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# Nutritional composition and fungal spoilage of cabbage and fluted pumpkin sold in Port Harcourt Nigeria

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## Abstract

Fungi are increasingly implicated as agents of the spoilage of economically important fruits and vegetables. This study was conducted to determine the fungal species responsible for the spoilage of cabbage (*Brassica oleracea*) and fluted pumpkin (*Telfairia occidentalis*) leaves sold in different markets in Port Harcourt, Nigeria. A total of 50 samples each of spoilt cabbage and pumpkin were analyzed for mycological, proximate, and mineral compositions. A total of 170 and 128 fungal isolates were obtained from cabbage and pumpkin, respectively. The fungal counts of the spoilt cabbage samples ranged from $5.1 \times 10^5$ CFU/g to $7.2\times10^6$ CFU/g with the samples from Rumuokoro and Mile 1 Market having the highest and lowest counts, respectively. The fungal counts of the pumpkin ranged from $2.8\times10^4$ CFU/g to $2.4\times10^5$ CFU/g with Rumuokoro and D/line markets producing the highest and lowest counts, respectively. The fungi identified were *Penicillium* sp., *Aspergillus* niger, *Cladosporium* sp., *Rhizopus* sp., *Aspergillus flavus*, *Fusarium* sp., *Trichophyton* sp., and *Saccharomyces* sp. *Aspergillus* sp. had the highest prevalence (88 %), followed by *Saccharomyces* sp. (84 %), *Penicillium* sp. (44 %), and *Rhizopus* sp. (44 %). The vegetables contained high amounts of crude protein and carbohydrate, while fat content is low. The vegetables are rich in Na, Mg, Ca, K, Cu, and Zn. This study showed that the fungi isolated are associated with the spoilage of cabbage and pumpkin leaves and can be traceable to poor handling and the hygienic condition of the market in which they are sold.

**Keywords:** Cabbage; Fluted pumpkin; Fungi; Vegetables

## 1. Introduction

Vegetables are the edible components of herbaceous plants, including roots, stems, leaves, and fruits, that are suitable for consumption either in their raw state or after being prepared [1]. They are high in vitamins and minerals, rendering their inclusion in every meal vital for humans. Vegetables, among others, have been among the most regularly consumed vegetables in Nigeria with consumption rate of 40 % in the past few decades [2]. They supply some key nutritional ingredients in the human daily diet, such as vitamins and minerals, that keep the body in excellent and healthy condition.

*Brassica oleraceae* (common name: Cabbage) is a leafy vegetable in the family of Brassicaceae (or Cruciferae). It is a biennial herbaceous plant with a short stem that is densely packed with green leaves. This leafy vegetable has a great therapeutic value and is effective against gastric ulcers [1]. It also contains a considerable amount of glutamine, an amino acid with anti-inflammatory properties when consumed uncooked [3].

*Telfairia occidentalis* (common name: Fluted pumpkin) belongs to the Cucurbitaceae family. It is a popular green vegetable in Nigeria, and is widely cultivated for its palatable and nutritious leaves. The leaves when compared with other tropical vegetables have high nutritive value. Its protein content (21 %) is higher than those of other commonly

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used leafy vegetables [4]. The leaves are rich in vitamins and minerals such as Ca, P, and Fe [5]. It has been demonstrated to have a hypolipidemic effect, which justifies its use in herbal medicines in African traditional medicine [1].

Microorganisms can infect vegetables at any time during distribution, processing, packaging, or food preparation process [6]. Fruit and vegetable microbial contamination can lead to food degradation and human illnesses. Vegetables have been linked to outbreaks of food-borne disease, resulting in major economic problems in Nigeria and the world at large [7]. These outbreaks range in size from a few hundred to thousands of people. Vegetable contamination can occur at any time during the pre- and post-harvest processes. It is estimated that approximately 30 % of all vegetables produced annually are lost due to microbial spoilage [8]. Bacteria, viruses, fungi, and parasites are among the organisms involved. This is encouraged by their high concentration of various sugars, minerals, vitamins, amino acids, and low pH, which also enhances the successful growth and survival of microorganisms [9]. Microorganisms that cause vegetable spoilage use extracellular lytic enzymes to destroy these polymers, releasing water and the plant's other intracellular contents for use as nutrition [10]. Some spoilage microorganisms can colonize and cause lesions on healthy, unharmed plant tissue [8]. Microbial spoilage of vegetables reduces the quantity for consumption and the profits obtained from sales [7].

