



Isolation and Identification of Fungal Pathogens Responsible for Postharvest Spoilage of Cucumber (*Cucumis sativus* L.) In Dutse Metropolis, Jigawa State, Nigeria

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ABSTRACT

This study examined the postharvest spoilage of cucumber (*Cucumis sativus* L.) caused by fungal pathogens in retail outlets in Dutse Metropolis, Jigawa State, Nigeria. Twelve cucumber samples were collected from three locations: Sabuwar Kasuwa, Hakimi Street, and Yan Tifa, with four samples per site. Fungal isolates were identified using morphological characteristics. The predominant fungi were *Aspergillus flavus*, *Aspergillus niger*, and *Aspergillus ustus*, as well as the yeast *Zygosaccharomyces bailii*, which was the most frequently isolated species. Pathogenicity tests confirmed that all isolates could cause rot, with *Aspergillus ustus* being the most virulent, resulting in a 47 mm diameter of rot and 25.5% weight loss. These results highlight the potential public health risks associated with fungal contamination, particularly the production of harmful mycotoxins. The study emphasizes the importance of adopting improved handling and storage practices to minimize food spoilage and ensure food safety. Regular monitoring of fungal contamination in retail outlets is recommended to protect consumer health.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a widely cultivated vegetable crop with significant nutritional and medicinal value. Originating in Southern Asia, the cucumber is now cultivated in various parts of the world, including Nigeria, where it holds a vital place in agricultural production and local economies. In Nigeria, particularly in the northeastern region, cucumber is an important crop that is cultivated during both the rainy season and through irrigation practices to ensure year-round availability [1,2]. The crop has gained popularity not only because of its nutritional benefits but also due to its medicinal uses and contribution to the health and well-being of the population.

Cucumbers are renowned for their rich nutrient content, offering a good source of vitamins such as A, C, K, and E, along with essential minerals like potassium, magnesium, calcium, and zinc [3]. These nutrients contribute to the overall health of individuals who regularly consume cucumbers, making the fruit a staple in many diets across the world. Furthermore, the cucumber's high

water content, which is approximately 96%, makes it a refreshing and hydrating fruit, especially in tropical climates, where it helps alleviate dehydration [4]. Due to these properties, cucumbers have become a versatile crop, used not only as a food item but also in the cosmetic industry for skincare products and treatments, further expanding their economic value.

In northern Nigeria, particularly in Dutse Metropolis, Jigawa State, cucumber cultivation has become an integral part of smallholder farming systems. Farmers cultivate the crop for both local consumption and commercial purposes, with the fruit often consumed raw or as part of salads. Its cooling properties make it a popular choice during the hot seasons, offering both nutritional value and relief from the heat. Despite the growing importance of cucumber in this region, the crop faces significant challenges, particularly regarding its susceptibility to postharvest diseases that result in substantial losses during storage and marketing.

One of the major issues facing cucumber farmers and vendors in Nigeria is the high perishability of the fruit, which is susceptible to various postharvest diseases. Postharvest losses, particularly those caused by fungal infections, significantly reduce the shelf life of cucumbers, rendering them unfit for consumption and leading to economic losses for farmers and vendors alike [5]. Fungal pathogens, such as *Aspergillus niger*, *Fusarium solani*, and *Rhizopus stolonifer*, are among the most common culprits responsible for cucumber spoilage. These fungi thrive in the warm, humid conditions typical of the region and quickly colonize the fruit, causing visible rot and other forms of deterioration [6].

The economic impact of cucumber spoilage is significant, particularly for smallholder farmers and market vendors who rely on the sale of fresh produce for their livelihoods. In addition to the direct financial losses, the rapid spoilage of cucumbers can lead to food insecurity in regions where the crop is a major source of nutrition. Moreover, the presence of fungi not only affects the appearance and marketability of the fruit but also poses potential health risks to consumers, as some fungal species produce mycotoxins that are harmful when ingested.

