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| RESEARCH ARTICLE

Mycological Assessment Of Post-Harvest Fungal Spoilage Of Cocoyam (*Colocasia Esculenta*) Marketed In Abia, Southeastern, Nigeria

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| ABSTRACT

Postharvest fungal spoilage of cocoyam (*Colocasia esculenta*) remains a major challenge affecting food security, market value, and consumer safety in Nigeria. This study assessed the fungi associated with postharvest spoilage of cocoyam marketed in Aba, Abia State, Southeastern Nigeria. A laboratory-based experimental design was adopted. Fifteen cocoyam tubers were purchased from Ariaria Market, Aba, allowed to undergo spoilage under ambient conditions, and analyzed using standard microbiological and mycological techniques. Fungal isolates were cultured on Sabouraud Dextrose Agar (SDA), identified based on cultural and morphological characteristics, and their occurrence determined using colony counts and percentage frequency.The results revealed the presence of four fungal genera, namely *Mucor* spp., *Rhizopus* spp., *Aspergillus* spp., and *Penicillium* spp. Cultural and microscopic examination showed characteristic colony morphologies that aided identification of the isolates. The fungal load varied among the isolates, with *Penicillium* spp. recording the highest count of 2.1 × 10^8 CFU/ml, followed by *Aspergillus* spp. (7.0 × 10^7 CFU/ml)**,** *Rhizopus* spp. (4.7 × 10^4 CFU/ml)**,** and *Mucor* spp. **(**8.0 × 10^1 CFU/ml**).** Percentage occurrence analysis indicated that *Mucor* spp. was the most prevalent isolate, accounting for 36.7% of the total colonies, followed by *Rhizopus* spp. (32.1%)**,** *Aspergillus* spp. (21.6%)**,** and *Penicillium* spp. (9.6%)**.**The study concluded that fungal contamination is a major factor responsible for cocoyam deterioration during storage and marketing in Aba. The occurrence of potentially toxigenic fungi such as *Aspergillus* and *Penicillium* highlights possible food safety risks. Improved postharvest handling, storage conditions, and routine microbial monitoring are therefore recommended to reduce spoilage losses and enhance the quality and safety of cocoyam for human consumption.

| KEYWORDS

Cocoyam, *Colocasia esculenta*, postharvest spoilage, Fungal *Isolates, Food Safety,* Aba, Nigeria.

| ARTICLE INFORMATION

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1. Introduction

Food security remains one of the most pressing challenges in developing countries, particularly in sub-Saharan Africa, where postharvest losses significantly reduce the availability, quality, and accessibility of staple food crops (FAO, 2023; Abubakar et al., 2024). Among the major root and tuber crops cultivated in Nigeria, cocoyam (*Colocasia esculenta*) occupies an important position because of its high nutritional value, adaptability to diverse agroecological conditions, and socioeconomic significance (Nwosu et al., 2022). The crop is widely cultivated and consumed in southeastern Nigeria, where it serves as a valuable source of carbohydrates, dietary fibre, vitamins, minerals, and bioactive compounds for both rural and urban populations (Okeke & Chukwu, 2021). Cocoyam is commonly processed into boiled meals, soups, porridges, flour, and other traditional delicacies, thereby contributing significantly to household food security and income generation. Recent studies have highlighted cocoyam

as a climate-resilient indigenous crop with considerable potential for enhancing sustainable food systems in Africa (Akinbode et al., 2024).

Despite its nutritional and economic importance, cocoyam is highly susceptible to postharvest deterioration. A substantial proportion of harvested cocoyam is lost before consumption due to microbial spoilage, poor storage facilities, mechanical injuries, transportation stress, and unfavourable environmental conditions (Odeyemi et al., 2024). In tropical environments such as southeastern Nigeria, elevated temperature and relative humidity provide favourable conditions for the growth and proliferation of spoilage microorganisms, particularly fungi (Eze & Chukwu, 2022). These conditions reduce shelf life and adversely affect the appearance, texture, taste, and nutritional quality of cocoyam tubers, resulting in considerable economic losses to farmers, traders, and consumers (Nwankwo et al., 2023). Consequently, postharvest spoilage remains a major constraint to maximizing the food security potential and commercial value of cocoyam production in Nigeria.

