Comparative evaluation of different storage methods of sweet potato (I*pomea batatas* {L}) and their management

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ABSTRACT

In vivo and *in vitro* study were conducted to evaluate the efficacy of five storage methods (*wood shaving, use of basket, wood ash, bamboo poles and storage on the floor*) of sweet potato and their management. Diseased tubers of sweet potato were collected from the field trial. The fungus was isolated from diseased potato tuber samples and identified using culture medium. The fungal species associated with the tuber rot of sweet potato and subsequent rot was isolated and identified in this study as *Aspergilus niger*, *Aspergilus flavus, Penicilum expansum, Rhalstonia solanacearum, Rhizopus stolonifer, Fusarium oxysporium* and *Fusarium solani. The experiment was carried out between December 2018 and March 2019 for a period of 3 months and repeated in December 2019 to March 2020 to determine the best storage method of sweet potato and their management.* From the physical observation the symptom shows three types of rots, which were ascertained as soft, dry and brown rot on Sweet potato tubers in different storage systems. From December 2018 after 3 months of storage were significantly different ($P < 0.05$) on the level of inhibition of the causal organisms on different storage methods used. Wood ash reduced the extent (2.7, 1.8 for dry and soft rot respectively) of tuber rot pathogens more than other storage methods, the least was from the tubers stored on the floor which recorded 95.5 from the dry rot and gave less value in soft rot (6.3), but the tubers stored in basket method had the highest rot incidence (34.8) in soft rot than every other storage method. In 2019 after 3 months storage shows the same sequence followed in 2018. Wood ash still takes the lead in control of rot induced pathogen than other methods with a value of 15.3 from dry rot and 99.53 for the floor which was the least in rot reduction. The degree of rot incidence in 2019 was higher than in 2018. The mean percentage dry rot in 2019 recorded 55.3 while mean dry rot in 2018 was 39.9. For the soft rot, the mean value was 12.4 and 8.7 (2019, 2018) respectively. This could be due to higher temperature regime of drought in 2019. Also, there was appreciable difference in nutrient values of the healthy and infected tubers of sweet potato. The test pathogens significantly affected the nutrient content of sweet potato tubers. *Aspergilius flavus* was the most virulent pathogen depleting the gross nutrient content of the tubers by 48.53%, this was closely followed by *Rhizopus stolonifer* which incurred mean percentage loss of 46.50. However, *Penicilium expansum* was the least virulent in the study. A mean percentage loss of nutrient of 29.65% was recorded on infected tubers due to the pathogen (*P. expansum*).

Key words: Diseases, inhibition, microorganism, test plant and treatments

INTRODUCTION

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Sweet potato (*Ipomea batatas*) constitutes an important staple food in the tropics; being one of the major source of carbohydrates, vitamins and dietary fibres. Despite the nutritional and economic importance of sweet potato, its production is limited by pests and diseases. It has been estimated that an average of over 25% of the yield is lost annually to diseases and pests globally (FAO, 1998). One of the major diseases affecting sweet potato production in the tropics is internal microbial rot (PROTA, 2004). Internal rot is the condition that develops in sweet potato tuber where the whole tuber appears wholesome and attractive, but has developed rapid and extensive breakdown of internal tissues (PROTA, 2013). This condition, with time renders the whole tuber rotten. Several microorganisms have been associated with rot in sweet potato. They include; *Aspergilus niger*, *Aspergilus flavus, Penicilum expansum, Rhalstonia solanacearum, Rhizopus stolonifer, Fusarium oxysporium* and *Fusarium solani* (Enyiukwu *et al*, 2014; PROTA, 2013). Good understanding of the various pests and diseases of sweet potato and their storage management is an important component of improved management technology and produce preservation from microbes-induced spoilages (Salami and Popoola, 2007; Kana *et al*., 2012). According to Arya (2010), of all losses caused by plant diseases, those that occur after harvest are the most costly. Cassava, yam and sweet potato are important sources of food in the tropics. Others are cocoyam, rice, maize, wheat, sorghum, millet and various fruits, legumes and vegetables. Sweet Potato (*Convolvulaceae; Ipomea batatas*) is an important food crop in Nigeria ranking third amongst important tuber crops of sub-saharan Africa (SSA) after yam and cassava (Amienyo and Ataga, 2007); with 100 million MT produced annually (Ewell and Matuura, 1991; Nwokocha, 1992). The crop according to Oladoye *et al*. (2013) is an important source of anthocyanidines and antioxidants. Rots pose serious problems to its production especially in vegetable potato. In Iran, survey showed that up to 10% pre-harvest and 20% post-harvest rots occurred in the crop (Bidarigh *et al*., 2012).These rots constitute major impediments to the drives for food security in Nigeria. Therefore, this investigation is aimed at evaluating the efficacy of different storage methods/media on reduction of fungi-induced rots of sweet potato; and on the improvement of the storagebility of the tubers in the humid tropical agro-ecology of Umudike, Nigeria. The specific objectives are to:

1. Isolate and identify the fungal rot organisms associated with stored sweet potato in Umudike.
2. Identify the most suitable low-input storage methods/ media for improved shelf-life of the tubers in the agro-ecology
3. To investigate the mechanism of damage by the pathogenic organisms during pathogenesis (Histological studies).

MATERIALS AND METHODS

This study was conducted at the NRCRI, Umudike, Nigeria. Relatively disease – free sweet potato were collected from the Sweet potato programme field trials of the National Root Crops Research Institute, Umudike. The treatments were as follows: wood shavings and wood ash, *use of basket, storage on the floor* and bamboo poles were obtained from the Institute neighborhood. The experiments were set up both in *vivo* and in *vitro*.

In *Vivo* experiment

The shelf – life of sweet potato tubers were evaluated by the *use of basket, storage on the floor*, raised bamboo plat forms, wood shaving and wood ash. Under shade storage consist of tubers stored on wood ash, wood shavings, raised bamboo poles and basket. Twenty (20kg) kilograms of the relatively diseased free tubers were stored on each storage method. The experiment was carried out in 2018 and 2019 for a period of 3 months. Data taken was on the types and number of rotted and un-rotted tubers per storage method/ medium per replicate.

In *Vitro* experiment

Rotted tubers were enveloped and taken to the Plant Protection Laboratory NRCRI, Umudike. Infected tubers were washed into water and rinsed in several changes of 500mL sterile distilled water. Bits of the diseased tuber tissues were plated on solidified synthetic PDA (Melbonne, Germany) contained in Petri dishes. The dishes were incubated for 7 days at room temperature of 27^{0}C. The mycelia that grow out of the tuber were repeatedly sub-cultured on fresh 20mL solidified PDA to obtain pure cultures of the organism. Bits of the 10-day old pure stocks were lifted unto a drop of lactophenol in cotton blue on sterile slides, teased gently and cornered with a cover slip. The slides thus prepared were mounted on a microscope and the identity of the organism ascertained with reference to Barnett and Hunter (1995).

Statistical analysis

Data generated from the experiment were analysed by ANOVA using GENSTAT 2008 Version. Means was separated by Fishers LSD (FLSD) at 0.05 Probability.

Results and Discussion

This study shows different types of rot infection on sweet potato tubers in different storage system. From the physical observation the symptom shows three types of rots, which were ascertained as soft, dry and brown rot. The result from Table 1 shows that a total of seven micro-organisms (*Aspergilus niger*, *Aspergilus flavus*, *Penicilum expansum*, *Rhalstonia solanacearum*, *Rhizopus stolonifer, Fusarium oxysporium* and *Fusarium solani)* were isolated from the rotted tubers of sweet potato, their frequency of occurrence and types of rots they cause are shown below.

