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Full Length Research Paper

Control of yam tuber rot with leaf extracts of *Xylopia aethiopica* and *Zingiber officinale*

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Investigation was carried out to test the potency of some plant extracts for the control of yam tuber rot caused by *Fusarium oxysporum, Aspergillus niger and Aspergillus flavus*. Hot water extracts were obtained from leaf and seed of uda (*Xylopia aethiopica*) and Ginger (*Zinigiber officinale*), and were found to be fungitoxic against the fungi. The extracts of suppressed the growth of these fungi in culture and reduced rot development in yam tubers.

Key words: *Xylopia aethiopica*, *Zinigiber officinale*, ginger, yam tuber rot.

INTRODUCTION

The food yam belongs to the genus *Dioscorea* in the family of Dioscoreacea and is monocotyledonous. It is one of the highly rated and commonest food crops of the tropical world. The edible varieties of yam are important food crop and serve as an important carbohydrate staple for millions of people in both the tropical and subtropical countries in West Africa, Caribbean, the Northern and Central part of South East Asia including parts of China, Malaysia, Japan and Oceania (Coursey, 1967; Okigbo and Ikediugwu, 2000). The FAO (1989) estimated that the world production is around 20 million ton per year. Nigeria alone, produce three quarter of the world total output of yams. Of the ten cultivated species, the six most important in Nigeria are *Dioscorea rotundata* Poir (white yam). *D. cayenensis* Lam (yellow yam). *D. alata* L. (Water yam). *D. dumetorum* (Cluster, or bitter yam). *D. esculenta* (Loir) bark (Chinese yam) and *D. bulbifera* L. (aeria yam) (Adeniji,1970; Okigbo, 2004).

The principal microorganisms associated with yam in Nigeria include *Aspergillus niger* Van Tiegh. *Hendersonula rotuloidea*, *Macrophomina phaseoli, Rhizopus nodosus* Namyslowski, *Botrodiploida theobrome*, *Fusarium monoliform* var subgluctinanus Wollenw and Reinking. *Pencilium sclerotigenum* Yamamota, and *Rosellina bundodes* (Berk and Br) Sacc. (Ogundana et al.,1970; Adeniji, 1970; Ogundana, 1972; Okigbo and Ikediugwu, 2000). Other fungi which have been reported as secondary invaders are *Fusarium oxysporum* Schlecht, *Cladosporium spearospermum*, *Fusarium solani, Geotrichum candidum* (Okafor, 1966; Coursey, 1967; Adeniji 1970).

The use of synthetic chemicals such as sodium orthiophenylphenate, borax, captan, thiobendazole, benomyl, bleach (sodium hypochlorite) have been found to significantly reduce storage rot in yam (Booth, 1974; Noon, 1978,). Other control methods involve the use of microorganism such as *Trichoderma viride* and *Bacillus subtilis* (Okigbo and Ikediugwu, 2000; Okigbo, 2002). However, farmers in developing economies such as Nigeria have hardly adopted these findings, because the majority of them cannot afford the financial cost. Moreover, chemical pesticides have the additional potential disadvantages of accumulation in the ecosystem and of induction of pesticide resistance in pathogens (Adeniji 1970; Okigbo and Ikediugwu, 2000; Okigbo, 2004). There is also the problem of lack of expertise in the safe handling of pesticides among most of the farmers. Biological control is generally favoured as a method of plant disease management because it does not have the disadvantages of chemicals (Amadioha and Obi, 1999). Kuhn and Hargreaves (1997) observed that

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substances found fungicidal *in vitro* in almost cases kill the fungus *in vivo*. Plants with such fungicidal properties include *Zingiber officinale* Roscoe and X*ylopia aethiopica* (Dunal) A. Rich (Maurice, 1993).

X. aethiopica (family: Annonacea) is an evergreen, aromatic slim tall tree which is found in the humid forest zones of West Africa (Irvine, 1961). The fruit has a repulsive properties which has been used in various forms to cure rheumatism (Maurice, 1993; Anonymous, 2004a). *Z. officinale* (family: Zingiberacea) is a herbaceous perennial plant which has an upright stems and narrow medium, green leaves arranged in two ranks on each stem. *Z. officinale* or ginger has been used in Asia for relief from arthritis rheumatism coughs, fever and infections diseases (Anonymous, 2004 b).

Plant extracts have been used to control diseases in cowpea (Amadioha and Obi, 1998) and banana (Okigbo and Emoghene, 2004). Pesticides of plant origin are specific biodegradable, cheap readily available and environmentally safe than synthetic chemicals. In this report, the antifungal properties of *X. aethiopica* and *Z. officinale* against some spoilage fungi responsible for yam tuber rot in storage were studied.

