Journal of Phytopathology and Pest Management 3(1): 46-59, 2016
pISSN:2356-8577 eISSN: 2356-6507
Journal homepage: http://ppmj.net/

Effect of *Azadirachta indica* extract on the radial growth of some test fungi isolated from two varieties of cocoyam (*Colocasia esculenta* L.) corms and cormels in some markets in Plateau State, Nigeria

S. G. Pandukur*, C. A. Amienyo

Department of Science Laboratory Technology and Department of Plant Science and Technology, Faculty of Natural Sciences, University of Jos, Jos Nigeria.

Abstract

Antifungal effect of aqueous and ethanol extracts of *Azadirachta indica* on the radial growth of fungal pathogens of stored cocoyam corms and cormels was investigated. Four different extract concentrations were used from the plant leaves. Pathogenicity test showed that: *Alternaria alternata, Fusarium oxysporum, Verticilium lateritium, Botrydiplodia theobramae, Colletotricum coccoides, Phythium myriotylum, Fusarium verticillioides, Rhizopus stolonifer* and *Geotricum candidum* induced rot in both varieties of healthy cocoyam corms and cormels after 7 days of inoculation. The highest aqueous extract inhibition recorded was 81.11% on *V. lateritium* at 10% while the least inhibitory effect was 18.35% observed at 2.5% on *G. candidum*. Meanwhile, the ethanol extract gave a highly significant (P<0.05) inhibitory effect of 87.21% at 10% and the least was 26.80% at 2.5% on *A.alternata* and *V. lateritium* respectively compared to the rest as recorded in aqueous extract at the same level of concentrations (10%). The fungitoxic potential of this plant extract on rot inducing fungi of stored cocoyam corms and cormels is indicative of its use to farmers as alternative to commercial or synthetic fungicides destroying our ecosystem and health.

Key words: Radial growth, antifungal effect, *Azadirachta indica*, cocoyam varieties, Plateau State.

* **Corresponding author:** S. G. Pandukur,
E-mail: psgpanl@yahoo.com

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Introduction

Cocoyam (*Colocasia esculenta* L. Schott) belongs to the genus *Colocasia,* and generally comprised of a large spherical corm (swollen underground storage stem), from which a few large leaves emerge (Onwueme, 1999). It refers to the two members of the *Araceae* family that are staple foods for many people in developing countries in Africa, Asia and the Pacific (Aguegui et al., 1992), namely *Colocasia esculenta* var. *antiquorum* (L.) Schott (Hubbard and Rehder) and those with large cormels sometimes called 'dasheen' classified as *Colocasia esculenta* var. *esculenta* L. Schott (Brooks, 2001). It is an important tropical tuberous crop, and a traditional starch staple food for millions of people in the developing countries of the tropics, subtropics, Pacific Islands, West Indies and the Mediterranean (Onwueme & Charles, 1994; 1999). Nutritionally, cocoyam is rich in carbohydrates (13-29%), vitamins and minerals. It also contains proteins (1.4-3.0%) the leaves are rich sources of vitamin B6, vitamin C, niacin, thiamin (B1) and riboflavin (B2) (Onwueme & Charles, 1999; 1994; Maduewesi & Onyike, 1981;). They are also rich in minerals such as iron, phosphorus, zinc, potassium, copper and manganese. In addition to starch, the corms and cormels are good sources of dietary fiber (0.60 -1.18) as well as oxalic acid, which cause serious irritation when raw corms come in contact with the skin (Zuhair and Hunter, 2000). The high digestibility and the very small size of the starch granules make cocoyam a very suitable base for baby's foods (Offei, et al., 2004). Although cocoyams are composed predominantly of starch, it is next only to certain varieties of yam in crude protein content among root crops (Uguanyi & Obeta, 1996). Production of cocoyam has not been given priority attention in many countries, probably because of its inability to earn foreign exchange, as well as its unacceptability by the high income countries for both consumption and other purposes (Eze & Okorji, 2003), this is believed to be attributed to its declining yields, low storability worsened by the devastating diseases of fungi that cause corms and cormels' rots in cocoyam after harvest. Post-harvest diseases/rots may be caused by either fungi or bacteria, although fungi are more common than bacteria (Olurinola et al., 1992). Rot is the softening and rotten of plants parts as a result of proteolytic enzyme secreted by the pathogen into the plant tissues which causes disintegration of the plant part or fruit (Akueshi et al., 2002). Many filamentous fungi, commonly known as molds causes root and corms decay. The conditions that promote plant diseases also favour the development of root rots (Adams et al., 1998). Corms and cormels rots are caused by opportunistic pathogens, those that cannot directly infect corm tissues unless the tissues are stressed (Uguanyi & Obeta, 1996). The rot may be soft rot, dry rot, watery rot depending on the pathogen that causes the rot. Under humid conditions, the typical, coarse and stingy mycelium of *Rhizopus sp* with its black sporangia develops over the disease tissue.Infected tissues become soft ramified by the fungal mycelium. Anthracnose (*C. coccoides*) is a rot that attacks cocoyam and fruits characterized by the spotting of the corms and cormels or the fruits,

