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MICROBIOLOGICAL, PROXIMATE AND PHYTOCHEMICAL ANALYSIS OF COCOYAM (*COLOCASIA ESCULENTA* SCHOTT. ARACEAE) COLLECTED FROM FIVE DIFFERENT MARKETS WITHIN WARRI METROPOLIS

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ABSTRACT

This study investigates the microbiological, proximate, and phytochemical characteristics of cocoyam (*Colocasia esculenta* Schott, Araceae). Cocoyam samples were sourced from a local market, subsequently washed, cut into smaller pieces, air-dried, and analyzed. The results indicated that the bacterial count in the cocoyam samples ranged from 2.30 ± 1.09 to 4.50 ± 1.91, while the fungal count varied from 2.00 ± 0.10 to 4.64 ± 1.01. The identified bacterial isolates included *Bacillus polymyxa, Staphylococcus aureus, Streptococcus lactis, Pseudomonas* spp., *Clostridium sporogenes,* and *Bacillus coagulans*. Meanwhile, the fungal isolates comprised *Saccharomyces* spp., *Candida* spp., *Mucor* spp., *Aspergillus niger,* and *Penicillium* spp. Proximate analysis revealed that protein content ranged from 12.58 to 24.11 mg/kg, carbohydrates from 28.46 to 57.90 mg/kg, ash from 2.40 to 6.69 mg/kg, fiber from 10.93 to 38.21 mg/kg, dry matter from 3.04 to 4.36 mg/kg, and moisture content from 62.19% to 96.12%. Bioactive compounds such as carbohydrates, saponins, phenols, triterpenoids, phlobatannins, and tannins were present in all market samples. Additionally, steroids, terpenoids, and glycosides were found only in the Effurun, Okere, and Igbo markets, while anthraquinones and alkaloids were detected in the Effurun, Sapele, and Okere markets, respectively. These findings underscore the nutritional potential of cocoyam and highlight its diverse phytochemical composition based on geographic origin.

INTRODUCTION

The *Araceae* family's perennial root crop known as Cocoyam, *Colocasia esculenta* (L.) Schott, is grown for its edible corms and cormels throughout the humid tropics with about 100 genera and 1500 species. Nigeria produces more than 3.3 million metric tonnes of the crop annually, according to Adejumo *et al.* (2019), making it the greatest producer in the world. The related arid *Xanthosoma spp*., often known as Tannia, should not be confused with it. Together, Cocoyam and Tannia are referred to as Cocoyams in Nigeria and certain other regions of the world. This study will focus on Cocoyam, also known as *Colocasia esculenta.*

Colocasia esculenta is an erect herbaceous perennial root crop of the genus *Colocasia* that is commonly farmed in tropical and subtropical regions of the world. Even though it is unknown when the crop first arrived in the region, it is currently grown in Cameroon, Nigeria, Ghana, and Burkina Faso where it has grown significantly in importance. *Colocasia esculenta* is now grown and distributed across the tropical world. West Africa has the largest area under cultivation, which also accounts for the highest production levels. Cocoyam is also widely

grown in the Caribbean and almost all humid and sub-humid regions of Asia (Adekunle and Akinyemi, 2024).

Their underground corms are the primary reason they are produced. Similar to many other tuber crops, the Cocoyam corm has a low protein (1.5 %) and fat (0.2 %) content and a very good source of ash (1.2 %), fiber (0.8 %), and starch (70-80 g/100 g dried Cocoyam). It is a very good source of vitamin B6, vitamin C, niacin, potassium, copper, and manganese, thiamine, riboflavin, iron, phosphorus, and zinc (Quach *et al*., 2003).

The corm of the Cocoyam has a lot of B-carotene, which gives the body vitamin A and antioxidant properties. It is beneficial to those with peptic ulcers, pancreatic disease, chronic liver issues, inflammatory bowel disease, and gall bladder disease because of its nature of starch (Ikpeme *et al.*, 2007). The starch is easily digestible; its flour is regarded as nutritious for babies. It also aids in gastrointestinal issues and provides iron (Albihn andq Savage, 2021).

Cocoyam is affected by numerous infectious and non-infectious diseases, but only a few cause serious yield losses. Fungal diseases are the most destructive, with major pathogens including *Phytophthora colocasiae*, *Pythium* species, *Cladosporium colocasiae*, *Fusarium* species, *Rhizopus stolonifer*, and *Sclerotium rolfsii*. Severe outbreaks, such as the cocoyam leaf blight epidemic in Nigeria around 2009, led to near-total crop failure. Studies across West Africa and the United States have shown that these fungi cause leaf blight, leaf spot, and corm rot, resulting in tissue maceration and complete plant destruction. Several researchers have identified multiple fungal species associated with both healthy and diseased cocoyam cultivars, highlighting their pathogenic role and economic importance.

