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Efficacy of Some Botanicals in the Control of Fungi Causing post harvest rot of Yam in Katube market, Obudu, Nigeria.

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Abstract: *Efficacy of some botanicals in the control of fungi causing post harvest rot of yam in Atube market, Obudu was conducted. The fungal pathogens isolated from the yam samples were Aspergillus niger, Botryodiplodia theobromae, Aspergillus flavus, and Aspergillus fumigatus. Water and ethanol extracts of the plant species at 10g/ml, 20g/ml, 30g/ml, 40g/ml and 50g/ml were tested against the fungal isolates in vitro. The inhibitory effects of water extracts of Daniellia oliveri, Moringa oleifera and Parkia biglobosa at 50g/ml on all test organisms ranged from 11.00 to 35.00 and at 10g/ml it ranged from 25.00 to 80.00. The inhibitory effect of ethanol extract of Daniellia oliveri, Parkia biglobosa and Moringa oleifera at 50g/ml on test organisms ranged from 6.50 to 34.50 and at 10g/ml it ranged from 8.00 to 77.50. There was no significant difference in the grand mean inhibitory effect of both water and ethanol extracts on Aspergillus niger and Aspergillus flavus at P = 0.05. There was significant difference in the grand mean inhibitory effect of water and ethanol extracts on Aspergillus fumigatus and Botryodiplodia theobromae. The extracts of Parkia biglobosa, Moringa oleifera and Daniellia oliveri are useful antifungal agents, inhibiting fungal growth at all concentrations.*

Keywords; *Efficacy, Botanicals, fungi, Atube market, rot, Post harvest.*

I. Introduction

Yam (*Dioscorea spp)* is among the most important staple food in the world especially some parts of the tropics and subtropics [1]. The most cultivated varieties in Nigeria are the *D. rotundata* (white yam), *D. cayenesis* (yellow yam) and *D. alata* (water yam) [2]. Nutritionally, yams are mainly carbohydrate foods. It is one of the most important dietary sources of energy produced in the tropics [3].

White yam *(Dioscorea rotundata*) is the most important and cultivated variety found in Africa. In 2005, [4] reported that Nigeria produces about 66.6% (26.6 million metric tonnes) of the total world's yam production every year. White yam (*Dioscorea rotundata*) is much preferred to other yam varieties and it constitutes about 80% of the total yam produced in Nigeria [5].Though this figure is high, demand for yam has always been more than the supply.

As important as yam is, its production is constrained by many problems ranging from high cost of production, attack by fungi, nematodes and pests, singly or in combination. These constraints are responsible for field suppression and tuber quality deterioration in storage [2]. The magnitude of these problems has made people express fears that yam production in Nigeria may decline substantially in the near future [3].

Rot is major factor limiting the post – harvest life of yams and losses can be very high. It is estimated that an average of 25- 50% of yam tubers produced in Nigeria are lost to pests and diseases [4]. The disease causing agents reduce the quantity and quality of yam and make them unappealing to the consumer. Losses due to post- harvest rot significantly affect farmers' and traders' income, food security and seed yams stored for planting. In Nigeria, over 60% of white yam get rotten when stored for planting [6].

Most rot of yam tubers are caused by pathogenic fungi such as *Aspergillus flavus, Aspergillus niger, Aspergillus fumigatus, Botryodiplodia theobromae, Fusarium oxysporum, Fusarium solani, Penicillium chrysogenum, Rhizoctonia spp, Penicillium oxacilum, Trichoderma viride* and *Rhizopus nodosus* [7]; [8].

It is therefore important to know the fungal organisms that are responsible for post-harvest rot of white yam in Atube market, obudu and seek their effective control measures to extend the life span of yam in storage.

II. Materials and Methods

2.1 Sample Collection

About 20 tubers of white yam *(Dioscorea rotundata*) with symptoms of rot were obtained from Atube market, Obudu Local Government Area of Cross River State. The yam tubers were packaged in polyethylene bags and taken to botany laboratory of the Benue State University, Makurdi, where they were assessed for microbial (fungal) presence.

2.2 Media Preparation

The medium used was Potato Dextrose Agar (PDA) prepared according to the manufacturers instruction. About 39.6g of powdered PDA medium was dissolved in1 litre of sterile distilled water and sterilized by autoclaving at 121^0C for 15 minutes.