while *R. stolonifer* a second common fungal pathogen, appears water soaked and may exude a clear liquid and begins to blossom with a black spots edges at the center of the corms and cormels. When they are first infected, show small, water-soaked, circular, sunken spots about ½ inch in diameter. Sometimes the centers are tan and they often have concentric rings around the spots. Spotted fruits and corms may rot completely (Adams et al., 1998). The causal fungi quickly ramified the tissue which turn brown and become soft and at times wet due to a rapid collapse of the cell walls. Fungi associated with this type of rot are *Rhizopus* spp, *Mucor circinelloides, Colletotrichum coccoides, Sclerotium rolfsii* and *Rhizoctonia solani* and *Armillariella mellea* (Bartzz et al., 2004; Amusa & Baiyewu, 1999; Adams et al., 1998; Green et al., 1995; Ikotun, 1983). Due to the devastating nature of these diseases and the serious threat to food security and income earnings, there have been calls from consumers, organizations and members of the public to scientists to identify the cause of this disease and an alternative measures for its control. Presently, considerable efforts are directed at exploring the potentials of botanicals (plant extracts) as alternatives or complimentary to synthetic chemicals (Anukworji, 2013). The use of chemicals has helped in control of rot, but due to the identifiable problems (e.g. chemical residues, biodegradation, phytotoxicity, pollution, development of resistance in target organism, high cost, at times non availability and hazard to man and his environment) renders them either slow to adopt by farmers or farmers have totally failed to adopt them, for one cultural reasons or the other (Okigbo & Odurukwu, 2009), hence alternative control methods are employed. Botanicals have the advantage of not only being readily available and affordable but are also sources of non-phytotoxic and easily biodegradable alternative fungicides and antibiotics, hence environment friendly (Okigbo & Omodamiro, 2006; Okigbo & Nmeka, 2005; Akueishi *et al.,* 2002). However, the benefits of these natural plant products over synthetic chemicals which cannot be overemphasized necessitated the need for undertaking this study to ascertain the antimicrobial potentials/efficacy of this plant extracts at different concentrations under different extraction medium (Aqueous and Ethanol) in controlling post-harvest deterioration of cocoyam (*C. esculenta* var. *esculenta* and *C. esculenta* var. *antiquorum* L.) corms and cormels. In line with the above calls, this research was undertaken to isolate and identify the causal agents of cocoyam deterioration in stores with a view to advancing measures of control by exploring the potentials of botanicals (Neem plant extract) as alternatives or complimentary to synthetic chemicals (fungicides).

Materials and methods

Sources of plant materials: Two varieties of cocoyam (*Colocasia esculenta* var. *esculenta* and *C. esculenta* var. *antiquorum* (L) Schott) corms and cormels with symptoms of post-harvest rot and fully expanded leaves of *Azadirachta indica* were collected from six markets (SKM, APM, PSM, DHM, MKM and BCM) in two local government areas (Mangu and Bokkos)

that are major producers of cocoyam in Plateau state. The botanical identities or taxonomic identification of the plants were authenticated by the Horticulture Unit of Federal college of Forestry Jos, Plateau State, Nigeria.