Cocoyam contains important phytochemicals and nutrients that contribute to plant defense and human health. Phytochemicals, including phenolics, flavonoids, alkaloids, tannins, and saponins, protect plants against environmental stress and pathogens while offering antioxidant, antimicrobial, anti-inflammatory, and medicinal benefits to humans. Phenolics and flavonoids are particularly abundant and well-studied for their protective roles. Nutritionally, cocoyam is rich in carbohydrates, which provide dietary energy, and has high moisture content (63–83%), low fat (0.3–0.6%), and variable fibre levels. These characteristics make cocoyam an important staple root crop with both nutritional and health-promoting value.

The aim of this study was to determine the microbial load of the inner tissues of Cocoyam (*Colocasia*. *esculenta*) and also its food value.

MATERIALS AND METHODS

Sample collection

In order to conduct an experimental investigation, random purchases of Cocoyam from five (5) open marketplaces in Warri, Delta State. The marketplaces are Igbudu, Effurun, Sapele, Okere, and Igbo Market, respectively. Cocoyam (*Colocasia esculenta*) samples were correctly labelled, packaged,

and transported to Affafume biomedical analytical and research lab for a variety of examinations.

Isolation of Fungi and Bacteria Associated with the Cocoyam Samples

The Cocoyam samples were carefully peeled and teased into small bits, after which they were placed in beakers awaiting the analyses.

Thirty-nine grams of potato dextrose agar (PDA, Oxoid, England) was measured into a conical flask, 500mls of water will be added. The conical flask was then heated. After heating, additional 500mls of water will be added to make it up to be 1 litre. The medium was then sterilized by autoclaving at 15psi (1210C) for 15minutes. chloramaphenicol at 10gm per 200ml of medium was introduced at pouring to inhibit the growth of bacteria Inoculation and transfer of culture were carried out on sterile inoculating bench CRC model HSB 60*180, after wiping with methylated spirit.

All glassware and slides were washed in OMO detergent, rinsed in several changes of tap water and finally with distilled water and allowed to dry. They were sterilized in an electric oven at a temperature of 60^0C for 24 hours. Cover slips were flame sterilized just before use. The droppers, pipettes, cotton wool and plugs were covered with aluminum foil to prevent entry of condensed water vapour into the media.

Ten milliliters of distilled water were pipetted into McCartney bottles representing each samples collected from the market. McCartney bottles representing each stock solution will be labeled according to the samples.

Stock solution will be prepared by weighing one gram of the collected Cocoyam sample in a glass Petri dish. The weighed samples will be teased into smaller bits and then transferred into the already sterilized McCartney bottles representing the different stock solution mentioned above.

McCartney bottles will be divided into five groups and already sterilized McCartney bottles labeling 10^1 to 10^6 with the stock bottle representing each samples. With a sterile pipette, 1ml each was transferred from the stock bottles into the bottles labeled 10^1 to 10^6 containing nine milliliters of sterilized distilled water for serial dilution preparation.

The pour plate method of inoculation was used in the isolation of the microorganisms associated with the samples. One ml each of the serial dilution prepared samples was pipette with the aid of a syringe and was transferred into the corresponding labeled Petri dishes. Nine ml of molten prepared nutrient agar (NA) and potato dextrose agar (PDA) was dispensed into the Petri dishes respectively. The Petri dishes were inoculated under room temperature for 24hrs.

