Original Research Article

Antimicrobial effects of four plant extracts against post harvest spoilage fungi of yam (*Dioscorea rotundata* Poir).

ABSTRACT

This study investigated the effects of plant extract on fungal pathogens responsible for yam rot in storage. Among the eight fungal pathogens isolated from yams with symptoms of post harvest rot, the inhibitory effects of four plant materials on four of these organisms (*Fusarium solani, Aspergillus niger, Botryodiplodia theobromae* and *Rhizopus stolonifer*) with the highest prevalence were examined. Phytochemicals test of these plant materials showed the presence of alkaloid, flavonoid, glycosides, saponin and tannins at different quantities. The pathogenicity test revealed that all the organisms tested were pathogenic on healthy yam tubers with *Aspergillus niger* being the most pathogenic. All the plant extracts inhibited the growth of the test organisms at varying degrees. The degree of inhibition was dependent on concentration of extract, extraction medium and the test organism. The highest inhibitory values were obtained from ethanol extracts of *Moringa oleifera* and *Azadirachta indica* at 7.5% and 10.0% concentration each, while *Gongronema latifolium* and *Xylopia aethiopicum* gave lower inhibitory values. This suggests that *Moringa oleifera* and *Azadirachta indica* are good bio killers and their biological active ingredients can be exploited for the control of yam rot.

Key words: Yam, Plant extracts, Fungi, Post harvest, *Moringa oleifera, Xylopia aethiopicum, Gongronema latifolium, Azadirachta indica.*

INTRODUCTION

Yam (*Dioscorea rotundata*) of the family Dioscoreaceae is a perennial herb cultivated for the consumption of its starchy tuber (Ezeibekwe, 2009). Yam is one of the highly rated staple food crops of the tropical world and serves as an important carbohydrate food for millions of people in the tropical and subtropical countries which includes but not limited to West Africa, Caribbean, China, Malaysia, Oceania and Japan (Okigbo and Ikediugwu, 2000; Okigbo and Nmeka, 2005). Yam is of great importance to the economy of Nigeria as food and medicine (Okigbo and Ogbonna, 2006) hence FAO (2005) recorded that Nigeria produces 66.6% of total World′s yam production every year. Yam contributes significantly to food security and its availability in the market for a considerable part of the year helps prevent food shortages because it stores relatively longer than other food crops (Opara and Nwokocha, 2015).

According to FAO (2008) more than 25% of yams produced in Nigeria every year are lost to various kinds of diseases and pests. Deterioration of cultivated yam usually starts in the field from seedling stage, through harvesting and progressed in storage, which occur when infected tubers do not have any sign of external symptoms (Amusa *et al.,* 2003; Okigbo and

Ogbonnaya, 2006). Yams are subjected to several diseases and these disease causing agents reduce the quantity and quality of yam by making them unmarketable and unappealing to the consumer (Ezeibekwe *et. al.,* 2009). Some of the fungi associated with post harvest rot of yam and tuber crops are: *Aspergillus flavus, Aspergillus niger, Ervinia caratovora, Botrydioplodia theobromae, Fusarium solani, Fusarium oxysporium, Trichoderma viride, Rhizopus nodosus etc* (Adeniji, 1970; Aidoo, 2007; Anukwuorji, *et al.,*2013; Ogundana *et al.,* 1970; Okigbo and Ikediugwu, 2000; Okigbo 2004).

Over the years, the use of chemicals has helped to control rot of root and tuber crops but not without challenges. With the constant use of chemicals, the target organisms can develop resistance, the use of chemical can also result to death by accumulating in man, poison and concentrate in food chain as they are usually not eco-friendly. Consequently, it is necessary to search for dependable and sustainable remedies that regard the requirement of man and its environment, hence plant extracts have been successfully used as viable alternative to control diseases in plants because they are relatively cheap, readily available and easily biodegradable (Amadioha, 2000; Amadioha and Obi, 1999; Anukwuorji, *et al.,* 2012; Ijato, 2011; Okigbo and Nmeka, 2005; Olufolaji, 1999). In other words, it is pertinent to find new types of antifungal for root and tuber crops which are not synthetic chemical; hence this research is on the antifungal activity of *Gongronema latifolium*, *Moringa oleifera, Xylopia aethiopicum* and *Azadirachta indica* on the primary organisms that induce rot of yam.