Fungi are increasingly becoming implicated as spoiling agents in commercially important fruits and vegetables. Fungal spoilage of certain vegetables is a prevalent phenomenon observed in various regions of Nigeria. Vegetables are susceptible to microbial contamination via direct contact with soil, pollen, water, and handling during postharvest processing or harvest. As a consequence, they serve as hosts for an extensive variety of microorganisms, encompassing both plant and human pathogens [11]. Extracellular pectinases and hemicellulases, which are significant components of fungal deterioration, are abundant in fungi [12].

Unsafe water used for rinsing the vegetables and sprinkling them to keep them fresh is also a source of contamination. Other possible sources of microorganisms include soil, faeces (human and animal origin), water (irrigation, cleaning), ice, animals (including insects and birds), handling of the product, harvesting and processing equipment, and transport [13].

It has been estimated that almost 20 % of all harvested vegetables go to waste due to spoiling, mostly in the post-harvest period [14]. This has been linked to the presence of potentially toxic or pathogenic fungi. Cases of infections or allergies confirmed the presence of pathogenic fungi. The production of mycotoxins and other toxic compounds by *Aspergillus* spp. has been confirmed to pose a global threat to the health of both humans and animals.

Cabbage (*Brassica oleracea*) and fluted pumpkin (*Telfairia occidentalis*) leaves are two of the most frequently used vegetables in Nigeria. Pumpkin leaves are used in the preparation of Nigerian soups and other dishes, while cabbage is commonly used in salad preparation. Considering the common use of these vegetables, there is a need to identify fungi associated with their spoilage to help in informed decision-making and advice to the government in the regulation of the markets so as to reduce the risk of contamination and infection arising from the handling and consumption of fruits. This study was carried out to evaluate fungi associated with the spoilage of cabbage and pumpkin leaves sold within Port Harcourt.

## 2. Material and method

### 2.1. Sample collection

A total of 100 samples of the vegetables (50 cabbage and pumpkin each) were obtained from five (5) different markets in Port Harcourt. The samples were collected in a sterile polythene bag and transported to the microbiology technology laboratory for immediate microbial analysis.

### 2.2. Microbial analysis of the samples

The total mesophilic fungi in the sample were analyzed by weighing 10 g of the samples into 90 ml of 1% sterile peptone water (diluents). Serial dilution was carried out aseptically using a sterile pipette. After dilution, an aliquot (0.1 ml) of the diluted samples was cultured on Potato Dextrose Agar (PDA) media using a sterile hockey stick. The cultured plates were incubated aerobically at 28–30 $^{\circ}$C for 48 h. This analysis was repeated for all the samples (cabbage and pumpkin leaves).

### 2.3. Enumeration and purification of the fungal isolates

After culture incubation, the total heterotrophic count of the fungi was determined by counting the colonial growth on the cultured plates, and the Colony Forming Units (CFU/g) were calculated. The different isolates of the cultures were purified by subculturing the isolates on the freshly prepared PDA based on their different cultural morphological characteristics and incubated at 30 $^{o}$C for 72 h. Pure isolates of the different fungi isolates were preserved on PDA at 4 $^{o}$C under good aseptic conditions for further analysis.

### 2.4. Identification of fungal isolates

The fungal isolates were named using cultural morphological characteristics such as coloration, colony growth pattern, and conidial morphology [15]. To identify the fungi, a mounting needle was used to put a drop of the stain on a clean slide. A small piece of the aerial mycelia from the representative fungi cultures was then taken out and put in a drop of lactophenol. The mycelium was well spread on the slide with the needle. A cover slip was gently placed with little pressure to eliminate air bubbles. The slide was then mounted and viewed under the light microscope with ×10 and ×40 objective lenses. The morphological characteristics and appearance of the fungal organisms seen were identified.

### 2.5. Proximate and mineral analysis of cabbage and fluted pumpkin leaves

*2.5.1. Sample treatment*

Cabbage and pumpkin leaves were thoroughly washed with distilled water to remove soluble impurities, air dried inside the laboratory at room temperature, and then crushed using a mortar and pestle into a fine powder.

*2.5.2. Proximate analysis*

Proximate analysis was determined using the standard method of [16]. The proximate components assessed were moisture, ash, fibre, fat, carbohydrate, and protein. Mineral contents assessed were sodium, potassium, phosphorus, magnesium, calcium, iron, and zinc.

