leaf juice for eczema; and treating boils and ulcers with corms in Madagascar.

Cocoyam has also been reported to contain a number of different health related effects due to its phytochemical constituents such as polyphenols and carotenoids (Champagne, 2010). Phytochemicals such as carotenoids are also nutritionally important as precursors to essential vitamins (Drapal, 2019). The presence of these phytochemicals is often associated with the pigmentation of the food due to their specific absorbance wavelengths of light (Davis, 2019). The underutilization of certain cultivars limits dietary (i.e., nutrient and antinutrients) diversity that would otherwise benefit human health and well-being. As such, the purpose of this research is to identify the antinutrientscomposition of nine cocoyam varieties (NXe001, NXe002, NXe003, NCe004, NCe005, NCe006, NCe007, NCe008, NCe009) grown in Port Harcourt, Rivers State, Nigeria.

Materials and Methods

Materials

Experimental Site

This study was conducted at the Research Plot, Department of Plant Science and Biotechnology, Rivers State University, Port Harcourt, Rivers State, Nigeria, which experiences tropical monsoon climate with a latitude and longitude of (4.804^{o}N and 6.980^{o}E) and an annual temperature range of 25^{o}C - 27^{o}C, annual rainfall of 200.45mm and relative humidity of 78% - 89%.

Soil Collection

Loam soil for the study was obtained from the Department of Plant Science and Biotechnology, Botanical Garden, Rivers State University, Port Harcourt, Rivers State, Nigeria. Twenty (20) kg of soil was sacked into a polythene bags.

Source of Plant Sample
Nine varieties of cocoyam corms(NXe001, NXe002, NXe003, NCe004, NCe005, NCe006, NCe007, NCe008, NCe009) were obtained from National Root Crops Research Institute (NRCRI), Jos, Plateau State, Nigeria.

Sowing of Corms
The corms were sown into polythene bags (55 x 49 x 49 cm) containing 20kg of loam soil at the rate of two corms per bag. Corms of equal sizes were selected for planting for uniformity and bases for comparative study.

Experimental Design
The corms planted in the polythene bags had nine varieties which was replicated six times and arranged in a Completely Randomized Design in the open field giving a sample size of 54 experimental units.

Cultural Practices
Watering of the plant was done at 2-days interval by applying one litre of water per experimental unit respectively; weeding and earthing of the plants were carried out when necessary.

Methods
Antinutrient Composition

Procedure for samples extraction and analysis of saponin and other anti-nutritional components or profile in plant sample
Materials used: Erlenmeyer flask, 50ml, Gooch crucibles, 50ml, 50 pore size, dispenser, ashless Whatman No. 40 filter paper, test tube, drying oven, muffle furnace, glass rod.

Reagents: 70% acetone in water (70ml acetone + 30ml water), pure acetone, 0.1M yb-acetate (that is $yb(CH_3COO)_3.4H_2O$), 0.1M triethanolamine (TEA) in 70% acetone ($N(CH_2.CH_2OH)_3$)

Preparation of yb-acetate
Twenty grams of yb-oxide was added to one litre of 0.15M acetic acid. Refluxed contents till solution became clear (approximately 10hrs). evaporated to about 250ml and recrystallized in about 500ml of 95% ethanol overnight, then filtered and dried crystal of yb-acetate (this yielded 40g).

Extraction procedures
Weighed 2.0g of sample into a set of test tube. Added 30ml of 70% acetone in water to the test tube. Placed the tube in an ultrasonic water bath at 10^oC for 5 minutes. Stirred occasionally with a glass rod. Filtered through a 50-60U Gooch crucible into a 50ml Erlenmeyer flask.

