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Control of Yam Rot with Plant Extract of *Curcuma longa, Syzygium Aromaticum* and *Cinnamomum Verum*

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ABSTRACT

The storage rot of yam (Dioscorea Spp) start from the field to the storage barn. Fungi pathogens affecting yam tubers are controlled using pesticides or plant extract. Diseases and healthy yam specie of Dioscorea rotundata were collected from different market (Eke Awka and Nkwo Amaenyi). The plant samples used were Curcuma longa (Turmeric), Syzygium aromaticum(Clove) and Cinnamomum verum (Cinnamon) and were dried under room temperature for three days then extracted using Soxhlet extractor before analysis. The antimicrobial activities of the plant extracts on fungi associated with rotting yams were obtained. Fungi isolation was done from the samples using standard procedures. The isolated fungi were identified as Aspergillus flavus,Aspergillus niger,Fusarium oxysporum, Fusarium solani etc. The treatment were given to the organism at 4mg/ml each of the three extract. From the analysis, result showed that all the extract have significant effect on the growth of the organism. The inhibition of the growth of these fungi was due to the fact that the plant contain active phytochemical component. This study shows that the extract can as well be used for the control of human fungi pathogen. It was also recommended that people should ensure they consume enough turmeric, clove and cinnamon in other to help prevent and fight against diseases and pharmaceutical industries should ensure to use these plant extract in the production of antifungal drugs.

Keywords: Yam, Rot, plant, Extract, *Curcuma longa, Syzygium aromaticum*, *Cinnamomum verum.*

1. INTRODUCTION

Yam (*Dioscorea spp*) is a tuber crop belonging to the family *Dioscoreaceae*. The species of economic importance include *Dioscorea rotundata, Dioscorea alata, Dioscorea cayenensis, Dioscorea dumetorum, Dioscorea bulbifera and Dioscorea esculentus.* In West Africa, like Nigeria, *Dioscorea spp* is widely cultivated especially *Dioscorea rotundata*. It is the most important food and income source for millions of producers, processors and consumers in West Africa. In 2012, world production of yam was estimated at 58.7 million tons with West Africa producing more than 92% (FAOSTAT, 2014). Nigeria and Ghana alone produced about 66% of the world's yam supply. About 48 million tons of the tubers are produced annually in this sub-region on 4 million hectares of land. Yam plays an important role by providing cash and dietary carbohydrate to millions of people (Okigbo *et al.*,2010). The crop also makes a substantial contribution to protein in the diet, ranking as the third most important source of supply. It has a better keeping quality than most other tropical root and tuber crops because the tubers have an extended period of dormancy during which physiological activities are at a minimum. Yam can therefore, serve as an important food security crop as well as an integral to the socio cultural life in this sub-region of Nigeria (Okigbo, 2015).

There are also losses in Yam due to post harvest rot significantly affecting farmers' and traders' income, food security and seed-yams stored for planting. The quality of yam tubers are affected by rots which makes then unappealing to consumers (Ogbo & Agu, 2014; Agu *et al.*, 2015). Losses of yams in storage mostly to rot are considered to be heavy in Nigeria; as a result the

demand for yam tubers has always exceeded its supply (FAO, 2018). Statistics have shown that an average of over 25% of the yield is lost annually to diseases and pests and over 50% of the yam tubers produced and harvested in Nigeria are lost in storage (FAO, 2018). Most rots of yam tubers are caused by pathogenic fungisuch as *Aspergillus flavus, Aspergillus niger* (Tiegh), *Fusarium oxysporum, Fusarium solani, Botryodiplodiatheobromae, Penicilllium chrysogenum, Rhizoctonia spp, Penicillium oxalicum, Trichoderma viride*and *Rhizopusnodosus* (Frank & Kingsley, 2014; Agu *et al*., 2014). It is a known fact that these fungi often time cause damage of yam as result caused great loss in the production of yam.

The history of yam dated back to early 5000BC when man in West Africa, began to gather yam during the Paleolithic era (Kwadwo,2009). Microbial deterioration of yam start in the soil reducing its capacity to germinate and its survival in the field and then progressed in storage which occur when infected tubers do not have any sign of external symptoms (Okigbo *et al*., 2010). The incidence of rotting varies with the species and with varieties within each species of yam. Nwakiti (2011) reported t that rot vary due to variations in the distributions of the microorganisms and does related to the soil mineral status because the differences in the mineral status are not known to be correlated with the type of organism isolated nor total percentage of rot. Several methods have been adopted for controlling losses due to post harvest disease of yam; these include the use of chemicals, biological method of control, curing uses of natural plant extracts, as reported by Amusa *et al.*, (2013). Because of the low capital income of farmers in Nigeria and lack of expertise in the safe handling of chemical, farmers resorted to the method of crop rotation, fallowing, planting of healthy material and destruction of infected crop cultivars in controlling the diseases of yam tubers (Nwakiti, 2013). Chemical method of control has helped to reduce the rate of storage losses and also increases yield obtained, but the problem arising with the use of chemicals is that it is expensive, can cause environmental pollution and may also induce pathogen resistance.