*2.5.3. Determination of mineral composition*

Two grams of the dried vegetable samples were accurately weighed into a porcelain crucible, ashed at 450-500$^{0}$ C and then cooled to room temperature in a dessicator. The ash was digested using a 5 mL mixture of $HNO_3$, $HClO_4$, and HCl in a 3:1:1 ratio. The digested solution was carefully transferred into a 100 ml volumetric flask and made up to the mark with distilled water. The mineral content (K, Na, Ca, Mg, Cu, Zn, and Fe) was determined using atomic absorption spectrophotometry ("AA-6800) analysis. Triplicate digestion of samples and blanks was carried out to ensure precision. Appropriate quality assurance procedures and precautions were carried out to ensure the reliability of the data.

### 2.6. Statistical analysis

The Statistical Package for Social Science (SPSS) was used for the data analysis. The fungi isolated were recorded as frequency and prevalence. An analysis of variance (ANOVA) was used to compute and arrive at a statistical decision, and $p<0.05$ was considered significant.

## 3. Results

### 3.1. Total heterotrophic fungal count of cabbage and pumpkin samples

**Table 1** Total heterotrophic fungal count of cabbage

| Location | CFU/g ±SD |
|---|---|
| Choba | $8.7×10^5$±0.87 |
| Rumuokoro | $7.2×10^6$±0.22 |
| D/Line | $1.3×10^6$±0.41 |
| Mile 1 | $5.1×10^5$±0.11 |
| Creek road | $2.4× 10^6$ ±0.18 |

CFU= Colony forming unit; g= Gram, SD= Standard deviation

The total heterotrophic fungal count (THFC) of the cabbage samples is shown in Table 1. The heterotrophic fungal count ranged from 5.1 ×10$^5$ CFU/g to 7.2×10$^6$ CFU/g. The samples from Rumuokoro market produced the highest count of heterotrophic fungi while the least count was recorded in the cabbage fruit sample from Mile 1 market.

The total heterotrophic fungal count of the pumpkin leave samples is shown in Table 2. The count of the heterotrophic fungi ranged from 2.8×10$^4$ CFU/g to 2.4×10$^5$ CFU/g. The sample of pumpkin leaves samples from Rumuokoro market produced the highest heterotrophic fungal count while the least count of heterotrophic fungi was recorded in the samples from D/line market.

**Table 2** Total heterotrophic fungal count of pumpkin leave leaves

| **Location** | **CFU/g ± SD** |
|---|---|
| Choba | 5.1×10$^4$±0.12 |
| Rumuokoro | 2.4×10$^5$±0.31 |
| D/Line | 2.8×10$^4$±0.21 |
| Mile 1 | 1.2×10$^5$±0.12 |
| Creek road | 4.8×10$^4$±0.21 |

CFU= Colony forming unit; g= Gram, SD=Standard deviation

## 3.2. Identification of fungal isolates

Table 3 shows the features of the fungal isolates identified following their macroscopic and microscopic characteristic. The fungal identified as a result of their distinct features were *Aspergillus flavus, Aspergillus niger*, *Penicillium*, *Cladosporium*, *Rhizopus*, *Fusarium*, *Trichophyton*, and *Saccharomyces* species.

**Table 3** Macroscopic and microscopic features of the fungal isolates

| **Isolates** | **Macroscopy** | **Microscopy** | **Probable Fungi** |
|---|---|---|---|
| F1 | Greenish velvety surface with white, rough reverse side. | Septate hyphae with simple conidiosphores. The phialiades end having brush-like clusters. | *Penicillium* sp. |
| F2 | Black-brownish, powdery surfaced mycelia with cracked reverse | Septate hyphae with cornida arranged with cornidia like a mop-head. | *Aspergillus niger* |
| F3 | Small, greenish and black powdery colonies. | Conidia developed at the end of conidiospores with septate mycelium | *Cladosporium* sp. |
| F4 | Brownish, powdery surfaced mycelia with smooth creamy reverse | Non-Septate hyphae with cornida arranged with round head end.cornidiospores | *Rhizopus* sp. |
| F5 | Yellow-greenish mycelia with cracked reverse | Septate hyphae with cornida arranged with cornidia like a mop-head. | *Aspergillus flavus* |
| F6 | Woolly to cottony, flat colonies with brown transverse. | Hyaline septate hyphae, conidiaphores, phalides, are produced from the branched conidia | *Fusarium* sp. |
| F7 | White-pinkish wooly appearance with red reverse ending | Septate phialids with rectangular conidiospores having spherical microconidia clustered | *Trichophyton* sp. |
| F8 | Creamy round, raised bacteria-like colonies | Unicellular, oval shaped cells | Saccharomyces sp. |