Table 1: Microorganisms isolated from Sweet potato, their frequency of occurrence and type of rots

Fungi isolate	Frequency of occurrence (%)	Types of rots
Aspergilius niger	13.7	Dry rot
Aspergilius flavus	10.9	Dry rot
Rhizopus stolonifera	60.1	Soft rot
Rhalstonia solanacearum	57.3	Brown rot
Fusarium oxysporium	12.6	Dry rot
Peniciliumexpansium	28.0	Dry rot
Fusarium solani	8.2	Dry rot

Table 2 shows the effect of storage methods on mean rots of ***Ipomea batatas*** in 2018 after 3 months of storage. There were significant differences ($P < 0.05$) on the level of inhibition of the causal organisms on different storage methods used. Wood ash reduced the extent of (2.7, 1.8 for dry and soft rot respectively) tuber rot induced pathogens more than other storage methods used and the least was from the tubers stored on the floor which recorded 95.5 from the dry rot and gave less value in soft rot (6.3), but the tubers stored in basket method had the highest rot incidence (47.2) in soft rot than every other storage method.

Table 2: Effect of storage methods on mean rots of *Ipomea batatas* in 2018 (3 Months of storage)

Storage methods	Dry rot (%)	Soft rot (%)	Brown rot (%)
Bamboo	41.8	5.5	4.0
Floor	95.5	6.3	21.8
Basket method	47.2	20.8	26.2
Wood ash	2.7	1.8	1.0
Wood shaving	12.2	9.0	5.8

Means	39.9	8.7	11.8
LSD0.05	**16.1***	**4.7***	**NS**

Table 3 also shows the effect of storage methods on mean rots of ***Ipomea batatas*** in 2019 after 3 months storage. The same sequence followed in 2018. Wood ash still takes the lead in control of rot induced pathogen in tuber rot of sweet potato than other methods with a value of 7.5 from dry rot and 99.3 for the floor which was the least in rot reduction in storage. But soft and wet rot were not significant. There were significant differences ($P < 0.05$) in the two years experiment. The degree of rot incidence in 2019 was higher than in 2018. The mean percentage dry rot in 2019 recorded 55.3 while mean dry rot in 2018 was 39.9. For the soft rot, the mean value were 12.4 and 8.7 (2019, 2018) respectively. This could be due to higher temperature regime of drought in 2019.

Table 3: Effect of storage methods on mean rots of *Ipomea batatas* in 2019 (3 Months of storage)

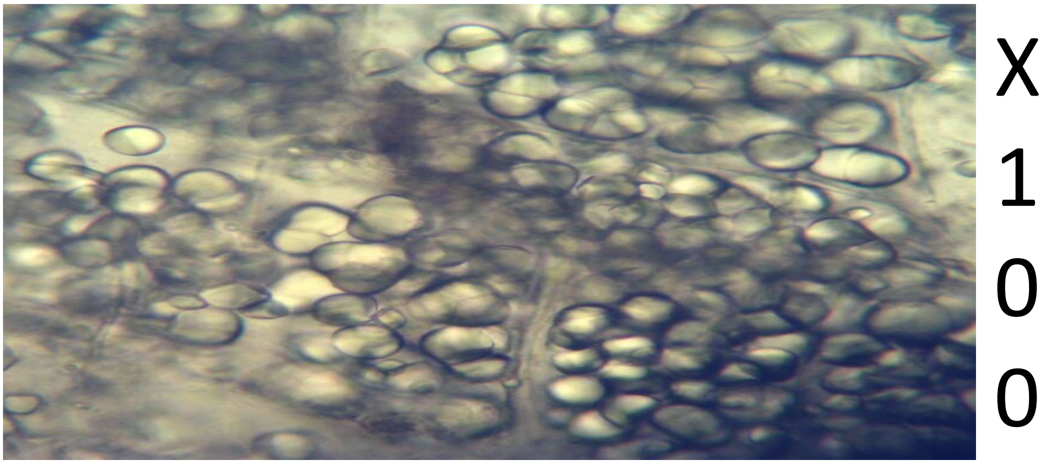
Storage methods	Dry rot (%)	Soft rot (%)	Brown rot (%)
Bamboo	87.3	9.3	8.0
Floor	99.3	7.5	18.8
Basket method	47.2	26.5	28.5
Wood ash	8.7	3.83	3.8
Wood shaving	33.8	14.7	12.5
Means	**55.3**	**12.4**	**14.3**
LSD0.05	**13.2****	**3.1****	**NS**