Isolation of fungal pathogens from rotten cocoyam corms and cormels: Sections of approximately 2×2mm each piece cut were then fortified with 50g/ml Streptomycin based and inoculated on Potato Dextrose Agar (sPDA). The plates were incubated at room temperature (28° C) for 3-5 days and then examined daily for the development of fungal growth.

Sub culturing / purification and identification of test fungi pathogens: When growth was established, subcultures were prepared using inocula from the different organisms in the mixed cultures to obtain pure cultures. The resulting pure cultures were used for characterization and subsequent identification of the fungal isolates with the aid of a compound microscope and a bi-nuclear (in order to get a very clear sporangia and sporangiospores) and identification guides by Domsch et al., (1980), Samson et al., (1995), Schipper and Stalpers, (2003), Ellis, (2005) and Ellis et al., (2007).

Preparation of crude extract from plant parts: Using cold solvent extraction method (Junaid et al., 2006; Harbone, 1973), four different concentrations were prepared by blending 25, 50, 75 and l00g portion of each processed sample and mixed with 100ml of each solvent (Aqueous and Ethanol) separately in a bottle to produce 25%, 50%, 75% and 100% extract concentrations, respectively and used for mycelial growth inhibition.

Test for purity: Each of the extracts obtained was tested to ensure its purity by streaking it separately onto sterile plates of the test media. The plates were incubated at 37°C for 24hrs (Cheesbrough, 2000) and was examined for possible growth of contaminants. The absence of which confirms the purity of the test extracts.

Effect of the plant extract on fungal growth: The effects of plant extract on mycelial growth of the nine test fungi was studied using the food poisoning techniques (Sangoyomi, 2004). One milliliter of each plant extract concentration (i.e. 25, 50, 75 and 100%) was dispensed per Petri dishes and 9ml of the media (molten PDA) was added to each of the Petri dishes containing extract and carefully spread evenly over the plate, given rise to PDA-extract mixed with a corresponding 2.5, 5.0, 7.5 and 10% extract concentration. This was used for the inhibition of mycelial growth. The agar extract mixture was allowed to solidify and then inoculated at the center with a 4mm diameter of mycelia obtained from the colony edge of 7-day old pure cultures of each of the four test fungi. Each treatment consists of six replicates. The negative control set up consists of SDW plate (sterile distilled water) inoculated with the test fungi as described above. Petri-dishes dispensed with molten sPDA and 50g/ml of Grisovid solution (0.5g in 100ml of sterilized distilled water) inoculated with each test fungus served as the commercial fungicides. All the plates were incubated at 28±2°C for 7-14 days

and examined daily for growth and presence of inhibition. Colony diameter was taken as the mean growth along two directions on two pre-drawn perpendicular lines on the reverse side of the plates. The effectiveness of the plant extract (fungitoxicity) was recorded in terms of percentage inhibition, which was calculated according to the method described by Whips, (1987).

$$\text{Percentage inhibition} = \frac{R1 - R2}{R1} \times 100$$

Where *R1* is the farthest radial distance of pathogen in negative control plates and *R2* is the farthest radial distance of the pathogen in extract-incorporated agar plates. Extracts were rated for their inhibitory effects using a scale by Sangoyomi, (2004); =0% inhibition (not effective), >0-20% inhibition (slightly effective), >20-50% inhibition (moderately effective), >50-<100% inhibition (effective), 100% (highly effective).

Experimental design: The experimental design used was Complete Randomized Design (CRD). The data collected were subjected to One Way Analysis of Variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) at 0.05 probability level.