MATERIALS AND METHODS

Sources of Materials.

Yam tubers that show symptom of rot were obtained from Garriki Market in Enugu State. Healthy yam tubers for pathogenicity test were also purchased from the same market. They were packed into a polythene bag and taken to the laboratory for analysis. *Gongronema latifolium, Azadirachta indica, Moringa oleifera* and *Xylopia aethiopicum* were collected from Agbani Village.

Plant Extract Preparation

The plant materials were closely examined for the presence of extraneous materials and deteriorated leaves which were removed. The sorted ones were first washed in running water and then in sterile distilled water. They were allowed to drain and then sun-dried separately for five days. Each of the plant materials was grounded separately and sieved in 1 mm diameter sieve to obtain a powdered processed sample used for the extraction. For ethanol extract preparation, 20 g of each ground leaf material was mixed (separately) with 100 ml of 70% ethanol in a 500 ml beaker. The extract was sieved through four layers of sterile cheese cloth. Different concentrations of 10, 25, 50 and 100% were prepared. The same process as for ethanol was followed for aqueous extract preparation.

Isolation, Purification, Characterization and Identification of Fungal Pathogens of Yam

Yam tubers with symptoms of rot were washed in tap water. They were then cut into 3mm diameter at the boundary area between healthy and rotten portion of the yam tuber. The cut tissues were surface sterilized with 70% ethanol and rinsed twice, then dried on sterile tissue paper and four sections of the sterilized tissue pieces plated out on PDA. The inoculated plates were incubated for five days at a room temperature and observed daily for emergence of colonies. When growth has established, subcultures were prepared by transferring hyphal tips from the colony edge to fresh plate of PDA with the aid of flame sterilized blade. The resulting pure cultures were used for characterization and subsequent identification of the isolates using identification guide and compound microscope.

Antifungal sensitivity of plant extracts on fungal growth (*in vitro*)

The effect of extracts on fungal growth was determined using the growth inhibition test *in vitro*. Before dispensing PDA into each of the plates, four equal sections were created on each Petri-dish by drawing two perpendicular lines on the reverse of the plate, the point where the two lines meet is taken to be the center. One ml from each of the concentrations was dispensed into 9ml of melted PDA in a Petri dish, shaken together and allowed to solidity; this gave rise to 2.5%, 5.0%, 7.5% and 10% extract concentrations. Four millimeter diameter mycelia disc obtained from the colony edge of 7-day old pure cultures of each of the four test fungi was inoculated at the center of the plate containing the PDA-extract mixture. Negative control experiments were set up without the addition of any plant material while positive control PDA plates were added 1 ml of Mancozeb. Three replicates were setup for each treatment and all the plates were incubated at 28±2 ℃ for five days. Percentage inhibition was calculated from the data obtained using the formula below:

$$\text{Growth inhibition (\%)} = \frac{DT-DC}{DC} \times \frac{100}{1}$$

Where DC – Average Diameter of control and
DT – Average Diameter of fungal colony
With treatment

Pathogenicity Test

Four test fungi isolated from the rotten yam tubers were tested on their ability or otherwise to induce rot on healthy yam tubers. The method of Okigbo and Ikediugwu (2000) was adopted. Fresh healthy yam tubers were washed with tap water and distilled thereafter sterilized with 70% ethanol. Cylindrical 1cm deep was removed aseptically from the healthy yam tuber with the aid of sterile 5mm cork borer and then a core sample of the isolate from a 7days old PDA pure culture was inserted into the hole created and was closed back. Part of the tuber removed earlier was cut off to compensate for the thickness of the agar inoculums. The replaced core at the point of inoculation was sealed with sterile petroleum jelly; the same process was done for the control but without any pathogen. All the inoculated tubers were incubated over a period of 7-14 days at the temperature of 28-30 ℃; they were checked daily for signs of rot. At the end of the 14days incubation period, the tubers were cut open along the point of each inoculation to expose the inner portion and the extent of rot examined, measured and recorded.

