

## Original Research

# Incidence of Pre-Harvest and Post-Harvest Diseases of Strawberry Fruit in Plateau State, Nigeria

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**ABSTRACT:** In Plateau State, strawberry (*Fragariaananassa* Duch.) is emerging as an economically important commercial fruit crop, providing and improving the nutrition of the local people, whose diet generally consisted of starch staples lacking essential vitamin and minerals. Despite these benefits, strawberry like most fruits, are prone to fungal spoilage, causing several economically important diseases/rots like anthracnose, soft rot, black rot and gray mold at both pre- and post-harvest stages. Strawberry fruits are delicate and succulent, and after harvest they can commonly undergo fungal spoilage. Annual reports have shown that 20% of fruits and vegetables produced are lost to spoilage; and Strawberry fruits are not exception. To assess the prevalence of the diseases, a comprehensive survey was carried out in 8 strawberry growing districts of Plateau State viz. 4 farms (Vom, Kuru, Bisichi and Lamingo) and 4 markets (Farin-Gada, Terminus, Vwang and Kuru) in Plateau State, Nigeria. This study was undertaken to isolate and identify the fungi that are associated with contamination of strawberry at pre- and postharvest stages commonly in Jos metropolis, Plateau State using standard microbiological methods. The data collected were analyzed using simple descriptive statistics (frequency and mean) and analysis of variance ( $P < 0.05$ ). Twelve (12) fungi isolates were identified viz: *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Colletotrichum Gloeosporioides*, *Schizosaccharomyces Pombe*, *Penicillium Myriotylum*, *Mucorspp*, *Geotrichum Candidum*, *Botrytis cinerea*, *Fusariumspp*, *Alternaria Alternata* and *Rhizopus Stolonifer*. Most of the fungi species were identified with varying percentage prevalence across the markets; *Colletotrichum Gloeosporioides* had the highest 18(15.0%) frequency of occurrence followed by *Fusariumspp* 15 (12.5%), *Botrytis cinerea* 13(12.8%) and *G. candidum* had the least 4(3.33%). This is the first ever detailed findings of its kind about the incidence of strawberry disease along with its distribution and characterization in Jos, Plateau State. The main strawberry pathogens associated with the strawberry fruit rots in this study are of economical and public health significance. Thus, management strategy must be taken through improved technology-based preservation methods that target in keeping the quality of strawberry fruit from farms, handling, transportation and storage.

**Keywords:** Strawberry pre- harvest and post-harvest diseases, anthracnose, graymold, pathogenicity, Plateau State

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## INTRODUCTION

Strawberry (*Fragariaananassa* Duch.), an herbaceous perennial plant with short stems (crowns) and densely spaced leaves in the genus *Fragaria* and in the family Rosaceae, is highly adaptable, widely cultivated, and extensively distributed (Bordelon, 2001). Planting scale of strawberry has been expanded rapidly, because it is a cash crop with a short production cycle, high effectiveness, and high efficiency (Basu *et al.*, 2014).

Strawberry fruits production has improved the diet of the local people, whose diet generally consisted of starch staples lacking essential vitamin and minerals and are beneficial to the human diet as a source of macro- and

micronutrients, vitamins and health promoting antioxidants (Basu *et al.*, 2014; Giampieri *et al.*, 2015). In the Northern part of Nigeria, strawberry farming is mostly done in the Northern part of Plateau State.

Despite these benefits, strawberry like most fruits, are prone to fungal spoilage. are particularly perishable, especially after harvest, when even if they are apparently healthy at the time of harvest, they can undergo spoilage (Feliziani *et al.*, 2016). These fruits were usually displayed on benches and in baskets for prospective customers in the open markets until sold, thereby exposing them to further microbial infection beside those associated with

the fruit surface. The main causes of decay of strawberry fruit during storage and shelf life are the development of rots that are caused by a range of fungi (Lv *et al.*, 2010; Fang *et al.*, 2012).

Meanwhile, strawberry cultivation in Nigeria is still an untapped goldmine despite its huge acceptance as a fruit in the country, in Nigeria, strawberry farming is mostly done in Plateau State due to the states cold climate but that does not mean it can't be grown in other parts of the country. Besides, it is a highly perishable fruit and the farmers do not have any training on its production and handling techniques (Ayala-Zavala *et al.*, 2007). The fruits are beset with problems of field and storage rot (Ma *et al.*, 2018).