2.3 Isolation of fungal pathogens from rotten yam tubers

Small sizes were cut from yam tubers infected with rot. They were first surface sterilized by dipping completely in a concentration of 5% sodium hypochloride solution for 2 mins. They were then removed and rinsed in several changes of sterile distilled water. The yam pieces were then placed on sterile paper towels to dry for 5 mins. The pieces of yam sections were placed on solidified Potato Dextrose Agar medium. Three replicates were made for each of the 20 samples of yam tubers. The inoculated plates were incubated at 25-28^0C and observations were made daily for possible microbial growth. After 5 - 7 days of growth, Sub-culturing was done to obtain pure cultures of the isolates.

2.4 Identification of fungal isolates

The identification of the isolates was done by examining the isolates macroscopically and microscopically. The colony characteristics such as colony appearance, change in medium colour and growth rate were observed. Shapes of the conidia and conidiophores were taken note of. These structural features were matched with standards in [9] and [10].

2.5 Pathogenicity Test

To confirm the pathogenicity of isolates from white yam, pure cultures of the isolates were used to inoculate three white yams per pathogen with 5mm diameter mycelia plugs of a 4 day old culture. On appearance of symptoms, the tissues at the margins of the healthy and diseased parts were surfaced sterilized, excised and plated onto Potato Dextrose Agar (PDA) and incubated at 25-28^oC for 5 - 7 days. At the end of this period, morphological characteristics and growth patterns observed in each case were compared with the ones of the original isolates. One tuber of white yam was used for each fungal isolate respectively, replicated three times and arranged in complete randomized design. Controls were yam tubers inoculated with sterile PDA only.
Following appearance of symptoms, 8 - 12 days post inoculation, rot severity index was assessed on a scale of 0 - 5, where 0 - no disease manifestation, 1 - 1-20% rot, 2 - 21-40% rot, 3 - 41-60% rot, 4 - 61-80% rot, 5 - 81-100% rot.

2.6 Collection of Plant Material

Fresh leaves of three selected plant species were collected in polyethylene bags and transported to the botany laboratory of the Benue State University Makurdi for preparation of extracts. They are *Parkia biglobosa* (locust bean tree), *Moringa oleifera* (Drumstick) and *Daniellia oliveri* (African Copaiba Balsam*).*

2.7 Preparation of Extracts of Plant Parts

Water and ethanol extracts of each selected plant species was prepared. Each of the leaves were washed under running tap water and soaked in a 1% solution of sodium hypochloride for 2 minutes. They were rinsed severally with sterile distilled water and air dried at room temperature for 30 mins. 50g each of the fresh leaves of the selected trees were weighed for both water and ethanol extractions respectively. The leaves were ground one after the other using a mortar and pestle. The mortar and pestle were washed after each type of leave was pounded to avoid mixture of their different components.
The macerates were transferred into beakers and each was soaked in100ml of sterile distilled water and 90% ethanol respectively for water and ethanol extractions.

2.8 Concentrations of Crude Extracts

Serial dilutions of the crude extracts of the leaves of each plant was prepared to give different concentrations of the extracts. Extract concentrations of 10g/ml, 20g/ml, 30g/ml, 40g/ml and 50g/ml were thus obtained for both water and ethanol extractions.

2.9 Antifungal Susceptibility Test in vitro

One ml of the extract concentration for both ethanol and water was dispensed in Petri dishes and 15-20mls of molten PDA was added. The Petri plates were swirled gently on the work bench to ensure even dispersion of the extracts. The Agar-extract mixture was allowed to solidify and used for the inhibition of mycelia growth for the tested fungi. 4mm diameter of mycelia disc obtained from the colony edge of 5day old culture of each of the test fungi was inoculated centrally onto the medium. Three replications were used for each fungal isolate. Controls were Petri plates containing PDA with no botanical extract and inoculated with the test

fungi. The plates were arranged on laboratory desk following complete randomized design. The Petri plates were then incubated at 25 - 28^{o}C for 5-7 days during which measurement of growth was done using a metre rule at an interval of 24 hours. Inhibition of fungal growth was calculated using the formula $\frac{R_1 - R_2}{R_1} \times 100$