Repeated the extraction three times following the above two steps. Rinsed the test tube with the final 3ml portion of 70% acetone in water and emptied into the crucible. Then returned the residue for saponins and other anti-nutritional factors analysis

Analysis on UV/VIS Spectrophotometer

Prepared working standards of 0.0, 2.0, 4.0, 6.0, 8.0ppm from the 1000ppm saponin reference standard using the equation C1V1=C2V2, in 100ml volumetric flask. The instrument model Genesys 105 UV/VIS was calibrated, using a certified calibrated standard of 4.0ppm to give 0.400 absorbance. The working standards were first run, which the software used to calculate and plot the standard equation. Then the absorbance of the samples of unknown concentration were ran. The instrument used the standard equation generated from the absorbance of the standard of known concentration to calculate the concentrations of the samples of unknown for reporting. The software calculated final results were displayed on the system or computer read out for reporting.

Procedures for the extraction and analysis of fatty acids profile using water 616/626 HPLC instrumentation

Materials used: waters 616/626 HPLC, fume hood, spatula, weighing balance, 5ml pipette, centrifuge machine, vortex mixer/shaker

Reagents used: mixture of acetic acid, propanoic acid, isobutryic acid, butyric acid, isovaleric acid, valeric acid, lactic acid in the ratio of 1:1 and dilute to 1000ml with ultrapure water. This was used to prepare the combined working standards for the analysis.

Extraction procedures

Weighed 2.5g of each sample into a set of 50ml centrifuge tubes. Dispensed 20ml of ultrapure water to cover the sample. Placed in a cold environment (fridge) at 4^{o}C and left for 7 days. Shaked the sample solution for 35 runs, centrifuged the sample for 10 minutes at 2000rpm. Decanted or transferred the supernatant to a set of new centrifuge tubes, labelled and stored in cold room. Pipetted 1.5ml of the above extracted sample solution, then mixed with the internal standard into a 10ml centrifuge tube. Mixed thoroughly and allowed to stand for a minimum of 30 minutes. Again, centrifuged the contents at 3000rpm for 10 minutes.

Analysis/running the sample extracts on the water 616/626 HPLC

The instrument was set up according to the manufacturers specification as follows: Nitrogen gas flow rate= 40ml/minutes, Temperature: for detector = 35^{o}C, for injector = 28^{o}C, Colum = 25^{o}C. Samples were arranged on a set of auto-analyser cups of 5ml each. A set of working standards of 0.0, 2.0, 4.0, 6.0 and 8.0ppm were first arranged on the autoanalyzer cups and arranged on the tray first, followed by the extracted samples. The prob of the instrument picks the sample through the injection port into the instrument. The heat temperature vaporizes the samples into different fractions for movement through the help of the Mobil phase and along the stationary phase. The lighter molecules elute to the detector first, measured by the interphase digital software, then followed by the heavier molecules until all the analysis get eluted. The detector used was fluorescence detector. The software stores the elution intensity of the standards of the known concentrations and uses it to calculate the concentration of the analytes of the unknown concentration and displays the final results on the computer rend out for printing or reporting.

Results

Antinutrients Composition

The antinutrient composition for all nine varieties of cocoyam is shown in Table 1, revealing the presence of phytate, tannin, oxalate, saponin, alkaloid, glycosides, flavonoids, phenols, amino acids, chlorophyll, carotenoids and fatty acids.

Phytate, tannin and oxalate were revealed to be highest (5.13±0.00; 14.75±0.00 and 18.86±0.00) in NCe008 and lowest (3.47±0.00; 9.98±0.00 and 12.77±0.00) in NCe004 respectively. Saponin content was more (9.54±0.00) in NCe008 than other varieties with NXe001 recording lowest (6.08±0.00). alkaloid content amongst all varieties had highest content (9.75±0.00) and lowest (1.00±0.00) in NCe007 and NCe006 respectively. Highest (2.51±0.00) and lowest (1.35±0.00) values of glycoside content was recorded from NXe002 and NCe009. Flavonoid content was lowest (35.35±0.04) in NCe009 and highest (44.39±0.00) in NCe008 compared to all varieties studied. Phenolics revealed that NXe002 and NCe004 as the highest (103.7±0.00) and lowest (52.06±0.00) values. Amino acid content amongst all varieties shows that NCe008 had highest (7.97±0.00) contents and lowest (3.25±0.00) contents recorded in NCe005. Chlorophyll content was more (78.41±0.00) in NCe004 than other varieties while less contents (18.66±0.00) recorded in NXe003. Highest value (88.73±0.00) and lowest values (57.30±0.00) of carotenoids were recorded in NCe009 and NCe005 compared to other varieties. Fatty acid content was recorded to be highest (1.96±0.00) and lowest (0.67±0.00) in NXe002 and NCe007 respectively. In general, NCe008 revealed to be high in antinutrients while NCe004 revealed to be least source of antinutrients amongst all cocoyam varieties studied.

