The scale **Journal Website:** https://thescalejournal.com.ng/
An Interdisciplinary Journal of
The ACADEMIC STAFF UNION OF POLYTECHNICS - ZONE D
ISSN: 2992-3727 Published 30th November, 2025

PROXIMATE COMPOSITION AND ANTINUTRIENT CONTENT OF THREE COCOYAM CORMS PURCHASED FROM NEW MARKET IN ABA, ABIA STATE, NIGERIA

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ABSTRACT
In this study, *Colocasia. esculenta, Xanthosoma sagittifolium* and *Xanthosoma atrovirens* corms were evaluated for their proximate, and their anti-nutrient factors. The analysis was carried out using standard analytical procedures. Significance of the Difference was measured using Anova (Least Significance difference). The moisture content of *Xanthosoma sagittifolium, Colocasia esculenta* and *Xanthosoma atrovirens* were10.32 %, 11.61 % and 10.47 % requisitely. Moisture content (11.61 %), Ash (2.68 %) and crude protein contents 6.53 % of *Colocasia esculenta* were significantly higher than in *Xanthosoma sagittifolium* and *Xanthosoma*. *atrovirens* Higher significant levels of crude fiber (1.60 %), Ether extracts (1.54 %) and carbohydrate 79.48 % were detected in *Xanthosoma sagittifolium. Colocasia. esculenta* showed significantly higher antinutrient levels of alkaloid 1.61 %, saponin 1.47 %, oxalate 2.65 %, HCN 1.82 %, phytate 1.29 % and flavonoid 1.35 % comparedto *C. esculenta*. and *X. atrovirens*
Keyword: Proximate, Antinutrient, Corms, Carbohydrate, Colacocia

INTODUCTION
Cocoyam (family Araceae) is a tropical staple crop cultivated primarily for its edible corms and cormels. The two main cultivated genera are *Colocasia* (taro) and *Xanthosoma* (tannia), both of which are important for food security in tropical and subtropical regions (Opara, 2003; Huang *et al*., 2010; Chaïr *et al*., 2016). Cocoyam is a tropical food crop that can be grown under flooded or upland conditions (Agu, *et al*.,2016). Cocoyam is valued for its nutritional composition, medicinal properties, animal feed potential, and cash income for farmers and traders. It is consumed boiled, roasted, fried, or processed into flour and starch for industrial uses. Cocoyam is one of the underutilized crops widely cultivated in tropical and subtropical areas of the world for its edible corms and cormels (Huang *et al*. 2010; Chaïr *et al*. 2016).
Despite being considered underutilized compared to yam, cassava, and sweet potato, cocoyam remains a staple for millions in West and Central Africa, particularly Nigeria, Ghana, and Cameroon, which account for over 60% of Africa's production (Onyeka, 2014). It is an important staple food crop for most rural population in Africa, Asia and Pacific Islands (Gebre *et al*. 2015; Ganança *et al*. 2017), including some parts of South Africa. Cocoyam has higher digestibility and greater mineral and vitamin content compared to cassava, making it a candidate for combating malnutrition. Mabhaudhi *et al*. (2014) in their report stated that increasing the competitiveness of taro can play an important role in alleviating poverty and ensuring long-term food security.

However, cocoyam corms contain antinutritional factors such as oxalates, phytates, alkaloids, and cyanogenic glycosides, which limit their bioavailability and safe utilization if not adequately. processed (Gemede & Ratta, 2014; Gupta *et al*., 2015). This study aimed to evaluate the proximate composition and antinutrient contents of three cocoyam varieties commonly consumed in Aba, Nigeria, thereby contributing to food quality data and nutritional planning.

ISSN: 2992-3727 Published 30th November, 2025

MATERIALS AND METHODS

Sample collection and Preparation

Three varieties of cocoyam *Colocasia esculenta, X. sagittifolium* (red cocoyam) and *X. atrovirens* (white cocoyam) samples were randomly selected and purchased from New Market in Aba, Abia State, Nigeria. Subsequently, the succulent part of the cocoyam varieties was collected, washed in running tap to remove sand and stone peeled and oven dried at 60 ºC. to constant weight. The dried samples were milled into fine flour and passed through a 2 mm sieve. Thereafter, the samples were placed in airtight container, well labeled for easy identification. until the analysis.