## 3.3. Prevalence and distribution of fungi associated with spoilt cabbage and pumpkin from five different markets

Table 4 shows the prevalence and distribution of fungal isolates in 50 spoilt cabbage samples from Choba, Rumuokoro, D/Line, Mile 1, and Creek Road market. The fungi, *Aspergillus* sp. had the highest prevalence and distribution across the 50 samples with the 88 % followed by *Saccharomyces* sp. with 84 % prevalence followed by *Penicillium* sp. and *Rhizopus* sp. with 44 % prevalence each while the fungi with the least prevalence and distribution was *Cladosporium* sp. recording 14% distribution among the sample of cabbage analyzed. Choba market had the highest prevalence and distribution of the fungal isolates.

Table 5 shows the prevalence and distribution of fungal isolates associated with 50 spoilt pumpkin leaves from the studied markets. The fungal isolates, *Saccharomyces* sp. and *Aspergillus* sp. recorded the highest prevalence of 82 % across the 50 sample of spoilt Pumpkin leave leaves followed by *Penicillium* sp. which recorded prevalence of 34% while the fungi with the least prevalence was *Trichophyton* sp. recording 4 % prevalence. However, Choba market had the highest prevalence and distribution of all the fungi.

### 3.4. Frequency of occurrence of fungi isolated

Figure 1 shows the frequency of occurrence of the fungi species isolated from spoilt cabbage samples. *Aspergillus niger* had the highest occurrence from the cabbage sample with the frequency of 26 % followed by *Saccharomyces* sp. and the fungus with the least frequency of occurrence in the sample was *Cladosporium* sp. having a frequency of 4 %. The frequency of occurrence of other fungi were *Saccharomyces* sp. (25 %), *Penicillium* sp (13 %), *Aspergillus flavus* (13%), *Rhizopus* sp. (13 %), *Fusarium* sp. (6 %).

**Table 4** Prevalence and distribution of fungi associated with spoilt cabbage in five different markets

| **Fungal isolates** | **Markets sampled n (%))** | | | | | |
|---|---|---|---|---|---|---|
| | **Choba (n=10)** | **Rumuokoro (n=10)** | **D/line (n=10)** | **Mile 1 (n=10)** | **Creek Road (n=10)** | **Total prevalence (N=50)** |
| *Penicillium* sp. | 8(80) | 5(50) | 4(40) | 5(50) | 3(30) | 25(44) |
| *Aspergillus niger* | 10(100) | 10(100) | 7(70) | 8(80) | 9(90) | 44(88) |
| *Cladosporium* sp. | 4(40) | 0(0) | 0(0) | 1(10) | 2(20) | 7(14) |
| *Fusarium* sp. | 2(20) | 4(40) | 0(0) | 1(10) | 2(20) | 9(18) |
| Saccharomyces sp. | 10(100) | 7(70) | 10(100) | 10(100) | 5(50) | 42(84) |
| *Rhizopus* sp. | 6(60) | 2(20) | 4(40) | 6(60) | 4(40) | 22(44) |
| *Aspergillus flavus* | 6(60) | 4(40) | 5(50) | 2(20) | 4(40) | 21(42) |
| Total | 46 (27.1) | 32(18.8) | 30 (17.6) | 33(19.4) | 29 (17.1) | 170 (100) |

n=Number of samples analyzed in each market, N=Total number of samples analyzed for each sample

