

SJMLS - 10 (4) - 007

Isolation and Identification of Fungi Associated with Spoilage of Post-Harvest Tomato Fruits (*Solanum lycopersicum* L.)Terna Peter Selumun^{1*}, Musa Sale Makeri¹, Terhide Samuel Tyohemba¹, Zainab Abubakar Gambo², Mery Asugu Mbahi¹, Musa Muhammad Babandina³ and Margaret Musa Atsen Danladi⁴Department of Biological Sciences, Federal University of Kashere, Gombe State ¹, Department of Biological Sciences, Federal University Gashua, Yobe State ², Department of Medical Laboratory Sciences, University of Abuja, FCT, Nigeria ³, Department of Microbiology, Plateau State University Bokkos, Nigeria ⁴Author for Correspondence*: makerymusa@gmail.com/ ORCID:0000-0002-9815-3771526436. <https://dx.doi.org/10.4314/sokjmls.v10i4.7>**Abstract**

Tomato (*Solanum lycopersicum* L.) is a widely cultivated and nutritionally important fruit crop that is prone to rapid deterioration after harvesting due to fungal invasion. This study investigated the fungi associated with post-harvest spoilage of tomatoes sold in selected markets. Spoiled tomato samples were collected aseptically and analyzed using standard microbiological techniques. Fungal isolates were identified based on cultural and microscopic characteristics. The predominant fungi identified were *Aspergillus niger*, *Rhizopus stolonifer*, *Penicillium spp.* and *Fusarium spp.* The frequency of occurrence revealed *A. niger* as the most dominant species across all samples. The presence of these fungi, which are capable of producing toxins and enzymes that degrade cell walls, suggests poor handling and storage conditions as key contributors to spoilage. Improved sanitation, adequate packaging, and controlled storage environments are therefore recommended to minimize fungal contamination and post-harvest losses.

Keywords: Tomato spoilage, fungi, *Aspergillus niger*, post-harvest losses, mycotoxins

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most economically and nutritionally important vegetable crops cultivated worldwide. It belongs to the family *Solanaceae* and serves as both a staple and a cash crop in many developing and industrialized nations. The fruit is consumed in a variety of forms—fresh, cooked, or processed—into products such as paste, puree, ketchup, and juice, making it a vital component

of human diets. Tomatoes are highly valued for their rich composition of essential nutrients, including vitamins A, B-complex, and C, as well as minerals like potassium and iron. They are also a major source of bioactive compounds such as lycopene, β -carotene, and phenolics, which act as antioxidants and contribute to the prevention of chronic diseases such as cardiovascular disorders and certain cancers.

Despite their nutritional and economic importance, tomatoes are highly perishable due to their high moisture content (about 93–95%), tender texture, and delicate skin, which make them prone to microbial spoilage shortly after harvest. Post-harvest losses of tomatoes are estimated to range between 25–40% in developing countries, largely due to inadequate handling, storage, and transportation practices (Somorin and Amusa, 2011; Okigbo and Nwosu, 2016; Gwa and Lum, 2023). Microbial spoilage, especially by fungi, constitutes a major factor contributing to these losses (Mateus *et al.*, 2021; Kabiru and Yusuf, 2023). Fungal pathogens not only degrade the quality of the fruits through enzymatic breakdown of cell walls, leading to soft rot, discoloration, unpleasant smell and reduction in their market and nutritional value (Onuorah and Orji, 2015).

Among the microorganisms associated with post-harvest deterioration, fungi play a predominant role because of their ability to grow under diverse environmental conditions and on a wide range of substrates. Common fungal genera implicated in tomato spoilage include *Aspergillus*, *Rhizopus*, *Penicillium*, and

Fusarium. These organisms often gain entry through wounds or natural openings in the fruit surface, particularly when mechanical injuries occur during harvesting, sorting, or transportation. The warm and humid conditions typical of tropical markets further favor their growth and sporulation (Adedeji and Aduramigba, 2016; Huang *et al.*, 2022). Moreover, several of these fungi, such as *Aspergillus* and *Fusarium*, are known to produce secondary mycotoxins metabolites that pose significant public health risks when contaminated fruits are consumed or processed (Adedeji and Aduramigba, 2016).

The onset of fungal infection may begin in the field but frequently becomes more severe during post-harvest handling due to cross-contamination and poor sanitation practices. Factors such as temperature, relative humidity, and mechanical bruising accelerate fungal colonization and fruit decay. Therefore, understanding the diversity and prevalence of fungi associated with tomato spoilage in local markets is essential for devising effective control and management strategies. Early identification of pathogenic fungi can inform appropriate handling, storage, and preservation techniques aimed at minimizing post-harvest losses, safeguarding consumer health, and enhancing the economic returns for tomato producers and vendors (Ajayi *et al.*, 2019).

Materials and Methods

Sample Collection

Spoiled tomato fruits were collected from local markets using sterile polyethylene bags. Samples showing typical signs of fungal infection soft rot, black spots, and mycelial growth were selected and transported to the microbiology laboratory for analysis (Awua *et al.*, 2022).