Quantitative Phytochemical Analysis

Phytochemical Analysis (Quantitative) Phytochemical tests were carried out to determine the presence of the bioactive compounds (alkaloid, glycosides, saponins, tannins, flavonoids, phytate, phenol and steroid) present in the plant materials, using different standard methods as described by Okwu (2005) and AOAC (2019).

Alkaloids Content

This was done by the alkaline precipitation gravimetric method Each of the samples (5 g) was weighed into a 250 ml beaker and 200 ml of 20 % acetic acid in ethanol (1:10) was added and covered to stand for 4 hrs. This was filtered and the extract was concentrated using water-bath to one quarter of its original volume by evaporation and treated with drop-wise addition of conc. aqueous NH_4OH until alkaloids was precipitated. The whole solution was allowed to settle and the precipitate was collected by filtration which was later dried and weighed. The alkaloid content was calculated and expressed as mg/100 g of the weight samples analyzed.

Saponins Content

Each of the plant samples (5 g) were dispersed in 200 ml of 20 % ethanol. The suspension was heated over a hot water bath for 4 hrs with continuous stirring at about 55 ^{O} C. The mixture was filtered and the residue re-extracted with another 200 ml of 20 % ethanol. The combined extracts were reduced to 40 ml over a water bath at about 90 ^{O}C. the concentration was transferred into a 250 ML separator funnel and 20 ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated after which n-butanol (60 ml) was subsequently added and the combined n-butanol extracts were washed twice 10 ml of 5% aqueous sodium chloride. The remaining solution was poured into a dried pre-weighed crucible and dried in an oven at 60 ^{o} C to a constant weight.

Flavonoids Content

The total flavonoid content of plant extract was determined as described by Okwu (2005). Each of the plant samples (5 g) was weighted into 100 ml plastic bottle and extracted repeatedly with 100 ml of 80 % aqueous ethanol at room temperature. It was filtered with Whatman No 42-fitter paper into 100 ml flask. The filtrate was transferred into a crucible dish and evaporated to dryness over a water bath. This was further dried in an oven at 60 ºC at 30 minutes and cooled in desiccators. The crucible and the content were weighted and recorded.

Oxalate

Total oxalate was determined by acid extraction and $KMNO_4$ titration. 0.5 g dried sample of cocoyam was extracted in 3 M HCL at 80-ºC for 1 hr, filtered and diluted to volume. An aliquot was precipitated with

ISSN: 2992-3727 Published 30th November, 2025

$CaCl_2$, the calcium oxalate dissolved in hot NCL, and titrated against standardized $KMNO_4$ until persistent pink endpoint. Oxalate content was calculated using stochiometric factors and expressed as mg/100 g DW

Phytate

Phytate was quantified using a modified Wade reagent method, 0;5 g sample was extracted with 0.2 M HCL for 2hr, centrifuged, and supernatant reacted with Fe (111)-sulfosalicylate (Wade reagent). Absorbance measured at 500 nm was compared to sodium phytate standards. Results were expressed as mg phytic acid/100 g DW (Gao *et al.,*2007). Cyanide concentration was obtained.

Hydrogen Cyanide (HCN)

Total cyanide was analyzed by acid hydrolysis followed by alkaline picrate colorimetry. Homogenized sample (10 g) was hydrolyzed with dilute H_2SO_4 and steam- distilled into 0.1 M NaOH. Aliquots were reacted alkaline picrate and Absorbance measured at 510 nm. Cyanide concentration was obtained from KCN standaeds and converted to mg HCN/100 g DW

Proximate Analysis

The analysis was conducted for healthy and undamaged cocoyam corms. Standard methods of the association of official analytical chemists (AOAC, 2019) with slight modifications where necessary were used to determine the crude protein, crude fibre, and crude fat, total ash content. The analyses were carried out in triplicates and the mean values were recorded.

Determination of Moisture Content

Moisture content was determined by oven drying method. Five grams of the sample was weighed into a clean, pre -weighed moisture can and dried in a hot air oven at 105 ^oC until a constant weight was achieved; the loss in weight was expressed as the percentage of moisture content
(AOAC, 2019).