where R_1 = radial growth of the pathogen in the control plates

R_2 = growth of the pathogen with treatment

2.10 Data Analysis

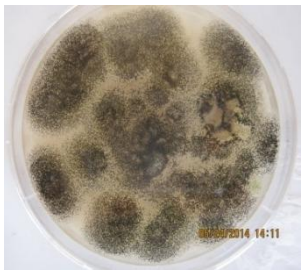
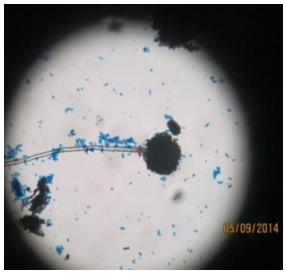
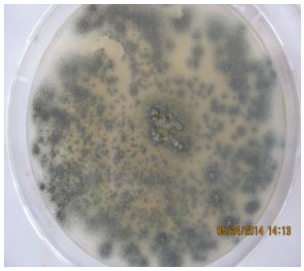
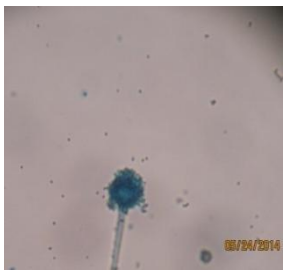
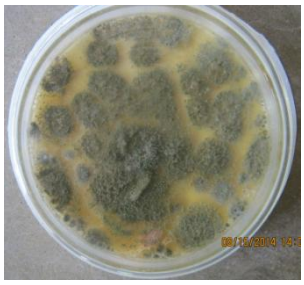
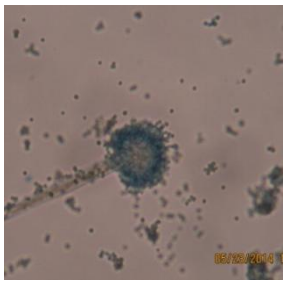
Data obtained from the study was analyzed using Analysis of Variance (ANOVA) and the Fishers Least Significant Difference was used to separate the means at 5% level of significance.

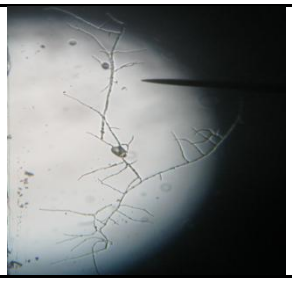
III. Results

3.1 Fungal pathogens isolated from yam samples

A total of four fungi namely *Botryodiplodia theobromae*, *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger* were isolated from the yam samples as shown in Table 1. Identification of the isolates was done using recommendations given by [9] and other electronic documentations on the genera isolated.

Table 1: Characterization of Fungal isolates from Yam samples on PDA.

Cultural/microscopic characteristics	Appearance on PDA	Photomicrograph	Probable organism
Colony colour is dark brown to black. Conidia are black and densely packed. Conidiophore length is 855 – 9 57(µm) and colour was hyaline to yellowish or slightly brown.			*Aspergillus niger*
Colony colour ranged from grayish to dark blue in colour. The conidia colour was dark green to blue. Conidiophore length was 265–365µm and it was uncoloured to grayish brown			*Aspergillus fumigatus*
Colony colour was parrot green to deep green. Conidia were light green in colour. Conidiophores length ranged from 550 – 678 µm .			*Aspergillus* flavus

Colony colour ranged from white to black. Mycelium is septate and the conidia are 2 celled.			*Botryodiplodia theobromae*

3.2 Pathogenicity test.

The Pathogenicity test showed that the fungal isolates induced rot in healthy yam tubers after 14 days of inoculation. The rot severity ranged from 3 – 5 which indicated 41 – 100% of tuber rot as shown in Table 2. Analysis of Variance revealed a significant difference in the disease causing potential of the fungal isolates on healthy yam tubers with respect to their controls as shown in Table 3.

Table 2: Disease causing potential of fungal isolates on healthy yam tubers

Fungal isolates/Replicates	C	R_1	R_2	R_3
Aspergillus niger	0	5	5	4
Aspergillus fumigates	0	4	4	4
Aspergillus flavus	0	4	3	3
Botryodiplodia theobromae	0	5	5	5

Key
C = Control
R_1 = Replicate 1
R_2 = Replicate 2
R_3 = Replicate 3

Severity Scale
0 - No infection
1 - 1 – 20% of rot
2 - 21 – 40% of rot
3 - 41 – 60% of rot
4 - 61 – 80% of rot
5 - 81 – 100% of rot

Table 3: Analysis of Variance in the disease causing potential of Fungal Isolates on healthy Yam tubers