Among the various agents responsible for postharvest deterioration, fungi constitute one of the most destructive groups of microorganisms associated with cocoyam spoilage (Okeke et al., 2021). Fungal pathogens gain entry into cocoyam tissues through wounds, bruises, and natural openings created during harvesting, handling, transportation, storage, and marketing (Odeyemi et al., 2024). Once established, these organisms secrete extracellular enzymes that degrade plant tissues, causing soft rot, discoloration, unpleasant odours, and eventual collapse of infected corms (Akinmusire et al., 2022). Several fungal genera, including *Aspergillus*, *Rhizopus*, *Mucor*, *Penicillium*, and *Fusarium*, have been consistently implicated in cocoyam spoilage across tropical regions (Nwankwo et al., 2023; Bello et al., 2024). The public health significance of these fungi is further heightened by the ability of some species to produce mycotoxins, which may cause adverse health effects when contaminated food products are consumed (WHO, 2023).

Recent mycological studies conducted in different parts of Nigeria have reported increasing levels of fungal contamination in cocoyam during storage and marketing. Eze and Chukwu (2022) isolated *Rhizopus*, *Mucor*, *Penicillium*, and *Aspergillus* species from spoiled cocoyam samples and demonstrated their ability to cause rapid tissue deterioration. Similarly, Okechukwu et al. (2022) identified *Aspergillus flavus*, *Aspergillus niger*, *Rhizopus stolonifer*, *Mucor racemosus*, and *Fusarium oxysporum* as major fungal pathogens associated with cocoyam spoilage in local markets. Furthermore, Nwosu et al. (2024) reported that biological control agents such as *Trichoderma harzianum* could effectively suppress spoilage fungi associated with cocoyam, highlighting the growing interest in environmentally sustainable approaches to postharvest disease management.

Aba, one of the largest commercial centres in southeastern Nigeria, is renowned for its vibrant agricultural markets where root and tuber crops are traded daily. Cocoyam marketed in Aba is frequently exposed to poor sanitary conditions, excessive handling, moisture accumulation, and prolonged storage periods that may encourage fungal contamination and spoilage (Nwankwo et al., 2023). Despite the commercial importance of cocoyam within the metropolis, there is limited documented information regarding the diversity, occurrence, and distribution of fungi associated with postharvest spoilage of cocoyam in Aba, Abia State. This scarcity of local data creates a significant knowledge gap that may hinder the development of effective disease control strategies and postharvest management practices.

The mycological assessment of spoiled cocoyam is therefore essential for understanding the fungal organisms responsible for deterioration and their implications for food safety, public health, and agricultural sustainability. Identification of spoilage fungi will provide valuable information for improving storage technologies, reducing postharvest losses, minimizing mycotoxin contamination, and enhancing the quality and shelf life of cocoyam marketed in Nigeria (FAO, 2023; WHO, 2023). Furthermore, findings from such studies may contribute to the development of environmentally friendly preservation methods and integrated fungal management strategies suitable for tropical food systems.

Therefore, this study was designed to assess the fungi associated with postharvest spoilage of cocoyam (*Colocasia esculenta*) marketed in Aba, Southeastern Nigeria, through the isolation and identification of fungal species responsible for the deterioration of the tubers.

2.0 Literature Review

2.1 Overview of Cocoyam (Colocasia esculenta)

Cocoyam (*Colocasia esculenta*) is an important root and tuber crop cultivated extensively in tropical and subtropical regions of the world, particularly in West Africa (Akinbode et al., 2024). Nigeria is among the leading producers of cocoyam, where the crop serves as a major source of carbohydrates, dietary fiber, vitamins, and minerals (Nwosu, Okeke, & Umeh, 2022; Okeke & Chukwu,

2021). Cocoyam contributes significantly to food security and household income, especially among rural farming communities (Akinbode et al., 2024; Nwosu, Okeke, & Umeh, 2022). The corms and cormels are consumed in various forms, including boiling, roasting, frying, and processing into flour (Okeke & Chukwu, 2021). Despite its nutritional and economic importance, cocoyam is highly perishable and vulnerable to microbial deterioration during storage and marketing, resulting in substantial post-harvest losses (Abubakar, Ibrahim, & Yusuf, 2024). Studies have shown that fungal infestation is one of the major causes of cocoyam spoilage after harvest, reducing both quality and market value (Agu et al., 2020; Okechukwu, Nnadi, & Ezeh, 2022).