Determination of Total Ash

Ash content was determined by incinerating 2 g of the sample in a muffle furnace at **550** ^oC until a light gray ash was obtained. The percentage ash content was calculated relative to the initial sample weight (AOAC, 2019)**,**

Determination of Crude Fibre

Crude fibre was determined by digestion 2 g defatted sample with 1;25 % H_2SO_4 followed by 1,25 % Na OH solution. The residue was filtered, dried, incinerated at 550 ^oC and the loss in weight after ashing was taking as crude fibre (AOAC, 2019).

Determination of Crude Protein

Crude protein was estimated by the Kjeldahj method which determines the total nitrogen content. Approximately 1 g of the sample was digested in concentrated Sulfuric acid using a catalyst, distilled and titrated with standard acid. The nitrogen obtained was multiplied by a conversion factor of6,25 to obtain crude protein (AOAC,2019)

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Determination of fat

Crude fat was determined using Soxhlet extraction with petroleum ether (boiling point 40 – 60 ^{o}C) as solvent. Two grams of the dried sample was extracted for 6hours, after which the solvent was evaporated **and** the fat residue weighed to obtain crude fat content (AOAC, 2019).

DETERMINATION OF CARBOHYDRATE (CHO). Carbohydrate content was calculated by difference subtracting the sum of moisture, Ash, fibre, fat, protein. 100 – (MC + Ash + fibre + fat + protein). (Onwuka,2018)

RESULT

In this study C. *esculenta*, *X. atrovirens* and *X. sagittifolium* were analyzed for their proximate content and with their anti-nutrient factors. The result of the proximate analysis table 1 indicated moisture content of *Xanthosoma sagittifolium Colocasia esculenta* and *Xanthosoma atrovirens* were 10.32%, 11.61 %) and 10.47 %) requisitely. the result also showed Moisture content (11.61), Ash (2.68%) and crude protein contents 6.53 detected in *Colocasia esculenta Xa* were significantly higher compared to *Xanthosoma sagittifolium* and *Xanthosoma*. *Atrovirens*. Ether extracts (1.54 %) dry matter 89.67 % and carbohydrate 79.84 % were significantly higher in *X, sagittifolium* than in *X, sagittifolium*, and *X. atrovirens*which were generally lower.

The result of antinutrient presented in table 4.2 showed that *C. esculenta* had significantly higher antinutrient levels of alkaloid 1.61, saponin 1.47, oxalate 2.65, HCN 1.82, phytate 1.29 and flavonoid 1.35 compared to *X, sagittifolium* and *X. atrovirens*

Table 4.1: Proximate composition of the cocoyam varieties

	MC	DM	ASH	CP	CF	Ee	CHO
C1	10.32 ± 0.08c	89.67 ± 0.08a	2.44 ± 0.01b	4.62 ± 0.00c	1.60 ± 0.01a	1.54 ± 0.01a	79.48 ± 0.09a
C2	11.61 ± 0.01a	88.38 ± 0.02c	2.68 ± 0.01a	6.53 ± 0.01a	1.52 ± 0.00b	1.43 ± 0.01b	76.22 ± 0.01c
C3	10.47 ± 0.03b	89.53 ± 0.03b	2.37 ± 0.01c	5.49 ± 0.01b	1.35 ± 0.01c	1.38 ± 0.01c	78.93 ± 0.04b
F-ratio	620.26	602.653	804.778	49567.2	2187.5	603	2768.27
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

CI-*X. sagittifolium C2--Colocasia esculenta,* and C3- *X. atrovirens* (white cocoyam)

Discussion

The proximate composition of the cocoyam varieties ci c2 c3 revealed significant differences across the analyzed parameters indicating inherent varietal influences on their phytochemical and nutritional quality.

Moisture

1he moisture content of the cocoyam varieties differed significantly ($p<0.05$) with C. *esculenta* (11.61 %) exhibiting the highest value followed by *X. atrovirens* (10.47 %) while *X. sagittifolium* had the lowest (10.32 %,). High moisture content in tubers often predisposes them to microbial deterioration thereby reducing storage stability (Eleazu & Okafor,2015), hence, the relatively lower moisture observed in *X. sagittifolium* suggest better shelf life potential.

