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Determination of Phytochemical Content of Dry *Colocasia Esculenta* (Cocoyam) Leaves Consumed by the People of Ezeagu in Enugu State, Nigeria

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ABSTRACT

This study investigated the phytochemical composition of dried *Colocasia esculenta* (cocoyam) leaves traditionally consumed in Ezeagu, Enugu State, Nigeria. The leaves, collected and air-dried, were subjected to both qualitative and quantitative phytochemical analyses using ethanol extraction. Qualitative screening revealed the presence of bioactive constituents including carbohydrates, reducing sugars, alkaloids, saponins, flavonoids, tannins, phenols, and glycosides. Quantitative results indicated high tannin content (16.15%), followed by alkaloids (1.41%) and saponins (1.03%). Flavonoids (0.61%), glycosides (0.014%), and phenols (0.0012%) were present in lower concentrations. The phytochemical profile underscores the nutritional and medicinal potential of dry cocoyam leaves, particularly their astringent, antioxidant, and therapeutic properties. These findings support the traditional use of cocoyam leaves in local diets and herbal remedies, and advocate for their wider dietary inclusion and further pharmacological exploration.

Key words: *Colocasia esculenta*, Dry cocoyam leaves, Phytochemical screening, Tannins, Alkaloids, Saponins, Ethnomedicine, Ezeagu, Enugu State, Nutraceuticals, Traditional vegetables

INTRODUCTION

Cocoyam was first promoted as a major crop during the Biafran era in 1969 and became a focus of agricultural research in Nigeria in 1976. It comprises two main species Colocasia esculenta (taro) and Xanthosoma mafafa (tannia) cultivated mainly for their corms and cormels (1). It ranks third among root and tuber crops in Nigeria after cassava and yam, with Nigeria being the world's top producer (1). Cocoyam is a perennial plant in the Araceae family, valued for its edible roots and leaves (2). The species, originating from Southeast Asia and the Americas, are used both as food and for health benefits across various regions, including Africa and Asia (1,3).

Phytochemicals are the plant derived chemicals possessing numerous herbal & medicinal properties. Medicinal plants with important bioactive compounds play a significant role in meeting the global healthcare needs. In fact, eighty percent of African populations use some form of traditional herbal medicine, and the worldwide annual market for herbal products approaches US$ 60 billion (4). Through phytochemical screening one could detect the various important compounds which could be used as the base of modern drugs that curing various diseases (2,5). Cocoyam possesses a range of biologically active phytoconstituents such as flavonoids, sterols, glycosides, and other micronutrients (6). Phytochemically, while both species contain valuable bioactive compounds such as flavonoids and phenolics, their profiles may differ, potentially leading to variations in their medicinal properties.

In Nigeria's diverse food culture, indigenous vegetables like cocoyam leaves play a vital role in local diets, especially in rural communities (5-7). Despite their nutritional value, these leaves are underutilized due to limited scientific awareness. Colocasia esculenta grows with broad, arrow-shaped leaves and is cultivated mainly for its corms, though the leaves are also edible. Its use is more prevalent in rural than urban areas in Nigeria (8). Previous toxicity tests confirm the leaves are safe for consumption (1, 9). However, limited studies exist on their nutrient composition in Nigeria, highlighting the need for further research.

Although cocoyam leaves are rich in nutrients, they are often overlooked. In Ezeagu, Enugu State, residents prefer consuming the dried form of the leaves. This study seeks to understand the phytochemical composition that may explain this preference.

This study aims to analyze the phytochemical content of dried Colocasia esculenta leaves. Like other leafy vegetables, cocoyam leaves are affordable nutrient sources that can improve dietary balance and food security, particularly in rural settings. They are consumed fresh or sun-dried for use during

dry seasons, though less so among urban populations. Understanding the phytochemical profile of dried cocoyam leaves may explain their preference and promote their wider dietary use.

METHODS

Sample collection and Preparation: Cocoyam leaves (Colocasia esculenta (taro)) were collected after seven to eight months of planting, was obtained from the farmland at Iwollo oghe, Ezeagu LGA of Enugu State, Nigeria. The sample was air dried for 3 days and was stored in a cool dry place until analysis started.