Table 1: Antinutrient Composition of Nine Colocasia Varieties

Sample	Phytate (g/100g)	Tannin (g/100g)	Oxalate (g/100g)	Saponin (g/100g)	Alkaloid (g/100g)	Glycosides (g/100g)	Flavonoids (g/100g)	Phenolics (g/100g)	Amino acids (%)	Chlorophyll (ug/g)	Carotenoids (ug/g)	Fatty-acids (g/100g)
NXe001	4.14±0.00^{a}	11.90±0.00^{f}	15.23±0.02^{e}	6.08±0.00^{h}	9.06±0.03^{d}	1.57±0.01^{e}	35.78±0.00^{h}	73.67±0.00^{g}	5.51±0.00	62.99±0.00	84.03±0.00	0.88±0.00
NXe002	3.90±0.00^{a}	11.23±0.00^{g}	14.43±0.11^{f}	7.29±0.04^{e}	8.69±0.00^{e}	2.51±0.05^{a}	40.92±0.00^{f}	103.7±0.00^{b}	4.49±0.00	42.67±0.00	77.44±0.00	1.96±0.00
NXe003	4.26±0.00^{a}	12.26±0.01^{d}	15.70±0.02^{d}	7.93±0.00^{d}	5.67±0.00^{i}	1.93±0.00^{d}	37.20±0.00^{g}	67.70±0.00^{h}	5.19±0.00	18.66±0.00	82.96±0.00	0.81±0.00
NCe004	3.47±0.00^{a}	9.98±0.00^{i}	12.77±0.01^{h}	6.46±0.00^{g}	9.24±0.00^{c}	2.26±0.00^{b}	42.24±0.00^{e}	52.06±0.00^{i}	3.71±0.00	78.41±0.00	81.50±0.00	0.80±0.00
NCe005	4.32±0.00^{a}	12.44±0.00^{c}	15.90±0.00^{c}	8.07±0.05^{c}	8.51±0.00^{g}	2.04±0.00^{c}	43.28±0.01^{c}	98.83±0.07^{c}	3.25±0.00	30.18±0.00	57.30±0.00	0.94±0.00
NCe006	4.25±0.00^{a}	12.22±0.00^{e}	15.64±0.00^{d}	7.91±0.00^{d}	1.00±0.00^{a}	1.92±0.00^{d}	43.80±0.00^{b}	109.59±0.05^{a}	3.67±0.00	55.06±0.00	81.54±0.00	0.86±0.00
NCe007	3.67±0.00^{a}	10.58±0.01^{h}	13.53±0.01^{g}	6.84±0.00^{f}	9.75±0.00^{b}	1.38±0.00^{f}	43.24±0.00^{d}	91.74±0.00^{d}	7.43±0.00	52.18±0.00	62.96±0.00	0.67±0.00
NCe008	5.13±0.00^{a}	14.75±0.00^{a}	18.86±0.00^{a}	9.54±0.00^{a}	8.64±0.00^{f}	2.24±0.00^{b}	44.39±0.00^{a}	84.70±0.00^{e}	7.97±0.00	26.94±0.00	77.27±0.00	1.95±0.00
NCe009	4.85±0.00^{a}	13.96±0.02^{b}	17.83±0.00^{b}	9.02±0.00^{b}	7.52±0.00^{h}	1.35±0.00^{g}	35.35±0.04^{i}	77.15±0.00^{f}	7.55±0.00	45.67±0.00	88.73±0.00	1.95±0.00
LSD	0.0000	0.0190	0.0710	0.0397	0.0182	0.0314	0.0286	0.0512	0.0000	0.0000	0.0000	0.0000
Significant Difference	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Means with different superscripts within the same row are significantly different ($p<0.05$)