Plate 1: Cocoyam samples gotten from Igbudu **market**

Plate 2: Cocoyam samples gotten from Effurun Market

Plate 3: Serial dilution

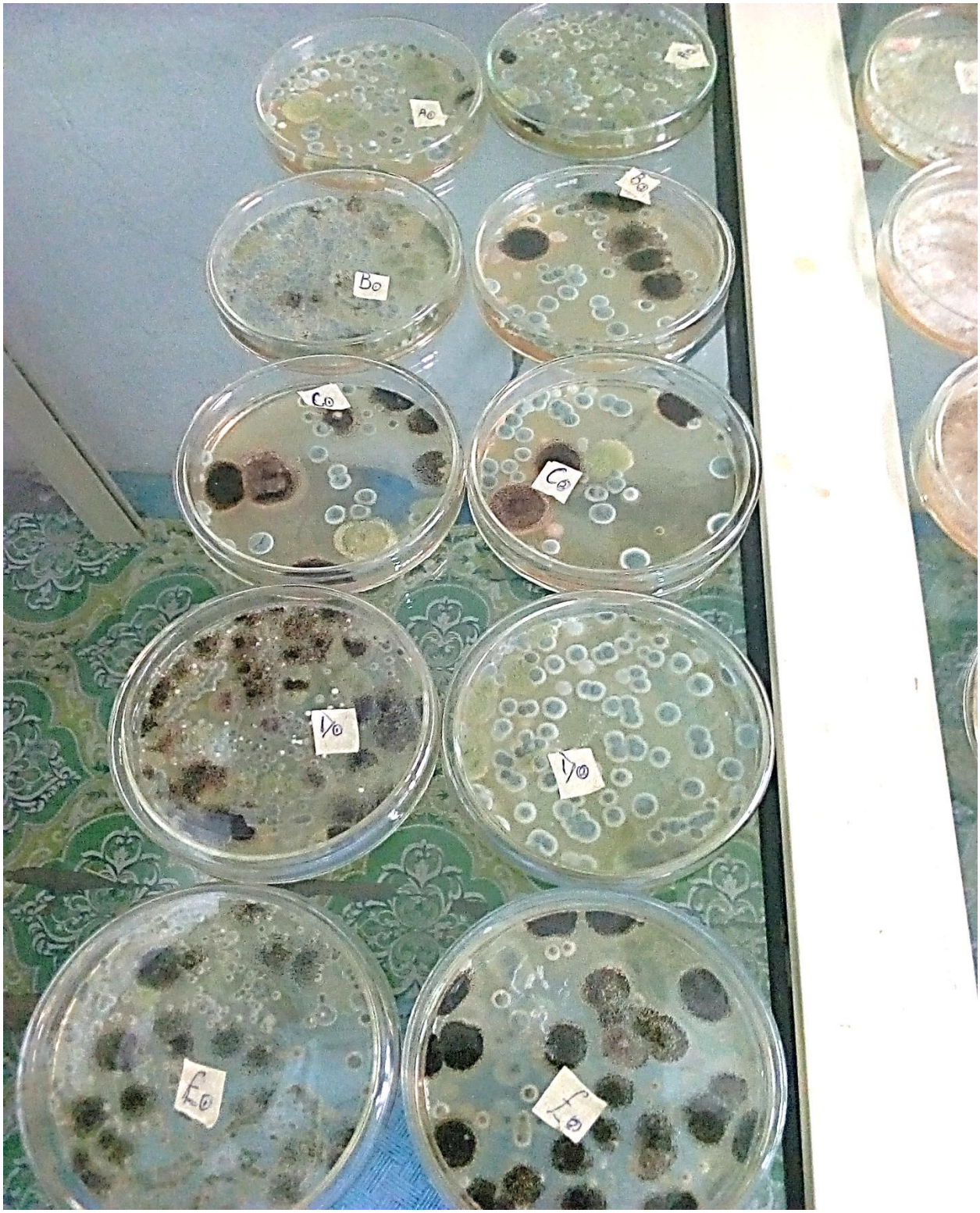

Plate 4: In inoculating chamber after 72 hours

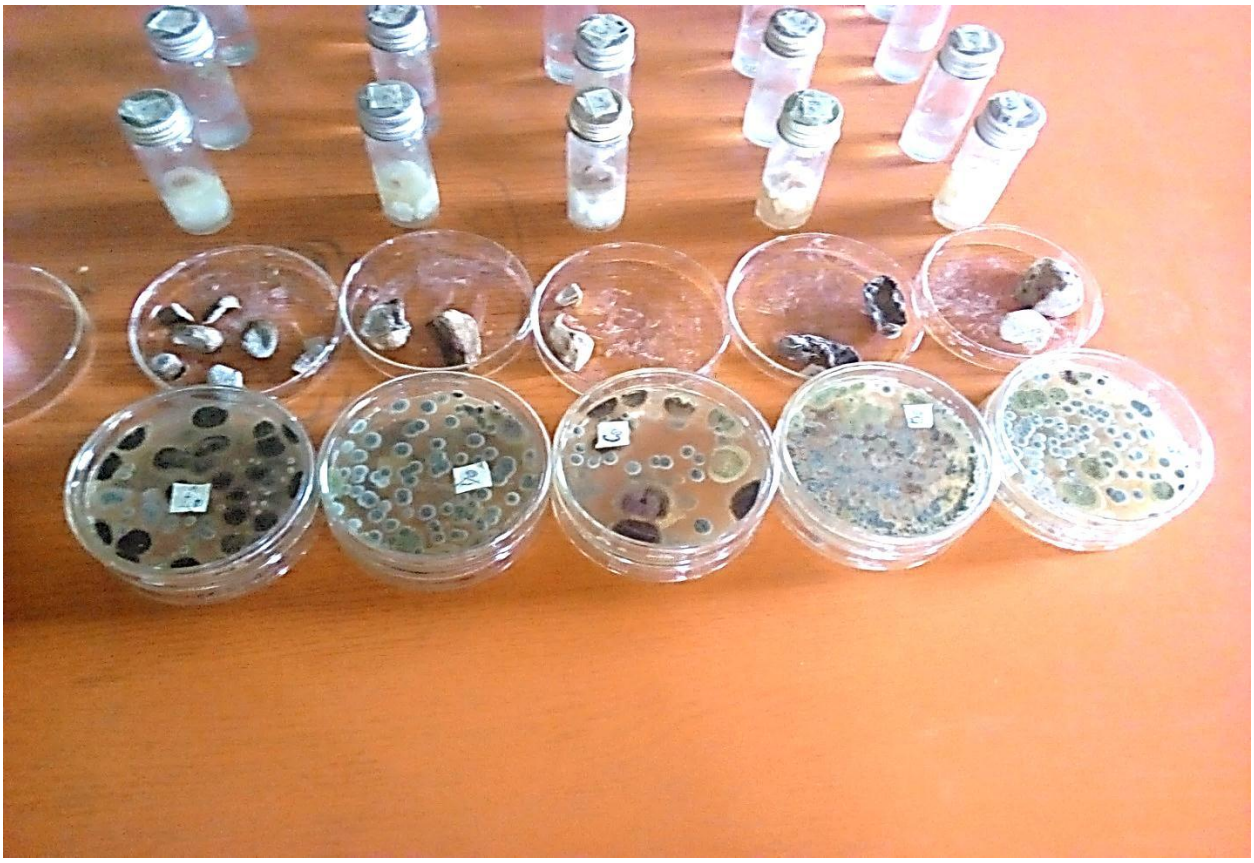

Plate 5: During Microbial Count