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Ash Content

Significant variation ($p<0.05$) was observed in the ash content which reflects the mineral levels \to be higher in *C. esculenta*. (2.68 ± 0.01%) followed by X. *sagittifolium* (2.44 ± 0.01%) and *X. atrovirens* (2.37 ± 0.01%) positioning *C. esculenta*. as the best mineral source. These finding is consistent with Matiki *et al* (2017).

Dry Matter

X. *sagittifolium* had the highest dry matter (89.67 ± 0.08a) followed by *X. atrovirens* had (89.53 ± 0.03b) and *C. esculenta*. was the lowest (88.38 ± 0.02c). this suggest that *C. esculenta*. contains more solid nutrients per unit weight making it potentially richer in food value.

Crude Protein

Crude protein content also varied significantly ($p< 0.05$) C. *esculenta* showed the highest crude protein content (6.53 ± 0.01a) while *X. atrovirens* (5.49 ± 0.01b) and *X.' sagittifolium* (4.62 ± 0.00c) had lower amounts, this suggest that *C. esculenta* may contribute more dietary protein which is important for body growth and repair. The value recoded in this study highlights the potential to complement protein deficient diet. These findings agree with (Olayiwola *et al* 2013) who reported protein contents ranging between 10 – 18 % in some cocoyam accessions.

CRUDE FIBRE

Crude fibre was highest *X.' sagittifolium* **(**1.60 ± 0.01a) followed by *C. esculenta* (1.52 ± 0.00b) while *X. atrovirens* (1.35 ± 0.01c) was the lowest. The higher fibre content in. *X.' sagittifolium* nay improve digestion.

Ether Extract

Ether extract (fat content was generally low across all varieties with minor differences reaffirming cocoyam's reputation as a low-fat food. The low-fat content is desirable from the health perspective, as it minimizes risks associated with lipid related disorders. Similar low-fat values have been reported for cocoyam by Wadal *et al,* (2019), further confirming that cocoyam is not a significant lipid source

Carbohydrate

The carbohydrate content of the cocoyam corms is considerably high 76.22 ± 0.01c, 78.93 ± 0.04b 79.48 ± 0.09a and Carbohydrate is a principal source of energy. This high level of carbohydrate observed in the corms is an indication that it is the main nutrient contained in cocoyam' as with the other root crops that provide dietary energy and this agrees with Eleazu (2012) who noted that carbohydrates constitute 70 to 80 of cocoyam corms making them reliable energy source. Therefore, the cocoyam corms can be served as an alternative source of carbohydrate for the consumers. Cocoyam is a rich source of carbohydrate, dietary fiber, but it is low in fat, protein and ash contents (Owusu-Darko *et al*., 2014). More so, the main nutrient supplied by cocoyam as with other roots and tuber crops is dietary energy provided by carbohydrates (Jirarat *et al*., 2006). Nutritionally, the carbohydrate content across the three varieties confirms cocoyam as a high-energy food comparable to other root crops (Eleazu, 2012; Owusu-Darko *et al*., 2014).

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Table 2 Antinutrients contents of the cocoyam varieties

	Alkaloid	Saponin	oxalate	HCN	phytate	Flavonoid
C1	1.46 ± 0.02a	1.39 ± 0.01b	2.38 ± 0.02b	1.24 ± 0.01c	0.95 ± 0.01b	0.84 ± 0.02c
C2	1.61 ± 0.06b	1.47 ± 0.01a	2.65 ± 0.06a	1.82 ± 0.01a	1.29 ± 0.01a	1.25 ± 0.01a
C3	1.41 ± 0.01a	1.26 ± 0.02c	1.93 ± 0.01c	1.47 ± 0.02b	0.85 ± 0.01c	1.09 ± 0.01b
F-ratio	26.565	236.083	254.771	2567.444	4945.333	1063.727
P-value	0.0010	<0.001	<0.001	<0.001	<0.001	<0.001

CI-*X. sagittifolium C2--Colocasia esculenta,* and C3- *X. atrovirens* (white cocoyam)