RESULTS

Isolation, characterization and Identification of fungi pathogens from rotten yam tubers

The following fungi (*Fusarium solani, Fusarium oxysporium, Aspergillus niger, Aspergillus flavus, Botryodiplodia theobromae, Rhizopus stolonifer, Rhizoctonia solani* and *Penicillium oxalicum*) were frequently isolated from rotten yam tubers. There was remarkable variation in their frequency of occurrence, *A. niger* with the frequency of 83.3% being the highest while *Rhizoctonia solani* (8.3%) being the least occurred (Fig. 1).

Pathogenicity Test

All the test organisms (*Fusarium solani, Aspergillus niger, Botryodiplodia theobromae* and *Rhizopus stolonifer*) were pathogenic to healthy yam tubers after 14 days of inoculation. The most pathogenic was *Aspergillus niger* (63%) while the least virulent was *Fusarium solani* (16%) (Fig. 2).

Effects of plant extracts at different concentrations on the growth of four test organisms *in vitro*

All the plant extracts showed varying degrees of inhibition on the test fungi, this was dependent on the concentration of the extract. With respect to ethanol extract, *Moringa oleifera* at 10% extract concentration showed the highest inhibitory effect of 74.00±4.583 on *Fusarium oxysporium,* this was significantly higher than other interractions, while the least inhibitory effect was recorded from *Gongronema latifolium* at 2.5% extract concentration. The value observed from the positive control was greater than all other interactions (Table 3).

On the effects of ethanol plant extracts on the inhibition of mycelia growth of *A.niger, Moringa oleifera* at 7.5% and 10% extract concentrations showed the highest inhibitory effect of 76.67±7.024 and 76.33±9.452 respectively, these were significantly better than other interactions with the exception of the positive control (82.00±13.115) (Table 4).

For *Penicillium,* ethanol extract of *Moringa oleifera* and *A. indica* each at 10% extract concentration with the inhibitory effects of 72.00±6.245 was the highest while the least inhibitory potent is *Xylopium aethiopicum* at 2.5% extract concentration (Table 5).

The highest inhibitory effect of 77.33±2.083 recorded from ethanol *Moringa oleifera* extract at 7.5% extract concentration was the highest even though not significantly different from its inhibitory effect at 10% extract concentration and the positive control with 75.33±6.110 and 76.00±14.000 inhibition respectively (Table 6).

For aqueous extracts on the inhibition of mycelia growth of *Fusarium oxysporium,* the significantly better inhibitory effect was recorded from *Moringa oleifera* at 10% concentration

and *A. indica* at 7.5% and 10% with inhibition percentages of 48.33±7.234, 46.00±5.875 and 46.00±7.211 respectively (Table 7).

Aqueous extract of *Moringa oleifera* at 7.5% and 10% concentration and *A.indica* at 7.5% and 10% depicted the highest inhibitory effect of 47.67±3.215, 48.33±6.073, 44.00±9.539 and 47.00±6.245 respectively. These were significantly higher than other interactions. The least effect of 0.67±1.155 and 1.00±1.732 was recorded from *Gongronema latifolium* and *Xylopium aethiopicum* at 2.5% extract concentration each (Table 8).

Table 9 clearly depicted that *Moringa oleifera* and *Azadirachta indica* all at 7.5% and 10%aqueous extract concentration had the best suppressive effect on the mycelia growth of *Penicillium spp* after 7 days of inoculation. *Gongronema latifolium* and *Xylopium aethiopicum* all at 2.5% extract concentration gave the least effect of 3.00±000 and 4.00±0.928 respectively. These were significantly lower than other interactions.