The results in Table 4 indicated appreciable difference in nutrient values of the healthy and infected tubers of sweet potato. The pathogens significantly affected the nutrient content of sweet potato tubers. *Aspergilius niger* was the most virulent pathogen depleting the gross nutrient content of the tubers by 48.53%, this was closely followed by *Rhizopus stolonifer* which incurred mean percentage loss of 46.50 However, *penicilium expansum* was the least virulent of the pathogens affecting the tubers in the study. A mean percentage loss of nutrient of 29.65% was recorded on infected tubers due to the pathogen (*P. expansum*). These pathogen organisms that reduced the nutrient content of tubers has been reported by Amadioha, 2004 which is in agreement with the result of this study.

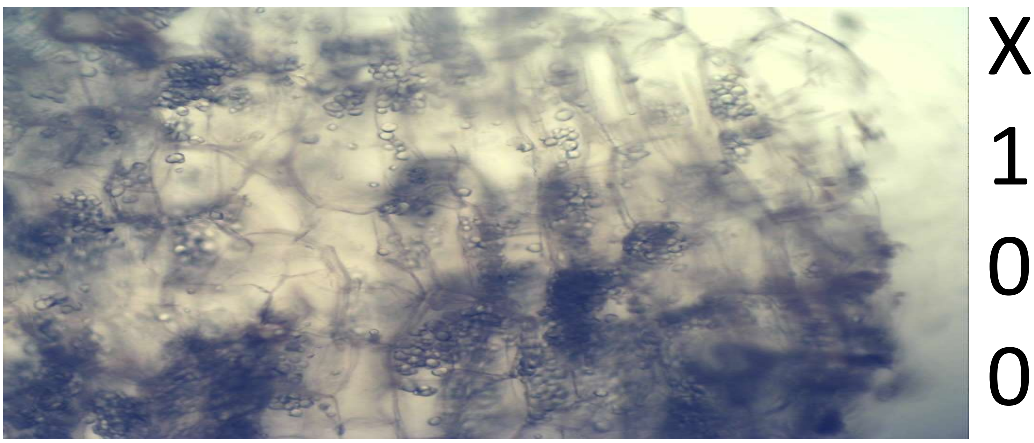
Table 4: Depletion of nutrient content of Sweet potato tuber by the pathogenic organism at Umudike

Pathogen	Healthy	Infected	Loss	%Loss	Mean% loss
A. niger	11.87	6.11	5.76	48.53	18.11
R. stolonifer	11.87	6.35	5.52	46.50	17.56
F. oxysporum	11.87	7.62	4.25	35.80	14.89
P. expansum	11.87	8.35	3.52	29.65	13.35
Mean	11.87	7.11	4.76	40.10	5.09
LSD (0.05)	**NS**	**1.64**	**0.38**	**1.02**	**1.01**

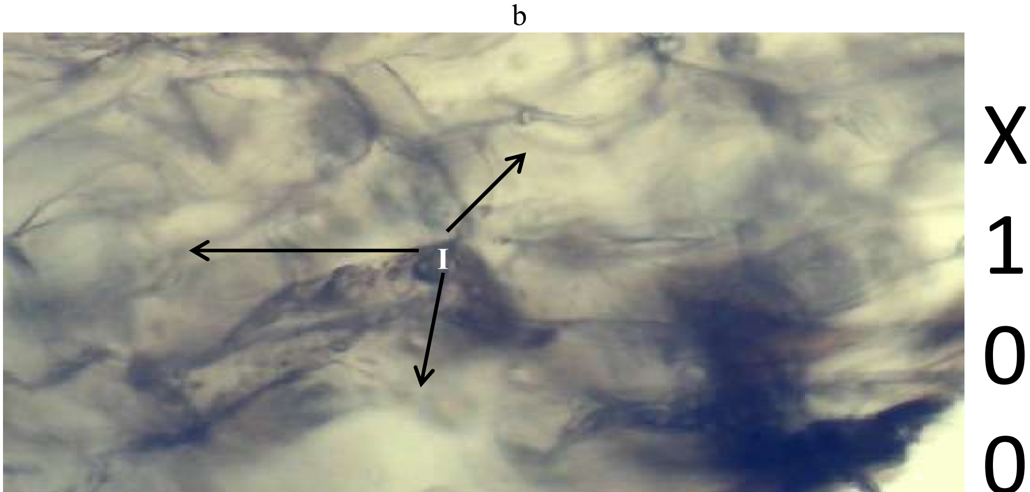
PLATE A – E SHOWS DEPLETION OF STARCH GRAINS OF SWEET POTATO TUBER BY DIFFERENT FUNGAL ORGANISMS