Yam serve a very important role in Nigeria were it is used for culture purposes, as source of income, as one of the major food that supply energy as well as source of revenue generation to the nation. But it is dishearten that yam often get spoiled starting from the soil and when harvested and stored for further usage or before marketing. This has caused great loss in revenue generation of farmers as well as food security in Nigeria. Therefore, there is a need to properly address the problem using a more reliable and environmental friendly technique that can be cheap and easily harnessed to solve this problem.

The study will be of benefit to farmers since farmer will become more enlightened on the best way to control fungi that causes rot in yam hence, reducing the food value of yam and revenue generated by farmers from the sale of yam. Future researchers will also benefit since the study will serve as a source material and references for future related study.

The aim of the study is isolation of fungi associated with yam, identification and control using plant extract. Specific objective is to; isolate fungi associated with yam, identify the fungi isolated and using plant extract to control the fungi.

2. LITERATURE REVIEW

Yam (*Discorea spp*.) is a major staple food in West Africa, where it provides food for over 60 million people (Nweke *et al.*, 2013). The West Africa yam belt, which stretches from west of Cameroun mountains to the Bandama river in central Cote D'Ivoire produces 95% of the annual world output of 33 million metric tonnes (Kwadwo,2009).

2.1 Yam Cultivars, Ecological areas and characteristics of varieties grown

Kwadwo (2009), reported that yam Species predominantly grown in Nigeria are the white yams *D. rotundata*, The environmental conditions of Nigeria characterized by light sandy soils in the transitional. The plant takes about eight months to mature. The stems and leaves are hairless. The skin of tuber is smooth and brown, while the flesh is usually white and firm.

The cultivar, *D. alata*, is more fibrous, coarser and poor quality than the white and yellow yams, produces large late maturing tubers. These tubers are not pound able into fufu because of its high water content. The tubers appear soft, and drops of water appear on the surface when cut, hence the name "water yam" (Irving, 2011).

2.2. Yam Rot Organisms

Microbial deterioration of stored products have been known to reduce the eating quantity and market value of yam (Amusa *et al.*, 2013).Studies have shown that fungal rot is the greatest cause of tuber loss in storage (IITA, 2009; Amusa *et al.*, 2013). The principal species of microorganisms associated with yam rot inNigeria are: *Botryodiplodia theobromae* Pat., *Fusarium oxysporum* Schlencht, *Penicillium oxalicum* Currie andThom., *Sclerotium rolfsii* Sacc, *Aspergillus niger* Van Tiegh and *A. tamarii* Kita (IITA, 2013; Amusa *et al.*, 2013; Okigbo, 2015).

Amusa & Baiyewa, (2011) classified microbial disease of yam tubers into categorizes based on symptoms and the causal agents. These are the dry rot, the soft rot and the wet or watery rot .In the dry rot, the infected tissues become hard and dry with varying coloration depending on the microorganism involved. It is caused by the *Fusarium* species and the species responsible for it are *Fusarium oxysporum*, *Fusariummoniliforme* and *Fusarium solani* (Morse, 2017). Okigbo & Emeka(2010),recorded the pathogenic fungi of the yam tuber which include *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus tamari*, *Botryodiplodiatheobromae*, *Cladosporium herbarum*, *Fusarion oxysporum*, *Fusarium solani*, *Penicillium chrysogenom*, *Penicillium oxalicum*, *Rhizopus nodosus*, *Rhizoctonia* spp. and *Trichoderma viride*. Microbial deterioration of yam start in the soil reducing its capacity to germinate and its survival in the field and then progressed in storage which occur when infected tubers do not have any sign of external symptoms(Okigbo *et al*.,2000)

2.3 Phytochemical Constituents of Plant

Phytochemical constituent of plant including alkaloids, tannins, flavonoids, saponins, steroids, glycosides, reducing sugars among others.

2.4 Alkaloids

These are organic nitrogenous compounds that have complex molecular structures of good pharmacological activity thus, bitter in taste and mostly basic in nature (El-Olemyl *et al.,* 2013). These chemicals comprise up largest single class of secondary plant substances which contain one or more nitrogen atoms usually in combination as part of cyclic system. Alkaloids do not have an exact nomenclature but they are named as proto alkaloids, when they are without heterocyclic ring in their structures, pseudo alkaloids are those alkaloids with and without heterocyclic rings that are not derived from amino acids and the carbon skeleton is soprenoid ,and true alkaloids, which are those that have heterocyclic rings in their structure. True alkaloids and photo alkaloids almost always have amino acids as their distal biosynthetic precursors and acetate is also incorporated in their structure. Alkaloids accumulate in actively growing tissues, epidermal and hypodermal cells, vascular sheath and latex vessels (Evans and Trease, 2009).

