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Fungi Associated with the Post-Harvest Loss of Sweet Potato

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Abstract: *Molds are the chief pathogens of stored sweet potato and as such cause huge post-harvest and economic losses to tuber farmers in Nigeria. This research was aimed at isolating and identifying molds associated with post-harvest loss of Ipomoea batatas L Lam. The spoilage molds identified were Aspergillus fumigatus, Aspergillus niger, and Rhizopus stolonifer. These isolates were subjected to pathogenicity tests using fresh healthy tubers in order to confirm their ability to elicit same spoilage symptoms in healthy tubers. Six healthy tubers were used for this study. Dry rot was recorded in all the tubers. Percentage Weight loss of tubers were monitored and values of 1.04 ± 0.44, 0.45 ± 0.46 and 0.75 ± 0.24 with P> 0.1 were recorded. Whereas values of 98.29 ± 0.35, 98.06 ± 1.00 and 98.73 ± 0.01 with P> 0.1 were recorded for the percentage rot severity.*

Keywords: *Ipomoea batatas L Lam, Fungal Pathogens, Rots, Pathogenicity.*

1. INTRODUCTION

Sweet potato (*Ipomoea batatas* L (Lam) belongs to the convolvulaceae family and is a root crop cultivated in many countries including Nigeria, Sierra Leone, Ghana. Sweet potato is an important food crop in Nigeria ranking third amongst important tuber crops of Sub-saharan Africa, after yam Yams second to cassava as the most important tropical root crop and are a staple crop in many parts of Africa and Southeast Asia [1-2, 3]. Sweet potato is grown in general for its storage roots, which are eaten fresh, steamed, or boiled. Sometimes the leaves are eaten as vegetables or may be processed into flour or starch. The vines are fed to livestock [4].

It is estimated that in the tropics each year between 25% and 40% of stored agricultural products are lost because of inadequate farm and village-level storage [5]. Quantitative and qualitative losses or a combination of both arising from post-harvest storage results from physical, physiological, or pathological factors or various combinations of these factors [3]. After harvesting, sweet potato roots are perishable products and are subject to high losses during transportation, storage and selling. The skin of the sweet potato root is damaged easily during harvest and post-harvest handling [6]. In addition, its high water content makes storage difficult and vulnerable to microbial attacks, resulting in high losses. Normally the fungi causing rot in sweet potato are lesion pathogens [7]. The rots include; Black rot (*Ceratocystis fimbriata*), Dry rot (*Aspergillus niger*, *Aspergillus fumigates*), Fusarium root and stem rot (*Fusarium solani*.), Foot rot (*Plenodomus destruens*), Soft rot (*Rhizopus stolonifer*), and Blue mold rot (*Penicillium spp*) [8].

Under a controlled environment, sweet potato roots can be stored for several months. Curing potato for 8 days at 15^{o} and 95^{o} RH will allow extended storage of up to 5months at 4^{o} C and 95%to 98%RH [9]. Curing allows injured roots marked by high water content to heal. Noticeable changes occurring are desiccation of several layers of the outermost parenchymal cells exposed to air on wounding. It has been shown that beneath the dissociated cells is a subsequent deposition of a polymeric material in the parenchymal cells [9]. Traditional storage method which include leaving tubers on open floor and burying in the ground, has recorded heavy losses owing to sprouting, rodent destructions, and insect and microbial damage [9]. Although sweet potato is comparatively easy to grow and has high consumer acceptability, its post-harvest has been dealt with rarely in the past. This particularly applies

to storage by small scale farmers, although this group of producers is the one that cultivates and stores roots and tubers most, especially in Africa [9].

The aim of this work is to isolate, characterize and identify fungi associated with post-harvest loss of sweet potato and also to carry out the pathogenicity tests of the rot-causing molds and to determine the number of occurrence and the severity of rots of the different rot-causing molds during the study.

2. MATERIALS AND METHOD

2.1. Sample Collection

A variety of sweet potato cultivated in South Eastern Nigeria was used in the study. A total of ten tubers were obtained from *Eke*-Awka market Awka south Local Government Area, Anambra State. The spoilt potato tubers were packed in sterile cellophane bags and transported to the laboratory of the Department of Applied Microbiology and Brewing, Nnamdi Azikiwe University and were used for the study.

2.2. Isolation of Rot-Causing Fungi

Spoilt potato tubers were rinsed in distilled water and were cut open with a sterile knife. Diseased tissues were picked from the point of advancement of rot with the aid of a sterile forceps and inoculated on a sabouraud's dextrose agar (SDA) medium. The inoculated plates were incubated at room temperature for 72 hours with monitoring done every 24hours. Developing fungal colonies were purified by repeated subculture technique. Pure cultures were maintained on agar slope at $4^{o}C$ in a refrigerator.