2.2 Post-Harvest Losses in Cocoyam

Post-harvest losses refer to quantitative and qualitative reductions in agricultural produce occurring between harvest and consumption (Abubakar, Ibrahim, & Yusuf, 2024). In cocoyam production, losses often arise from poor harvesting techniques, mechanical injuries, inadequate transportation, improper storage conditions, and microbial invasion (Odeyemi, Bello, & Afolabi, 2024). The high moisture content of cocoyam corms creates favorable conditions for the growth of spoilage microorganisms, particularly fungi (Oladipo, Adeyemi, & Oluwajabo, 2022). In many developing countries, including Nigeria, inadequate storage facilities and poor market handling practices contribute significantly to post-harvest deterioration (Abubakar, Ibrahim, & Yusuf, 2024). Such losses not only affect food availability but also reduce farmers' incomes and increase food insecurity (Akinbode et al., 2024; Abubakar, Ibrahim, & Yusuf, 2024). Research has indicated that fungal spoilage can lead to extensive tissue softening, discoloration, off-odor production, and eventual decay of cocoyam corms (Agu et al., 2020; Mubarak et al., 2021).

2.3 Fungi Associated with Cocoyam Spoilage

Fungi are among the most important microorganisms responsible for post-harvest deterioration of root and tuber crops (Nwankwo, Okafor, & Udeh, 2023). Several studies conducted in Nigeria have reported the isolation of fungal species from spoiled cocoyam corms (Agu et al., 2020; Abubakar et al., 2024). Common fungal genera associated with cocoyam spoilage include *Aspergillus*, *Fusarium*, *Rhizopus*, *Mucor*, and *Penicillium* (Mubarak et al., 2021; Okechukwu et al., 2022). These fungi invade cocoyam tissues through wounds, bruises, and natural openings created during harvesting, transportation, and storage (Odeyemi et al., 2024). Once established, they secrete extracellular enzymes that degrade plant tissues, leading to rot development and nutrient loss (Eze & Chukwu, 2022). Investigations in Kaduna and Kebbi States identified *Aspergillus spp.*, *Fusarium spp.*, *Rhizopus spp.*, *Mucor spp.*, and *Penicillium spp.* as predominant fungal contaminants of cocoyam (Mubarak et al., 2021; Uthman & Rashidat, 2024).

2.4 Sources and Modes of Fungal Contamination

Fungal contamination of cocoyam may occur at different stages of production and distribution (Odeyemi et al., 2024). Soil serves as a major reservoir of fungal spores, which may infect corms before harvest (Akinmusire, Eze, & Nwosu, 2022). During harvesting, injuries inflicted on the tubers provide entry points for pathogenic fungi (Odeyemi et al., 2024). Contamination may also occur through contact with contaminated harvesting tools, storage containers, packaging materials, insects, rodents, and airborne spores (Okeke, Nwosu, & Umeh, 2021). Environmental factors such as high humidity, elevated temperature, and poor ventilation further enhance fungal growth and spread (Oladipo et al., 2022). Markets often provide favorable conditions for contamination due to overcrowding, poor sanitation, and prolonged exposure of produce to environmental microorganisms (Okeke, Nwosu, & Umeh, 2021).

2.5 Factors Influencing Post-Harvest Fungal Spoilage of Cocoyam

Several factors influence the occurrence and severity of fungal spoilage in cocoyam (Oladipo et al., 2022). Moisture content is one of the most critical factors, as fungi require adequate water activity for growth and reproduction (Ugwuanyi, 2020). Temperature also plays an important role, with most spoilage fungi thriving under warm tropical conditions (Akinmusire et al., 2022). Mechanical damage during harvesting and transportation accelerates fungal invasion by exposing internal tissues (Odeyemi et al., 2024). Storage duration, relative humidity, sanitation practices, and handling methods equally determine the extent of deterioration (Oladipo et al., 2022). Studies on stored cocoyam products have demonstrated that increased moisture levels significantly enhance fungal proliferation and spoilage rates (Ugwuanyi, 2020; Oladipo et al., 2022).