Inhibitory effects of aqueous plant extracts on the mycelia growth of *Rhizopus spp* followed the same trend as table 8 and 9. The least inhibitory effects of 3.67±0.152 and 4.67±0.686 were recorded from *Gongronema latifolium* and *Xylopium aethiopicum* all at 2.5% extract concentration, while the highest inhibitory effects were recorded from *Moringa oleifera* and *Azadirachta indica* all at 7.5% and10% extract concentration. The positive control proved more potent with 76.00±14.000 inhibition (Table 10).

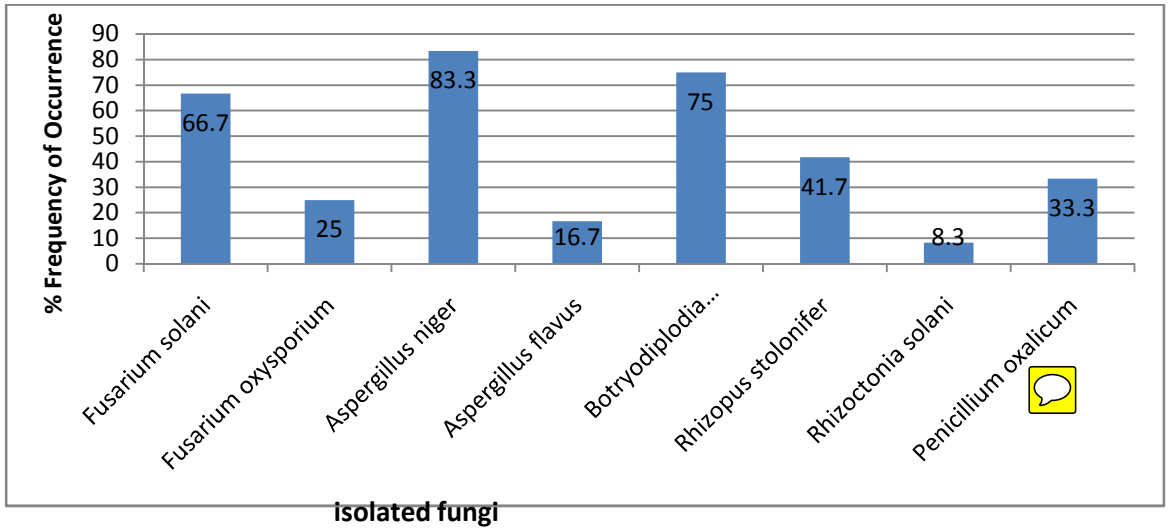
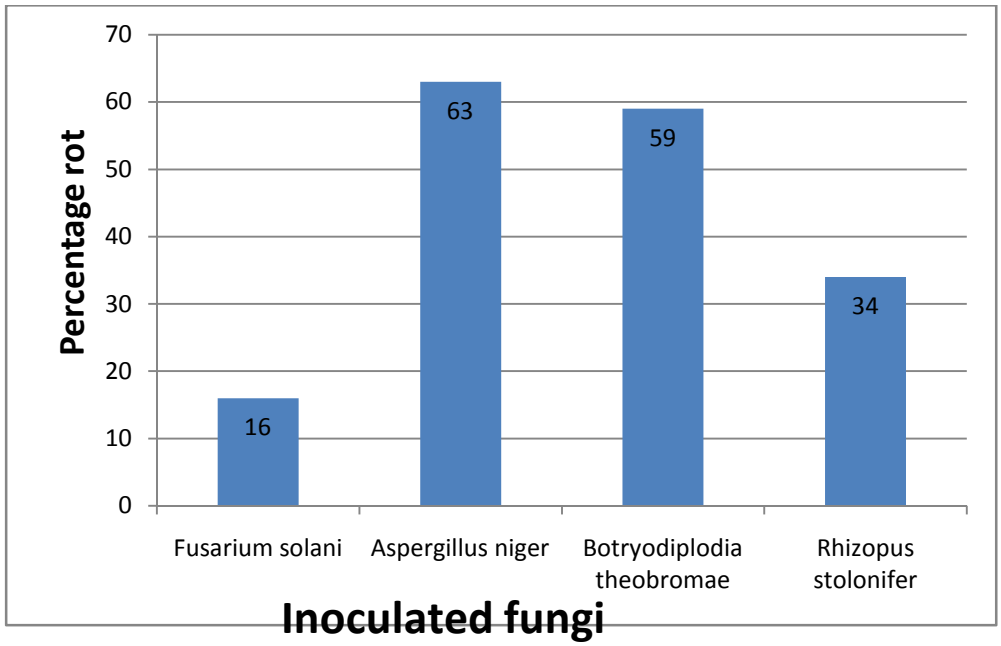