Alkaloids are usually colourless, often optically active substance, most are crystalline but few are liquid at room temperature e.g. nicotine.(Kanoma, Muhammad, Abdullahi, Shehu, Maishanu& Isah,2014). The alkaloid quinine for example is one of the predominant bitter substances known, and is significantly bitter at molar concentration of 1 X 105. The most common precursors of alkaloids are amino acids. Many alkaloids are terpenoids in nature and some (e.g Solanine, the steroidal alkaloid of the potato) are the best considered from the biosynthetic point of view as modified terpenoids. Others are aromatic compounds e.g. colchicines. Alkaloids are rich in the angiosperms families and are generally absent or infrequent in the gymnosperms, ferns and lower plants (Evans and Trease, 2009).

2.5 Tannins

The term tannins denote substances present in plant extracts which are able to combine with proteins of animal hides and convert them into leather. Tannins are widely distributed in plants and occur in solution in the cell sap, often in distinct vacuoles. Tannins are readily soluble in water or alcohol, given as stringent solution that is useful in medicine. They are also used with ferric chloride in compound inks of greenish black to bluish black colours. There are two main groups of tannins; namely, true tannins and pseudo tannins. The true tannins are complex phenolic compounds (Kanoma, Muhammad, Abdullahi, Shehu, Maishanu& Isah,2014). They display the general properties of tannins and are precipitated by gelatin in a 1% aqueous solution. True tannins are further classified into two main classes; hydrolysable (pyrogallol)tannins (Ellagitannin and gallitannin), and condensed tannins (catechol and catechin). The pseudo tannins (gallic and ellagic acids) are simple phenolics that give some of the tests of tannins, but are not precipitated by gelatin.

Tannins have a therapeutic value as astringents, since; they are able to precipitate proteins. Through this effect they can be used to stop hemorrhage and to treat diarrhea as well as local burns (EL-Olemyl *el al*., 2013).

2.6 Flavonoids

These are the largest group of naturally occurring phenols and they occur in the plant both in the free state and as glycosides. The flavonoids group may be described as a series of C6-C3-C6 compounds (Kanoma, Muhammad ,Abdullahi, Shehu, Maishanu& Isah,2014). The majority of flavonoids are characterized by containing linkage of the three carbon chain with one of the benzene rings. Flavonoids are widely distributed in nature, but are more common in the cell sap of higher plants. They usually constitute the yellow, red and blue pigments of flowers and fruits. Flavonoids are important in many industries such as fermentation of tea,

tannins of. Some flavonoids have fungicidal properties and are found to protect the plant against attack by pest and parasite (Evans and Trease, 1999).

2.7 Saponin

Saponin is one of the groups of glycosides found in many plant species with known foaming properties when mixed with water, allowing the formation of small stable bubbles. Saponins are normally broken down in the digestive system and are toxic when absorbed into the blood stream (Kanoma, Muhammad,Abdullahi, Shehu, Maishanu& Isah,2014).

They are used in modern times in the manufacture of fire extinguisher foam, tooth paste, shampoos, liquid soap and cosmetics. It is also used to increase the foaming of beer soft drink. As glycosides they are hydrolysed by acids to give an agylcone (sapogenin) and various sugar and related uronin acids. The steroidal saponin and rtocyclicterpenoids have a glycosydial linkage at -C3 and have a common biogenetic origin through malvalonic acid and isoprenoid unit (Evans and Trease, 2009).

2.8 Glycosides

Glycosides are non-reducing substances, which on hydrolysis with reagents or enzymes yield one or more reducing sugars among the products of hydrolysis. The usual linkage between the sugar and agylcone is an oxygenlinkage, connecting the reducing group of a sugar and an alcoholic or phenolic hydroxyl group of the agylcone. Such glycosides, sometimes called O-glycosides, are the most numerous ones found in nature. Other glycosides however occur, e.g. S-glycosides and N-glycosides in S-glycosides, e.g. Sinirin, where the sugar is linked to the thiol group of the agylcone (Kanoma, Muhammad,Abdullahi, Shehu, Maishanu& Isah,2014). In n-glycosides There are also c-glycosides (e.g. barbalion) in which the sugar is linked to the agylcone by a carbon to carbon bond. All naturally occurring glycosides are of the β-type, although the α-linkage is found in some carbohydrates such as sucrose, glycogen and starch (Evans and Trease, 2009).