**Table 5** Prevalence and Distribution of Fungi Associated with Spoilt Pumpkin Leaves from Five Markets

| **Fungal isolates** | **Markets sampled (n(%))** | | | | | |
|---|---|---|---|---|---|---|
| | **Choba (n=10)** | **Rumuokoro (n=10)** | **D/line (n=10)** | **Mile 1 (n=10)** | **Creek Road (n=10)** | **Total prevalence (N=50)** |
| *Rhizopus* sp. | 3(30) | 4(40) | 3(30) | 1(10) | 2(20) | 13(26) |
| *Aspergillus niger* | 10(100) | 10(100) | 8(80) | 6(60) | 7(70) | 41(82) |
| *Aspergillus flavus* | 2(20) | 3(30) | 1(10) | 3(30) | 0(0) | 9(18) |
| *Fusarium* sp. | 2(20) | 3(30) | 0(0) | 0(0) | 0(0) | 5(10) |
| *Penicillium* sp. | 3(30) | 5(50) | 3(30) | 3(30) | 3(30) | 17(34) |
| *Saccharomyces* sp. | 10(100) | 8(80) | 7(70) | 8(80) | 8(80) | 41(82) |
| *Trichophyton* sp. | 1(10) | 0(0) | 1(10) | 0(0) | 0(0) | 2(4) |
| Total | 31(24.2) | 33(25.8) | 23 (18.0) | 21 (16.4) | 20(15.6) | 128(100) |

n=Number of samples analyzed in each market, N=Total number of samples analyzed for each sample

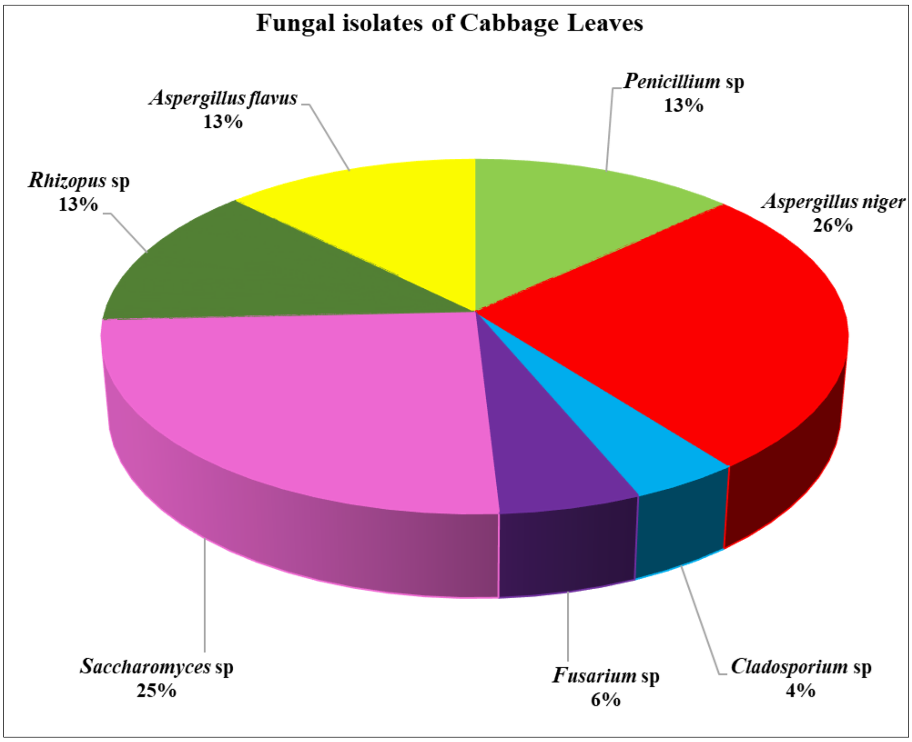


**Figure 1** Frequency of occurrence of the fungi in cabbage leaves

Figure 2 shows the frequency of occurrence of the fungi species isolated from spoilt pumpkin leave leaves samples. *Aspergillus niger* and *Saccharomyces* recorded the highest frequency of occurrence of 32 % while the fungi with the least frequency of 2 % was *Trichopyton* sp. Other fungi frequency of occurrence in associated with spoilt Pumpkin leaves were; *Penicillium* sp. (23 %), *Rhizopus* sp. (10 %), *Aspergillus flavus*, (7 %) and *Fusarium* sp. (4 %).