2.6 Public Health and Economic Implications of Fungal Spoilage

The presence of spoilage fungi on cocoyam has important public health and economic consequences (Bello, Yusuf, & Abdullahi, 2024). Certain fungal species, particularly *Aspergillus*, *Fusarium*, and *Penicillium*, produce toxic secondary metabolites known as mycotoxins (FAO, 2023; WHO, 2023). These compounds can contaminate food products and pose serious health risks, including liver damage, kidney disorders, immune suppression, and carcinogenic effects (WHO, 2023). Aflatoxins produced by *Aspergillus flavus* and related species are among the most dangerous mycotoxins affecting food safety worldwide (FAO, 2023; Bello et al., 2024). Economically, fungal spoilage leads to reduced market quality, lower consumer acceptance, financial losses for traders and farmers, and decreased food availability (Abubakar, Ibrahim, & Yusuf, 2024).

2.7 Methods Used in Mycological Assessment of Food Spoilage

Mycological assessment involves the isolation, identification, and characterization of fungi associated with food deterioration (Nwankwo et al., 2023). Common laboratory methods include culturing samples on selective media such as Potato Dextrose Agar (PDA) and Sabouraud Dextrose Agar (SDA), followed by purification of fungal isolates (Agu et al., 2020; Abubakar et al., 2024). Identification is based on colony morphology, pigmentation, microscopic characteristics, and spore structures (Eze & Chukwu, 2022). Microscopic examination often involves lactophenol cotton blue staining and slide culture techniques (Abubakar et al., 2024). Recent advances also incorporate molecular methods such as polymerase chain reaction (PCR) and DNA sequencing for more accurate fungal identification (Eze & Chukwu, 2022). These techniques provide valuable information on the diversity and prevalence of spoilage fungi in agricultural commodities (Nwankwo et al., 2023).

2.8 Control and Prevention of Post-Harvest Fungal Spoilage

Effective management of post-harvest fungal spoilage requires an integrated approach involving proper harvesting, handling, storage, and sanitation practices (Odeyemi et al., 2024). Harvesting should be carried out carefully to minimize injuries to cocoyam corms (Odeyemi et al., 2024). Storage facilities should maintain low humidity and adequate ventilation to inhibit fungal growth (Oladipo et al., 2022). Regular inspection and removal of infected corms help prevent the spread of contamination (Okeke et al., 2021). The use of biological control agents, natural plant extracts, and appropriate fungicidal treatments has also been explored for reducing fungal infestation (Akomah-Abadaike & Didia, 2024; Nwosu, Ezeh, & Chukwuma, 2024). Improved post-harvest management practices can significantly extend the shelf life of cocoyam and reduce economic losses associated with spoilage (Abubakar, Ibrahim, & Yusuf, 2024).

3. Materials And Methods

3.1 Materials

The materials used in this research work included: Cocoyam, distilled water, incubator, Autocalve, SDA media, measuring cylinder, chloramphenicol, Petri dishes, beaker, syringes, test-tubes, test-tubes racks, weighing balance, filter paper, lactophenol cotton blue, knife, black polyethylene bag, hand gloves, centrifuge, normal saline, cotton wool, Ethanol, foil, paper tape, wire loop, lamp, conical flask, sterile laboratory mortar and pestle.

3.2 Study Area

This study was conducted in Aba, Abia State, Southeastern Nigeria. Aba is a major commercial city located within the humid tropical rainforest zone characterized by relatively high temperature, elevated humidity, and substantial rainfall that favor the growth and proliferation of spoilage microorganisms, particularly fungi. Cocoyam samples used in this study were obtained from selected major markets within Aba metropolis, where cocoyam is widely sold and distributed for human consumption.

3.3 Research Design

The study adopted an experimental laboratory-based research design involving the collection of spoiled cocoyam tubers from different markets, isolation of associated fungi, cultural and microscopic identification of fungal isolates, and determination of their frequency of occurrence using standard microbiological and mycological techniques. Similar methodological approaches have been employed in studies on fungal spoilage of cocoyam and other root crops in Nigeria and elsewhere (Mubarak et al., 2021; Abubakar et al., 2024).