Glycosides occur widely in nature and occur in low concentration in nearly all plants. They occur not only in angiosperms but also in lower plants e.g. in streptomyces species. Glycosides are found in all parts of the plant, in roots, bark, leaves, flowers, fruits and seeds. Much plant pigments responsible for the colour of flowers and fruits are glycosides. Glycoside formation may well be a method of storing certain organic compounds e.g. phenols. It is also suggested that, some glycosides have a role of defence against the invasion of the tissue by micro-organisms subsequent to wounding, since many agylcones are aseptic and hence bactericidal in character.

Plant glycosides that are currently used in medicine, though not larger in number, are important drugs. Glycosides of medicinal plants may be used as cardial stimulants (e.g. digitoxin and quabian or laxatives) Sinnosides and barbaloin or local irritants e.g. sinigrin or analgesics (silicon) and against capillary frugility(hesperidin) (Evans and Trease, 2009; Obia,2014).

2.9 Traditional Uses

Extracts of various parts of plant such as turmeric, cinnamon among other are used extensively in traditional African medicine (Xu *et al.*, 2013), especially for the preparation of remedies for the treatment of laryngitis, cough and liver diseases (Farombi and Owoeye, 2011).

3. MATERIALS AND METHOD

3.0 Collection of Plant Materials

Dioscorea rotundata Poir (white yam) was purchased from Eke Awka and transported in a sterile bag to Department of Botany Nnamdi Azikiwe University and identified by a taxonomist (Prof. C.U Okoke) before being taken to Maeve academic research laboratory for experimental Analysis.

3.1 Experimental Equipment

The equipment's used in the experiment includes, autoclave, knife, binocular microscope, microscopic slide, slid cover, conical flask, 250ml and 500ml beaker, inoculating loop, cotton wool, cork borer, foil, burnson burner petri dish, masking tape and weighing balance.

3.2 Experimental Reagents

The reagents used are; phenol red, lactophenol, distill water,ethanol, antibiotics (chloramphenicol), sabougourd dextrose agar(SDA)and Czapek Dox agar (CZ), feric chloride, hydrochloric acid, ammonia etc.

3.3 Preparation of Samples

The surface of the sample *Dioscorea rotundata* (white yam) first surface sterilized with 70% alcohol and the infected portion cut off into small pieces of size 5cm by 5cm which weighing 10grams then kept in beaker ready for use.

The plants (Cinnamon, clove and turmeric) were dried under room temperature at 25± 1^0c for 5days. The sample was grinded into powdery form and ready for analysis.

3.4 Preparation Of Culture Media

Czapek(2010) method of media preparation was used. One gram of sabougourd dextrox agar(SDA) and Czapek Dox agar (CZ) was dissolved in 45ml of distill water, then autoclaved for 15min under the pressure of 15 pounds pressure(psi) at a temperature of 121^0_C. The media was poured into petri dish and allowed to cool into cake form ready for inoculation. Ten grams(10g) weigh sample of *Dioscorea rotundata* (white yam) was inoculated into sabougourd dextrox agar and incubated for 72hours for growth. After the incubation period, the observed growth was subculture to get a pure culture.

3.5 Colony Count

The direct colony count method by W.H.O (2010) was used. In this method, the colonies of fungi were counted directly from the cultured plate.

3.6 Qualitative Phytochemicals Screening

Test for Tannins. The experiment was conducted according to Ejikeme *et al.*(2014) manual. Two grams (2g) of the plant sample(*Curcumalonga*) measure into a test tube and boiled for 10 minutes in a water bath containing 30 cm3 of water. Filtration was carried out after boiling using number 42 (125 mm) Whatman filter paper. To $5cm^3$ of the filtrate was added 3 drops of 0.1% ferric chloride. A brownish green or a blue black colouration showed positive test.

Test for Phlobatannin. The sample was prepared contains 30 gms of water and 30 cm3 of distilled water**.** After 24 hours of extraction, each wood sample was boiled with aqueous hydrochloric acid and the deposit of red precipitate showed positive test. All the following test are carried out according to standard procedures reported in the paper Ejikeme *et a.,l*(2014*).*

3.7Anti-microbial Assay

The methods of Shiriki *et al.*(2015) manual was employed using the extracts prepared above. 4ml, 6ml and 8ml of the plant extract were pipetted into labeled sterile petri dishes containing the pure culture of the microbial organism respectively. The Inhibition zones of the microorganism was evaluated and was recorded in terms of radial growth of the
microbes on the medium with and without extracts and results were analyzed on the basis of percentage growth inhibitions of microorganisms. The inhibition of microbial growth on SDA medium was used to quantify the toxicity of extracts. Percentage growth inhibition for 5 days was calculated.

$$\text{Percentage Growth inhibition} = \frac{R_1 - R_2}{R_2} \times \frac{100}{1}$$

Where R_1 = is the furthest radial distance of pathogens in control plates
Where R_2 = is the furthest radial distance of pathogens in extract (treated) plates. The inhibition percentage was determined as a guide in selecting the minimum inhibition concentration that will be effective in controlling the microbial organisms.