Fig. 1. Percentage occurrence of isolated fungi pathogens on rotten yam tubers samples



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179 **Fig. 2: Mean Percentage of Rot (Pathogenicity Test) on Healthy Yam Tubers**

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181 Table 1: Inhibitory effects of ethanol plant extracts at different concentrations on the growth of
182 *Fusarium oxysporium* at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	83.00±6.083f	83.00±6.083e	83.00±6.083d	83.00±6.083d
G. latifolium	4.67±0.163b	7.67±1.807b	35.00±5.568b	36.67±5.275b
X.aethiopicum	6.00±1.732c	6.33±1.970b	36.67±5.85b	37.33±3.215b
M. oleifera	45.00±5.000e	46.67±5.275d	69.67±5.508c	74.00±4.583d
A.indica	25.00±5.000d	28.67±2.767c	60.67±8.021c	61.67±7.638c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

183 Results are in Mean ±Std
184 The same letter in a column is not significantly different
185

Table 2: Inhibitory effects of ethanol plant extracts at different concentrations on the growth of *Aspergillus niger* at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	82.00±13.115e	82.00±13.115e	82.00±13.115f	82.00±13.115e
G. latifolium	2.33±0.517b	9.67±2.082b	30.33±4.240b	31.67±5.408b
X.aethiopicum	5.67±0.658c	10.00±2.292b	40.33±2.517c	37.00±6.083b
M. oleifera	32.67±0.429d	51.67±3.786d	76.67±7.024e	76.33±9.452d
A.indica	32.67±2.517d	35.67±5.452c	49.00±5.568a	57.67±5.774c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std
The same letter in a column is not significantly different

Table 3: Inhibitory effects of ethanol plant extracts at different concentrations on the growth of *Penicillium* spp at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	86.67±10.732d	86.67±10.732d	86.67±10.73d	86.67±10.732d
G. latifolium	16.00±4.000b	17.00±2.646b	37.67±4.041b	35.00±3.606b
X.aethiopicum	14.00±1.464b	13.00±3.606b	34.00±5.292b	36.33±4.676b
M. oleifera	40.67±1.155c	43.33±4.041c	62.33±4.933c	72.00±6.245c
A.indica	38.00±2.646c	40.00±0.000c	60.00±4.000c	72.00±6.245c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std
The same letter in a column is not significantly different

Table 4: Inhibitory effects of ethanol plant extracts at different concentrations on the growth of *Rhizopus* spp at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	76.00±14.000e	76.00±14.000d	76.00±14.000d	76.00±14.000d
G. latifolium	10.67±3.786b	10.00±2.718b	35.00±2.646b	38.00±4.359b
X.aethiopicum	18.00±4.568b	18.33±1.528c	37.33±2.517	39.67±0.577b
M. oleifera	48.33±2.082d	51.00±8.933c	77.33±2.083d	75.33±6.110d
A.indica	47.33±3.786d	48.33±8.622c	69.00±1.539c	65.00±6.288c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std
The same letter in a column is not significantly different

Table 5: Inhibitory effects of aqueous plant extracts at different concentrations on the growth of *Fusarium oxysporium* at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	83.00±6.083d	83.00±6.083f	83.00±6.083e	83.00±6.083e
G. latifolium	0.67±1.155b	2.67±0.517b	12.00±1.732b	12.67±1.015b
X.aethiopicum	1.33±1.155b	7.67±1.528c	22.00±2.646c	22.67±3.506c
M. oleifera	20.33±4.505c	26.33±4.163e	44.33±3.512d	48.33±7.234d
A.indica	17.00±4.359c	19.67±4.505d	46.00±5.875d	46.00±7.211d
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std
The same letter in a column is not significantly different