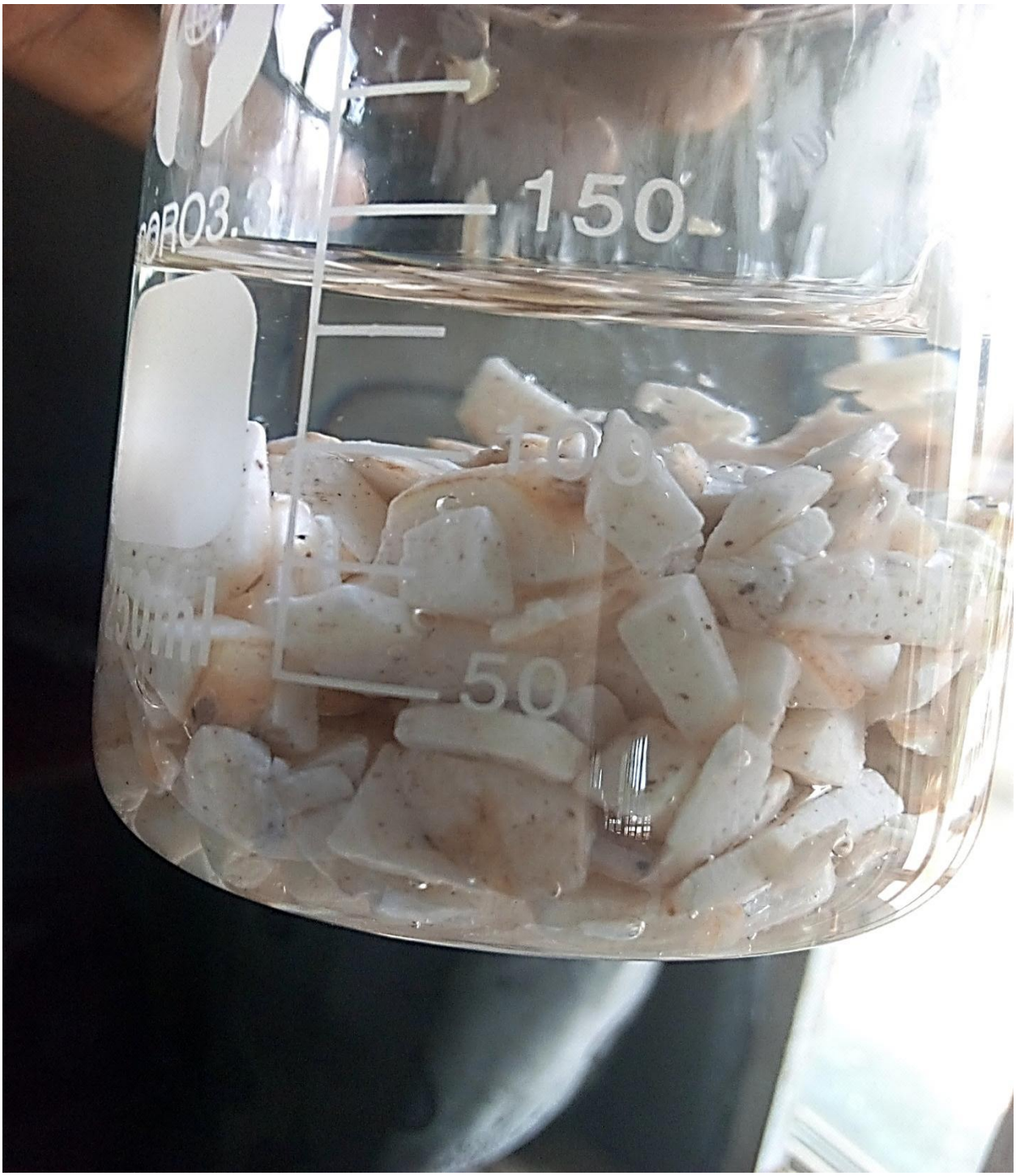

Plate 6: Teased Cocoyam in a beaker for carbohydrate test

Determination of microbial load

The microbial load of the samples was determined by visibly by counting the colony forming unit after 24 hours for bacteria and after 72hrs for fungi