3.8 Identification of Fungi Isolate

Both morphological and anatomical characteristics of the fungi were used in the identification process of the fungi isolate. This was done as follows.

A:Morphological identification(methods of Shiriki *et al*,(2015) and Cheesbrough, (2000) manual were used. The growth pattern and pigments produced in Czapek Dox agar (CZ) fungi differential media was observed, match against those in fungi identification kit and recorded accordingly.

B: Anatomical Identification: Here, the methods of Shiriki *et al*,(2015) and Cheesbrough, (2000)manual were used for the various tests and examinations. A smear of the fungi growth was fix on two different slide and one stained with phenol red while the other was stained with lactophenol. Both of the smears were viewed under binocular microscope and the anatomical characteristic recorded and as well match against those on fungi identification kit then identified accordingly.

3.9 Pathogenicity Test

Pure culture of the fungi was isolated using inoculation loop of length 5cm while a healthy yam tuber was surface sterilized using 100% ethanol. With the use of cork borer, a smooth deep cut was made on the healthy yam tuber to a depth of 2cm with a diameter of 10mm wide. The pure culture of the fungi was inoculated and the 10mm cover of the initial cut healthy yam part was used to cover it and was sealed with candle wax. The sample was kept in an incubation chamber for 72hr then being observed every 3 days to ascertain the pathogenicity of the organism.

4. RESULTS

4.1. Phytochemical Screening of Clove *(Syzygiumaromaticum),*Tumeric (*Curcuma longa*) and Cinnamon *(Cinnamomum verum)*

The result of the phytochemical screening of Clove *(Syzygium aromaticum),* Tumeric (*Curcuma longa*) and Cinnamon *(Cinnamomum verum)* is revealed in table 4.1. The tableshows that alkaloid was deeply present in clove extract. The table also revealed that glycoside, saponin and saponin glycoside were present; while flavonoid and cardiac glycoside were absent in clove extract. The result revealed that flavonoid, saponin and saponin glycoside, alkaloid, glycosides, steroid and terpenoid were present; while cardiac glycoside and anthraquinone were absent in the extract of *Curcuma longa.* The result also revealed that alkaloid, flavonoid, glycoside, terpenoid, saponin, anthraquinone and saponin glycoside were present ; while steroid and cardiac glycoside were absent.

Table 4.1. Phytochemical Screening of Clove *(Syzygium aromaticum),* Tumeric (*Cucurma longa*) and Cinnamon *(Cinnamomum verum).*

Parameters	Clove Extract	Turmeric Extract	Cinnamon Extract
Alkaloids	+++	+	+
Flavonoid	-	++	+
Glycoside	++	+	+
Steroid	+	+	-
Terpenoid	+	+	+
Saponin	++	++	+
Cardiac glycoside	-	-	-
Anthraquinone	+	-	+
Saponin glycoside	++	++	+

Keys: moderately present (++), present in excess(+++), present in little quantity (+), Absent(-)

4.2. Antimicrobial activity at 4mg/ml
zone of inhibition

The result of the Antimicrobial activity at 4mg/ml zone of inhibition is shown in table 4.2. The result revealed that cinnamon gave higher inhibition of *Aspergillus* spp., *Fusarium* spp and mould fungi (11.3±0.014mg/ml, 13.35±0.028mg/ml and 13.8mg/ml)respectively. The result also revealed that the clove gave least inhibition *Aspergillus* spp and mould fungi (8.10±0.056mg/ml and 6.87±0.021mg/ml) respectively; while turmeric extract gave least inhibition of turmeric (9.18±0.056mg/ml) . The result also revealed that the plant extracts gave higher inhibition of the tested organisms when compared with the control experiment

.4.2. Antimicrobial activity at 4mg/ml zone of inhibition

	Aspergillus spp	*Fusarium* spp	Mould fungi
Control	6.3±0.014	6.90±0.028	7.15±0.007
Clove	8.10±0.056	9.30±0.014	6.87±0.021
Turmeric	9.79±0.014	9.18±0.056	8.28±0.014
Cinnamon	11.3±0.014	13.35±0.028	13.8±0.000

Results are in mean ± standard deviation

The result of the Antimicrobial activity at 4mg/ml zone of inhibition is also shown in figure 1. The result revealed that cinnamon gave higher inhibition of *Aspergillus* spp., *Fusarium spp* and mould fungi. The result also revealed that the clove gave least inhibition *Aspergillus* spp and mould fungi; while turmeric extract gave least inhibition of turmeric . The result also revealed that the plant extracts gave higher inhibition of the tested organisms when compared with the control experiment.