Despite the importance of the cucumber as an agricultural product in Nigeria, there is limited research on the specific fungi responsible for cucumber spoilage in Dutse Metropolis, Jigawa State. This lack of information hinders the development of effective strategies to mitigate postharvest losses and improve the quality of cucumbers sold in local markets. Previous studies have identified several fungal species associated with cucumber spoilage in other parts of Nigeria and the world, but the unique environmental conditions of Dutse necessitate localized research to identify the pathogens present in this region and determine their pathogenicity.

The focus of this study is to isolate, identify, and assess the pathogenicity of fungi associated with cucumber spoilage in Dutse Metropolis, Jigawa State. By conducting this research, we aim to fill the existing knowledge gap regarding the postharvest diseases affecting cucumbers in this area. The findings will provide valuable insights into the types of fungi responsible for spoilage, enabling the development of targeted interventions to reduce postharvest losses. This, in turn, will benefit farmers and vendors by extending the shelf life of cucumbers, improving their marketability and ultimately contributing to food security and economic stability in the region.

Understanding the fungal pathogens responsible for cucumber spoilage is essential for developing effective management practices. Such practices may include improved postharvest handling, the use of antifungal treatments, or the development of resistant cucumber varieties. Addressing the issue of postharvest losses will not only enhance the profitability of cucumber production in Jigawa State but will also support broader agricultural development goals in Nigeria.

This study aims to provide a comprehensive understanding of the fungi responsible for cucumber spoilage in Dutse Metropolis. By identifying the specific pathogens involved and their modes of infection, we can contribute to the development of sustainable solutions to mitigate postharvest losses, enhance food safety, and improve the livelihoods of cucumber farmers and vendors in Jigawa State.

MATERIALS AND METHODS

Description of Study Area

The determination of the incidence and severity of cucumber postharvest rots was conducted between July and September 2024 in selected markets in Dutse, Jigawa State, Nigeria. Dutse lies between latitudes 11° 42' N and 9° 20' E, covering a total area of approximately 5,070 km². The area experiences a tropical climate with distinct dry and rainy seasons. The rainy season usually starts in May and lasts until October, with August and September being the wettest months. Dutse records an average annual rainfall of about 600 mm. The dry season begins in late October and extends to late April.

Sample Collection

Four rotted and healthy cucumber (*Cucumis sativus* L.) fruits were randomly sampled from each of the following markets: Hakimi Street Market, Yan Tifa Market and Sabuwar Kasuwa Market in Dutse in 2024. This resulted in a total of twelve fruits being examined. The rotted samples were collected in clean, separate polythene bags and taken to the Biology Laboratory of Jigawa State Polytechnic, Dutse, Jigawa State, for further studies.

Preparation of Potato Dextrose Agar (PDA)

Thirty-nine grams of PDA were dissolved in 1 liter of distilled water. The solution was transferred into a conical flask, covered with cotton, wrapped in aluminum foil, and autoclaved at 121°C for 15 minutes under 10 lbs pressure. To prevent bacterial contamination, 6 milliliters (0.1%) of streptomycin was added to the sterilized medium just before pouring it into Petri dishes. The medium was allowed to cool and solidify before use [7].

Isolation and Identification of Fungal Pathogens

Using a sterilized knife, the diseased cucumber fruits were peeled and cut into small pieces (approximately 5 mm in diameter). These pieces were sterilized in a 0.01% mercury chloride solution for 30 seconds, rinsed in five changes of distilled water, and dried on sterilized filter paper. They were then plated in the center of a 9 cm Petri dish containing 20 mL of solidified medium. The cultures were incubated at room temperature (27-32 °C) for three days until new colonies appeared. Developing fungal colonies were subcultured onto fresh PDA plates to obtain pure cultures using the method described by Zakari *et al.* [7].

A sterile needle was used to transfer a small, circular piece (2 mm) of pure culture to a sterilized slide, which was then stained with lacto-phenol cotton blue and examined at 10x magnification, following the procedures outlined by Fawole and Oso [8]. Fungal isolates were characterized using growth patterns, mycelial coloration, and microscopic analysis of vegetative and reproductive structures, following the methodology outlined by Soma [9].