2.3. Characterization of Rot-Causing Fungus

This was done based on the description of the gross morphological appearance of fungal colonies on the SDA culture medium and the slide culture technique for microscopic evaluation with reference to the Manual of Fungal Atlas [10].

2.4. Pathogenicity Test

Freshly and healthy tubers of sweet potato were washed with tap water and surface sterilized with 70% ethanol. The pure culture of each fungal isolate was introduced into the sweet potato tubers hole created by a flame sterilized syringe. All the treated tubers were put singly into sterile polythene bags and incubated at room temperature for 14 days. The sweet potato tubers was cut through and examined for rot at the end of the incubation period. An isolate was confirmed pathogenic, if it causes rot similar to that observed on the diseased sweet potato from where it was isolated. The percentage severity of rot was determined by removing the rotted portions from the whole tubers and taking the final weight of the individual sweet potato tuber. The percentage severity of rot (Sr %) was calculated [3, 19].

$$Sr\ (\%) = \frac{W - w}{w} \times 100$$

Where:

W = Initial weight of healthy sweet potato tuber

w = final weight of rotted tuber portion.

2.5. Statistical Method

The completely randomized experimental design and appropriate replicates were adopted in all measurements. Data were subjected to Analyses of variance (ANOVA).

3. RESULTS AND DISCUSSION

3.1. Characterisation and Identification of Rot-Causing Fungi.

Three distinct fungal colony types were isolated from the sweet potato samples and the 3 are considered pathogenic to the sweet potatoes were fully characterized. The report of molecular identification showed that the 3 pathogenic species, *Aspergillus fumigatus, Aspergillus niger and Rhizopus stolonifer* were observed.

Table 1 shows the cultural and microscopic features of the fungal isolates whereas table 2a & b shows the number of occurrence of each isolates in the diseased potato tubers and the categories of rots during the pathogenicity test with the method of Ogbo and Agu [3].

Table1. *Cultural and Microscopic features of the fungal isolates*

Isolates	Cultural features	Microscopic features	Organism
1	On SDA, colonies had rapid growth rate. However, colonies were flat and compact with yellow basal felt covered by a dense layer of black conidial heads with powdery texture. The colour on the reverse side was pale yellow. Colonies were incubated at 30^{o}C for 5 days.	Septate hyphae with Conidiophores were hyaline or pale-brown to black, erect, simple, with foot cells basally, inflated at the apex forming globose vesicles, bearing conidial heads split into over 4 loose conidial columns with over 4 fragments apically composed of catenulate conidia.	*Aspergillus niger*
2	On SDA, colonies showed typical blue-green surface pigmentation with a suede-like surface consisting of a dense felt of conidiophores. Texture was powdery and the colour on the reverse side was yellow	Septate hyphae with thin-walled Conidiophore stipes are short, smooth-walled and had conical-shaped terminal vesicles. Conidia were produced in basipetal succession forming long chains and are globose to subglobose	*Aspergillus fumigatus*
3	On SDA, Colonies are very fast growing, cottony to fluffy, white to yellow, becoming dark-grey.	Sporangiospores are hyaline, grey or brownish, globose to ellipsoidal, and smooth-walled, and erect, simple or branched, forming large, terminal, globose to spherical, multispored sporangia, without apophyses and with well-developed subtending columellae.	*Rhizopus stolonifer*

3.2. Fungal ROT of Sweet Potato

All the sweet potato tubers studied suffered fungal rots which were caused by different fungal isolates and their number of occurrence as shown in table 2a and b below. The storage rot fungi isolated during this study are the same with those reported previously [12]. It is of interest to note that the types of rots caused by our isolates are in complete agreement with the categorization of Amusa and Baiyewu [13]. Dry rot is the most predominant category and only few cases of soft rot were observed during this study, while wet rot was not observed at all. Wet rot arises from secondary infection with *Erwinia carotovora*.

Table2a. *Occurrence of the fungal isolates in the spoilt potato tubers*

Samples	***Aspergillus* sp**	***Rhizopus* sp**
1	_	_
2	+	_
3	_	_
4	_	+
5	_	_
6	_	_
7	+	_
8	+	_
9	_	+
10	+	_

KEY:

+ = detected.

- = undetected.

Aspergillus species occurred mostly in all the samples examined.