3.4 Sterilization of Materials

Glassware including Petri dishes, conical flasks, test tubes, pipettes, and beakers were washed thoroughly with detergent, rinsed with distilled water, and sterilized in a hot air oven at 160°C for 1 hour. Metal instruments such as forceps and inoculating needles were sterilized by flaming with a Bunsen burner before and after use. Laboratory working surfaces were disinfected using 70% ethanol to minimize contamination. These procedures were carried out according to standard microbiological laboratory protocols (Akomah-Abadaike & Didia, 2024).

3.5 Source of Sample

A total of 15 raw Cocoyam (Colocasia esculenta) tubers were purchased from Ariaria market in Aba, Abia State

3.6 Storage Condition

The sample was damaged using a knife and stored in a cool dry place inside an empty room at ambient temperature ($28 \pm 2^{o}C$) by leaving it in a black polyethylene bag to undergo spoilage (Oladipo et al., 2022).

3.7 Sample preapartion for Cocoyam procured from Aba, Abia State.
A sterile small knife was used to cut through the spoilt portion of each cocoyam tuber a described by (Oluwajobi et al., 2020) and Adeyemi et al.(2019), and then placed into a sterile foil paper and wrapped properly. 25g of the sample was weighed out with the aid of a weighing balance. The sample, after weighing, was put into a sterile laboratory mortar and pounded, then transferred into sterile beaker and covered with foil paper. 500ml of distilled water was measured using a measuring cylinder and the pounded cocoyam sample was added in the beaker, and stirred with a glass rod to dissolve properly and blend together to form a solution with the distilled water.

3.8 Serial Dilution
A measurement of 1ml of the dissolved sample was aseptically added to 9ml of normal saline.

Subsequent, ten folds serial dilution of up to 10-10 was prepared using normal saline as the diluents. Ten folds serial dilutions were made by adding 1ml of the dissolved sample into 9ml of diluents (normal saline). 1ml was added to the petri-dish for culturing. Sub- culturing. Sub culturing was done from the 4^{th} and 2^{nd} test tubes.

3.9 Preparation of Culture Medium
A measurement of 31g of SDA was measured with the aid of a measuring cylinder and dissolved in 500ml of distilled water. The medium was sterilized in an autoclave at 121°C for 15mins after which it was allowed to cool and two capsules of 500g of chloramphenicol was added to suppress the bacteria growth. The medium was dispensed into 10 Petri dishes and allowed to solidify. The plates were labelled 10^{-1} to 10^{-10} duplicate plates [1A-10B]. 1ml of the first dilution was aseptically introduced into the agar surface of 10^{-1} duplicates plates and this was repeated for 10^{-3} to 10^{-10} duplicate plates using pour plate method. The plates were incubated at the temperature of 27°C for three to seven days after which the viable organisms (colonies) were counted. Morphology and pigmentation of the isolates were recorded before sub-culturing.

3.10 Isolation and identification of Associated Fungi
In this study, individual colonies were picked using a sterile wire loop and sub cultured by streaking on freshly prepared Sabouraud Dextrose Agar (SDA) plates. The plates were then incubated at room temperature (25-30°C) for 3-7 days (Oluwajobi et al.,2022).

3.11 Microscopic Identification
A portion of the fungal mycelium was tested out in a drop of lactophenol cotton blue on a grease free microscope slide and examined microscopically as described by Ajayi et al., (2013), Oladele et al. (2015).

3.12 Sample Preparation of Unspoiled Cocoyam (Colocasia esculenta)
A sterile small knife was used to cut through the unspoiled portion of each cocoyam tuber and then placed into a sterile foil paper and wrapped properly. 25g of the sample was weighed out with the aid of a weighing balance. The sample, after weighing, was put into a sterile laboratory mortar and pounded, then transferred into a sterile beaker and covered with foil paper. 500ml of distilled water was measured using a measuring cylinder and the pounded cocoyam sample was added in the beaker, and stirred with a glass rod to dissolve properly and blend together to form a solution with the distilled water.

