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RESEARCH ARTICLE

Study of Fungi on Stored Maize (*Zea mays* L.) in Kebbi State, Nigeria

Mubarak Aminu* and Jibrin Naka Keta
Department of Plant Science and Biotechnology, Kebbi State University of Science and Technology, Aliero, Nigeria

ABSTRACT

The present study was carried out to determine the fungal species associated with stored Maize from three villages: Sabiyel, Dan warai and Jiga all within Aliero L.G.A. From each village, twenty spike of silo maize were collected, making a total of sixty samples. Fungi were investigated using the standard procedure recommended by the ICFM. Eight fungal species were isolated and identified from the results obtained; *Aspergillus niger*, *Mucor racemosus, Aspergillus fumagatus, Aspergillus terries*, *Fusarium* species, *Ceplosporium* species, *Aspergillus flavus* and *Penicillium* species. *Aspergillus niger* had the highest mean frequency and percentage 3.00 (16.60%) while the lowest was obtained in Penicillium species 1.67 (9.77%). Jiga village had the highest fungal rate of 87.5% and Sabiyel with the lowest 75% based on locations. In conclusion, it was observed that perishable agricultural food is susceptible to spoilage by fungi, probably because these organisms' spores are easily transmitted via the air, during transportation, harvest, handling, and preservations of these products might lead to spoilage of stored maize grains. There is a need for proper storage techniques, farmers' awareness of the health implications of these fungi, and adequate storage conditions in the study area to reduce contamination of store maize grains by these fungal isolates.

Keywords: Maize; Silos; Fungi; Prevalence; Aliero

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*Corresponding author e-mail address: moubaraqameenuaburga30@gmail.com (Aminu. M)

INTRODUCTION

Zea mays, often known as "Masara" in Hausa and "Maize" in English, is a staple crop grown in northern Nigeria and many other nations. It is a Graminaceae (IITA, 2005). Since maize is easily grown and adaptable to many agro-ecological zones, rainfall, people's culture as well as diverse food uses and storage properties, it is a staple in millions of Africans' diets (Asiedu, 1986). As a result of its many applications, it is a vital crop in Kebbi State, Nigeria, and developed Maize is the third most important crop in the world, consumed directly by humans and indirectly by animals, according to Cimmy & Earo (1999). Various villages in Kebbi State employ silos, sacks, and open storage to preserve maize grains, depending on the farmer's interest, geography, and culture.

Some fungi are toxic to humans, producing infections and contaminating and spoiling food goods. In the dawn of agriculture and food storage, rotting fungi sought their tithe (Pitt and Hocking, 2009; Jain, 2006). Storage fungi grow after harvesting, transporting, or processing (Scudamore, 1993). From planting to harvest, maize is plagued by over sixty illnesses. While corn seeds are viable during storage, fungus can remain attached to them and affect germination seedlings. Xerophytic organisms such as Aspergillus, Penicillium, and Fusarium are commonly detected in stored grains (Castellari et al., 2010; Keta et al., 2019).

Several fungi species thrive on maize grain, particularly the genus Aspergillus, Penicillium, and Fusarium are known agricultural pollutants that can create hazardous secondary metabolites or mycotoxins (Keta et al., 2019). Storage microorganisms can contaminate grains, rendering them unsafe for human consumption. According to Keta et al. (2019), maize demand would decline due to global agricultural productivity. Fungi currently cause 50-80% of damage or loss of maize in the field or storage (Castlellarie et al., 2010). So, study on fungus prevalence on stored maize is urgently needed in Aliero. This study sought to identify and characterise the stored fungus species in the study area.

MATERIALS AND METHODS

The Aliero Local Government Area is located in Kebbi State, northwestern Nigeria. The city has a landmass of 412sqk and is located at 11°3'S, 12°47'N, 3°6'W, and 4°27'E. The landscape is level and slightly sloping, with compact, firm brown soil and Sudan Savanna flora. It has a dry season from May to October and a rainy season (June to September). From November until January is Harmattan. The area is characterised by severe fog and dust, and extreme cold during the day and night (Singh and Abubakar, 2013). March and April are frequently the hottest months. Most Aliero residents are agrarian, focusing on onion and paper production. Largest onion and maize market in NW Nigeria.

The survey was undertaken at Aliero L.G.A.'s Sabiyel, Dan warai, and Jiga to pick stored Zea mays. Each collection point received maize in a sanitised polythene bag. The grains were placed in sterile polythene bags and sent to the Aliero Department of Plant Science and Biotechnology for additional analysis.

All glassware (Petri dishes, test tubes, conical flasks) was carefully washed with detergent and dried in a hot air oven at 160°C for 45-60 minutes. The oven items were allowed to cool slowly. The oven door was not opened until the internal temperature was below 50°C, to avoid glassware cracking and polluted air entering the oven (Cheesbrough, 2000).

PDA was constructed as directed by the manufacturer. 0.05 mg/ml chloramphenicol was used to limit bacterial growth (Cheesbrough, 2000).

In each test tube, one gramme of store maize grain powder was homogenised with two grammes (2 g) of each sample. The homogenate was diluted tenfold. It was incubated in Potato Dextrose Agar medium for five days at 29oC.

Isolation of fungi via spread plate. A sterile Petri dish containing already prepared and sanitised Potato Dextrose Agar (PDA) in plates was introduced and spread uniformly with a sterile glass rod. The plate also contained 0.05 mg/ml chloramphenicol to prevent bacterial growth. Invert the plate and incubate for 3-7 days at 28°C. To obtain pure isolates, these plates were subculturing on fresh sterile PDA plates for 7 days.