Results

The effect of concentrations of the plant extract of neem (*A. indica*) leaves on the test organisms isolated from the two cocoyam varieties was significant (P<0.05). Radial growth of the inhibition was as the concentration of the extract also increased as follows (2.5% > 5.0% >1.5%>10.0%). The aqueous and ethanol extracts were highly significant (P<0.05) on the inhibition of all test fungi *(A. alternata, B. theobramae, V. lateritium, F. oxyspurum, F. verticillioides, G. candidum, P. myriotylum* and *R. stolonifer.* The test revealed a very significance different (P<0.05) between ethanol and aqueous extract of *A. indica.* The ethanol extract gave the highest mean inhibition than the aqueous medium. The highest aqueous extract inhibition recorded was 81.11% (effective) on *V. lateritium* by 10% extract concentration while the least inhibitory effect was 18.35% (stimulatory) observed at 2.5% extract concentration on *G. candidum* (Fig. 1 and Table 1) respectively. The aqueous extract of *A. indica* gave the highest inhibitory effect of 73.39% which was effective and significant (P<0.05) at 10% extract concentration on the radial growth of *A. alternata.* The least inhibition on *A. alternata* was 42.75% (moderately effective) at an extract concentration of 2.5%. The negative control did not show an inhibitory effect on the growth of the test fungi. However, the standard drug (Grisovid) had an inhibitory effect of 99.60% (effective) at 0.5% extract concentration of the fungus (Fig. 1 and Table 1). The ethanol extract of *A. indica* gave the highest inhibitory effect of 87.21% (effective) at 10% on *A. alternate* which was significant (P<0.05).Meanwhile, the least inhibitory effect recorded by ethanol extract was 26.80% (slightly effective) on G, *candidum.* The control (SDW) did not show any inhibition (Fig. 2 and Table 2).

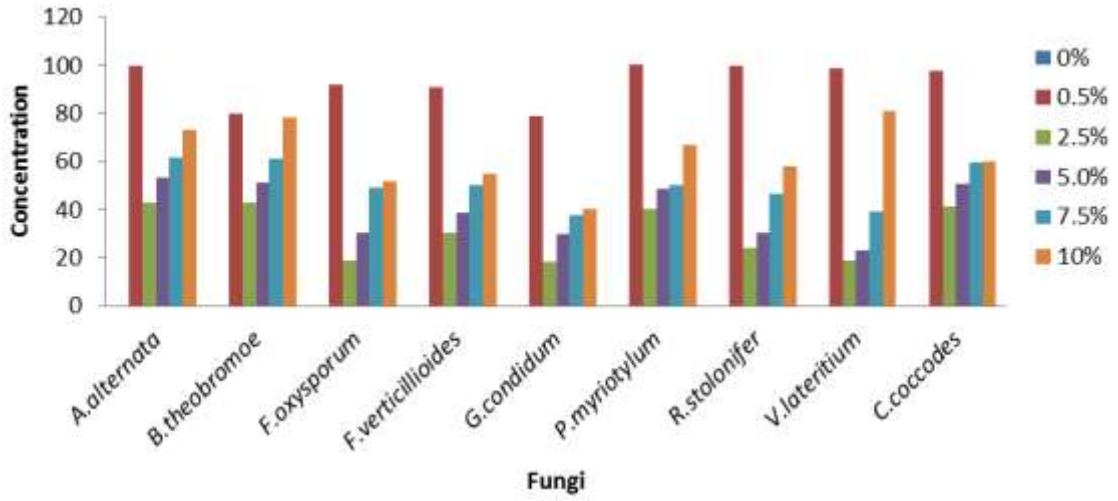

Figure 1: Effect of aqueous extract of *A. indica* on the radial growth of nine fungal species.

Table 1: Effect of aqueous extract of *A. indica* on the radial growth of nine fungal species.