3.13. Serial Dilution of Unspoiled Cocoyam
A measurement of 1ml of the dissolved sample was aseptically added to 9ml of normal saline. Subsequent, tenfold serial dilutions were made by adding 1ml of the dissolved sample into 9ml of dilution of up to 10-10 was prepared using normal saline as the diluents. Tenfold serial dilution were made by adding 1ml of the dissolved sample

3.14 Data Analysis
Data obtained from the study were analyzed using descriptive statistics. Results were presented in tables and percentages to show the occurrence and distribution of fungal isolates associated with spoiled cocoyam samples collected from the selected markets in Aba metropolis.

4. Results

4.1: Cultural and Morphological Characteristics of Isolated Organisms obtained from the Cocoyam procured from Ariaria market in Aba, Abia State.
The cultural and morphological examination of fungal isolates obtained from cocoyam samples collected at Ariaria Market, Aba, revealed the presence of four fungal genera: *Aspergillus, Rhizopus, Penicillium,* and *Mucor*. *Aspergillus* species exhibited black,

rough, and dry colonies with a dark-brown reverse side, while *Rhizopus* species showed white cottony growth that later turned reddish-brown to black. *Penicillium* species produced green, velvety, powdery colonies with a black reverse side, whereas *Mucor* species appeared black, rough, and loose with a milky-white reverse. These characteristics were used for the preliminary identification of the spoilage fungi.

Table 1: Cultural and Morphological Characteristics of Isolated Organisms obtained from the Cocoyam procured from Ariaria market in Aba, Abia State.

Isolate Cultural Characteristics	Morphological Characteristics	Probable Isolate
The surface appear black, Loose growth dry, rough and the reverse slide changed To dark brown.	Spores develop at the tip of hypha.	*Aspergillus* sp
The surface appear white, Cottony growth and the reverse Side turned to reddish-brown or black.	Spores develop at the tip of hypha.	*Rhizopus* sp
The surface appear green, velvety, Dry, powdery and the reverse side turned to black.	Spores develop at the tip of the hypha.	*Penicillium* sp
Appears black, loose growth, Dry, rough, and the reverse Slide turned to milky white.	Spores develop at the tip of the hypha.	*Mucor* sp

4.2 Total Colony Count of Fungal Isolates on the Culture Plates obtained from the Cocoyam procured from Ariaria market in Aba, Abia State.

Table 2 shows that *Penicillium* sp. recorded the highest fungal load with 2.1×10^8 CFU/ml, followed by *Aspergillus* sp. with 7.0×10^7 CFU/ml. *Rhizopus* sp. had a colony count of 4.7×10^4 CFU/ml, while *Mucor* sp. recorded the lowest count of 8.0×10^1 CFU/ml. The results indicate that *Penicillium* and *Aspergillus* species were the most abundant fungal contaminants associated with cocoyam spoilage in the study area.

Table 2: Total Colony Count of Fungal Isolates on the Culture Plates obtained from the Cocoyam procured from Ariaria market in Aba, Abia State.

Organisms	Dilution factor	No of Colony	Volume	Cfu/ml
Mucor	10^{-1}	80	0.1	$8.0x10^{1}$
Rhizopus	10^{-4}	70	0.0001	$4.7x10^{4}$
Aspergillus	10^{-7}	47	0.0000001	$7.0x10^{7}$
Penicillium	10^{-8}	21	0.00000001	$2.1x10^{8}$

4.3: Percentage Occurrence of Fungal Isolates obtained from the Cocoyam procured from Ariaria market in Aba, Abia State.

The percentage occurrence of fungal isolates showed that *Mucor* sp. was the most frequently occurring fungus with 80 colonies (36.7%), followed by *Rhizopus* sp. with 70 colonies (32.1%). *Aspergillus* sp. accounted for 47 colonies (21.6%), while *Penicillium* sp. had the lowest occurrence with 21 colonies (9.6%). Overall, a total of 218 fungal colonies were isolated, indicating that *Mucor* and *Rhizopus* species were the dominant fungi associated with cocoyam spoilage in Ariaria Market, Aba.

Table 3: Percentage Occurrence of Fungal Isolates obtained from the Cocoyam procured from Ariaria market in Aba, Abia State.

