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Fungal spoilage of cayenne pepper (*Capsicum annuum*) and scotch bonnet pepper (*Capsicum chinense*)

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Abstract

The fungal spoilage of scotch bonnet pepper and cayenne pepper was investigated. About 20 Samples of cayenne pepper (*Capsicum annuum*) and scoth bonnet pepper (*Capsicum chinense*) were obtained from five differerent sellers (four samples each) including two (2) spoiled and two (2) fresh samples in Wadata market in Makurdi metropolis. The samples were serially diluted and dilution 10^{-2} and 10^{-4} dilution factors were used, inoculation was done using pour plate method onto SDA medium and the colonies were enumerated in colony forming unit per gram (CFU/g). Identification of the colonies was done from the colony characteristics such as color, shape and type of hyphae under the microscope using the compendium for fungi. Production of afflatoxin by the isolated fungi was also determined. The occurrences of the isolated organisms was recorded based on frequencies and percentage. The isolated fingi were *Trychophyton* Sp, *Geotrichum Sp, Mucor* Sp, and Yeast. Preservation and proper handling of different species of pepper should be taken seriously and hygienically to reduce spoilage organisms and hence bring post-harvest losses of pepper to a minimal level.

Keywords: *Capsicum annuum, Capsicum chinense,* Food spoilage, Fungal Spoilage, Spoilage

1. Introduction

The term "spoilage" refers to any harm or injury to food that lowers its quality or renders it unusable (Akinmusire, 2011). According to Ademoh et al. (2017), the phrase "food spoilage" describes the unintended spread of microorganisms within the food that render it unpleasant to eat or hazardous for human consumption. Food preservation refers to the prevention of food spoiling. Food preservation techniques that reduce microbial activity in food have a vital role in preventing food spoiling (Ewekeye et al., 2013). The most significant rotting organisms found on pepper fruits are fungus (Bashar et al., 2012). In addition, there are some zygomycetes like *Mucor* sp. and *Rhizopus* sp., as well as a few imperfect fungi including *Penicillium* sp., *Aspergillus* sp., and *Alternaria* sp. These fungi produce a lot of spores, and are almost always present where fruits are cultivated, and are handled in such a way that they can attack fruits at different stages, from harvest to consumption, by taking advantage of any bruising or injury. According to research, fungi enter their hosts' tissues through lenticels, stomata, and the unbroken epidermis through appresorium or germ tubes, which are natural apertures. (Aziagba et al., 2015). The Solanaceae family contains the unusual genus *Capsicum.* In spite of the genus having more than 30 recognized species, only five of them—*Capsicum annuum*, *Capsicum, chinense*, *Capsicum*

frutescens, Capsicum baccatum var. pendulum, and *Capsicum pubescens*—are domesticated (Ikechi-Nwogu *et al*., 2021).

2. An overview of pepper

Pepper is mostly grown in Nigeria's Savanna ecological zones as a mixed-crop or monoculture both during the rainy season and dry season with irrigation. When making stew and soup, it can be used in fresh form, as paste, puree, juice, or ground with other vegetables (Kobina & Ebenezer, 2012). In terms of the economy, food, and pharmaceutical industries, pepper plays a significant role. It contains the most vitamin C of any plant and has significant therapeutic benefits, including the ability to prevent heart disease, activate blood circulation, and possess antioxidant capabilities (Costa et al., 2019). Despite the significance of pepper as a spice, peppers are prone to several diseases that lower the fruit's field and market value. Because so much pepper crop is lost both on the field and in storage, pests and illnesses are some of the major factors that work against optimum production. These illnesses range from those that are transmitted through the soil and affect the roots and stems to those that damage the leaves and fruits. The severity of these illnesses, which can be brought on by bacteria, fungi, or viruses, varies from nation to nation depending on climatic factors and the virulence of the causing agents (Truong et al., 2013).