The microbial load/ml was then determined by the formula stated below

$$\text{Count/ml} = \frac{\text{No of colonies on plate}}{\text{Amount plated}} x \frac{1}{\text{dilution factor}}$$

Determination of percentage occurrence

This was done using the formula stated below

$$\%\ \text{occurrence} = \frac{\text{No of a particular isolate on plate}}{\text{Total number isolates on same}} x \frac{100}{1}$$

Sub-culturing of microorganisms

NA and PDA that had just been made were poured into Petri dishes that had already been sanitised and allowed to set. The streaking technique will be used to separate the individual bacterial cultures into a new plate for further research from the old plates containing the microorganism. A fresh developing part of the fungal culture was carefully transferred into brand-new PDA plates using a sterile needle.

Determination of the Phytochemical Constituent of the Cocoyam Samples

Alkaloids

A determined weight of the sample was mixed in a 1:10 (10%) ratio with 10% acetic acid solution in ethanol. The mixture was left to stand at 28oC for 4 hours. Whatman No. 42 grade filter paper was then used to filter it. By using evaporation to reduce the filtrate to a quarter of its original volume, aqueous conc. ammonium hydroxide (NH4OH) was added drop by drop until the alkaloid precipitated. The alkaloid precipitate was collected in a weighted filter paper, cleaned with a solution of 1% ammonia, and dried at 800C in the oven. Alkaloid concentration was determined and reported as a percentage of the sample's weight.

Flavonoids

Each sample, weighing 0.5 grammes, was cooked for 30 minutes over reflux in 50 millilitres of a 2M HCl solution. After allowing it to cool, it was filtered using Whatman No. 42 filter paper. Beginning with a drop, an equal volume of ethyl acetate was added to the extract in the measured volume. Filtering was used to recover the flavonoid precipitate using weighted filter paper. The weight of flavonoid in the sample was determined by the ensuing weight difference.

Tannins

Each sample was measured into a 50 ml beaker weighing 0.2 g, adding 20 ml of 50% methanol, covered with paraffin, and heated in a water bath at 77–80 oC for an hour while being agitated with a glass rod to avoid lumping. The extract was quantitatively filtered into a 100 ml volumetric flask using double-layered Whatman No. 1 filter paper with a rinse of 50% methanol. With distilled water, this was precisely prepared and well-combined. Pipetting 1 ml of sample extract

into a 50 ml volumetric flask together with 20 ml of distilled water, 2.5 ml of the Folin-Denis reagent, and 10 ml of 17% Na2C03 required careful mixing. Distilled water was added to the proper measurements, the mixture was thoroughly mixed, and it was left to stand for 20 minutes before a bluish-green coloration appeared. Standard Tannic Acid solutions in the 0–10 ppm range underwent the same processing as the aforementioned 1 ml sample. After colour development, the absorbance of the Tannic Acid Standard solutions and samples were measured using a Spectronic 21D Spectrophotometer at a wavelength of 760 nm.

Percentage tannin was calculated using the formula:

$$\text{Tannin (\%)} = \frac{\text{Absorbance of sample x Average gradient x Dilution factor}}{\text{Weight of sample x 10,000}}$$

Saponin

A 250 ml beaker was filled with one gramme of the finely powdered sample and 100 ml of isobutyl alcohol. To ensure even mixing, the mixture was shaken on a UDY shaker for five hours. The liquid was then put into a 100 ml beaker and filtered using a Whatman No. 1 filter paper before 20 ml of a 40% saturated magnesium carbonate solution (mgCo3) was added. To get a clear, colourless solution, the mixture produced with saturated MgC03 was once more filtered through a Whatman No 1 filter paper. Then, 2 ml of a 5% iron (111) chloride (FeCl3) solution was added and adjusted to the proper volume with distilled water after being pipetted into a 50 ml volumetric flask with 1 ml of the colourless solution. It was left to stand for 30 minutes to acquire a blood red colour. After that, standard saponin solutions ranging from 0 to 10 ppm were made using saponin stock solution. Similar to what was done for 1 ml sample 3 above, the standard solutions were treated with 2 ml of 5% FeCl solution. After colour development, the sample's absorbance as well as standard saponin solutions were measured using a Spectronic 2D Spectrophotometer at a wavelength of 380 nm.