Keys:
NXe **001- Ede Ocha White Flesh Colocasia**
NXe**002-Ede Uhie Pink Flesh Colosia**
NXe **003-Okoroko Yellow Flesh Colocasia**
NCe 004-Coco- ndiya White Flesh Colocasia
NCe 005-Ede Ofe Green Cream Flesh Colocasia
NCe 006-Ede Ofe purpe Cream Flesh Colocasia
NCe 007-Giant Ede Ofe White Flesh Colocasia
NCe 008-Ukpong Cream Flesh Colocasia
NCe 009- Gyana Purple Flesh Colocasia

Discussion

The results for antinutrients composition revealed trace amount of phytate, oxalate, tannin, saponin, alkaloid, glycosides, flavonoids and phenolics as it aligns with the results of Kalu *et al.,* (2020) who reported the presence of oxalate, phytate, tannin, saponin and cyanide. Similar results were also recorded by Krishnapriya and Suganthi (2017) in their study, as the reports of other researchers also agrees to the current findings (Olaleye *et al.,* 2013; Grace *et al.,* 2018) who reported similar observations. In humans and most animals, alkaloids and flavonoids have been observed to possess antidiuretic, antispasmodic, antimicrobial, anti-inflammatory and analgesic effects (Owoyele *et al.,* 2002).

The values for phytate, tannin and oxalate from this study were relatively higher than those reported in the study by Grace *et al.,* (2018), similar values of results were also revealed by Huang *et al.,* (2007) in their study in *Colocasia*. Tannins being phenolics compounds that react with proteins (Alkaf *et al.,* 2019) serve as astringent and adversely affect feed intake. Tannins also bring about their antinutritional influence by precipitation or binding dietary protein and digestive enzymes to form complex which are not readily digestible (Bertozzi *et al.,* 2021). Tannins have also been reported to inhibit the activities of some enzymes like amylase and lipase (Gnanasekara, 2018).

Oxalates have been reported to have an effect on human nutrition and health by accumulating kidney stone (Mesret, 2025). Popova and Mihaylova (2019) reported that even small amount of oxalate causes burning in the ears, eyes, mouth and throat and when taken in large amount causes abdominal pain, muscle weakness, nausea and diarrhoea. Garc (2022) reported that the presence of compounds such as magnesium and potassium in oxalate rich foods have a role in reducing the risk of kidney stone.

Saponins as recorded in this study have been reported to have potentials of obstructing nutrient assimilation by rumen microbiota and subsequently impairing nutritional digestibility and overall animal productivity (Singh *et al.,* 2025). This study also corresponds to the reports of Bhandari and Kawabata (2004) stating that several antinutrients are present in roots and tuber crops. Similar results to this current study were also observed in the reports of Huang *et al.,* (2007) and Njinatang *et al.,* (2008).

The glycosides values in this study corresponds to those reported by Norman *et al.,* (2007). Amino content of this current study agrees with the results of Singh *et al.,* (2023) and Sarita *et al.,* (2025) as it is reported to be important in combating malnutrition (Alam *et al.,* 2021). The chlorophyll and carotenoids contents of this study correlates with the findings of Sarket *et al.,* (2019). The results are in agreement with Nuwamanya *et al.,* (2014) in cassava, Ghodke *et al.,* (2018) in onions and Norshazila *et al.,* (2017).

Conclusion

This study addressed the knowledge gap that existed in cocoyam, particularly the paucity of scientific data by providing information on antinutritionalfactors of the nine varieties under study. the result which revealed that NCe008 recorded higher values for antinutrient profile making it a good source for bioactive compounds which is beneficial for medicinal and therapeutic uses.Although the occurrence of high antinutrients in NCe008 does not diminish its priority; it defines the next research task of processing or breeding strategies that lower antinutrients without sacrificing other nutritional contents.

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