The strawberry diseases have been recorded in other countries like China, Florida, Korea and are mainly root rot, gray mold, soft rot, powdery mildew, anthracnose, leaf spot, and brown spot (Lvet *et al.*, 2010; Fang *et al.*, 2012; Sylla *et al.*, 2013; Asad-Uz-Zaman *et al.*, 2015).

In Plateau State, Nigeria, no fungal diseases of strawberry have been reported. To the best of my knowledge, this is the first report about strawberry fruits rots caused by fungal pathogens in Plateau State and North Central Nigeria. In addition, there are limited or no available reports on postharvest diseases of strawberries that are cultivated or grown in Nigeria, except few reports on the imported fruits. Thus, this preliminary survey/findings was undertaken with the sole aim of identifying the causes of the strawberry pre and postharvest diseases associated with the fruit crop cultivated and sold in Jos, Plateau State.

## MATERIALS AND METHODS

### Study site and location

The surveys were conducted during the crop season of 2022-2023 (which starts mid- August and ends June) at the strawberry growing farms (Vom, Kuru, Bisichi and Lamingo) and markets (Farin-Gada, Terminus, Vwang and Kuru) covering four local government Areas belonging to Plateau North Senatorial District, Plateau State, Nigeria. Suspected diseased samples of the rhizospheres (soils and roots parts), plant leaves and fruits were collected and taken to the Department of Science Laboratory Technology, Central laboratory, University of Jos for further studies.

### Isolation of fungi from strawberry plants (Rhizosphere/Phylloplane and fruits)

Isolation was done from thinner roots, cut into small segments of 1cm length from adjoining areas of diseased and healthy areas of the strawberry plants. Swab Method

was used where sterile swab sticks were employed in collecting samples from the infected regions of the fruits that had soot, white rot and dark-brown sunken soft regions. The fungi and yeast were identified using the simple gram stain and fungal growths that appeared were primarily identified using cultural and morphological features according to the method of Domsch *et al.* (1993). All fungal colonies or isolated fungi specie were identified to species level under the microscope using conidial and/or spore structures and mycelia characteristics.

### Statistical analysis

Data was analyzed using SPSS and One-Way Analysis of Variance (ANOVA). The P-value <0.05 were considered statistically significant.

## RESULTS AND DISCUSSION

### Results of the cultural and morphological characteristics of fungi isolated

Twelve (12) fungi isolates were implicated with the infected strawberry fruits from the four markets surveyed. Viz: *Aspergillus flavus*, *Schizosaccharomyces Pombe*, *Aspergillus fumigatus*, *Aspergillus niger*, *Colletotrichum Gloeosporioides*, *Mucorspp*, *Penicillium Myriotylum*, *Geotrichum Candidum*, *Botrytis cinerea*, *Fusarium spp*, *Alternaria Alternata* and *Rhizopus Stolonifer*. The results in (Table 1) show that the most isolated fungi from the gray mold/watery soft rot strawberry samples were *Botrytis cinerea*, *Mucorspp*. and *Penicillium spp* and *Rhizopus sp*. Those associated to Soft/white rots are *Mucorspp*, *Rhizopus sp*, *Penicillium Myriotylum* and *Botrytis cinerea*. Meanwhile, most isolated fungi from anthracnose rot of strawberry fruits are *Colletotrichum Gloeosporioides*, *Aspergillus niger*, *A. flavus*, *Penicillium Myriotylum*, *Botrytis cinerea*, *Rhizopus Stolonifer*, and *Geotrichum Candidum* (Table 1).

This study revealed the fungi associated with some rot diseases in strawberry fruits in Plateau State. The presence and isolation of these microorganisms depict that they are the causal agents responsible for the deterioration of such an economical and nutritious fruit crop. All the fungi isolates recovered from the strawberry soils, roots, leaves and pre and postharvest fruits rots were all important pathogens isolated from the eight locations as suspected agents of the strawberry fruit spoilage molds in Plateau State. Several fruit spoilage fungi from different region has been isolated and identified (Al-Hindi *et al.*, 2011). The pathogens strains were tentatively identified and were found to be associated with the strawberry fruit's rots but in varying