Antinutrient Composition

The antinutrient composition of *Xanthosoma sagittifolium, C. esculenta*. and *X. atrovirens* varied significantly across all parameters assessed (Table 2). Antinutrients are naturally occurring compounds in plants that reduce the bioavailability of nutrients though some exhibit health promoting effects when present in moderate moderate concentrations (Gemede and Ratta,2014; Gupta *et al*., 2015). The antinutrient profile (Table 2) revealed higher concentrations of alkaloids (1.61%), saponins (1.47%), oxalates (2.65%), hydrogen cyanide (1.82%), phytates (1.29%), and flavonoids (1.35%) in *C. esculenta* compared to the other varieties. While these compounds reduce nutrient bioavailability, moderate levels may confer functional health benefits.

Alkaloids

Among the samples *C. esculenta*. recorded the highest alkaloid content (1.61 ± 0.06b) followed by *Xanthosoma sagittifolium* (1.46 ± 0.02[a]) while X. *atrovirens* had the lowest concentration (1.41 ± 0.01[a]). Alkaloids though known for their toxicity in high doses may also contribute medicinal and analgesic effects (Hussain *et al.,*2012). However, higher concentration in *C. esculenta*. suggest that this variety may impart stronger bitter taste compared to Xanthosoma *sagittifolium* and *X. atrovirens*

Saponins

Saponins concentration ranged from 1.26 ± 0.02c to 1.47 ± 0.01a. the highest content was observed in *C. esculenta*. while *X. atrovirens* showed the lowest. Saponins are associated with reduced feed intake and inference in nutrient absorption. They also possess hypocholesterolemia and anticancer properties (Okwu, 2005). The relatively low levels observed in all samples suggest minimal adverse nutritional effect.

Hydrocyanic acid (HCN)

C. esculenta. exhibited the highest level (1.82 ± 0.01a) and the lowest in *X. sagittiffolium* (1.24 ± 0.01c). Excessive cyanide intake poses toxicological risk, thus making *X. sagittiffolium for food safety.* Although cyanogenic glycosides contribute to flavor, excessive levels are toxic and require reduction through processing (Udensi *et al*/.2010)

Phytate

Phytate content ranged between **0.85** ± 0.01c 0.95 ± 0.01b and 1.29 ± 0.01a) *C. esculenta*. and *Xanthosoma sagittifolium* contained significantly higher levels than *X. atrovirens*. Phytates chelate essential minerals such as Ca, Zn thereby reducing their bioavailability (Gupta *et al.,*2015)'

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Oxalate concentration

Oxalate concentration ranged from (1.93 ± 0.01c) X*, sagittifolium* to (2.65 ± 0.06a) *C. esculenta*. Oxalates are important because of their ability to form insoluble complexes with calcium reducing its bioavailability (Oboh, 2006).

Flavonoids

Flavonoids C. *esculenta*. exhibited highest flavonoid content (1.25 ± 0.01a) followed by *C. esculenta*. (1.09 ± 0.01b) while *Xanthosoma sagittifolium* recorded the lowest (.84 ± 0.02c) flavonoids are widely recognized as antioxidant despite being categorized as antinutrient (Panche *et al*., 2016). the higher level of flavonoids in *Colocasia esculenta suggest* that this variety may offer greater functional heajth benefits compared to *Xanthosoma sagittifolium and X. atrovirens*

Overall, varietal differences observed align with reports by Matikiti *et al.* (2017) and Wadal *et al*. (2019), suggesting that genetic diversity influences nutrient composition and antinutrient levels in cocoyam. These findings underscore the importance of varietal selection in maximizing nutritional value while minimizing antinutritional risks.

CONCLUSION

From this research, it can be inferred that the cocoyam varieties studied are rich in nutrients and antinutrient factors needed for good growth, maintenance and health of the human body. The result demonstrates that while C. *esculenta*. was superior in protein and mineral content *X. sagittifolium* offers advantage in terms of carbohydrate fibre then *X. atrovirens* generally exhibited lower values across most parameters. These compositional differences highlight the importance of varietal selection in cocoyam utilization whether for direct consumption or nutrition health.

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