Fungal Isolates	*A. niger*	*A. flavus*	*A. fumigatus*	*B. theobromae*
Pathogenicity	5.00^{a}	4.00^{a}	4.00^{a}	5.00^{a}
Control	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}
LSD(0.05)	**0.93**	**0.92**	**0.91**	**0.00**

Footnote: Means not tagged with same alphabets are significant at P= 0.05

3.3 Mean inhibitory effect of water extract of leaves of *Moringa oleifera* on test organisms.

The highest significant inhibitory effect was observed on both *Botryodiplodia theobromae* and *Aspergillus fumigatus* at 50g/ml (11.00) while the least significant inhibitory effect was observed at 10g/ml (77.50) and (41.00) respectively. On *A. flavus,* highest inhibitory effect was observed at 50g/ml (13.50) and the lowest inhibitory effect was observed at 10g/ml (35.00).On *A. niger,* the highest inhibitory effect was observed at 50g/ml (36.00) and the lowest inhibitory effect was observed at 10g/ml (60.50) as shown in Table 4.

Table 4: Mean inhibitory effect of Water extract of *Moringa oleifera* on test organisms.

Conc g/ml	*A. flavus*	*A. niger*	*B. theobromae*	*A. fumigatus*
10	35.00	60.50	77.50^{a}	41.00^{a}
20	29.00	41.00	56.50^{b}	29.50^{b}
30	24.00	59.00	49.50^{b}	21.00^{b}
40	14.50	52.50	44.50^{b}	26.00^{b}
50	13.50	36.00	11.00^{c}	11.00^{b}
LSD(0.05)	**NS**	**NS**	**13.57**	**8.92**

Footnote: Means not tagged with same alphabets are significant otherwise they are the same at P=0.05
NS - No significant difference

3.4 Mean inhibitory effect of ethanol extracts of *Moringa oleifera* on test fungi

The highest significant inhibitory effect was observed on *Aspergillus niger* at 50g/ml and 20g/ml (22.50) while the least significant inhibitory effect was observed 10g/ml (53.50). On *Botryodiplodia theobromae*, highest significant inhibitory effect was observed at 50g/ml (17.00) and the lowest significant inhibitory effect was observed at10g/ml (60.00). On *A. fumigatus*, highest inhibitory effect was observed at 50g/ml (16.00) and lowest inhibitory effect was observed at 10g/ml (60.00). On *A. flavus*, highest inhibitory effect was observed at 50g/ml (7.00) while the lowest inhibitory effect was observed at 10g/ml (29.00) as shown in Table 5.

Table 5: Mean inhibitory effect of Ethanol extract of *Moringa oleifera* on test organisms.

Conc g/ml	*A. flavus*	*A. niger*	*B. theobromae*	*A. fumigatus*
10	29.00	53.50[a]	60.00[a]	60.00
20	19.00	22.50[b]	35.50[b]	39.00
30	21.50	23.50[b]	25.50[c]	30.00
40	26.50	25.00[b]	22.50[c]	45.00
50	7.00	22.50[b]	17.00[c]	16.00
LSD(0.05)	**NS**	**11.54**	**8.89**	**NS**

Footnote: Means not tagged with same alphabets are significant otherwise, they are the same at P=0.05
NS - No significant difference

3.5 Mean inhibitory effect of water extracts of *Daniellia oliveri* on test fungi

The highest inhibitory effect was observed at 50g/ml (20.00) on *Aspergillus flavus* and the least inhibitory effect at 10g/ml (80.00) was on *Aspergillus niger*. Significant inhibitory effect was observed on *Aspergillus flavus* and *Botryodiplodia theobromae*. On *Aspergillus flavus*, all means were significantly different in their zones of inhibition except at 20g/ml (41.50) and 40g/ml (46.00) while all inhibitory effects on *Botryodiplodia theobromae* were insignificant except at 30g/ml (80.00) as shown in Table 6.

Table 6: Mean inhibitory effect of Water extract of *Daniellia oliveri* on test organisms.