Table2b. *Categories of rots observed on the sweet potato tubers sample during storage and their fungal causative.*

Sweet potato sample	Category of Rots	Isolates
P2, P8 & P10	Dry Rot	*Aspergillus niger*
P4 & P10	Soft Rot	*Rhizopus stolonifer*
P7	Dry Rot	*Aspergillus fumigatus*

3.3. Effects of Fungal Rots on the Weight of the Sweet Potato Tubers

It is well known that sweet potatoes undergo weight loss during storage. This arises from water loss by transpiration and loss of dry matter through the physiological change of respiration and sprouting [14]. The overall effects of these changes are the shriveling as well as loss of the food quality of the tuber. Different samples of *Ipomoea batatas L (Lam)* suffered significantly different level of weight loss during storage. (Table 2b). Fungal rots aggravated weight loss in all the sample of sweet potato with samples p2, p8 and p10 having *Aspergillus niger* as its pathogenic organism, suffering much significant effects than others. These differences are perhaps attributed to the difference in moisture content and texture of the tissues of the sweet potatoes [15]. Table 3 shows the pathogenicity test on sweet potato, table 4 shows the mean percentage severity of rots loss in sweet potato tubers and table 5 shows the mean percentage weight loss in sweet potato tubers.

Table3. *Pathogenicity test on sweet potato*

Sample	Final weight (Fw)	Rotted Weight (Rw)	Initial Weight (Iw)	Percentage Weight-loss (%)	Mean
P11	230.1	1.6	231.8	0.73	1.04
P12	197.I	1.9	199.8	1.35	
P13	204.9	1.8	206.5	0.77	0.44
P14	345.1	0.4	345.5	0.12	
P15	154.0	0.3	154.9	0.58	0.75
P16	150	1.3	151.4	0.92	

Table4. *Mean percentage severity of Rots loss in sweet potato tubers at the end of their shelf life*

Samples	Organism Inoculated	Mean % severity rots ± S.D
P11 **P12**	*Rhizopus stolonifer*	98.28 ± 0.35
P13 **P14**	*Aspergillus niger*	99.06 ± 1.00
P15 **P16**	*Aspergillus fumigatus*	98.72 ± 0.01

Table5. *mean percentage weight loss in sweet potato tubers at the end of their shelf lives.*

Samples	Organisms Inoculated	Mean % weight loss ± SD
P11 **P12**	*Rhizopus stolonifer*	1.04 ± 0.44
P13 **P14**	*Aspergillus niger*	0.45 ± 0.46
P15 **P16**	*Aspergillus fumigatus*	0.75 ± 0.24

4. DISCUSSION

This work has shown that the molds associated with storage of rots of sweet potato tubers in *Eke*-Awka market Awka south Local Government Area, Anambra State, were *Rhizopus stolonifer, Aspergillus niger and Aspergillus fumigates*. This is similar to the finding of Salami [16], who identified *Fusarium roselens, Rhizopus stolonifer, Aspergillus fumigatus, penicillium,Aspergillus niger* species were responsible for post harvest rot of sweet potato tubers. Amienyo [1] reported that *Rhizopus stolonifer* is the most frequently isolated fungus from spoilt sweet potato tubers in South western, Nigeria. The results of this study are in agreement with the findings of other researchers (Agu *et al.,* 2014) that fungi constitute a menace in storage rots of many agricultural commodities. It was observed that *Aspergillus niger and Rhizopus stolonifer* were the most frequently isolated fungus from spoilt sweet potato tubers in Anmabra State. The results of pathogenicity test indicated that fungi induce different level of decay with *Aspergillus niger* the most virulent fungus. Salami [16] reported *Rhizopus oryzae* as the most virulent among the fungi associated with storage rots of sweet potato tubers in South western, Nigeria.

Post harvest rot of sweet potato tubers may be due to its low pH, moisture content and nutritional compositions which make it susceptible to infection by fungi. The high incidence of storage rots of sweet potato tubers encountered in Anambra State could be related to prevailing climatic factors and storage conditions. It could also be attributed to handling procedures during harvest, transit, marketing

and storage places. Post harvest loss of root and tubers has been of serious problem to farmers and warring against food security [17]. This study has shown that fungal rot is the greatest cause of rot of sweet potato in storage. Colonization of the tubers by fungi will be lead to reduction in consumption materials, market value and production of mycotoxins. Consumption of excess mycotoxins can cause illness or death [18]. The pathogenic fungi can cause allergies in susceptible individuals.

5. CONCLUSION

Mold infestation contributes to the problems encountered during post-harvest storage of sweet potato. The results of the present study have revealed the spoiled sweet potato tubers were mainly contaminated with *Aspergillus sp, Rhizopus sp*. These pathogens have lead to enormous loss of sweet potato tubers despite its economic and nutritive value. Presence of the rot-causing fungi on these tubers most especially *Aspergillus niger* poses a serious threat to health of consumers as the organism could produce mycotoxins, which are lethal when consumed. Most of the fungi isolated were observed to be able to reinfect healthy sweet potato tubers within short time, which poses a serious economic threat to sellers of tubers in *Eke*-Awka market Awka south, Anambra State. It is important to adopt disease control practices that will be affordable by the bulk of resource-poor farmers in our part of the world and it will ensure substantial contribution of the sweet potato to food supply and national economy.

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