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Fungal Deterioration of Eggplant (*Solanum melongena* L.) Fruits in Maiduguri Metropolis, Borno State, Nigeria

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Abstract: Deteriorated samples of White and Yellow varieties of eggplant (*Solanum melongena* L.) were collected from Gamboru vegetable market, Baga Motor Park, Bama Motor Park and Maiduguri Monday Market and assessed for the presence of rot associated fungal pathogens. Four *Aspergillus* species viz. *A. niger, A. oryzae, A. ustus* and *A. wentii* and four yeast species viz. *Candida tropicalis, Saccharomyces cerevisiae, S. pombe* and *Zygosaccharomyces bailii* were isolated and identified. The results showed that the most contaminated eggplant samples were from Monday market (62.7%) and Baga motor park (62.5%). Both White and Yellow varieties were infected with either of the isolates. *Aspergillus ustus* (80%), *Aspergillus niger* (74.5%) and *S. pombe* (74.3%) were the most frequently isolated pathogens from the varieties. Yeasts thrive well anaerobically and fungal growth is promoted by injury. Their presence in high number in the spoilt eggplant varieties was an indication of poor storage conditions in which the fruits were kept and distributed or sold in all the locations studied. Improvement on how and where to store the fruits are necessary to reduce postharvest rots leading to economic loss.

Key words: *Aspergillus* spp. · Yeast species · Eggplant · White variety · Yellow variety

INTRODUCTION

Solanum L., a complex and large genus of the family Solanaceae has several species which are referred to as eggplant or African garden egg [1]. Eggplant is one of the most commonly consumed fruit vegetables in tropical Africa, in quantity and value probably third after tomato and onion [2].They constitute important fruit and leafy vegetables and provide dietary supplements especially, in China, India, South East Asia and other West African countries [3]. Some of these species are important for their medicinal qualities [4, 5]. These nutritional and medicinal benefits have helped enhance their wide-spread cultivation across continents and cultural boundaries [2].

Fifteen species are commonly found in Nigeria [6] out of which *Solanum melongena* L., *S. aethiopicum* L. and *S. macrocarpon* L. are the most popular [1, 7]. The northern and southern parts of the country are involved in the cultivation of different varieties of eggplant that vary in fruit colour, shapes and sizes [4].The yellow, white and thick green skinned varieties are largely grown in north [8].

Eggplant fruits are subject to attack by fungal pathogens leading to postharvest rots and diseases. Zacharia and Philip [9] and Gambari *et al*. [10] isolated *Alternaria solani, Fusarium solani, Colletotrichum gloeosporioides, Botrytis cinerea, Penicillium sp., Rhizopus nigricans, Curvularia lunata, Botryodiplodia theobromae, Mucor sp., Rhizoctonia solani* and *Aspergillus niger* from rotten fruits of eggplant. *Alternaria solani*, *A. alternata*, *A. flavus*, *M. hiemalis* and *R. stolonifer* were identified [11] to be associated and responsible for spoilage of eggplant. The fungal pathogens isolated as the causative agents of eggplant fruit rot were *Phomopsismelongenae* and *Collectotrichumme longenae* [12]. Naureen *et al*. [13] reported that *Fusarium solani, Geotrichum sp.* and *Phytophthora capsici* were responsible for postharvest deterioration of eggplant.

These fungi can cause significant economic losses not only in eggplant but in most fresh fruits and vegetables. Losses of perishable fruits resulting from postharvest diseases must be reduce to meet up the growing concern of the world population. Very little have

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been done in the area of postharvest pathology in Nigeria, particularly eggplant postharvest diseases. It is, therefore, the objectives of this study to investigate fungi associated with two varieties of eggplant (*Solanum melongena* L.) in Maiduguri, Nigeria and to determine the pathogenicity of the isolated fungi.

MATERIALS AND METHODS

The experiment for the isolation and identification of fungal pathogens found on rotten varieties of eggplant fruits was conducted at the Plant Pathology Laboratory, Department of Crop Protection, University of Maiduguri, Nigeria during the months of April to June, 2015.

Sample Collection: Samples of two garden egg varieties, White and Yellow showing symptoms of rot and discoloration were collected from four different locations in Maiduguri Metropolitan Council for the laboratory assessment. The locations were Gamboru vegetable market, Baga Motor Park, Bama Motor Park and Maiduguri Monday Market. A total of 48 samples of rotten eggplant fruits were collected from the locations.

Culturing Procedure: Each sample was washed and surface sterilized in 1% commercial bleach for one minute. These were then rinsed in three successive changes of sterile distilled water and blotted dry with sterile filter paper. From each sample, five pieces of segments measuring 3 mm^3 from the advancing margins of rotted lesions and the healthy tissues were cut out with sterile scalpel and forceps and plated on acidified potato dextrose agar (PDA) in 90 mm Petri dishes. The plates were incubated at room temperature (28±2℃) for seven days.

Identification of the Isolated Fungi: During incubation of the plated samples, developing fungal colonies were sub-cultured continuously on fresh PDA plates to obtain pure cultures of the isolates. Fungal isolates were identified based on growth pattern, colour of mycelia and microscopic examinations of vegetative and reproductive structures of the fungi according to International Mycological Institute [14] and Barnett and Hunter [15].