Determination of Fungal Rot of Cucumber

The determination of fungal rot in cucumbers was assessed by sampling the number of fruits with rot from the total number of healthy ones in each market [6]. These were expressed in percentage using the formula:

$$\left(\frac{\text{Number of rotted cucumber fruits}}{\text{Total number of cucumber fruits}} \right) \times 100$$

Pathogenicity Test

The pathogenicity test was conducted following the method described by Okigbo *et al.* [10]. Healthy cucumber fruits of similar size and weight were selected and surface sterilized by immersing them in 70% ethanol for 60 seconds, followed by rinsing in three separate changes of distilled water. Holes measuring 1 cm were made in each fruit using a sterilized cork borer. A 10 mm disc of pure organism culture was placed into the holes, which were then sealed with vaseline to prevent contamination from other organisms. The fruits were labeled with masking tape and stored in polythene bags. They were incubated at room temperature for one week to determine whether the isolated organisms were responsible for the cucumber rot. A similar setup was used as a control, but distilled water was used in place of the fungal inoculum.

RESULTS

Occurrence of Fungal Isolates

This study investigated the fungal species associated with spoiled cucumber fruits (*Cucumis sativus* L.) obtained from three major markets within Dutse Local Government Area, Jigawa State, Nigeria: Hakimi Street Market (HK), Yan Tifa Market (YT), and Sabuwar Kasuwa Market (SK). The isolation process revealed five distinct fungal isolates: *Zygosaccharomyces bailii*, *Aspergillus niger*, *Aspergillus flavus*, *Saccharomyces cerevisiae*, and *Aspergillus ustus*. All isolates were detected in cucumber samples from each market. Notably, *Z. bailii* had the highest total occurrence, accounting for 29.2% of the isolates across all locations (Table 1).

Frequency of Occurrence

The frequency distribution of fungal isolates from infected cucumber samples is detailed in Table 2. *Z. bailii* occurred most frequently (22.0%), followed by *S. cerevisiae* (15.3%), *A. niger* (18.4%), *A. flavus* (14.8%), and *A. ustus* (11.0%). These findings highlight the significant presence of spoilage fungi across all market samples.

Pathogenicity of Fungal Isolates

Pathogenicity tests conducted on fresh cucumber fruits revealed that all fungal isolates were capable of causing varying degrees of rot (Table 3). The most virulent pathogen was *Z. bailii*, which produced the largest rot diameter of 47 mm and was associated with the highest weight loss (25.5%). *A. ustus* also exhibited significant pathogenicity with a rot diameter of 34 mm and 17.4% weight loss. In contrast, *A. niger* was the least pathogenic, causing a rot diameter of 34 mm and a lower weight loss. These results underscore the potential of *Z. bailii* and *A. ustus* to cause substantial postharvest damage to cucumber fruits, emphasizing their importance in spoilage management strategies.

Table 1. Occurrence of fungal isolates in spoiled cucumber fruits from different markets in Dutse LGA, Jigawa State.

Fungal Isolate	SK	HK	YT	Total occurrence (%)
<i>Z. bailii</i>	+	+	+	29.2%
<i>A. niger</i>	+	+	+	18.4%
<i>A. flavus</i>	+	+	+	14.8%
<i>S. cerevisiae</i>	+	+	+	15.3%
<i>A. ustus</i>	+	+	+	11.0%

Key: SK = Sabuwar Kasuwa, HK = Hakimi Street, YT = Yan Tifa, += Present

Table 2. Frequency of occurrence of fungal isolates from infected cucumber samples.

Fungal Isolate	Frequency of Occurrence (%)
<i>Zygosaccharomyces bailii</i>	22.0%
<i>Aspergillus niger</i>	18.4%
<i>Aspergillus flavus</i>	14.8%
<i>Saccharomyces cerevisiae</i>	15.3%
<i>Aspergillus ustus</i>	11.0%

Table 3. Pathogenicity of fungal isolates on fresh cucumber fruits.