Extraction: The extract was prepared by soaking method. Ethanol was used as the solvent of the extraction. The collected plant materials were ground to powder. 5g of the plant powder was taken and soaked into 100ml of ethanol for 3 hours.

Qualitative Analysis of Phytochemical Constituents

Ethanol extract of colocasia esculenta (L) was subjected to qualitative tests for the identification of various active constituents.

- **Tests for Carbohydrate**

Molish's test: 2-3 drops of naphthol was added in test solution (dry cocoyam leave extract). Then few drops of concentrated sulphuric acid were added from the side of the test tube. Violet colour ring was formed at the junction of two layers which indicated the presence of carbohydrates.

Barford's test: This reagent was prepared by dissolving 13.3g of crystalline neutral copper acetate in 200ml of 1% acetic acid solution. The test residue was dissolved in water and heated with a little of the reagent. If a red precipitate of cuprons oxide is formed within two minutes, monosaccharide is present.

Benedict test: To 1ml of aqueous extract, 5ml of benedict reagent(a complex solution of sodium carbonate, sodium citrate and copper sulphate pentahydrate) was added and the resulted mixture was boiled for 5mins. Initially, the solution turned green and upon boiling, a red,yellow or green precipitate was formed indicating the presence of reducing sugar.

Seliwanoff's test: To 1ml of aqueous extract, 3ml of seliwanoff's reagent (mixture of resorcinol in hydrochloric acid) was added and boiled for 2mins. A red solution was obtained which indicated a positive reaction.

- **Tests for Amino acids**

Ninhydrine test: The Ninhydrine reagent is 0.1% solution of ninhydrine in n-butanol. A little of this reagent was added to the test extract. A violet or purple colour is developed if amino acids are present.

Test for Proteins

Biuret test: To the above prepared extract, equal volume of 40% sodium hydroxide and 1% copper sulphate solution were added. Violet or purple colour produced shows the presence of proteins.

Xanthoprotein test: To the extract, 1ml of concentrated sulphuric acid was added, white precipitate was observed, then the solution was boiled. Yellow precipitate was observed, finally ammonium hydroxide was added and precipitate turns yellow if the reaction is positive.

- **Test for Flavonoids**

20% NAOH test: 2ml of extract was added with few drops of 20% sodium hydroxide, formation of intense yellow colour was observed. To this, few drops of 70% dilute hydrochloric acid were added and the yellow colour disappeared. Formation and disappearance of yellow colour indicates the presence of flavonoids in the sample extract.

Shinoda test: Pieces of magnesium ribbon and concentrated HCL were added to the sample extract after few minutes and pink colour showed the presence of flavonoid.

Pew's test: 5ml of the sample extract was mixed with 0.1g of metallic zinc and 8ml of concentrated sulphuric acid. The mixture was observed for red colour as indicative of flavonoids.

- **Test for Alkaloids**

Small quantity of extract was separately treated with few drops of dilute hydrochloric acid and filtered. The filterate was used for Wagner's test and Dragendroff's test

Wagner's test: 1ml of Wagner's reagent (iodine in potassium iodide) was added to the filterate. The appearance of reddish brown precipitate indicates the presence of alkaloids.

Dragendroff's test: 1ml of Dragendroff's reagent (potassium bismuth iodide) was added to the filterate. The appearance of brick red precipitate indicates the presence of alkaloids.

Marquis test: 1ml of marquis reagent (formaline and H_2SO_4) was added to 1ml of sample extract. 2ml of concentrated sulphuric acid and few drops of 40% formaldehyde were added and mixed. The appearance of dark orange or purple colour indicates the presence of alkaloids.

- **Test for Saponins**

Saponin foam test: 6ml of distilled water was added to 2ml of sample extract and shaken vigorously. Formation of bubbles or persistent foam indicates the presence of saponins.