Percentage saponin was calculated using the formula:

$$\text{Saponin (\%)} = \frac{\text{Absorbance of sample x Average gradient x Dilution factor}}{\text{Weight of sample x 10,000}}$$

Total polyphenols

One millilitre of the 0.2 N Folin-Ciocalteau reagent and 0.8 millilitres of the 7.5% sodium carbonate solution were added to 200 microliters of the extracted sample, which was done in triplicate. The mixture was thoroughly mixed before being left to stand for 30 minutes at room temperature. On a Shimadzu 300 UV-Vis spectrophotometer, absorption at 765 nm was measured (Shimadzu UV-1601). The standard curve produced by gallic acid concentrations of 100–400 mg/l served as the foundation for quantification.

Determination of the Proximate Values of the Cocoyam Samples

This method was done using the official methods of analysis (AOAC,2007)

Moisture

A previously measured crucible was filled with two grammes of the sample. The sample-containing crucible was then put into an oven that had been preheated to 100 OC and dried overnight for 24 hours to a consistent weight. The crucible containing the sample was taken out of the oven after 24 hours, placed in a desiccator, allowed to cool for 10, and then weighed.

If the weight of empty crucible was Wo, weight of crucible plus sample was W_1 and weight of crucible plus oven-dried sample W_3

$$\% \text{ Dry Matter(DM)} = \frac{W_3 - W_0}{W_1 - W_0} x \frac{100}{1}$$

$$\% \text{ Moisture} = \frac{W_1 - W_3}{W_1 - W_0} x \frac{100}{1}$$

or % Moisture = 100 – % DM.

Ash

Two grams of the samples were weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550ºC and left for about 4 hours. About this time it had turned to white ash. The crucible and its content were cooled to about 100ºC in air, then room temperature in a desiccator and weighed. This was done in duplicate. The percentage ash was calculated from the formula below:

$$\text{Ash content} = \frac{\text{wt. of ash}}{\text{Original wt. 1of sample}} \times 100$$

Fibre

Two grams of the sample was accurately weighed into the fibre flask and 100ml of 0.255N H_2SO_4 added. The mixture was heated under reflux for 1 hour with the heating mantle. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which 100ml of (0.313N NaOH) was added and heated under reflux for another 1 hour. The mixture was filtered through a fibre sieve cloth and 10ml of acetone added to dissolve any organic constituent. The residue was washed with about 50ml hot water on the sieve cloth before it was finally transferred into the crucible. The crucible and the residue were oven-dried at 105ºC overnight to drive off moisture. The oven-dried crucible containing the residue was cooled in a desiccator and later weighed to obtain the weight $W_{\underline{1}}$. The crucible with weight $W_{\underline{1}}$ was transferred to the muffle furnace for Ashing at 550°C for 4 hours. The crucible containing white or grey ash (free of carbonaceous material) was cooled in the desiccator and weighed to obtain $W_{\underline{2}}$. The difference $W_{\underline{1}} – W_{\underline{2}}$ gives the weight of fibre. The percentage fibre was obtained by the formula:

$$\% \text{ Fibre} = \frac{W_1 - W_2}{\text{wt. of sample}} \times \frac{100}{}$$

Crude fat

One gram of each dried sample was weighed into fat free extraction thimble and plugged lightly with cotton wool. The thimble was placed in the extractor and fitted with reflux condenser and a 250ml soxhlet flask which had been previously dried in the oven, cooled in the desiccator and weighed. The soxhlet flask was then filled to $^3/_4$ of its volume with petroleum ether (boiling point. 40º – 60ºC). The soxhlet flask, extractor plus condenser set were placed on the heater. The heater was put on for six hours with constant running water from the tap for condensation of ether vapour. The set was constantly watched for ether leaks and the heat source is adjusted appropriately for the ether to boil gently. The Ether was left to siphon over several times (at least 10 – 12 times) until it was short of siphoning. Any ether content of the extractor was carefully drained into the ether stock bottle. The thimble containing sample was then removed and dried on a clock glass on the bench top. The extractor, flask and condenser were replaced and the distillation continued until the flask was practically dry. The flask which now contained the fat or oil was detached, its exterior cleaned and dried to a constant weight in the oven. If the initial weight of dry soxhlet flask was Wo and the final weight of oven dried flask + oil/fat was W_1, percentage fat/oil was obtained by the formula:

$$\frac{W_1 - Wo}{\text{Wt. of Sample taken}} \times \frac{100}{}$$

Nitrogen content

Nitrogen content of the samples was determined by the kjeldahl method. The method involves: Digestion, Distillation and Titration.

Digestion

Two grams of the sample into a round bottom flask and add 25mls of concentrated sulphuric acid, 0.5g of copper sulphate and 5g of sodium sulphate.