Conc g/ml	*A. flavus*	*A .niger*	*B. theobromae*	*A. fumigatus*
10	69.50[a]	80.00	50.00[a]	77.50
20	41.50[b]	60.50	42.50[a]	75.00
30	56.30[c]	45.00	80.00[b]	65.00
40	46.00[b]	42.50	39.00[ad]	34.00
50	20.00[d]	35.00	29.50[cd]	31.00
LSD(0.05)	**11.54**	**NS**	**12.98**	**NS**

Footnote: Means not tagged with same alphabets are significant otherwise, they are the same at P=0.05
NS - No significant difference

3.6 Mean inhibitory effect of ethanol extracts of *Daniellia oliveri* on test fungi

There was insignificant inhibitory effect at all concentrations on *Aspergillus flavus, Aspergillus niger* and *Botryodiplodia theobromae* while *A. fumigatus* had highest significant inhibitory effect at 50g/ml (5.00) and least significant inhibitory effect at 10g/ml (30.00). On *A. flavus* highest inhibitory effect was observed at 50g/ml (12.50) and least inhibitory effect was observed at 40g/ml (16.50). On *A. niger*, highest inhibitory effect was observed at 50g/ml (9.50) while least inhibitory effect was observed at 40g/ml (24.00). On *B. theobromae*, highest inhibitory effect was observed at 50g/ml (6.50) and least inhibitory effect was observed at 40g/ml and 10g/ml (8.00) respectively as shown in Table 7.

Table 7: Mean inhibitory effect of Ethanol extract of *Daniellia oliveri* on test organisms.

Conc g/ml	*A. flavus*	*A. niger*	*B. theobromae*	*A. fumigatus*
10	36.50	28.50	8.00	30.00[a]
20	22.50	41.00	15.50	14.00[b]
30	28.50	47.00	17.50	9.50[bd]
40	16.50	24.00	8.00	15.00[b]
50	12.50	9.50	6.50	5.00[cd]
LSD(0.05)	**NS**	**NS**	**NS**	**7.17**

Footnote: Means not tagged with same alphabets are significant; otherwise they are the same at P=0.05
NS - No significant difference

3.7 Mean inhibitory effect of water extract of *Parkia biglobosa* on test fungi

There was insignificant inhibitory effect on all the fungal isolates at all concentrations except on *Aspergillus flavus* which had significant highest inhibitory effect at 50g/ml (16.50cm) and least significant effect at 10g/ml (63.50cm). On A. niger, highest inhibitory effect was observed at 50g/ml (26.50) and lowest inhibitory effect was observed at 10g/ml (57.50). On *A.fumigatus*, highest inhibitory effect was observed at 50g/ml (18.00) and the lowest was at 10g/ml (25.50). On *B. theobromae*, highest inhibitory effect was observed at 50g/ml (22.50) and the lowest was at 20g/ml (58.00) as shown in Table 8.

Table 8: Mean inhibitory effect of Water extract of *Parkia biglobosa* on test organisms.

Conc g/ml	*A. flavus*	*A. niger*	*B. theobromae*	*A. fumigatus*
10	63.50[a]	57.50	57.50	25.50
20	43.50[b]	56.00	58.00	39.00
30	47.00[b]	43.50	40.80	35.00
40	35.50[b]	47.50	48.00	39.00
50	16.50[c]	26.50	22.50	18.00
LSD(0.05)	**11.13**	**NS**	**NS**	**NS**

Footnote: Means not tagged with same alphabets are significant; otherwise they are the same at P=0.05
NS - No significant difference

3.8 Mean inhibitory effect of ethanol extracts of *Parkia biglobosa* on fungal Isolates

There was insignificant inhibitory effect of *Parkia biglobosa* on the test organisms at all concentrations. Highest inhibitory effect was observed on *A. flavus* at 40g/ml and 50g/ml (12.50). Lowest inhibitory effect was observed on *A.niger* at 10g/ml (77.50) followed by *A. fumigatus* (75.00), *B. theobromae* (69.00) and *A. flavus* (41.50) respectively. *A. niger* and *B. theobromae* shared highest inhibitory effect at 50g/ml (34.50) and *A. fumigatus* had highest inhibitory effect at 50g/ml (27.00) as shown in Table 9.

Table 9: Mean inhibitory effect of Ethanol Extract of *Parkia biglobosa* on test organisms.