Fungi	Concentration and categorization of inhibitory or stimulatory effect											
	0%SDW		0.5% GV		2.5%		5.0%		7.5%		10%	
	%	cat	%	cat	%	cat	%	cat	%	cat	%	cat
A.alternata	0.00	NE	86.34	E	46.07	ME	68.78	E	75.27	E	87.21	E
B.theobromae	0.00	NE	98.30	E	50.64	E	61.78	E	96.04	E	80.01	E
F.oxysporum	0.00	NE	92.83	E	29.83	SE	43.98	ME	59.30	E	61.78	E
C.coccoides	0.00	NE	96.81	E	48.11	ME	57.00	E	66.78	E	67.42	E
G.candidum	0.00	NE	96.81	E	28.50	SE	38.70	ME	46.00	ME	59.79	E
P.myriotylum	0.00	NE	100.0	E	59.32	E	66.80	E	72.16	E	87.14	E
R.stolonifer	0.00	NE	100.0	E	36.12	ME	44.07	ME	57.08	E	62.43	E
F.verticillioides	0.00	NE	100.0	E	49.32	ME	56.81	E	70.16	E	82.34	E
V.lateritium	0.00	NE	100.0	E	26.80	SE	33.98	ME	49.30	ME	61.88	E

NE= not effective, ME= moderately effective, SE= slightly effective, E= effective, S= stimulatory.

The ethanol extract of *A. indica* gave the highest inhibitory effect of 87.21% at 10% extract concentration on the mycelial growth of *A. alternata* which was significant (P<0.05), while the least was 46.07% at an extract concentration of 2.5%. The aqueous extract of *A. indica* with percentage inhibition of 78.21% had the highest inhibitory effect on *B. theobromae* at 10% extract concentration while the least was recorded at 2.5% of42.80%. This result was highly significant (P<0.05) when compared to the one inhibited by ethanol extract at the same rate of concentration (Fig. 1 and Table 1). The ethanol extract of *A. indica* at 2.5% and 5.0% concentrations had the least inhibitory effect of 50.64% and

61.78% respectively on the mycelial growth of *B. theobromae.* At 7.5% and 10%extract concentrations of *A. indica,* 69.04% and 80.01% inhibitions were observed. Meanwhile, Grisovit showed about 98.3% inhibitory effect on the growth of the test fungi (Fig. 2 and Table2).

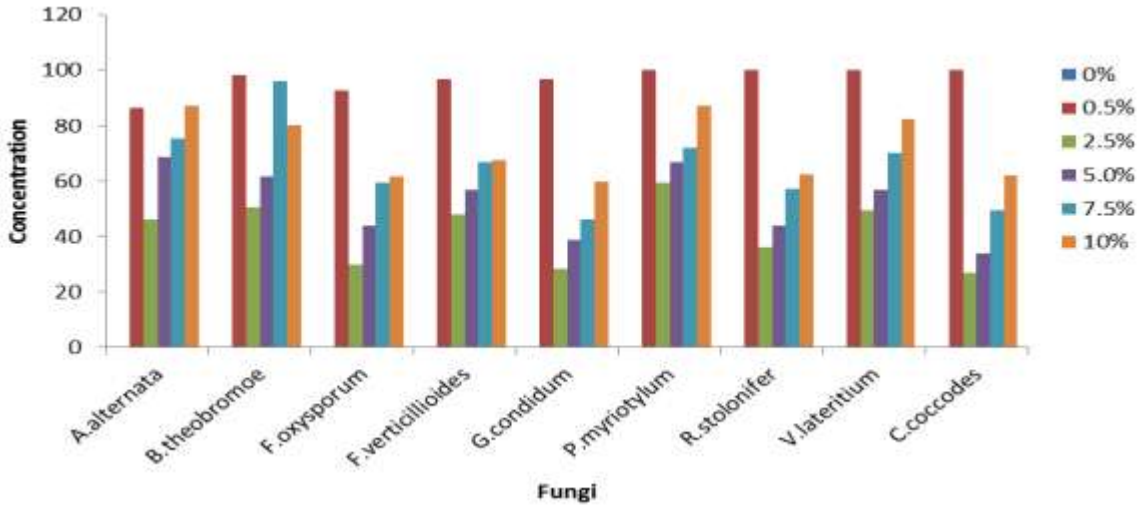

Figure 2: Effect of ethanol extract of A. *indica* on the radial growth of nine fungal species