In particular when pepper is planted in furrow irrigation, Phytophthora capsic L., a soil-borne fungus, produces a quick and complete withering of the aerial portions and is one of the main fungal infections affecting pepper species (Ewekeye *et al*., 2013). These soil-borne fungi, *Verticilliun dahliae* and *Sceletium rolfsii*, are host-specific and have been found to cause serious wilting in pepper plants, particularly perennial species (Alsohaili & Bani-Hasan, 2018). Early invasion of pepper plants, particularly young seedlings, has been found to result in complete loss of seedlings. The majority of pepper species are infected by a range of poly viruses in Mediterranean, subtropical, and tropical environments. One of the most crucial elements in the cultivation of pepper crops is disease management. Invading microorganisms, such as fungus, can reduce pepper performance and quality and prevent an ideal yield (Ewekeye et al., 2013; Akinyemi & Liamngee, 2018).

3. Sample collection

About 20 Samples of cayenne pepper (*Capsicum annuum*) and scoth bonnet pepper (*Capsicum chinense*) were obtained from five different sellers (four samples each) including two (2) spoiled and two (2) fresh samples in Wadata market in Makurdi metropolis. They were packaged in clean polyethene bags and were transported to the Research Laboratory, Department of Microbiology Joseph Sarwuan Tarka University for analysis.

3.1. Sample preparation and pnoculation

After washing the pepper samples in sterile distilled water, the water was serially diluted. Using the pour plate and spread plate procedure, this was then inoculated into culture media that had been prepared for colony enumeration.

3.2. Media preparation

3.2.1. Preparation of Sabouraud Dextrose Agar (SDA)

In order to completely dissolve the medium, the SDA was dissolved in 900 ml of deionized water, the pH was changed with hydrochloric acid to 5.6, and the final volume was adjusted to one Liter. The sterilization process took 15 minutes at 121℃. This was poured into Petri plates after being allowed to cool to 45℃.

3.3. Fungi isolation

The serial dilution and pour plate method on SDA was used to isolate the fungi from the pepper sample. The morphology, growth patterns, coloring of the spores and mycelia, and dispersion of the spores of the isolates were all macroscopically investigated.

3.4. Microscopic Examination for Fungal Isolates

The technique outlined by Barnett and Hunter (2001) was used to mount the fungal isolates in lactophenol cotton blue stain solution on slides with cover slips and microscopically analyze them for spores and vegetative bodies (Lema et al., 2018).

4. Findings and discussion

Fruits and vegetables frequently include pollutants like bacteria and fungi (Udoh et al., 2015). The three most common fungal isolates from pepper samples in a study by Aziagba *et al*. (2015) were *Aspergillus niger*, *Rhizopus stolonifer*, and *Alternaria alternate*. *Escherichia coli* (83.3%), *Salmonella* sp (66.7%), *Pseudomonas* sp (33.3%), *Staphylococcus aureus* (66.7%), *Shigella* sp (33.3%), and *Mucor* sp (66.7%) were all identified from rotten pepper in a different study by Odebisi-Omokanye et al. (Odebisi-Omokanye et al., 2015).

In this study, the following fungi species were isolated from both fresh and spoiled pepper samples. They include Yeast (37.5%), *Mucor* (12.5%), *Ectothrix* sp (12.5%), *Geotrichum* sp (12.5%) and Trychophyton Sp (25%). The isolation of these fungi species is in agreement with the work of Aziagba et al. (2015) who also reported fungi species predominantly in his study. Although his reported included *Aspergillus* spp and *Alternaria* spp which contrasts this report because, in this work, there is no report of *Aspergillus* spp and Alternaria spp. In this work, the predominant fungal isolates are Yeast (37.5%) followed by Geotrichum spp (25%). This also contradicts with the report of Kobina and Ebenezer (2012) and who reported *Apergillus* as the predominant species associated with the spoilage of pepper.

The contamination of this product with fungi organisms is because there are plenty of their spores in the air, and the warmth and humidity encourage their growth. The growth of fungi is influenced by moisture and temperature, therefore identifying meteorological variables that are conducive to fungi can be used to forecast the richness and quantity of fungi in environments with various climatic circumstances (Ademoh et al., 2017). The occurrence and severity of fungal diseases on plants are typically greatly influenced by atmospheric moisture, which is the most significant environmental element. For spore germination and effective infection, high relative humidity and several hours of open surface water are essential (Udoh et al., 2015).