Fungal Isolate	Rot Diameter (mm)
<i>Zygosaccharomyces bailii</i>	47
<i>Aspergillus niger</i>	34
<i>Aspergillus flavus</i>	39
<i>Saccharomyces cerevisiae</i>	36
<i>Aspergillus ustus</i>	34

DISCUSSION

This study examined the occurrence and pathogenic potential of fungal isolates associated with spoiled cucumber (*Cucumis sativus* L.) fruits collected from three major markets in Dutse Local Government Area, Jigawa State, Nigeria: Sabuwar Kasuwa (SK), Hakimi Street (HK), and Yan Tifa (YT). A total of twelve samples—four from each location—were analyzed to determine the fungal species present and assess their spoilage potential.

It was discovered that five fungal species were consistently isolated across all sample sites: *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ustus*, *Saccharomyces cerevisiae*, and *Zygosaccharomyces bailii*. All of these isolates were recovered from each of the three markets, which indicates a widespread presence of spoilage fungi in the region's cucumber supply chain (Table 1). Notably, *Z. bailii* was found to exhibit the highest overall occurrence at 29.2%, which emphasizes its prominence as a major spoilage organism. Its high prevalence is consistent with the literature, which identifies *Z. bailii* as a resilient spoilage yeast capable of tolerating preservatives and high osmotic environments [11,12].

As far as frequency is concerned, *Z. bailii* accounted for 22.0% of all fungal isolates, followed by *A. niger* (18.4%), *S. cerevisiae* (15.3%), *A. flavus* (14.8%), and *A. ustus* (11.0%) (Table 2). The particular dominance of *Aspergillus* species is particularly significant due to their potential to produce mycotoxins, such as aflatoxins, posing serious food safety risks [13]. The presence of both *A. flavus* and *A. niger* in 33% of the total isolates underlines their relevance in postharvest spoilage, which corroborates findings from similar studies in Nigeria and other tropical regions [14,15].

Pathogenicity assays have revealed that all five fungal isolates were found to be capable of inducing visible rot on fresh cucumber fruits (Table 3). Of these, *Aspergillus ustus* demonstrated the highest pathogenicity, which produces a rot diameter of 47 mm and a corresponding weight loss of 25.5%. *Z. bailii* also displayed robust pathogenicity with a rot diameter of 42 mm and a weight loss of 22.1%, which highlights its dual role as both a frequent contaminant and an active agent of spoilage.

On the other hand, *A. niger* exhibited the lowest rot diameter (34 mm) and the least weight loss (17.4%). However, its presence remains concerning due to its ability to produce mycotoxins. The detection of two spoilage yeasts in the samples, including *S. cerevisiae* and *Z. bailii*, is notable, as these organisms are proficient at starting fermentation processes that can alter the flavor, texture, and marketability of fresh produce. *Z. bailii*, in particular, is known for its ability to proliferate under both aerobic and anaerobic conditions and in the presence of preservatives, making it a challenging spoilage agent to control in postharvest systems [11]. Overall, these findings underscore the prevalence and pathogenicity of key fungal species associated with cucumber spoilage in Dutse. Environmental factors, such as high humidity and temperature, likely contribute to the proliferation and virulence of these fungi. The study underscores the importance of enhancing postharvest handling, fungal monitoring, and food safety measures in local markets.

CONCLUSION

This study effectively identified and characterized fungal pathogens associated with cucumber spoilage in Dutse, Jigawa State, Nigeria. The prevalent species included *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ustus*, and the yeast *Zygosaccharomyces bailii*. Pathogenicity tests confirmed the ability of these fungi to induce significant rot in cucumbers, with *Aspergillus ustus* demonstrating the highest pathogenicity. The findings underscore a critical public health concern due to the potential for mycotoxin production by these fungi. To mitigate spoilage and protect consumer health, implementing improved handling practices, maintaining optimal storage conditions, and conducting regular monitoring of fungal contamination in retail outlets are essential. Vendors should adopt strict hygiene protocols during harvesting, transportation, and storage to minimize fungal contamination, while the establishment of cool storage facilities can significantly reduce spoilage and extend shelf life. Continuous surveillance of fungal contamination in retail outlets is essential to enable timely interventions. Additionally, workshops and training programs should be conducted to raise vendor awareness about the risks associated with fungal contamination and to promote proper handling practices.

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ETHICAL COMPLIANCE

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Consent for publication: No person's data was presented.

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