Diseased symptom/appearance of fruits	Types of Rot	Types of fungi isolated From the infected fruits
Whitish macerated growth covering the bark/skin of the strawberry fruits. watery leakage causes an unsightly mess and is characterized by a soft and watery rot appearance that quickly causes the collapse of the entire fruit but leaves the cuticle intact.	Botrytis/Graymold	<i>Rhizopus</i> sp., <i>Botrytis cinerea</i> , <i>Mucor</i> sp. and <i>Penicillium</i> sp.
Wet oozing white fluid covering some parts of the fruit tissues and macerations.	White/Soft Rot	<i>Mucor</i> sp., <i>Rhizopus</i> sp., <i>P. meriotylum</i> , <i>Botrytis</i> spp.
Strawberry tissue covered with greenish mycelia, funny yellowish brown and Greyish-black tissues with internal ramification. Soft rot water-soaked appearance, brown lesions.	Anthracnose	<i>Aspergillus niger</i> , <i>A. flavus</i> , <i>Penicillium</i> sp., <i>Botrytis cinerea</i> , <i>Rhizopus stolonifer</i> , <i>G. candidum</i> and <i>Colletotrichum gloeosporioides</i>
Dark brownish-black fruits. On the fruit surface, white hyphae appeared in the early stage, and a white layer of mold formed in the late stage.	Brown/Black Rot	<i>Aspergillus</i> sp., <i>Fusarium</i> sp., <i>Alternaria alternaria</i> , <i>Geotrichum candidum</i>

**Table 2:** Percentage frequency of occurrence and Distribution of fungal isolates from Strawberry in Farin-Gada Market, Terminus Market, Vom market and Kuru market (%).

Fungal Isolates	Farin-Gada market	Terminus market	Vom market	Kuru market	Total No. of isolates in the 4 markets
<i>S. pombe</i>	8(6.67)	9(7.50)	11(9.17)	13(10.8)	41
<i>A. flavus</i>	9(7.50)	10(8.33)	8(6.67)	10(8.33)	37
<i>A. fumigatus</i>	9(7.50)	11(9.17)	9(7.50)	9(7.50)	38
<i>A. niger</i>	8(6.67)	12(10.0)	10(8.33)	13(10.8)	43
<i>C. gloeosporioides</i>	18(15.0)	14(11.7)	16(13.3)	10(8.33)	58
<i>Penicillium</i> spp.	9(7.50)	11(9.17)	8(6.67)	9(7.50)	37
<i>R. stolonifer</i>	10(8.33)	8(6.67)	10(8.33)	10(8.33)	38
<i>Mucor</i> spp.	9(7.50)	8(6.67)	9(7.50)	7(5.83)	33
<i>Penicillium</i> spp.	8(6.67)	8(6.67)	8(6.67)	10(8.33)	34
<i>B. cinerea</i>	13(10.8)	10(8.33)	11(9.17)	12(10.0)	46
<i>Fusarium</i> spp.	15(12.5)	12(10.0)	14(11.7)	12(10.0)	53
<i>G. candidum</i>	4(3.33)	7(5.83)	6(5.00)	5(4.17)	22
Total	120	120	120	120	480

degrees causing Botrytis/Graymold, Anthracnose brown rot and white/soft rots. This study agreed with the report by Sabrina *et al.* (2017), Feliziani and Romanazzi (2016), Akinmusire (2011), Nadim *et al.* (2014) who in their separate works on postharvest decay of strawberry fruit: etiology, epidemiology, and disease management in Italy reported that the main strawberry pathogens are *Botrytis cinerea*, followed by *Rhizopus stolonifer*, *Colletotrichum* spp. and *Aspergillus fumigatus* which are the major pathogens responsible for postharvest decay of strawberry fruit (Table 2).

These fungi can infect the plant at every stage of its development and has been found in every part of the plant, including leaves, fruits, flowers, petioles. These pathogens thrived under cool climate and humid. Under this condition, the most important surviving factor is low temperature which is the weather on the Plateau where this research was carried out. This corroborated the work by Feliziani and Romanazzi (2016) and Sabrina *et al.* (2017) who also reported a new disease of strawberry, fruit rot, caused by some fungi in tropical regions.

## Conclusion

A review of the literature and historical data on strawberry production and diseases showed that there is no research data on this pathogen affecting strawberry in Nigeria. Thus, this is the first report of a strawberry disease caused by *Aspergillus fumigatus*, *Colletotrichum gloeosporioides*, *Botrytis cinerea* and *Rhizopus stolonifer*. Researchers have shown that the recent disruption of the global food supplies is predominantly due to post-harvest losses associated with biotic (microbes) and abiotic (climate). Therefore, proper strategy to control pre- and post-harvest diseases caused by these fungal pathogens, management handling and processing or any other mode of plant protection is required to control the economic loss.

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