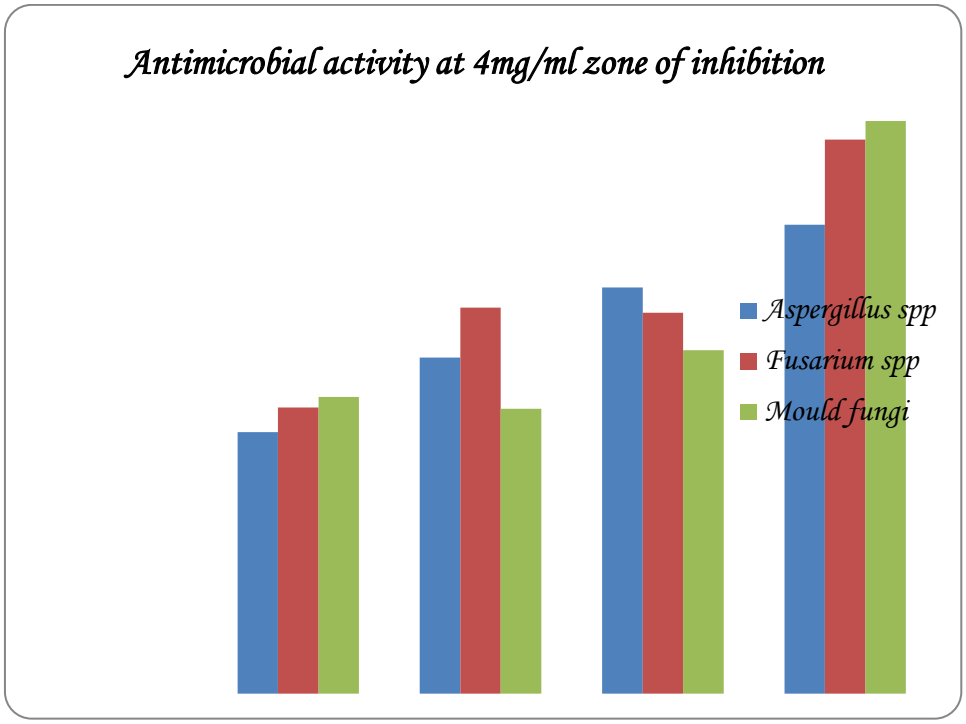

Figure 1: Antimicrobial activity at 4mg/ml zone of inhibition

4.2. Antimicrobial activity at 8mg/ml
zone of inhibition

The result of the Antimicrobial activity at 4mg/ml zone of inhibition is shown in table 4.2. The result revealed that cinnamon gave higher inhibition of *Aspergillus* spp., *Fusarium* spp and mould fungi (12.9±0.000mg/ml, 14.4±0.014mg/ml and 14.1±0.006mg/ml) respectively.

The result also revealed that the clove gave least inhibition *Aspergillus* sppand mould fungi (11.21±0.021mg/ml and 7.12±0.056mg/ml) respectively; while turmeric extract gave least inhibition of turmeric (10.12±0.014mg/ml). The result also revealed that the plant extracts gave higher inhibition of the tested organisms when compared with the control experiment.

Table 4.3. Antimicrobial activity at 8mg/ml zone of inhibition

	Aspergillus spp	*Fusarium* spp	Mould fungi
Control	7.2±0.056	8.12±0.021	9.32±0.000
Clove	11.21±0.021	10.34±0.014	7.12±0.056
Turmeric	12.1±0.014	10.12±0.014	13.21±0.000
Cinnamon	12.9±0.000	14.4±0.014	14.1±0.006

Results are in mean ± standard deviation

The result of the Antimicrobial activity at 8mg/ml zone of inhibition is also shown in figure 2. The result revealed that cinnamon gave higher inhibition of *Aspergillus* spp., *Fusarium spp* and mould fungi. The result also revealed that the clove gave least inhibition *Aspergillus spp* and mould fungi; while turmeric extract gave least inhibition of turmeric . The result also revealed that the plant extracts gave higher inhibition of the tested organisms when compared with the control experiment

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Plate 1: A healthy white yam *(Dioscorea rotundata*)