The aqueous extract of *A. indica* at 2.5% concentration had the least inhibitory effect of 18.76%on the mycelial growth of *F. oxyspurum.* At 10% extract concentration, the highest inhibition of51.78% was observed. This was significantly (P<0.05) different from the one observed inethanol extract on *B. theobramae* at the same level of concentration. Meanwhile, Grisovit showed about 91.68% inhibitory effect on the growth of the test fungi (Fig. 1 and Table 1). The ethanol extract of *A. indica* in (Fig. 2 and Table 2) had the highest inhibitory effect on *F. oxysporum* of 61.78% at 10% extract concentration while the least inhibition of 2o of ibggg9.83% was recorded at 2.5% extract concentration. The result also revealed a significantly different (P<0.05) inhibitory effects from other levels of concentrations observed in *A. alternate* at the same level. The aqueous extract of *A. indica* had the highest inhibitory effect on *V. lateritium* of (60.30%) at 10% extract concentration while the least inhibitory effect was recorded at 2.0% extract concentration of'41.27% (Fig. land Table 1). The ethanol extract *of A. indica* recorded a percentage inhibition of 67.42% on *C. coccoides* as the highest inhibitory effect at 10% extract concentration which was not significantly different (P>0.05) from the one observed at 7.5% extract concentration (66.42%). Meanwhile, the control drug (Grisovit) showed an effective inhibition on the growth of *C. coccoides.* The least inhibition was recorded at 2.5% extract concentration of 48.11% (Fig. 2 and Table 2). Aqueous extract of *A. indica* gave the highest inhibition of 40.32% at 10% extract concentration on *G. candidum* while the least was 18.35% inhibition recorded at 2.5% extract concentration. This result is

far less compared to all the other fungi species in terms of inhibitory effect (Fig. 1 and Table 1). Ethanol extract of *A, indica* and Grisovid showed a significant (P<0.05) variance in the inhibition of mycelial growth of *G. candidum* at the various concentrations levels tested. All the concentrations showed a moderate effect on inhibition for the plant extract with rather fluctuating values with 10% extract concentration as the highest value (59.79%) and the least was 28.50% at 2.5% extract concentration. This result further revealed none significantly different (P>0.05) inhibition from *F. oxysporium* at the same level (Fig. 2 and Table 2). The aqueous extract of *A, indica* had the highest inhibitory effect on *F. oxysporum* of (66.70%) at 10% extract concentration while the least inhibition of (40.07%) was recorded at 2.5% extract concentration. The control drug (Grisovid) had 100% inhibitory effect on the test organism. Meanwhile, the control (water) did not show any inhibitory effects at all levels of concentrations (Fig. l and Table 1). The result of the ethanol extract of *A. indica* gave the highest inhibitory effect at 10.0% extract concentration recorded in *P. meriotylum* of 87.14% followed by 72.16% at 7.5% extract concentration while the least inhibitory effect was 66.80% and 59.32% at 5.0% and 2.5% extract concentration respectively. The inhibitory effect of *A. indica* on *P. myriotylum* was significantly (P<0.05) higher than that of other fungi isolated and tested at the same rate (Fig. 2 and Table 2). Meanwhile, Grisovid showed about 100% inhibition on the growth of the fungus, whereas the control did not show any inhibition. There was also a significant difference (P<0.05) between the entire concentrations rate. The results of the aqueous extract of *A. indica* on *R. stolonifer* had the highest inhibitory effect of (58.06%) at 10% extract concentration while the least was (24.30%) at 2.5% extract concentration. Grisovid (standard antifungal drug) recorded an inhibitory effect of (99.82%) at 0.5% extract concentration (Fig. 1 and Table 1).

Table 2: Effect of ethanol extract of *A. indica* on the radial growth of fungal species.