- **Test for Tannins**

Ferric chloride test: Few drops of 10% alcoholic ferric chloride solution were added to 2ml of sample extract. The occurrence of blackish blue colour indicated the presence of gallic tannins and a green blackish colour indicated the presence of catechol tannins.

- **Test for Phenols**

2ml of 5% aqueous ferric chloride was added to 2ml of sample extract. Formation of blue colour indicated the presence of phenols in the sample extract.

- **Test for Glycosides**

Keller-kelloni test: 1ml of gracial acetic acid containing traces of ferric chloride and 1ml of concentrated sulphuric acid were added to the sample extract carefully. A reddish brown colour formed at the junction of two layers and upper layer turned bluish green indicated the presence of glycosides.

- **Test for Phlobatannins**

2ml of the sample extract was added into dilute HCL and observed for red precipitate which indicates the presence of phlobatannins.

- **Test for Steroids**

Salkowaski reaction: 2ml of chloroform and 2ml of concentrated ferric acid were added from the side of the test tube containing sample extract. The test tube was shaken for few minutes. The development of red colour in the chloroforms layer indicated the presence of steroids.

- **Test for Terpenoids**

0.5ml of chloroform was added to 1ml of sample extract followed by a few drops of concentrated sulphuric acid. Formation of reddish brown precipitate indicates the presence of terpenoids in the extract.

Quantitative Analysis of Phytochemical Constituents

Ethanol extract of colocasia esculenta(L) was subjected to quantitative tests to determine the percentage quantity of various active constituents.

- **Determination of Alkaloids**

Quantitative determination of alkaloid was according to the methodology by (10).

5.024g of the sample was weighed into a 250ml conical flask and 200ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4hours. It was filtered and the extract was concentrated on a hot plate to one-quarter of the original volume. 50ml of ammonium hydroxide was added and allowed to settle. The filter paper was weighed (0.826g) and was used to filter the solution. The filtrate was decarded while the residue is the alkaloid which was dried using electrothermal oven and then weighed (0.897g).

The formular below was used to determine the percentage alkaloid content.

% Alkaloid =W2-W1/WT * 100/1

Where,

W1 = weight of empty filter paper

W2 = weight after drying

WT = weight of sample

- **Determination of Saponins**

Saponin quantitative determination was carried out using the method reported by (11).

100ml of 20% ethanol was added to the 5.028g of powdered dry cocoyam leave in 250ml cornical flask. The mixture was allowed to stand for 4hours. The mixture was heated to concentrate it. The concentrated mixture was turned into the separating funnel and 20ml of diethyl ether was added to separate the sample. The lower part of the mixture was collected and added back to the separating funnel while the upper part was discarded. Then 20ml of n-butanol was added to the collected solution and was shaken thoroughly. The mixture was allowed to settle and the lower part was discarded. 10ml of 5% NaCl was added. After adding NaCl, the lower part was discarded again. Then another 10ml of 5% NaCl was added and shaken thoroughly to wash out impurities and lower part was discarded again. An empty crucible was weighed (18.290g) and the solution was introduced into it and was kept inside electro thermal oven for drying. After drying the crucible was weighed (18.342g).

The formular below was used to determine the percentage saponin content.

% Saponin =W2-W1/WT * 100/1

Where,

W1 = weight of empty crucible

W2 = weight after drying

WT = weight of sample

- **Determination of Tannins**

10ml of petroleum ether was added to 2g of the sample in 250ml cornical flask and was tightly closed with a foil. The mixture was allowed to stand for 24hours. The mixture was decanted then 20ml of solution of 20% acetic in ethanol was added and was shaken thoroughly for an hour. The mixture was filtered. 20ml of ammonium hydroxide was added to it, shaken thoroughly and was heated for 20mins to remove some of the ammonium hydroxide (to concentrate). 5ml of the mixture was collected and put into a beaker then 20ml of ethanol was added to it. It was titrated with 0.1M sodium hydroxide using phenolphthalein as indicator until pink end product is achieved.