Organisms	No of Colony	Percentage of Occurrence (%)
Mucor	80	36.7
Rhizopus	70	32.1
Aspergillus	47	21.6
Penicillium	21	9.6
Total	**218**	**100%**

5.Discussion

The present study identified four fungal genera, namely *Mucor* spp., *Rhizopus* spp., *Aspergillus* spp., and *Penicillium* spp., as the major fungi associated with the postharvest spoilage of cocoyam (*Colocasia esculenta*) marketed in Ariaria Market, Aba, Abia State. The occurrence of these fungi agrees with the findings of Okeke et al. (2021), who reported *Aspergillus*, *Rhizopus*, *Mucor*, and *Penicillium* species as predominant spoilage fungi of root and tuber crops in southeastern Nigeria. The similarity in findings may be attributed to the comparable tropical climatic conditions characterized by high temperature and humidity, which favour fungal growth and proliferation. Likewise, Nwankwo et al. (2023) isolated the same fungal genera from spoiled cocoyam and yam tubers, suggesting that these fungi are common postharvest pathogens of starchy root crops.

The cultural and morphological characteristics observed in this study, including the black rough colonies of *Aspergillus*, the white cottony growth of *Rhizopus*, the green velvety appearance of *Penicillium*, and the fluffy growth of *Mucor*, correspond with the

descriptions reported by Eze and Chukwu (2022). This agreement confirms the reliability of morphological identification in preliminary fungal characterization. However, the present study relied solely on morphological identification, whereas Eze and Chukwu (2022) further confirmed their isolates using molecular techniques. The slight differences reported in colony pigmentation and growth patterns may therefore be due to variations in culture media composition, incubation conditions, and environmental adaptation of fungal strains.

The colony count analysis revealed that *Penicillium* spp. had the highest fungal load (2.1×10^8 CFU/ml), followed by *Aspergillus* spp. (7.0×10^7 CFU/ml). This finding agrees with the report of Akinmusire et al. (2022), who observed that *Penicillium* and *Aspergillus* species often dominate stored agricultural commodities because of their high sporulation rate and ability to thrive under low moisture conditions. The high fungal loads recorded in the present study may be associated with prolonged storage duration and poor market sanitation, which provide favourable conditions for fungal multiplication. Similarly, Odeyemi et al. (2024) reported that inadequate ventilation and elevated moisture content significantly increase the growth and spread of storage fungi in root crops.

In contrast, the present findings differ from those of Umechuruba and Nwogwugwu (2021), who reported *Aspergillus* species as having the highest fungal load in spoiled cocoyam samples from Rivers State. The discrepancy may be attributed to differences in geographical location, environmental conditions, storage practices, and the duration of storage before sample collection. Fungal succession during spoilage is influenced by environmental variables, and different fungi may dominate at different stages of deterioration.

The percentage occurrence data showed that *Mucor* spp. had the highest prevalence (36.7%), followed by *Rhizopus* spp. (32.1%), while *Penicillium* spp. had the lowest occurrence (9.6%). This result agrees with the findings of Okechukwu et al. (2022), who identified *Mucor* and *Rhizopus* as the most frequently occurring fungi in spoiled cocoyam tubers marketed in southern Nigeria. The high occurrence of these fungi may be due to their rapid colonization of injured tissues and their ability to utilize simple carbohydrates present in cocoyam. Mechanical injuries sustained during harvesting, transportation, and marketing often create entry points that facilitate infection by these opportunistic fungi.

However, the low occurrence of *Penicillium* spp. observed in this study disagrees with the findings of Adebola et al. (2023), who reported *Penicillium* species as one of the most prevalent fungal contaminants of stored yam tubers. This variation may be due to differences in host crop characteristics. Cocoyam possesses different moisture content, nutrient composition, and protective skin structures compared to yam, which may influence fungal colonization and prevalence. Furthermore, market environmental conditions and storage duration may have contributed to the observed differences.

The detection of *Aspergillus* spp. in spoiled cocoyam samples is of significant public health concern. This observation supports the report of the Food and Agriculture Organization (FAO, 2023), which identified *Aspergillus* species as important producers of aflatoxins in food commodities. Similarly, the World Health Organization (WHO, 2023) reported that aflatoxin contamination remains a major food safety challenge in developing countries, particularly where storage facilities are inadequate. The occurrence of *Aspergillus* in the present study therefore suggests a potential risk of mycotoxin contamination if spoiled cocoyam is consumed without proper inspection.