Conc *g*/ml	*A .flavus*	*A. niger*	*B. theobromae*	*A. fumigatus*
10	41.50	77.50	69.00	75.00
20	43.00	60.00	53.50	63.00
30	33.50	48.00	38.50	52.00
40	12.50	40.00	39.00	35.00
50	12.50	34.50	34.50	27.00
LSD(0.05)	**NS**	**NS**	**NS**	**NS**

Footnote: Means not tagged with same alphabets are significant; otherwise they are the same at P=0.05
NS - No significant difference

3.9 Grand mean inhibitory effect of water extracts of the three plant species on the test organisms

There was insignificant inhibitory effect of all the water extracts of the three plants species on *Aspergillus* flavus, *Aspergillus niger* and *Botryodiplodia theobromae* except on *Aspergillus fumigatus* where the effects of *M. oleifera* and *P. biglobosa* were significantly different from that of *D. oliveri* as shown in Table 10.

Table 10: Grand Mean inhibitory effect of Water extracts of all the three plant species on test organisms.

Plant Extract	*A. flavus*	*A. niger*	*B. theobromae*	*A.fumigatus*
M.oleifera	23.20	49.80	47.80	25.70[a]
D.oliveri	46.66	52.60	48.20	56.50[b]
P.biglobosa	41.20	46.20	45.36	31.30[a]
LSD(0.05)	**NS**	**NS**	**NS**	**21.21**

Footnote: Means not tagged with same alphabets are significant; otherwise they are the same at P=0.05

NS - No significant difference

3.10 Grand mean inhibitory effect of ethanol extracts of the three plant species on test fungi

There was significant inhibitory effect of all the ethanol extracts of the three plant species on *Botryodiplodia theobromae* and *Aspergillus fumigatus.* Extracts of *M. oleifera* and *P. biglobosa* were significantly different from that of *D. oliveri* in their effects on *B. thoebromae* and *A. fumigatus* as shown in Table 11.

Table 11: Grand Mean inhibitory effect of Ethanol extracts of all the three plant species on test organisms.

Plant Extract	*A. flavus*	*A. niger*	*B. theobromae*	*A. fumigatus*
M.oleifera	20.60	29.40	32.10[a]	38.00[a]
D.oliveri	23.30	30.00	11.10[b]	14.70[b]
P.biglobosa	28.60	52.00	46.90[a]	50.40[a]
LSD(0.05)	**NS**	**NS**	**18.12**	**21.75**

Footnote: Means not tagged with same letters are significant; otherwise they are the same at P=0.05

NS - No significant difference

3.11 Comparative grand mean inhibitory effect between water and ethanol extracts of the three plant species on test fungi

There was significant inhibitory effect between water and ethanol extracts of *Daniellia oliveri* on *Aspergillus niger* (21.40) while water and ethanol extracts of *Moringa oleifera* and *Parkia biglobosa* had insignificant inhibitory effect on *Aspergillus niger.*

There was significant inhibitory effect between water and ethanol extracts of *Moringa oleifera* on *Aspergillus flavus* (19.92) while water and ethanol extracts of *Daniellia oliveri* and *Parkia biglobosa* had insignificant inhibitory effect on *Aspergillus flavus.* Water and ethanol extracts of *Daniellia oliveri* showed significant inhibitory effect on *Botryodiplodia theobromae* (20.54) while water and ethanol extracts of *Moringa oleifera* and *Parkia biglobosa* had insignificant inhibitory effect on *Botryodiplodia theobromae*. Water and ethanol extracts of *Daniellia oliveri* showed significant inhibitory effect on *Aspergillus fumigatus* (25.13) while water and ethanol extracts of *Moringa oleifera* and *Parkia biglobosa* had insignificant inhibitory effect on *Aspergillus fumigatus* as shown in table 12.

Table 12: Comparative grand Mean inhibitory effect of water and ethanol extracts of the three plant species on test fungi

Solvents	*A niger*			*A flavus*			*B theobromae*			*A fumigatus*		
	MO	**DO**	**PB**	**MO**	**DO**	**PB**	**MO**	**DO**	**PB**	**MO**	**DO**	**PB**
Water extract	23.20	46.66**a**	41.20	49.80[a]	52.60	46.20	47.80	48.20[a]	45.36	25.70	56.50[a]	31.30
Ethanol extract	20.60	23.30[b]	28.60	29.40[b]	30.00	52.00	32.10	11.10[b]	46.90	38.00	14.70[b]	50.50
LSD (0.05)	**NS**	**21.40**	**NS**	**17.92**	**NS**	**NS**	**NS**	**20.54**	**NS**	**NS**	**25.13**	**NS**

Footnote: Means not tagged with same alphabets are significant otherwise they are the same at P=0.05

Key

NS - No significant difference

MO - *Moringa oleifera*

DO - *Daniellia oliveri*

PB - *Parkia biglobosa*

IV. Discussion

The Fungal organisms associated with rot of white yam (*Dioscorea rotundata*) in this present study were *Aspergillus niger, Apergillus flavus, Aspergillus fumigatus,* and *Botryodiplodia theobromae*. These organisms have been associated with post harvest rot as reported by [11] , [12], [1].