High relative humidity and moderate temperatures are favorable for the growth of fungus, while low relative humidity and extremely high temperatures prevent growth and spore germination, according to field research on plant diseases (Truong et al*.,* 2013). The presence of these fungal organisms can be a source of spoilage and this can also lower the quality of the product. It can also pose a threat to life of consumers as most of these fungal organisms can produce aflatoxins which are harmful to human health. Therefore proper measures should be taken to avoid the introduction of fungal contaminants at any point during the cultivation and storage of pepper.

Table 1: Morphological appearances of fungi colonies on Potato Dextrose Agar (PDA) from samples of Wadata market

Samples	No of Colonies(CFU/g)	Colour	Aflatoxin	PDA stain
SSWDT[a]	1.30×10^4	White	-	*Geotrichum* Sp
SSWDT[b]	5.90×10^5	Milk	-	*Tryccophyton* Sp
SFWDT[c]	5.00×10^2	Light green surrounded by white mould	+	Yeast cells attached to hyphae
SFWDT[d]	3.00×10^4	White	+	*Mucor* Sp
CFWDT[e]	2.00×10^2	Light green surrounded by white mould	+	*Yeast* cells attached to hyphae
CFWDT[f]	1.00×10^4	Light green surrounded by white mould	+	*Ectothrix dermatophyte*
CSWDT[g]	4.50×10^3	Light green surrounded by white mould	+	Yeast cells attached to hyphae
CSWDT[h]	1.50×10^5	Yellow and off-white	-	*Tryccophyton* Sp

Key:

SSWDT =Spoiled scotch bonnet pepper from Wadata market

SFWDT = Fresh scotch bonnet pepper from Wadata market

CSWDT = Spoiled cayenne pepper from Wadata market,

CFWDT= Fresh Cayennne pepper from Wadata market

Figure 1: Bar chart showing the frequencies of the isolated fungi

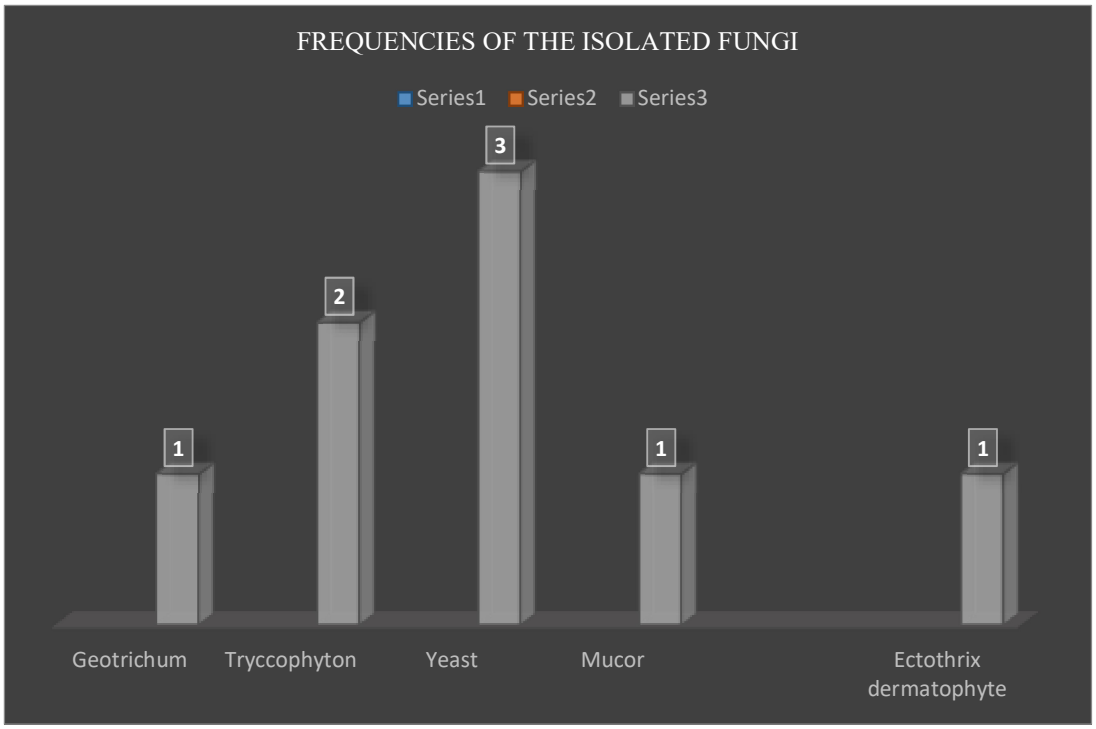
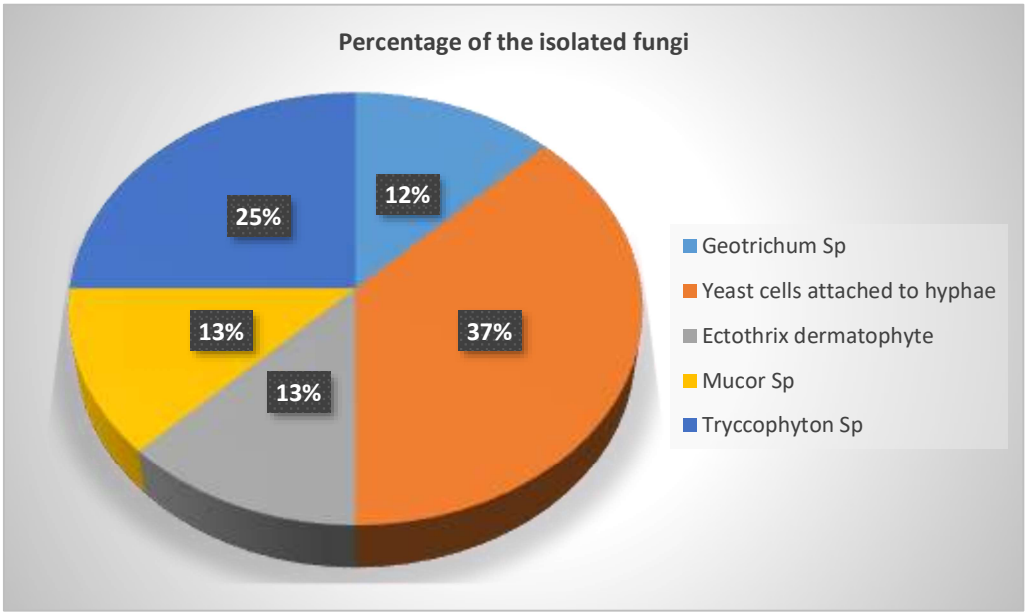


Figure 2: Pie Percentage occurrence of the isolated fungi in the samples



5. Contribution of the study

This study reveals the fungal contamination of cayenne pepper (*Capsicum annum*) and scotch bonnete pepper (*Capssicum chinnense*). It also highlightened the need for proper storage and preservative techniques in the storage and preservation of fresh fruits and vegetables in order to reduce the incidence of microbial contamination and to minimize spoilage.

6. Implications of the study

The contamination of pepper with the named fungal isolates in this study can be a major source of spoilage. The presence of these spoilage organisms is detrimental due to a loss in quality of the product and the risk it can pose on the health of consumers.

7. Conclusion

The microbial spoilage of pepper samples was determined both on scotch bonnet pepper and cayenne pepper. The result shows that pepper of the *Capsicum* genera are carriers of pathogenic fungi, including Yeast, *Mucor* sp, *Ectothrix* sp, *Geotrichum* sp and *Trychophyton* Sp. Therefore, fresh fruits of *Capsicum* Sp should be handled with care during harvesting, transportation, storage and marketing to reduce fungal contamination.

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