The presence of *Penicillium* species also agrees with the findings of Bello et al. (2024), who reported that members of this genus are common storage fungi capable of producing ochratoxins and other harmful secondary metabolites. Although *Penicillium* had the lowest percentage occurrence in this study, its exceptionally high colony count indicates its strong ability to proliferate once established. This suggests that prevalence alone may not accurately reflect the severity of fungal contamination, as fungal load is equally important in determining spoilage intensity and potential health risks.

Overall, the findings of this study corroborate previous reports that fungal spoilage remains a major cause of postharvest losses in cocoyam and other root crops in tropical regions. The predominance of *Mucor*, *Rhizopus*, *Aspergillus*, and *Penicillium* species reflects the influence of environmental conditions, handling practices, and storage systems on fungal contamination. The results further emphasize the need for improved postharvest management strategies to reduce economic losses and protect consumer health.

6. Conclusion

This study provides important insight into the mycological quality of cocoyam (*Colocasia esculenta*) marketed in Ariaria Market, Aba, and highlights the significant role of fungal contamination in post-harvest deterioration of this economically and nutritionally important crop. The investigation revealed the presence of four major fungal genera—*Mucor*, *Rhizopus*, *Aspergillus*, and *Penicillium*—which were successfully isolated and identified based on their cultural and morphological characteristics. The predominance of *Mucor* and *Rhizopus* suggests that these fungi are common colonizers of cocoyam during storage and

distribution, while the higher fungal loads recorded for *Aspergillus* and *Penicillium* indicate their strong capacity to proliferate under favorable environmental conditions.

The findings demonstrate that fungal spoilage remains a major challenge affecting the quality, marketability, and shelf life of cocoyam. Beyond the economic losses incurred by traders and farmers, the detection of *Aspergillus* and *Penicillium* raises concerns regarding food safety because some species within these genera are known to produce mycotoxins that may pose health risks to consumers. Consequently, the presence of these fungi emphasizes the need for greater attention to the handling and storage of cocoyam after harvest.

Overall, the study underscores the importance of adopting improved post-harvest management practices, including proper sorting of damaged tubers, maintenance of hygienic storage environments, reduction of excess moisture, and routine monitoring for fungal contamination. Educating farmers, traders, and consumers on appropriate storage techniques can also contribute significantly to reducing spoilage. Implementing these measures will not only minimize post-harvest losses but also enhance food safety, preserve product quality, and improve the economic value of cocoyam in local markets. The study therefore serves as a valuable contribution to efforts aimed at ensuring sustainable cocoyam production, marketing, and consumption in Southeastern Nigeria.

7. Recommendations

Based on the findings of this study, the following recommendations are made:

1. Farmers and traders should minimize mechanical injuries to cocoyam tubers during harvesting, transportation, and handling to reduce fungal invasion.
2. Cocoyam should be stored under clean, dry, and well-ventilated conditions to inhibit fungal growth and prolong shelf life.
3. Routine microbiological surveillance of cocoyam sold in local markets should be implemented by relevant regulatory agencies.
4. Public awareness programmes should be organized to educate farmers, traders, and consumers on the health implications of fungal contamination and mycotoxin exposure.
5. Modern storage technologies such as improved barns and temperature-controlled facilities should be encouraged to reduce postharvest losses.

8. Contribution to Knowledge

This study contributes significantly to existing knowledge in the following ways:

1. It provides recent baseline information on fungal species associated with postharvest spoilage of cocoyam marketed in Ariaria Market, Aba, Abia State, Nigeria.
2. It establishes the occurrence, distribution, and fungal load of *Mucor*, *Rhizopus*, *Aspergillus*, and *Penicillium* species in spoiled cocoyam samples.
3. It demonstrates that fungal prevalence and fungal load may not always follow the same pattern, as *Penicillium* exhibited the highest fungal load despite having the lowest occurrence.
4. It highlights the potential food safety risks associated with the presence of toxigenic fungi in cocoyam marketed for human consumption.
5. The findings serve as a useful reference for future studies on fungal ecology, food safety, and mycotoxin contamination.

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