The pathogenicity test showed that the fungal isolates inoculated into healthy yam tubers caused tuber rot. This was due to the ability of the fungal pathogens to utilize the nutrients of the yam as a substrate for growth and development. This result is similar to the report on fungi associated with Nigerian yams by [13], [11] and [12].

In another set of experiments, the water and ethanol extracts of the three plant species; *Parkia biglobosa*, *Daniellia oliveri* and *Moringa oleifera* showed antifungal activities against the test fungi at all concentrations in vitro. This implies that locally occurring plants commonly used in folklore human medicine also posses anti microbial effects on post harvest fungi. This conform to the results obtained from the studies of

[14] and [15] on the bioassay of some plant extracts on some fungal pathogens. This also agrees with the reports of [16], [17] and [18] on the inhibitory action of plant products employed on the mycelia growth and spore germination of other pathogenic fungi.

It was observed that susceptibility of the test fungi increased with increasing concentration of the plant extracts for all the fungal isolates. This may have resulted from variation in the principal active ingredients present in the extracts. The effectiveness of a plant extract depends on the nature and amount of active ingredient found in it.

This agrees with the findings of [19] who reported significant inhibitory property of Neem (*A. indica*) extract that contains azadrachtin which is known to be fungitoxic against most fungal pathogens just as [20] found the extract of *Ocimum gratissimum* to reduce the growth of *Rhizopus spp.* Also, [21] and [22] reported that the phytochemical screening of the plant species used in this study showed the presence of alkaloids, saponins, tannins, flavonoids, glycosides and phenol compounds.

An increase in the concentration of the plant extracts correspondingly decreased the growth of the test fungi. This is because an increase in the concentration of the extract implied an increase in the active ingredient of the solu tion which acts on the fungus thereby affecting its physiological processes and consequently lowering the growth of the fungus.

The ethanol extract of *D. oliveri* recorded the highest grand inhibitory effect of (11.10) on *Botryodiplodia theobromae* and the least was water extract of *D. oliveri* (56.50) on *A. fumigatus*. The ethanol extract of *Moringa oleifera* recorded grand mean inhibitory effect of (20.60) on *Aspergillus niger*, (29.40) on *Aspergillus flavus*, (32.10) on *Botryodiplodia theobromae*, (38.00) on *Aspergillus fumigatus* compared to water extract which had a mean inhibitory effect of (23.20) on *Aspergillus niger*, (49.80) on *Aspergillus flavus*, (47.80) on *Botryodiplodia theobromae* and (25.70) on *Aspergillus fumigatus.*

This is in agreement with [23] who stated that plant extracts in organic solvents provided more consistent antimicrobial activity compared to water extracts.

The most sensitive test organism in this study was *Botryodiplodia theobromae* which had an inhibitory diameter of (11.10) on ethanol extract of *Daniellia oliveri.* The least sensitive test organism was *Aspergillus fumigatus* with an inhibitory diameter of (56.50) on water extract of *D. oliveri*. The differences recorded in the fungitoxic activity of the extracts may also be attributed to the solubility of the active ingredients in water and ethanol or the presence or absence of inhibitors for the fungitoxic principle. Also the effectiveness of the ethanol extracts than water extracts observed in this study is probably due to its ability to extract more bioactive compounds from the plant material which are effective on the test organisms.

The active ingredient present in an extract is influenced by many factors which include the age of the plant, extracting solvent, method of extraction and time of harvesting the plant material.

V. Conclusion

This study has confirmed and established that the extracts of *Parkia biglobosa*, *Daniellia oliveri* and *Moringa oleifera* are useful antifungal agents, inhibiting fungal growth at all concentrations. This agrees with earlier reports of [24] on the inhibition of growth and sporulation of fungal pathogens on *Ipomea batatas* and *Dioscorea* species. and [25] on the use of *Xylopia aethiopica* and *Zingiber officinale* to control yam tuber rot caused by F. *oxysporum*, *Aspergillus niger* and *Aspergillus flavus*.

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