- **Determination of Flavonoids**

25ml of 80% methanol was added tp 1g of the sample in 250ml cornical flask and was shaken thoroughly for 5mins before filtration. 1.5ml of methanol was added to the filtrate. 0.1ml of both aluminium chloride and potassium acetate was also added. Lastly, 2.8ml of water was added to it. 1ml of the solution was put into a test tube in two places A and B. The absorbance of the solution was taken using the UV-VIS spectrophotometer.

- **Determination of Phenols**

45ml of 50% methanol was added to 1g of the sample in 250ml cornical flask and was shaken thoroughly before filtration. 0.5ml of the filtrate was introduced into the test tube in two places A and B. 5ml of water was added to the test tubes. Then 0.75ml of phenol reagent was added and allowed to stand for 5mins. 2ml of $NaCO_3$ (sodium carbonate solution) was added and the volume was made up to 12.5ml with water and was allowed to stand for 30mins. The absorbance was taken at 765nm using UV-VIS spectrophotometer.

- **Determination of Glycosides**

100ml of water was added to 5g of the sample in 250ml cornical flask and was shaken thoroughly before filtration. 1ml of the filtrate was introduced into the test tube in two places A and B. 2ml of DNS (Dinitroalicyclic acid) was added. The solution was heated for 10mins using electric cooker. After cooling, 10ml of water was added and the absorbance was taken at 540nm using UV-VIS spectrophotometer.

RESULTS

Table 1: Result showing qualitative phytochemical analysis of dry cocoyam leaf (Colocasia esculenta L).

S/N	CONSTITUENT	EXPERIMENTAL METHOD	RESULT
1	**Carbohydrates**		
A	Carbohydrates	Molisch's test	++
B	Polysaccharides	Iodine Test	ND
C	Reducing sugar	Benedict's test	++
		Fehling's test	
D	Reducing Monosaccharide	Barfoed's Test	ND
		Seliwanoff test	++
2	**Protein**		
A	Protein Test	Biuret Test	ND
B	Amino Acid	Ninhydrin Test	ND
C	Aromatic Amino Acid	Xantheoprotein	ND

		Cysteine test	ND
3.	**Oil**	Filter paper	
Secondary Metabolites			
4.	Saponins	Foam Test	+
5.	Tannin (Catecholic)	Ferric Chloride Test	+
6.	Flavonoids	Alkaline Test	++
		ShinodaTes	ND
		Pew'sTest	+
7.	Alkaloids	Alkaloid test	++
		Wagner's Test	ND
		Dragindroff Test	ND
		Hager's test	ND
		Simon's Tess	ND
8.	Steroids	Salkowiski test	ND
		Libermans test	
9.	Terpeniods		ND
10.	Glycosides	Keller-kilani test	++
11.	Phenol	5% Fecl3 test	+
12.	Phlobatannins		ND

+ Present in trace concentration

++ Present in moderately high concentration

+++ Present in very high concentration

ND- (not detected)

Results showing the qualitative phytochemical screening of Colocasia esculenta L (Table 1) showed that alkaloids and flavonoids were moderately present in dry cocoyam leaf while saponins, tannins and phenols were in low concentration.

Table 2: Result showing quantitative phytochemical analysis of dry cocoyam leaf (Colocasia esculenta L).

S/N	PHYTOCHEMICALS	VALUES (%)
1	Alkaloids	1.4132
2	Saponins	1.0342
3	Flavonoids	0.60541
4	Phenols	0.00122
5	Tannins	16.1538
6	Glycosides	0.01365

Values are expressed in percentage.

Results from quantitative analysis (Table 2) showed that tannins (16.1538%), alkaloids(1.4132%) and saponins (1.0342%) were higher in the dry cocoyam leaf when compared with flavonoids (0.60541%), phenols (0.00122%) and glycosides (0.01365%).

DISCUSSION

This study aimed to determine the phytochemical composition of dried *Colocasia esculenta* (cocoyam) leaves through qualitative and quantitative analyses. The qualitative screening (Table 1) indicated the presence of several bioactive constituents including carbohydrates, reducing sugars, alkaloids, saponins, glycosides, flavonoids, tannins, and phenolic compounds. Quantitative results (Table 2) further revealed that tannins (16.15%) were present in the highest concentration, followed by alkaloids (1.41%), saponins (1.03%), flavonoids (0.61%), glycosides (0.014%), and phenols (0.0012%).