Fungi	Concentration and categorization of inhibitory or stimulatory effect											
	0%SDW		0.5% GV		2.5%		5.0%		7.5%		10%	
	%	cat	%	cat	%	cat	%	cat	%	cat	%	cat
A.alternata	0.00	NE	86.34	E	46.07	ME	68.78	E	75.27	E	87.21	E
B.theobromae	0.00	NE	98.30	E	50.64	E	61.78	E	96.04	E	80.01	E
F.oxysporum	0.00	NE	92.83	E	29.83	SE	43.98	ME	59.30	E	61.78	E
C.coccoides	0.00	NE	96.81	E	48.11	ME	57.00	E	66.78	E	67.42	E
G.candidum	0.00	NE	96.81	E	28.50	SE	38.70	ME	46.00	ME	59.79	E
P.myriotylum	0.00	NE	100.0	E	59.32	E	66.80	E	72.16	E	87.14	E
R.stolonifer	0.00	NE	100.0	E	36.12	ME	44.07	ME	57.08	E	62.43	E
F.verticillioides	0.00	NE	100.0	E	49.32	ME	56.81	E	70.16	E	82.34	E
V.lateritium	0.00	NE	100.0	E	26.80	SE	33.98	ME	49.30	ME	61.88	E

NE= not effective, ME= moderately effective, SE= slightly effective, E= effective, S= stimulatory.

The ethanol extract of *A. indica* had the highest inhibitory effect on *R.stolonifer* of 62.43% at 10% extract concentration followed by 57.08% at 7.5% extract concentration. This result was significantly (P<0.05) different from each other and significantly (P<0.05)greater than 44.07% and 36.12% recorded by 5.0% and 2.5% extract concentration respectively when compared to others. The aqueous extract of *A. indica* had the highest inhibitory effect on *F. verticillioides* of (54.72%) at 10% extract concentration while the least inhibition of (30.17%) was recorded at 2.5% extract concentration. The control drug (Grisovid) had 91.00% inhibitory effect on the test organism. Meanwhile, the control (water) did not show any inhibitory effects at all levels of concentrations (Fig. 1 and Table 1). The result of the ethanol extract of *A. indica* gave the highest inhibitory effect of *F. verticillioides* by 82.34% at 10.0% extract concentration. The inhibitory effect of *A. indica* on the test organism was significantly (P<0.05) higher than that of other fungi isolated and tested at the same rate when compared (Fig. 2 and Table 2). Meanwhile, Grisovid showed about 100% in inhibition on the growth of the fungus, whereas the control did not show any inhibition. There was also a significant (P<0.05) difference between the entire concentration rate. At 10.0% extract concentration, the highest inhibitory effect was recorded in *F. verticillioides* of 82.34% at 10% followed by 70.16% at 7.5% extract concentration while the least inhibitory effect was 49.32% and 56.81% at 2.5% and 5.0% extract concentration respectively (Fig. 2 and Table 2). *A. indica* at 2.5% extract concentration had the least inhibitory effect of 18.86% on the mycelial growth of *V. lateritium.* At 10% extract concentration, the highest inhibition of 81.11% was observed. This was significantly (P<0.05) different from the one observed on the ethanol extract at the same level of concentration. Meanwhile, Grisovit showed about 98.68% inhibitory effect on the growth of the test fungi (Fig. l and Table 1). The ethanol extract of *A. indica* had the highest inhibitory effect on *V. lateritium* of 61.88% at 10% extract concentration while the least inhibition of 26.80% was recorded at 2.5% extract concentration. The result also revealed a significant (P<0.05) inhibitory effects from other levels of concentration observed in *V. lateritium* at the same level. Meanwhile, Grisovit showed about 100% inhibitory effect on the growth of the test fungi (Fig.2 and Table 2).

Discussion

This study revealed that fungitoxic compounds were present in *A. indica,* since it was able to inhibit the growth of the test fungi. This result is in consonance with the earlier reports of several researches that used different fungal organisms and plants (Suleiman, 2010; Okigbo *et al*, 2009c; Sangoyomi *et al*, 2009; Amienyo & Ataga, 2007; Okigbo & Omodamiro, 2006) hence the plant extracts used have the potential application in the protection of mechanically injured cocoyam corms and cormels against fungal rot. However, the efficacy of *A. indica* extract differed with the concentration, solvent of extraction and with each test organism. Ethanol extracts were more effective