The samples were then heated using a heating mantle in a fume cupboard slowly at first to prevent undue frothing, continue to digest for 45mins until the sample become clear pale green. The samples were allowed cool and 100mls of distilled water. Distillation was done against 10mls of the boiled digest using 10mls of sodium hydroxide and 50mls of 2% boric acid containing screened methyl red indicator. The alkaline ammonium borate formed is titrated directly with 0.1*N* HCl. The titre value which is the volume of acid used is recorded. The volume of acid used is fitted into the formula which becomes

$$\%N = 14 \text{ x.} \left\{ \frac{VA \text{ x } 0.1 \text{ x } w \text{ x} 100}{1000 \text{x} 100} \right\}$$

VA = volume of acid used

w= weight of sample

Calculation: Percent Crude Protein (CP)

CP = % N X F

- F = 6.25 for all forages and feeds except wheat grains
- F = 5.70 for wheat grains

RESULTS

Table 1 shows the bacteria count of cocoyam Samples obtained from different market. The Bacterial count of cocoyam samples ranged from 2.30±1.09 - 4.50±1.91. While fungi count of cocoyam samples ranged from 2.00±0.10 - 4.64±1.01. The highest bacterial count (4.50±1.91) was observed in Effurun market samples, while the highest fungi count (4.64±1.01) was seen in Igbo market sample.

Table 2 shows the cultural, morphological and biochemical characteristics of the bacterial isolates. The cultural characteristics used to identify the bacterial isolate were elevation, margin, colour, shape and size. The morphological characteristics used were gram staining, cell type, cell arrangement and spore staining. While the biochemical characteristics include catalase, oxidase, coagulase, citrate, urease, indole and glucose. The probable bacterial isolates were *Bacillus polymyxa, Staphylococcus aureus, Streptococcus lactis, Pseudomonas* spp., *Clostridium sporogenes* and *Bacillus coagulans.*

Table 3 shows the cultural and morphological characteristics of the fungal counts. The cultural characteristics used to identify the fungal isolate were margin, colour, shape and size. The morphological characteristics used were nature of hyphae, colour of spore, type

of spore and appearance of special structure. The probable fungal isolates were *Saccharomyces* spp., *Candida* spp., *Mucor* spp., *Aspergillus niger and Penicillium* spp.

Table 1: Bacteria count of cocoyam samples obtained from different market

Market	**Bacteria count x10^4 cfu/g**	**Fungi count x10^3 cfu/g**
Igbudu	2.30±1.09	2.00±0.10
Effurun	4.50±1.91	3.47±0.72
Sapele	3.80±1.00	2.83±0.56
Okere	2.90±1.21	3.41±0.93
Igbo	3.10±1.10	4.64±1.01

Values are presented as mean ± SEM; n=3.

Table 2: Cultural, morphological and biochemical characteristics of the bacterial isolates

Characteristics	**1**	**2**	**3**	**4**	**5**	**6**
Cultural						
Elevation	Flat	Convex	Convex	Low convex	Convex	Convex
Margin	Entire	Entire	Smooth	Entire	Entire	Entire
Colour	Cream	Yellow	White	Cream	Cream	Cream
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Size	Large	Medium	Small	Medium	Medium	Large
Morphological						
Gram staining	+	+	+	-	+	+
Cell type	Rod	Cocci	Cocci	Rod	Rod	Rod
Cell arrangement	Chains	Cluster	Chains	Single	Single	Chains
Biochemical						
Catalase	+	+	-	+	+	+
Oxidase	-	-	-	+	-	-
Coagulase	+	+	-	-	-	-
Citrate	+	+	+	+	+	+
Urease	+	+	+	-	-	-
Indole	-	-	-	-	-	-
Glucose	+	+	+	+	+	+
Isolates	*Bacillus polymyxa*	*Staphylococcus aureus*	*Streptococcus lactis*	*Pseudomonas* spp.	*Clostridium sporogenes*	*Bacillus coagulans*

Table 3: Cultural and morphological characteristics of the fungi solates

Characteristics	**1**	**2**	**3**	**4**	**5**
Cultural	Large creamy colony with convex elevation and entire margin	Medium creamy colony with convex elevation and entire margin	White flat colony with reverse side colourless	Back fluffy with reverse side yellow	Green flat with white periphery
Morphological					
Nature of hyphae	Pseudohyphae	Pseudohyphae	Non-septate	Septate	Septate
Colour of spore	Colourless	Colourless	Colourless	Brown	Dirty white
Type of spore	Chlamydospore	Chlamydospore	Sporangiophore	Conidiophores	Conidiophores
Appearance of special structure	Budding	Budding	Sporangium	Foot cells	Brush like penicillus
Isolates	*Saccharomyces* spp.	*Candida* spp.	*Mucor* spp.	*Aspergillus niger*	*Penicillium* spp.

Table 4 shows the proximate analysis of cocoyam samples obtained from different market. The crude fat ranged from 6.46 - 2.36 mg/kg, with the highest value from Igbo market. Crude protein ranged from 12.58 - 24.11 mg/kg, with the highest value from Igbudu market. Crude carbohydrates ranged from 28.46 - 57.90 mg/kg, with the highest value from Igbudu market. Ash content ranged from 2.40 - 6.69 mg/kg , with the highest value from Okere market. Fibre content ranged from 10.93 - 38.21 mg/kg , with the highest value from Okere market. Dry matter content ranged from 3.04 - 4.36 mg/kg , with the highest value from Igbo market. Moisture content ranged from 62.19 - 96.12 %, with the highest value from Igbudu market.