The high levels of tannins suggest potential antioxidant, antimicrobial, and astringent properties, while alkaloids and saponins are known to exhibit a wide range of pharmacological activities such as anti-inflammatory, antimicrobial, and cytotoxic effects. The presence of glycosides, although in low concentration, is noteworthy due to their established cardioactive, anti-inflammatory, and antidiabetic properties.

Olaleye et al. (12) reported significant levels of alkaloids, flavonoids, saponins, and tannins in common leafy vegetables such as *Telfairia occidentalis*. These compounds were attributed to various therapeutic potentials. The phytochemical profile of *Colocasia esculenta* leaves in this study aligns with these findings, particularly regarding the notable levels of alkaloids, tannins, and saponins. However, the tannin content observed in cocoyam leaves was substantially higher, indicating a potentially stronger antioxidant or antimicrobial activity. The findings by Ogukwe et al. (13) on *Manihot esculenta* leaves also revealed a rich composition of alkaloids, flavonoids, and saponins, with moderate levels of tannins. In contrast, *Colocasia esculenta* leaves demonstrated higher tannin content and comparatively moderate levels of alkaloids and flavonoids. This distinction underscores a unique phytochemical profile in cocoyam leaves, potentially making them more suitable for applications where astringency or polyphenol-related activities are desired. Kalu and Uchechukwu, (14) analyzed the phytochemical constituents of *Xanthosoma sagittifolium* leaves and reported the presence of saponins, flavonoids, phenols, and glycosides. The current analysis of *Colocasia esculenta* leaves revealed a similar spectrum of compounds. However, the phenol content was markedly lower, while tannin concentration was significantly higher. These differences may be attributed to species variation within the Araceae family, environmental factors, or differences in sample preparation and analytical techniques. Alawode, (15) conducted solvent-based phytochemical screening on *Icacina trichantha*, demonstrating that solvent polarity significantly affects the extraction of specific phytochemicals. Hexane (non-polar), ethyl acetate (intermediate polarity), and methanol (polar) were employed to isolate diverse compounds from leaf and tuber extracts. This study, although not stratified by solvent type, confirmed the presence of both polar and moderately polar constituents such as flavonoids, glycosides, and saponins. The absence of steroids and terpenoids in the cocoyam leaf sample may reflect either true absence or extraction limitations related to solvent selection.

Notably, Alawode's findings also revealed that leaves generally contain a greater diversity and concentration of phytochemicals than tubers. This trend is corroborated in the present analysis of *Colocasia esculenta*, supporting the assertion that leafy plant parts tend to serve as richer sources of bioactive compounds. The phytochemical richness of cocoyam leaves validates their traditional use in herbal medicine and functional food preparations.

The detection of key phytochemicals such as tannins, alkaloids, flavonoids, saponins, glycosides, and phenols in dried *Colocasia esculenta* leaves supports their potential use in therapeutic and nutraceutical applications. Comparisons with previous studies reveal that cocoyam leaves possess a unique phytochemical profile, particularly due to the high tannin content, which may confer distinctive biofunctional properties. Further investigation involving solvent-partitioned extraction and bioactivity assays is recommended to validate the pharmacological relevance and enhance the utilization of this plant in health-promoting formulations.

CONCLUSION

The phytochemical analysis of dried *Colocasia esculenta* leaves revealed a rich composition of biologically active compounds, with particularly high levels of tannins, alkaloids, and saponins. These constituents are associated with various health benefits, including antioxidant, antimicrobial, and anti-inflammatory activities. The results validate the ethnobotanical importance of cocoyam leaves among the people of Ezeagu, where the dried form is preferred and commonly used in food and traditional medicine. The high tannin content suggests potential applications in disease prevention and functional food development. This study contributes to the growing body of knowledge on underutilized indigenous vegetables and highlights the need for further research into the pharmacological properties and processing effects on the bioavailability of these phytochemicals.

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