Table 6: Inhibitory effects of aqueous plant extracts at different concentrations on the growth of *Aspergillus niger* at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	82.00±13.115e	82.00±13.115f	82.00±13.115d	82.00±13.115d
G. latifolium	0.67±1.155b	3.67±0.041b	18.33±2.887b	18.00±6.557b
X.aethiopicum	1.00±1.732b	7.67±1.506c	15.67±4.041b	17.67±3.662b
M. oleifera	19.00±5.533d	37.33±5.504e	47.67±3.215c	48.33±6.073c
A.indica	13.00±4.937c	23.00±4.550d	44.00±9.539c	47.00±6.245c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std
The same letter in a column is not significantly different

Table 7: Inhibitory effects of aqueous plant extracts at different concentrations on the growth of *Penicillium spp* at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	86.67±10.732e	86.67±10.732d	86.67±10.732d	86.67±10.732d
G. latifolium	3.00±0.000b	6.67±2.082d	18.33±2.887b	21.67±3.505b
X.aethiopicum	4.00±0.928b	5.67±2.371b	15.67±4.041b	21.67±3.970b
M. oleifera	18.67±3.234d	24.33±3.506c	47.67±3.215c	50.00±5.292c
A.indica	14.33±2.371c	24.67±4.238c	44.00±9.539c	47.00±8.888c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std
The same letter in a column is not significantly different

Table 8: Inhibitory effects of aqueous plant extracts at different concentrations on the growth of *Rhizopus spp* at day 7 after inoculation

Plant materials and control	**Concentrations (%)**			
	2.5	**5.0**	**7.5**	**10.0**
+ve Control	76.00±14.000d	76.00±14.000e	76.00±14.000d	76.00±14.000d
G. latifolium	3.67±0.152b	6.00±1.000b	20.33±3.215b	24.67±4.619b
X.aethiopicum	4.67±0.686b	14.33±7.024c	19.33±2.506b	26.67±5.686b
M. oleifera	22.67±4.933c	30.67±2.082d	46.33±2.327c	48.67±2.517c
A.indica	19.33±3.506c	30.00±0.817d	45.33±4.041c	46.33±5.686c
-ve Control	0.00±0.000a	0.00±0.000a	0.00±0.000a	0.00±0.000a
P-value	0.000	0.000	0.000	0.000

Results are in Mean ±Std

The same letter in a column is not significantly different

Table 9: Qualitative phytochemicals present in *X. aethiopicum, M.olerifera, G. latifolium* and *A. indica*

Phytochemicals	**Plant materials**			
	X. aethiopicum	*M.oleifera*	*G. latifolium*	*A. indica*
Alkaloid	-	+	-	+++
Saponin	+	++	++	++
Tannins	-	+++	-	+++
Flavonoid	++	++	++	++
Glycoside	-	+	-	-

Table 10: Quantitative phytochemicals present in *X. aethiopicum, M.olerifera, G. latifolium* and *A. indica*

Plant materials	**Phytochemicals (%)**				
	Alkaloid	Saponin	Tannins	Flavonoid	Glycoside
X. aethiopicum	0.4	2.41	0	3.61	0
M.oleifera	5.31	13.86	15.46	7.30	0.50
G. latifolium	1.21	19.24	0.93	12.16	0
A. indica	4.06	13.86	19.42	8.31	0.005