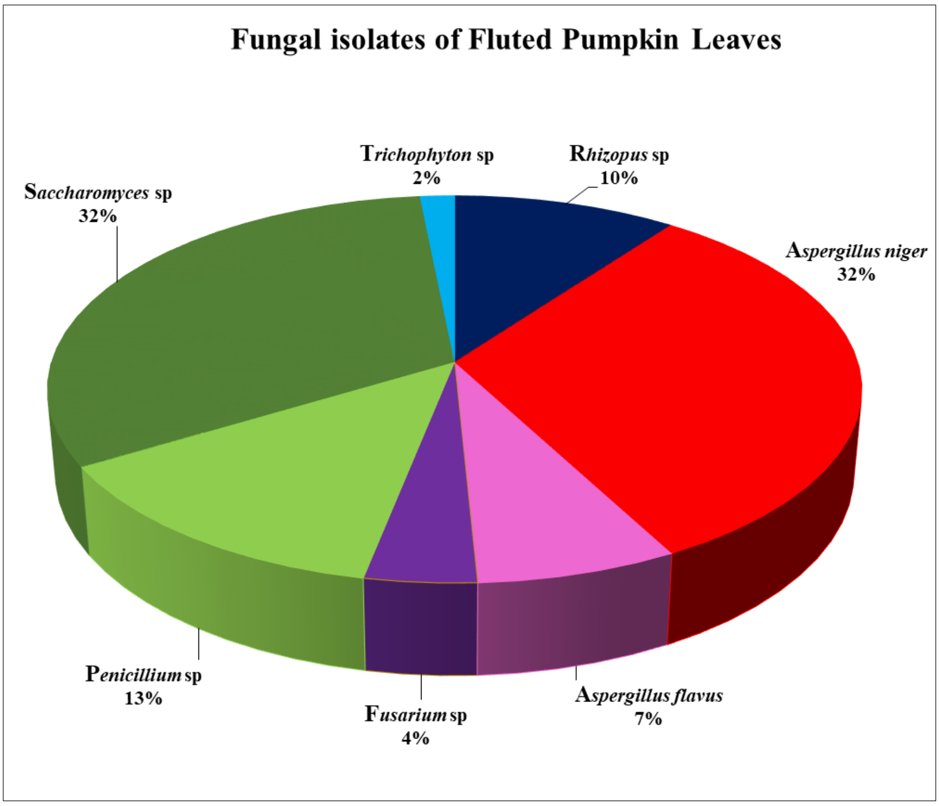


**Figure 2** Frequency of occurrence of the fungi in pumpkin leave samples

### 3.5. Proximate and mineral composition of cabbage and fluted pumpkin leaves

Proximate composition and mineral content of cabbage and pumpkin are presented in Table 6. The table revealed that the cabbage sampled had moisture content of 79.8 %, carbohydrate content of 11.4 % and protein content of 2.7 %. The crude fats and fibre components were 0.4 % and 4.2 % respectively. The mineral compositions of the cabbage revealed that potassium was the highest mineral component (488.1 mg/100g) while copper was the least mineral (0.17 mg/100g).

Fluted pumkin leaves contain high percentage of moisture (57.2 %), protein (33.5 %), and carbohydrate (21.3 %), while the percentage composition of fat (2.3 %) is relatively low. Mineral analysis showed that fluted pumpkin had high sodium (74.3 mg/100 g) and calcium (73.7 mg/100 g). Magnesium, potassium, and iron were present in considerable amount. However, moderate amounts of copper, zinc, and magnesium were present. The lowest mineral was zinc (15.1 mg/100 g).

**Table 6** Proximate compositions of cabbage and pumpkin leaves

| Parameters | Percentage Composition (Mean±SD) | |
|---|---|---|
| | **Cabbage** | **Pumpkin** |
| Moisture (%) | 79.8 ± 0.32 | 57.2 ± 0.12 |
| Ash (%) | 1.5 ± 0.61 | 1.8 ± 0.38 |
| Carbohydrate (%) | 11.4± 0.16 | 21.3 ± 0.20 |
| Protein (%) | 2.7 ± 0.41 | 13.5 ± 0.11 |
| Crude fat (%) | 0.4 ± 0.30 | 2.3 ± 0.41 |
| Crude Fibre (%) | 4.2 ± 0.22 | 3.9 ± 0.36 |
| Sodium (mg/100 g) | 184.3 ± 0.39 | 74.3 ± 0.40 |
| Potassium (mg/100 g) | 488.1 ± 0.10 | 41.1 ± 0.20 |
| Magnesium (mg/100 g) | 64.9 ± 0.19 | 52.4 ± 0.33 |
| Calcium (mg/100 g) | 38.1 ± 0.20 | 63.7 ± 0.01 |
| Copper (mg/100 g) | 0.17 ± 0.43 | 16.8 ± 0.22 |
| Iron (mg/100 g) | 4.2± 0.23 | 28.2± 0.08 |
| Zinc (mg/100 g) | 3.7± 0.11 | 15.1± 0.66 |

Values are means of duplicates: SD= Standard error of the mean

## 4. Discussion

Fungal pathogens are causing losses of marketable quality and hygiene of vegetables, resulting in major economic problem in Nigeria and the world at large. This study evaluated the fungal associated with the spoilage of cabbage and pumpkin leaves from five different markets of Port Harcourt, Nigeria.