Table 4.5 shows the phytochemical components of cocoyam samples obtained from different market. Bioactive substances such as carbohydrate, saponins, phenol, triterpenoids, phlobatannins and tannins were found present in all the market samples. However Steroids Terpenoids and

Glycosides was found only Effurun, Okere and Igbo market, while Anthraquinones and Alkaloids was found in Effurun, Sapele and Okere market respectively.

Table 4: Proximate analysis of cocoyam samples obtained from different market

Parameters	**Igbudu**	**Effurun**	**Sapele**	**Okere**	**Igbo**
			Market (mg/kg)		
Crude fat	2.36	2.56	3.62	6.36	6.46
Crude protein	24.11	14.01	12.58	17.49	18.47
Crude carbohydrates	57.90	34.00	56.25	28.46	53.42
Ash	2.40	5.90	5.23	6.69	6.37
Fibre	10.93	20.03	26.58	38.21	21.30
Dry Matter	3.88	3.04	3.85	3.68	4.36
Moisture	96.12	60.92	75.38	85.34	62.19

Table 4.5: Phytochemical components of cocoyam samples obtained from different market

Phytochemicals	**Igbudu**	**Effurun**	**Sapele**	**Okere**	**Igbo**
			Market (mg/kg)		
Alkaloids	-	+	+	+	-
Carbohydrate	+	+	+	+	+
Saponins	+	+	+	+	+
Phenol	+	+	+	+	+
Triterpenoids	+	+	+	+	+
Terpenoids	-	+	-	+	+
Phlobatannins	+	+	+	+	+
Flavonoids	+	+	-	-	-
Glycosides	-	+	-	+	+
Steroids	-	+	-	+	+
Tannins	+	+	+	+	+
Anthraquinones	-	+	+	+	-

Key:

+ = present

- = not detected

DISCUSSION

This study assessed cocoyam samples from five markets in Warri Metropolis to evaluate microbial contamination, nutritional quality, and phytochemical composition. Results showed considerable variation in microbial load, with bacterial counts ranging from 2.30±1.09 to 4.50±1.91 and fungal counts from 2.00±0.10 to 4.64±1.01. Effurun Market recorded the highest bacterial load, while Igbo Market had the highest fungal count, raising food safety concerns. Identified bacterial isolates included *Bacillus polymyxa*, *Staphylococcus aureus*, *Streptococcus lactis*, *Pseudomonas* spp., *Clostridium sporogenes*, and *Bacillus coagulans*, while fungal isolates comprised *Saccharomyces*, *Candida*, *Mucor*, *Aspergillus niger*, and *Penicillium* species. These organisms reflect both beneficial and pathogenic microbes, emphasizing the need for proper handling and monitoring of cocoyam in urban markets.

Nutritional analysis revealed significant differences among markets in proximate composition, including crude fat, protein, carbohydrates, ash, fibre, dry matter, and moisture content. Crude fat ranged from 2.36–6.46 Mg/Kg, protein from 12.58–24.11 Mg/Kg, carbohydrates from 28.46–57.90 Mg/Kg, and moisture content from 62.19–96.12%, indicating variations in energy value, nutrient density, and shelf life. Phytochemical screening confirmed the presence of key bioactive compounds such as phenols, saponins, tannins, triterpenoids, and carbohydrates across all samples, with some compounds showing market-specific occurrence. These findings highlight cocoyam's nutritional and medicinal potential, while also demonstrating that environmental conditions and market handling practices influence its microbial safety and biochemical composition.

Conclusion and Recommendation

The study of cocoyam (*Colocasia esculenta* Schott., Araceae) collected from five different markets within Warri Metropolis provides crucial insights into its microbiological, proximate, and phytochemical properties. The microbiological analysis revealed varying levels of microbial contamination across the samples, indicating differences in handling and storage practices among the markets. This inconsistency underscores the importance of proper food safety measures to mitigate health risks associated with microbial pathogens. In contrast, the proximate analysis showed relatively uniform nutritional composition across all samples, highlighting cocoyam's potential as a nutritious food source rich in carbohydrates and dietary fiber. However, slight variations in moisture content and ash levels suggest that environmental factors may influence these parameters. Furthermore, the phytochemical analysis identified significant antioxidant properties consistent throughout the samples, suggesting that cocoyam could serve as a valuable source of bioactive compounds beneficial for human health.

In summary, while there are notable differences in microbiological quality among cocoyam samples from various markets in Warri Metropolis, their proximate and phytochemical profiles exhibit remarkable

consistency. This comparison emphasizes both the necessity for improved hygiene standards and the inherent nutritional value of cocoyam as a staple crop. Future studies should focus on enhancing post-harvest practices to ensure food safety while promoting its consumption for health benefits.

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