DISCUSSION AND CONCLUSION

Organisms that were consistently associated with yam tubers spoilage in this research were: *Aspergillus niger, Aspergillus flavus, Botrydiplodia theobromae, Rhizopus stolonifer, Rhizoctonia solani and Penicillum oxalicum,* this is in tandeem with the reports of several scientists (Anukwuorji, *et al.,*2013; Okigbo *et al.,* 2009; Ameinyo and Atanga 2007) as the organisms that are mainly prevalent in the post harvest deterioration of root and tuber crops such as potato, cocoyam, cassava etc. The most prevalent organism was *A. niger* (83.3%) followed by *B. theobromae* (75%) and *F. solani* (66.7%), this does not completely agree with the result of Okigbo *et al.,*(2009) who reported that *B. theobromae* was the most prevalent. Pathogenicity study revealed that all the test pathogens were pathogenic on healthy yam tubers (*in vitro*) with different degrees of virulence. The most virulent was *A. niger* (63%) while the least virulent was *F. solani* (16%), this agrees with the result of Anukwuorji *et al.,*(2013) and Okigbo *et al.,*(2014) on potato and yam respectively who reported that *F. solani* was the least virulent while *A.niger* was the most virulent. This is in sharp contrast with the reports of Okigbo and Emeka, (2010) who recorded that *B. theobromae* was the most virulent. Rot of root and tuber crops often starts in the field and progresses in storage (Ezeibekwe *et al.,*2009). Pathogenic microorganisms mainly penetrates yam tubers through natural openings and sometimes through wounds that occur during harvesting, handling and transportation from field to barn and sometimes to market (Ameinyo and Ataga, 2007). The soils adhering to harvested tubers have been confirmed to contain a good quantity of microorganisms that could induce rot in the tubers (Okigbo and Ogbonna, 2006).

The antifungal potential of some plant materials in controlling different organisms pathogenic to food crops has been reported by some scientists such as Enyiukwu *et al.,* (2013), Okigbo *et al.,* (2009), Anukwuorji *et al.,* (2013); Ekpo and Asiedu (2009). Other biocontrol measures like the use of microbial antagonists such as *B.subtilis* and *T. viride* were also well documented (Okigbo and Ikediugwu, 2000; Okigbo, 2002; Okigbo and Emeka, 2010).

The inference of this research work depicted that the radial growth (*in vitro*) of the entire test organisms were greatly inhibited by all the plant extracts tested at varying degrees. This is an indication that fungitoxic compounds abounds in the plant materials. This agrees perfectly with the reports of Amienyo and Ataga (2007) and Anukwuorji, *et al.,* (2013) all on rot of potato tubers.

Results obtained from the effects of various plant materials showed that *M. olerifera* and *A. indica* at 7.5% and 10% concentration were better inhibitors than *G. latifolium* and *X. aethiopicum* at 2.5% and 5.0% extract concentration. This is in tandem with the documentation of Ramesh *et al.,*(2009) on deterioration of cassava who reported that *A. indica* significantly controlled the rot inducing pathogens. The differences in the inhibition ability can be linked to the differences in the nature, quantity and quality of their biological active ingredient (Okigbo *et*

*al.,*2009; 2013; Onifade, 2002), this suggest the potential of plant materials as alternative to synthetic chemicals.

Quantitative and qualitative phytochemical screening of test plants proved positive to most of the phytochemicals tested, with few exceptions. The presence of biological active substances have been showed to bestow resistance to plants against pathogenic microorganisms (Srinwasan *et al.,*2001). Therefore the antimycotic potentials of these plants can be linked to the presence of different phytochemicals inherent in them (Okwu and Joshia, 2006). Pharmacological and medicinal values of these phytochemicals was proved by the documentations of several scientists (Okwu, 2004; Okigbo *et al.,*2009; Caragay, 1992).

The fact that about 25% of yam produced annually in Africa is lost due to rot is appalling; hence post harvest spoilage of yam should be of global concern. However, if Nigeria will still top the list of yam producing countries, then all stakeholders in Nigeria (farmers, government, research institutes, Non-governmental organizations etc) must be involved in finding a lasting solution to this menace. No doubt, plant extract is fast becoming a more reliable solution to the problem of rot; hence the demonstrated antifungal potential of these plant materials recommends them as natural fungicides. Therefore, to overcome the problem of yam rot and rot of other tuber crops, urgent effort and attention should be channeled towards harnessing the potential of these plant materials (extracts).

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