The fungi were identified by their colonial and microscopic features. Cheesbrough's lactophenol cotton blue staining and slide culture were used to characterise the fungi (2006). The fungus were identified by Oyeleke and Manga (2008).

RESULTS AND DISCUSSION

The fungal associated with the stored maize were identified based on the cultures were of pathogen grown on PDA in Petri dishes at 28±20C for 7days and were used to record observations (Table 1). The fungal pathogens observed in 2-3 days of incubation were seen in petri plates. Mean highest frequency and percentage of fungi distributed were obtained in Aspergillus niger 3.00 ± 00 (16.60%) while lowest was obtained in Penicillium species with a value of 1.67 ± 0.57 (9.77%) as presented in (Table 2). However, Jaga had the highest fungal distribution values of 87.5 followed by Dan warai 62.5% and Sabiyel town with fewer values of 7.5% as shown in Table 3.

From the storage maize grains within Aliero metropolis, eight fungal species (Table 1) were

Table 1. Microscopic Morphological Feature of Fungal Isolates (Oyeleke and Manga, 2008)

Isolates	Microscopic Examination	Colony Appearances
Aspergillus niger	Hyphae a septate with thick walls. Conidiaspores bearing conidial head and clear	White later becoming dark in color. The reverse side are pale yellow
Mucor racemosus	Sporangia are dark with zygospores. Hyphae long branched with septate	Colonies were grey in color
Aspergillus fumagatus	Conidioshores are smooth shoot having conical shapes with terminal vesicles	Colonies were commonly blue green with white borders
Aspergillus terries	Conidiosphores bearing conidial heads with hyaline smooth walls	Dense yellow later brown in color
Fusarium species	Multicelled sicked conidiosphore with micro-conidia	Colonies were fast growing pale bright in color
Ceplosporium species	Septate hyphae with thin conidiospores non-ramified in ring shapes	Grey white in color
Aspergillus flavus	Conidiosphore are borne laterally on hyphae, non-septate, numerous with sterigmate	Velvelty colonies
Penicillium species	Hyphea are septate with smooth walled conidiospjores bearing long chains conidia	Green velvety colonies formed

Table 2. Mean Frequency and Percentage Occurrence of the Fungal Isolated from Silos Maize

Identified Fungi	Mean Frequency	Percentage of Occurrence (%)
Aspergillus niger	3.00 ± 0.00^{a}	16.60
Mucor racemosus	2.00 ± 0.00^{a}	13.00
A. fumagatus	2.67 ± 0.57^{abc}	14.03
A. terries	2.90 ± 58^{d}	13.28
Fusarium sp.	2.00 ± 1.00^{ab}	10.52
Ceplosporium species	2.00 ± 1.00^{ab}	10.52
A. flavus	2.33 ± 57^{abc}	12.28
Penicillium sp.	1.67 ± 15^{b}	9.77

n=3, Values with different superscripts shows significant difference at ($p<0.005$)

Table 3. Distribution of Fungi Isolates with Respect to Locations

Villages	Fungal Isolates	Distribution (%)
Sabiyel	*Aspergillus niger, A. fumagatus, A. terries, Ceplosporium species, Fusarium species* and *A. flavus.*	75

Dan warai	*Ceplosporium* species*, Fusarium* species, *A. flavus, Penicillium* species and *A. niger.*	62.5
Jiga	*A. niger, Mucor racemosus, A. terries, A. fumagatus, Fusarium* species*, A. flavus* and *Penicillium* species	87.5

isolated and identified in this study. Similar, fungi species were obtained and reported by Bandh et al. (2010) associated with head disease of maize. However, the absence of *Ceplosporium* species in their findings and the presences of *Ceplosporium* species in this research could be due to the study's location, environmental factors, and maize sampled used. These species isolated are agents contaminates stored maize in silos (Keta *et al*., 2019). Suttajit's (1989) research confirmed that fungi live in many environments and require unique circumstances for growth and reproduction. These fungi were found to be important in the degradation of stored maize seeds by Lino et al. Aspergillus and Penicillium are saprophytic and parasitic fungus, respectively. They cause contamination, grain loss, toxin generation, and housing spoilage (Dutta, 2005). The same conditions that favour Fusarium growth also favour mycotoxin formation on cereal grains. Mycotoxins thrive in damp environments (Xu, 2003; Doohan et al., 2003). Magan et al. (2003) confirmed the climate, plant, and storage conditions influence fungus formation.

However, our analysis found that Aspergillus niger had the highest mean frequency of 3.0000a (16.60%). Aspergillus species were found to be the most prevalent and dominating genus in Shashemene and Arsinagelle districts of Ethiopia by Ofgea and Gure (2015). These findings matched Keta et al. (2019) findings of the most prevalent Aspergillus species on maize grain in Gunea Savanna. The high prevalence of Aspergillus species in this study may be attributed to the moisture content of maize and other environmental conditions that encourage fungal proliferation and colonisation.

CONCLUSION

Species include *Aspergillus niger, Mucor racemosus, Aspergillus fumagatus, Aspergillus terries, Fusarium species, Aspergillus flavus,* and *Penicillium* species found in this study provide proof of stored grain contamination. Mycotoxins, especially aflatoxins, are abundant in Aspergillus and other fungus species. People in Aliero town who may store their corn may suffer major health difficulties and financial losses. The research area and Nigeria in general require optimal preservation techniques, environmental and storage conditions to minimise contamination and economic loss of our critical agricultural commodities, primarily maize grain.

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