a



b



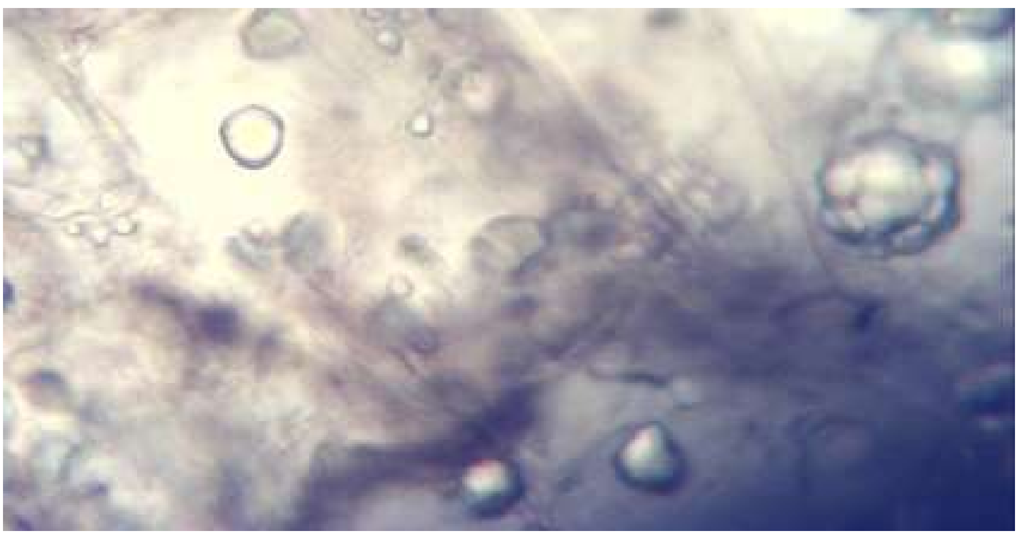
c

(a) Fresh healthy sweet potato (Ipomea batatas) showing intact cells packed with starch grains.
(b) Cells depleted of starch grains 1 week after infection by *Aspergilus niger*
(c) Total collapse of cell wall boundaries 2 weeks after infection by *Aspergilus niger.* i: shows depletion of starch grains and ramification of hyphae both inter and intracellular tissue completely macerated.

X1000

d

(d) Total collapse of cell boundaries and ramification of hyphae both inter- and intracellular 2 weeks after infection by *Rhizopus stolonifer*



X1000

e

(e) Depletion of cell wall boundaries and ramification of hyphae both inter-and intracellular 2 weeks after infection by *Penicilium expansum*

Conclusion

This study indicates that there was greater occurrence of dry rot than soft or brown rots amongst the storage methods used. It also shows that wood ash compared well in rot control than other treatments. This may be as a result of wood ash been alkaline in nature and could be that the organisms do not operate well in an alkalinity environment. Therefore, wood ash is a good storage media for *I. batatas* and can effectively minimize post-harvest rot development of Sweet potato tubers in storage. While storing in cemented floor is not an ideal storage media for Sweet potato because it encourages rot development especially dry rot. The reason could be that cemented floor absorbs heat more than other methods in this study.

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