Results showed that seven fungal species: *A. niger, A. flavus, Fusarium* sp., *Penicillium* sp., *Rhizopus* sp., *Trichophyton* sp., *Cladosporium* sp., and yeast (*Saccharomyces* sp.) were associated with the contamination of Brassica oleracea (Cabbage) and Telfairia occidentalis (fluted pumpkin). The slight variation in the microbial load from different market sources can be traced to the prewashing with refreshing water.

Fungi causing spoilage of vegetables have been isolated and characterized by many studies [17,1, 6, 18]. The result agrees with the reports of Tsado et al. [17] and Abu et al. [1] who reported that that these organisms could be linked to the spoilage of raw vegetables. *Aspergillus* species have been implicated in causing aspergillosis that infects and contaminates preharvest and post-harvest fruits and vegetable crops with the carcinogenic secondary metabolite aflatoxin [19]. Fusarium which can be pathogenic or epiphytic is recognized as a causative agent of fusarium wilts in various vegetable crops [20]. It causes Fusarium wilt is a plant disease that is attributed to the pathogenic fungus *Fusarium oxysporum* [21]. *Penicillium* species particularly *P. expansum* is the causative agent of blue-mold disease, which holds significant economic implications being the foremost post-harvest disease affecting fruit and vegetables during storage. Furthermore, certain strains of the fungus have the capability to produce the mycotoxin known as patulin, in addition to inducing spoilage [22]. In large dosages, this mycotoxin causes both acute and chronic consequences in animals, including edema of blood vessels and tissues and the formation of sarcomas. It produces gastrointestinal distress in humans, including nausea, vomiting, and abdominal pain [23]. *Cladosporium* species (*Cladosporium herbarum*) causes spoilage and spot diseases of fresh fruits and vegetables [24].

Vegetables may sustain physical damage during harvesting, storing, packaging, and shipping, which raises the risk of fungal contamination and post-harvest loss [25]. Furthermore, improper vegetable handling in these marketplaces may exacerbate the issue. Poor vendor hygiene, the use of microbiologically unsafe containers, careless handling techniques, and unfavorable ambient factors, such as a sanitarily hazardous marketing atmosphere, may all contribute to the market conditions that encourage contamination [7]. Increased vegetable loss as a result of microbial deterioration and the presence of some human infections could be the outcome of the issues ~~(Okojie and Isah, 2014)~~. According to Abu et al. [1], the presence of faeces or untreated sewage in the environment, as well as pathogens in the soil or water, can also be a cause of pre- and post-harvest contamination of vegetables.

The proximate and nutritional composition of vegetables revealed the underlying factors contributing to their susceptibility to microbial infection. Moisture content (MC) has a significant impact on food safety and shelf life. The higher the MC, the shorter the time a food will keep before rotting. Moisture-rich foods are more vulnerable to microbial attack, whereas low moisture levels inhibit microbial growth. Moisture levels of 14% or higher stimulate fungal growth, while lower moisture levels avoid spoiling [18]. In addition, Cabbage and Pumpkin leaves possess significant amounts of vitamins, minerals and dietary fibre, with low fat and calorie contents, revealing that they are vegetables of promising nutritional value.

## 5. Conclusion

The result of this study showed that the fungi *A. niger, A. flavus, Fusarium* sp., *Penicillium* sp., *Rhizopus* sp., *Trichophyton* sp., *Cladosporium* sp., and *Saccharomyces* species (yeast) are fungi that are associated with the spoilage of cabbage and pumpkin leaves. These contamination and spoilage can also be relative to the hygienic condition of the markets in which they are sold as in the course of this study, Rumuokoro and Choba market recorded higher prevalence of these spoilage microorganisms. Some of the fungi isolated from the spoilt vegetable overtime have been understood to have the potential for toxicity hence a public health concern. The study also confirmed that the organisms isolated from the spoilt vegetables samples in the markets are not limited to a particular location as most of the fungi isolated were found in almost all the locations.

Farmers and vendors should be educated on proper hygienic ways to handle, prepare, transport and display these vegetables to reduce exposure to spoilage and pathogenic fungi. Vegetable such as cabbage and pumpkin should be washed in clean or iodized water before sending into the market for sale.

## Compliance with ethical standards

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### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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