Isolation of Fungi

Each sample was surface sterilized with 1% sodium hypochlorite and rinsed with sterile distilled water. Small sections of infected tissue were inoculated onto Potato Dextrose Agar (PDA) plates supplemented with chloramphenicol to inhibit bacterial growth. Plates were incubated at 28 ± 2 °C for 5–7 days (Barnett and Hunter, 1998).

Identification of Isolates

Pure cultures were obtained by subculturing distinct fungal colonies. Identification was based on colony morphology, color, spore type, and microscopic examination using lactophenol cotton blue stain, following standard mycological keys (Bennett and Klich, 2002).

Determination of Frequency of Occurrence

The frequency of each fungal isolate was determined by calculating the number of times a species appeared in relation to the total number of isolates, expressed as a percentage (Bennett and Klich, 2003; Bhat and Reddy, 2017).

Results

Four fungal species were consistently isolated and identified from spoiled tomato fruits: *Aspergillus niger*, *Rhizopus stolonifer*, *Penicillium spp.*, and *Fusarium spp.* Among these, *A. niger* had the highest frequency of occurrence (45%), followed by *R. stolonifer* (30%), *Penicillium spp.* (15%), and *Fusarium spp.* (10%). Colonies of *A. niger* appeared black with rough spores, while *R. stolonifera* showed cotton-like white mycelia turning grayish-black with age. The isolates caused characteristic soft rot symptoms, confirming their spoilage potential.

Table 1: Description of the result of cultured fungi isolation

Sample	Appearance on plate (PDA)	Microscopy features	Fungi identification
S1	Black, powdery colonies, radial growth	Globose conidial heads on conidiophores	<i>Aspergillus niger</i>
S2	Blue-green, velvety colonies with white margin	Brush-like conidiophores with chains of conidia	<i>Penicillium</i> spp.
S3	Mixed black, blue-green, and pinkish cottony colonies	Globose conidial heads, brush-like conidiophores, canoe-shaped macroconidia	<i>Aspergillus niger</i> , <i>Penicillium</i> spp., <i>Fusarium</i> spp
S4	Black colonies, dense radial growth	Globose conidial heads	<i>Aspergillus niger</i>
Control (C)	No growth	No fungal structures observed	None

Discussion

The findings of this study align with previous reports that *A. niger* and *R. stolonifer* are major spoilage fungi of tomato fruits during post-harvest handling. The high occurrence of *A. niger* suggests its adaptability to varying environmental conditions and its efficiency in producing extracellular enzymes that degrade fruit tissues (Bryden, 2012). The detection of *Penicillium* and *Fusarium* species further supports their known roles in post-harvest fruit decay and toxin production. Poor handling, exposure to high humidity, and improper storage practices promote fungal proliferation. These conditions often occur during market display and transportation in tropical regions, where temperature and humidity are favorable for fungal growth (Centers for Disease Control and Prevention, 2024). Implementation of improved handling techniques, temperature control, and hygienic practices can therefore significantly reduce fungal spoilage and post-harvest losses (Bryden, 2012; Fox and Fimeche, 2013; Cooney and Emerson, 2018; Eskola *et al.*, 2022; Dayok *et al.*, 2024). Six factors were found to be linked to high levels of mycotoxins in African foods, in varying degrees. Climate change (Human *et al.*, 2022) and environmental factors (Narang *et al.*, 2017) remains the main driving factors in the production of mycotoxins.

Consumption of fungi contaminated food can have effect on the health of people (Tanaka *et al.*, 2007). Inappropriate use of fungicides has been shown to lead to resistance among fungal pathogens. Therefore, it is necessary to evaluate the sensitivity of fungi spoilage and post-harvest losses to various classes of fungicide and to determine the effectiveness of different concentrations of commonly used fungicides (Kim *et al.*, 2007).

Conclusion

This study confirmed that *Aspergillus niger*, *Rhizopus stolonifer*, *Penicillium* spp., and *Fusarium* spp. are the principal fungi associated with the spoilage of post-harvest tomato fruits. The dominance of *A. niger* indicates its major role in tomato deterioration. Enhanced storage conditions, proper handling, and the application of safe antifungal treatments are recommended to mitigate fungal contamination and maintain tomato fruit quality (Fink-Gremmels, 2008).

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Citation: Terna Peter Selumun, Musa Sale Makeri, Terhide Samuel Tyohemba, Zainab Abubakar Gambo, Mery Asugu Mbahi, Musa Muhammad Babandina and Margaret Musa Atsen Danladi. Isolation and Identification of Fungi Associated with Spoilage of Post-Harvest Tomato Fruits (*Solanum lycopersicum* L.). *Sokoto Journal of Medical Laboratory Science*; **10(4)**: 63 – 67. <https://dx.doi.org/10.4314/sokjmls.v10i4.7>

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