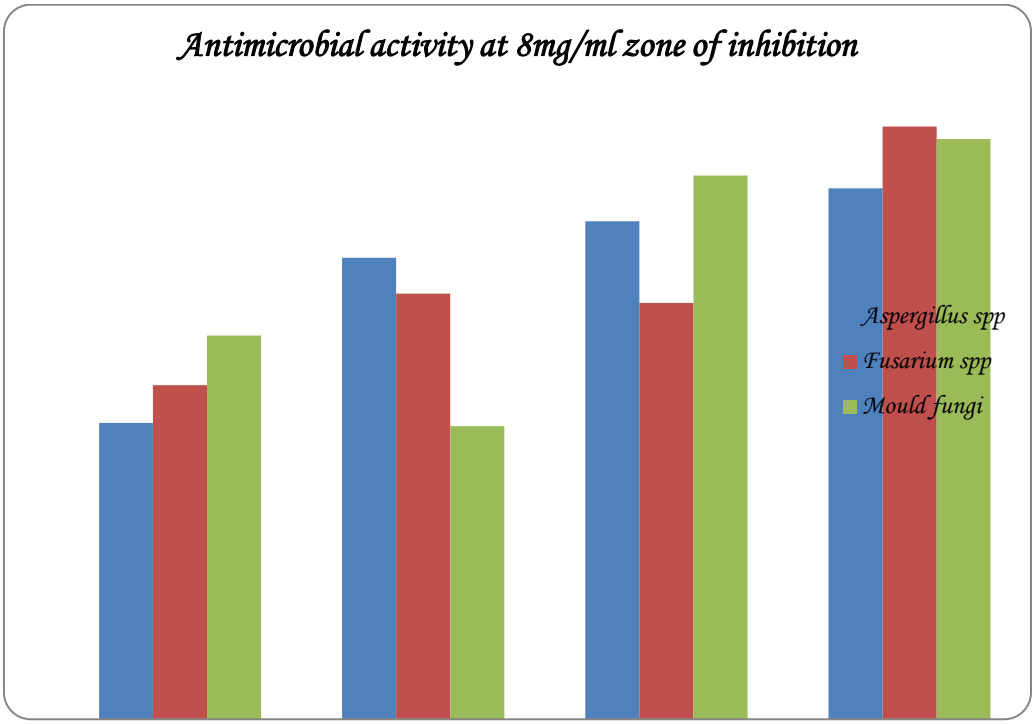

Figure 2: Antimicrobial activity at 8mg/ml zone of Inhibition

Plate 2: Yam with a rot

Plate 3: Culture media inoculated with ten grams (10g) of *Dioscorea rotundata*

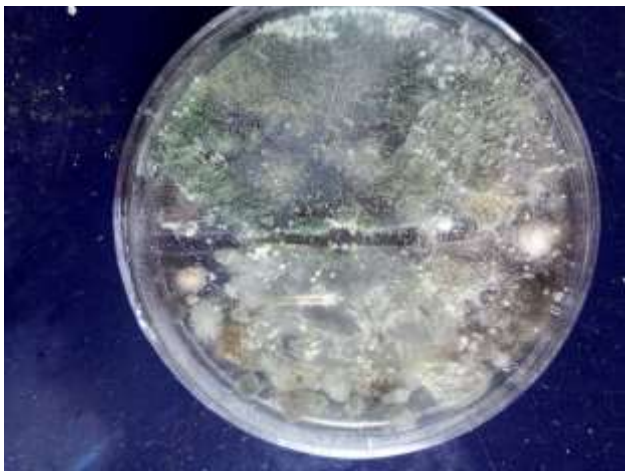

Plate 4: pure culture

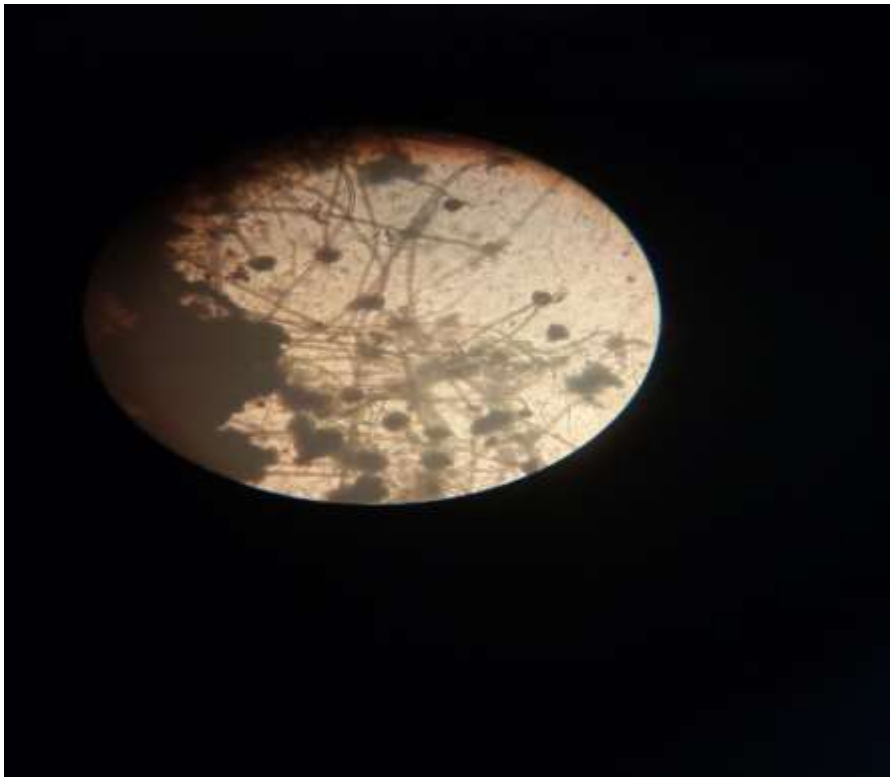

Plate 5: Microscopic view of *Aspergilius fungi*

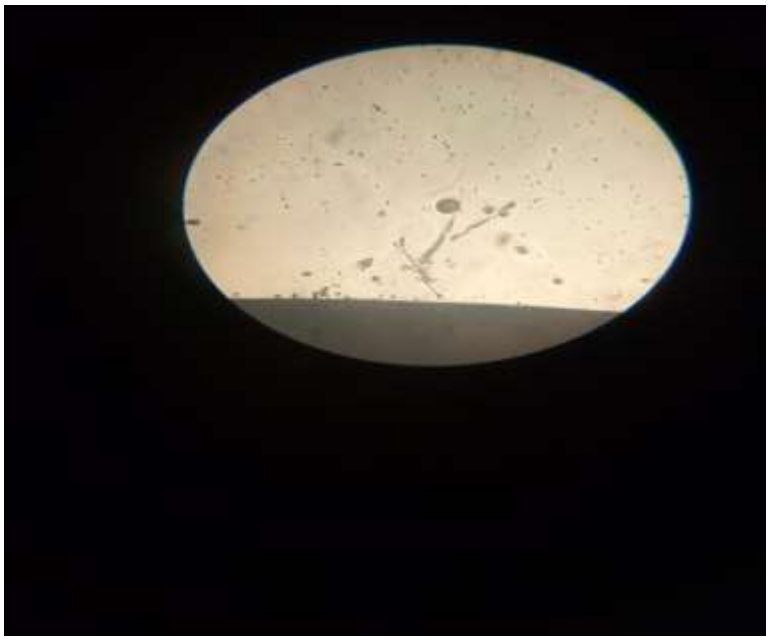

Plate 6: Microscopic view of *fussarium spp*

5. DISCUSSION, CONCLUSION AND RECOMMENDATION

Findings of the study showed that clove extract, turmeric and cinnamon contain alkaloid, phenol, saponin among others. This finding agree with the findings,Esimone *et al.*, (2017) who documented phytochemical constituents of turmeric, cinnamon and clove to include saponins, tannins, flavonoids, proteins, glycosides, reducing sugar, starch, sterols and triterpenoids, with flavonoids predominating. These phytochemicals give the plant it's antimicrobial effect on the control of fungi organism. The finding of the study also indicated that the extract of this planthas antimicrobial effect against *Aspergillusspp, Fusarium spp*, Mould fungi. The effect of these extract on these fungi are more significant and better at a higher concentration. This implies the higher the concentration in milligram per milliliter the better the inhibition of the microorganisms. This findings is in agreement with the finding ofIwu, (2013).who reported that medicinal uses plant like tumreric and clove include it's use as purgative, antiparasitic, antimicrobial, antiviral, anti-inflamatory, antidote to the effects of *Strophantus gratus*, remedy for guinea-worm infection and for the treatment of gastroenteritis, rheumatism, asthma, menstrual cramps, throat infections, cure headache, relieve colic, chest colds, cough and liver disorders. The finding also corroborate with the findings of Farombi and Owoeye, (2011) and Xu *et al.*, (2013), who said that extracts of various parts of plant such as turmeric, cinnamon among otherare used extensively in traditional African medicine especially for the preparation of remedies for the treatment of laryngitis, cough and liver diseases.

5.1 Conclusion

Evidence from the study showed that extracts from cinnamon,turmeric, and clove have significant inhibitory effect against fungi organism such as*Aspergillus spp*, *fusarium spp*and mould fungi. It was also noted from the study that higher dosage of this extract gives a better inhibitory effect against the fungi.

5.2 Recommendation

Based on the finding of the study, the followings are recommended.

1. People should ensure they consume enough turmeric, cinnamon and clove in other
2. to help prevent and fight diseases.
3. Pharmaceutical industries should ensure to use these plant extracts in the production of antifungal drugs.

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