than aqueous extract, which suggests the water used in the extraction process was probably not able to dissolve all the principle compounds present in the plant, which could have been present in the ethanol extract. Ethanol is an organic solvent and will dissolve organic compounds better, hence liberate the active compounds (phytochemical) required for antifungal activity, this agrees with the report of Ekwenye and Elegalam, (2005). *A. indica* depicted an effective/high rate of inhibition on the radial growth of all the test fungi ranging from 26.80% to 87.21% ethanol extract whereas, aqueous extract showed a lower inhibition rate ranging from 18.35% to 81.11%, though it was unable to eliminate all the test fungi. This result agreed with the findings of Sangoyomi, (2004) on yam rot, Suleiman, (2010) on postharvest rot of Yam and that of Anukworji et al., (2013) on isolation of fungi causing rot of cocoyam and control, who reported a highly effective inhibition of *A. niger, F. solani, S. rolfsii* and *B. theobromae* with *A. sativum* and *A. indica* respectively. The commercial fungicides (Grisovid) showed a very significant ($P<0.05$) inhibition on the radial growth of the fungal mycelia tested (78.86-100%). Meanwhile, *P. myriotylum* and *R. stolonifer* showed the highest percentage inhibition of (100% and 99.82%, respectively) with the control antifungal drug (Grisovid). A similar pattern was also observed in the fungistatic effect of the plant extract with respect to concentration. 10.0% extract concentration proved to be the most fungistatic on all the test organisms, followed by 7.5%, while the least inhibitory effect was observed at 2.5% extract concentration. This was because at 0.5% extract concentration, no inhibition was noticed. This result is in agreement with the reports of many workers or researches like the observations of Suleiman, (2010) and Anukworji et al, (2013), who stated a significant difference ($P<0.05$) between mycelia growth value recorded on the various plants extracts concentrations. The presence of bioactive substance have been reported to confer resistance to plants against bacteria, fungi and pests (Srinwasan et al, 2001), this therefore explain the demonstration of antifungal activity by the plant extract (*A. indicd*) used in this study. The antifungal property of this plant extract could probably be due to the presence of phytochemicals which are inhibitory to the growth of the test pathogens and the difference in susceptibility of each of the test isolates to the different concentrations of the plant. This also agrees with the findings of some workers (Okigbo and Odurukwu, 2009; Okigbo *et al.,* 2009a; Okigbo and Ajalie, 2005; Okigbo and Nmeka, 2005; Amadioha, 2004; Onifade, 2002). It was also noted that the plant extract proved to be as effective as the standard synthesize fungicide (Girisovid) and was even in some cases preferred than these conventional chemicals usually used in disease control of plants, indicating that some natural antimicrobial active ingredients are indeed contained in this plant extract (John & James, 2004). Nicholson and Hammerschmidt, (1992) and Amadioha, (2004) revealed the inhibitory effects of phenolics compounds and their roles in disease resistant, that the greater effectiveness of the extract may be due to inherent chemical constituents or bioactive

ingredients of the plant extract. These active principles in the plant extract included anti-fungal polyphenolic components. The results from the present study is also similar to the findings of Anukworji et al, (2013) on the isolation of fungi causing rot of cocoyam (*C. esculenta*) and control with plant extracts and Okigbo et al., (2009b) on effects of plant extracts on rot causing fungi of yam. This study has revealed the potentials of aqueous and ethanol extracts of *A. indica* as an alternative or complimentary to synthetic chemicals in controlling cocoyam corms and cormels rot because of its fungitoxic activity on the test organisms, although greater emphasis was given on the aqueous extract because of its readability to the local or peasant farmer in terms of its extraction and health implications. Moreover, the result of this study has gone a long way in proving a better alternative to the over-dependence on synthetic fungicides, which could reduce over- reliance on one source of agricultural chemicals to farmers that are reported to predict long term harmful consequences on the environment, man and animals, as well as reduce cost of production. Therefore, the demonstration of the activity of the extract against the test fungi produces scientific bases for the local usage of this plant in controlling fungal deterioration of cocoyam corms and cormels. Moreover, since the plant is available, less expensive, and environmentally friendly and with ease of extraction method, it can be confidently harnessed in the control of post-harvest deterioration of cocoyam corms and cormels.

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