Pathogenicity Test: The isolated fungi were tested for their ability to induce rot in healthy eggplant fruits. Twelve healthy samples from each of the two varieties of garden egg were washed and surface sterilized with 1% commercial bleach and then washed in running tap water. The fruits were weighed before inoculation to serve as fresh weight in grammes. With the aid of a sterile cork borer, 5mm diameter cylindrical holes were dug into the healthy garden egg fruits and the plugs were pulled out. In each hole, a 3mm diameter mycelial disc of pure culture of each of the fungal isolates was introduced by placing it at the bottom of the hole. The plugs were carefully replaced and the wounded area sealed with sterile petroleum jelly to prevent external infection. The inoculated fruits were incubated at room temperature (28±2℃) for 10 days. A control was set up using healthy garden egg fruits. A hole was dug using a sterile cork borer in each fruit and sterilized 3mm PDA disc placed into the holes of the healthy fruits and sealed with petroleum jelly. Each treatment was replicated three times. Inoculated garden egg fruits were subsequently observed for rot development. After which, the fruits were then weighed again to get the final weight after weight after inoculation. The degree of Pathogenicity of each fungus on the inoculated samples was determined by measuring diameter (mm) of rotten parts and Weight loss (g).

RESULTS

Table 1 shows the frequency of fungi isolated from rotten eggplant collected from four locations in Maiduguri Metropolis, Borno State, Nigeria. There were four fungal species (*Aspergillus* spp.) and four yeast species associated with the rotten eggplant collected from all the four locations. *Aspergillus ustus* and *Aspergillus wentii* occurred on all the eggplant samples collected from Baga motor park and Monday market in Maiduguri, while *A. wentii* occurred on all the eggplant samples collected from Monday market. Also 92% of the samples collected from Baga Motor Park were associated with the yeast, *Saccharomyces cerevisiae*. Samples collected from Gamboru market had the lowest infection (40%) with *Candida tropicalis*.

Among the four locations, samples from Bamamotor park had the least infection (44.1%) across the pathogens. While Monday market and Baga motor park had the highest with over 62% of their samples infected. *Candida tropicalis* occurred least often (10%) across locations, while the highest frequency (86.7%) of *A. wentii* was observed in rotten sample of White variety (Table 2). About 80% of rotten samples of both White and Yellow varieties were infected with *A. ustus*. More than 70% of rotten sample of White variety were associated with *A. niger, A. oryzae* and *S. pombe* and similarly sample of Yellow variety were infected with

Table 1: Frequency of occurrence of fungi isolated from rotten eggplant collected from four locations in Maiduguri.

	Frequency of occurrence from locations (%)				
Fungi	Gamboru Market	Monday Market	Baga Motor Park	Bama Motor Park	Mean
Aspergillus niger	63.3	76.7	78.2	50.0	67.1
A. oryzae	60.0	80.0	0	50.0	47.5
A. ustus	71.1	70.0	100	0	60.3
A. wentii	0	100	100	60.0	65.0
Candida tropicalis	40.0	0	0	0	10.0
Saccharomyces cerevisiae	60.0	80.0	92.0	55.6	71.9
S. pombe	60.0	55.0	80.0	77.5	68.1
Zygosaccharomyces bailii	60.0	40.0	50.0	60.0	52.5
Mean	51.8	62.7	62.5	44.1	

Table 2: Frequency of occurrence of fungi isolated from two varieties of eggplant

	Frequency of occurrence on varieties (%)		
Fungi	White	Yellow	Mean
A. niger	70.6	78.4	74.5
A. oryzae	71.1	0	35.6
A. ustus	80.0	80.0	80.0
A. wentii	86.7	0	43.4
C. tropicalis	0	40.0	20.0
S. cerevisiae	64.8	73.3	69.1
S. pombe	70.9	77.7	74.3
Z. bailii	0	49.2	24.6
Mean	55.6	49.8	

Table 3. Pathogenicity test on White variety of eggplant

Fungi	Fresh weight before inoculation (g)	Final weight after inoculation (g)	Weight loss (g)	Diameter of rot (mm)
A. niger	130.3	104.2	26.1	42.0
A. oryzae	63.6	35.2	28.4	45.0
A. ustus	133.1	96.0	37.1	53.0
A. wentii	141.2	107.2	34.0	49.0
S. cerevisiae	138.1	106.7	31.7	46.0
S. pombe	78.3	50.5	28.1	43.0
Control	105.5	87.1	18.4	10.0

A. niger, S. cerevisiae and *S. pombe. Saccharomyces cerevisiae* was the most frequently (71.9%) isolated pathogen across locations.

Mean percentage occurrence of fungi in rotten sample of Yellow variety was lower than those isolated from White variety. On the average across varieties, *A. ustus* was the most frequently isolated fungus from both varieties, followed by *A. niger, S. pombe* and *S. cerevisiae. A. oryzae* and *A. wentii* were not found associated with the rotten tissues of the Yellow variety while *C. tropicalis* and *Z. bailii* were not found in the tissues of the White variety.

The pathogenicity test had revealed that all the isolated fungi and the yeasts were pathogenic to White variety (Table 3). The most pathogenic fungus was *A. ustus* which had the largest rot size and the highest weight loss. This was followed by tissue deterioration by *A. wentii, S. cerevisiae* and *A. oryzae.* None of the fungi or the yeasts had less than 40mm size of rot lesions and 25 g of weight loss due to deterioration. However, *A. niger* was the least pathogenic measured both in terms of rot size and amount of weight lost due to decay.

Two fungi (*A. niger* and *A. ustus*) and four yeasts (*C. tropicalis, S. cerevisiae, S. pombe* and *Z. bailii*) which were isolated from Yellow variety all proved to be pathogenic to the fruit (Table 4). Rotting was larger in the fruits inoculated with *A. ustus, S. cerevisiae* and *Z. bailii* than *A. niger* and the other yeasts inoculated fruits. The highest disintegration occurred on fruits inoculated with *A. ustus* while the least rot size and weight loss were observed on fruits inoculated with *A. niger* and *S. pombe.*

Table 4: Pathogenicity test on Yellow variety of eggplant

Fungi	Fresh weight before inoculation (g)	Final weight after inoculation (g)	Weight loss (g)	Diameter of rot (mm)
A. niger	111.3	80.0	31.3	41.0
A. ustus	71.1	30.2	40.9	53.0
C. tropicalis	70.6	36.2	34.4	46.0
S. cerevisiae	70.2	34.2	36.0	50.0
S. pombe	75.8	54.0	21.8	40.0
Z. bailii	130.3	96.4	33.9	49.0
Control	75.5	56.9	18.6	11.0

DISCUSSION

Gamboru vegetable market serves as the main vegetable market in Maiduguri and from there; the fruits and vegetables are distributed to different sale outlets in and around the Metropolis. In the present study,there were four *Aspergillus* species viz. *A. niger, A. oryzae, A. ustus* and *A. wentii* and four yeast species viz. *Candida tropicalis, Saccharomyces cerevisiae, S. pombe*and *Zygosaccharomyces bailii* found on rotten garden egg varieties collected from all the four locationsin Maiduguri Metropolis. *Aspergillus wentii* and *A. ustus* occurred most frequently (100%) on rotten varieties collected from Baga Motor Park. Also92% of the samples collected from the same location were associated with the yeast, *Saccharomyces cerevisiae.*Yaji *et al*. [16] similarly reported that all eggplant samples collected from three locations in MakurdiMetropolis were contaminated with various species of fungal pathogens but did not find yeasts.These rot inducing pathogens could have been either acquired from the fieldduring or after harvest or during transitor acquired during storage. Fungal growths are promoted by fruit injury whereas yeasts thrive well on sugary materials especially when air is a limiting factor as in storage conditions.

Both White and Yellow varieties of rotten eggplantsamplesassessed in the present study were infected with either *A. niger, A. oryzae, A. ustus, A. wentii, C. tropicalis, S. cerevisiae, S. pombe or Z. bailii.* The White variety was infected with all the four species of *Aspergillus* and two species of yeasts. The Yellow variety was found associated with two *Aspergillus* species and four yeasts species. None of the varieties had less than 70% of the fungal species and 40% of the yeast species. Fungal genera, particularly, *Aspergillus* have been similarly implicated [10, 16] in the spoilage of eggplant fruits. Attack of eggplant fruits byother fungal pathogens resulted in postharvest deterioration [13] soft rot of fruit [17] Blossom end rot and fruit Anthracnose [18] Black Mold Rot, Gray Mold Rot and Hairy Rot [19].

Four yeast species were among the pathogens identified to be causing rots of eggplant fruits in the present study. The results agree with the findings of Akinmusire [20] and Oviasogie *et al*. [21] found *Candida tropicalis* associated with *Citrus sinensis.* Ibrahim and Sada [22] recovered *Saccharomyces sp.* and *Schizosaccharonuyces* sp. from some rotten fruit samples. Yeast isolates associated with rots of onion, tomato and pawpaw included *Candida albicans, Candida guilliermondii*, *Candida tropicalis* and *Saccharomyces cerevisiae* [23-25].

The present study showed that the fungi and yeast pathogens isolated from either the White or the Yellow variety of eggplant proved to be pathogenic to the fruits. The most pathogenic fungus was *A. ustus* which had the highest rot size and the highest fruit weight loss in both varieties. However, Gambari *et al*. [10] reported that *Rhizoctonia solani* was the most severe fungal pathogen on eggplant fruits *S. cerevisiae* was the most pathogenic yeast in both eggplant varieties.

CONCLUSION

This study has shown that eggplant like any other fruits is susceptible toyeasts invasion in addition to the fungal pathogensresponsible for postharvest rots. They were responsible for spoilage of eggplant collected from all the locations.Since yeasts thrive well anaerobically and fungal growth is promoted by injury, their presence in high number in the spoilt eggplant varietiessuggests poor handling of the fruits and poor storage conditions from the eggplant handlers. Improvement on how and where to store the fruits are necessary to reduce postharvest rots leading to economic loss.

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