MATERIALS AND METHODS

Source of yam and plant materials

Rotted yam tubers were collected from the yam barn of National Root Crops Research Institute (N.R.C.R.I.), Umudike, Nigeria. This was packaged in polyethylene bags and taken to the Laboratory where they were kept until required. Healthy yam tubers were also obtained from N.R.C.R.I as well as from Umuahia town market, Abia State, Nigeria. The tubers were washed and rinsed in running tap water before being used for pathogenicity test.

X. aethiopica and *Z. officinale* used in the experiment were collected from forest of Umuahia, Abia State, and were authenticated in the Department of Forestry, Michael Okpara University of Agriculture, Umudike, Nigeria and samples deposited in the herbarium with voucher number 11169.

Isolation of pathogens

Rotted yam tuber was rinsed in sterilized water, surface sterilized with 70% ethanol and cut open. About 3 pieces (3 mm diameter) of the infected tissues were picked with a flamed sterilized forceps and inoculated on the solidified PDA medium in different plates. The inoculated plates were incubated at room temperature (28°C) and observations were made daily for emergence of colonies. Subculturing was done to obtain pure cultures of the isolate. Stock cultures were prepared using slants of PDA in McCartney bottles and stored in a refrigerator at 4°C.

Pathogenicity test

A fresh, healthy tuber yam was washed with tap water and distilled water, and thereafter sterilized with 70% ethanol. Cylindrical discs were removed from the tuber with a sterile 4 mm cork borer. A four disc of five days old cultures of the isolates was used to plug the holes created in the tubers and the disc of the tuber in the cork borer was replaced, then Vaseline was applied on the point of inoculation. This was done for all the isolates obtained in pure cultures.

Preparation of plant extracts

X. aethiopica and *Z. officinale* seeds (100 g, each) were washed in the laboratory with tap water and grounded separately and added to 10 ml of hot water. This was vigorously stirred and left to stand for 1 h. The solution was later filtered and used as the extract.

Effect of the extract on fungal growth

The method of Amadioha and Obi (1999) was used to determine the effect of the extract on fungal growth. This involves creating a four equal section on each petri-dish by drawing two perpendicular lines at the bottom of the plate, the point of intersection indicating the centre of the plate. This was done before dispensing PDA into each of the plates. About 2 ml of the extract of the various plant materials were separately introduced into the petridish containing the media (PDA). A disc (4 mm diameter) of the pure culture of *Fusarium* sp. or *A. Flavus* or *A. niger* was placed on the extract, just at the point of intersection of the two lines drawn at the bottom of the petridish. Control experiments were set up without the addition of any plant material. Fungi toxicity was recorded in terms of percentage colony inhibition and calculated according the formula of Pandey et al. (1982).

Growth inhibition (%) = [(DC-DT)/DC] X 100

Where DC = average diameter of control, and
DT = average diameter of fungal colony with treatment.

Table 1. Occurrence of fungi in rotted yam.

Isolates	Occurrence %
F. oxysporum	13.96
A. niger	11.51
A. flavus	3.62
Rhizopus sp.	13.58
Penicllium sp.	15.21
P. chrysogenum	1.25
Botryodiploidia theobromae	5.70
Fusarium solani	2.13
Rhizoctonia solani	2.38
Geotrichum spp.	1.31
T. viride	14.14

Table 2. Growth inhibition of *F. oxysporum*, *A. niger* and *A. flavus* in culture by extracts of *X. aethiopica* and *Z. officinale*.

Plant material	Growth inhibition (%)		
	F. oxysporum	***A. niger***	***A. flavus***
X. aethiopica	52.2%	28.3%	27.3%
Z. officinale	31.5%	33.3%	18.2%

RESULTS AND DISCUSSION

Several spoilage fungi were isolated from rotted yams (Table 1). The most frequently occurring fungi are *Penicillium oxalicum*, *Trichoderma viride*, and *F. oxysporum*. The pathogenicity test revealed that three spoilage fungi (*F. oxysporum, A. niger and A. flavus*) induce rot in yams. *A. niger* was the most virulent. Hot water extracts of *X. aethiopica* and *Z. officinale* inhibited the radial growth of these fungi (Table 2), the inhibition being highest with *F. oxysporum*. The control experiment showed an uninhibited growth of the pathogens.

Several works have been carried on the areas of tuber rot of yam caused by several microorganisms in stored yams and in the field (Ogundana et al., 1970; Adeniji, 1970; Okigbo and Ikediugwu, 2001). Microorganisms responsible for rot in tubers in storage have also long been identified (Ogundana et al., 1970; Okigbo and Ikediugwu, 2000; Okigbo, 2002). These fungi include the ones that were identified in this work. In most cases, microorganisms gain access into yams through natural opening and wounds that occurs during harvesting and transporting from field to storage barn (Ogundana et al., 1970). However, yam tubers at time of harvest may already be infested by pathogens derived from disease foliage, roots or mother tubers. Tubers, which are already attacked by rotting pathogens when harvested get spoiled to greater extent in storage. The soil adhering to the tubers contain many organisms, indicating that potential pathogens are ubiquitous on the surface of normal freshly harvested yam tuber (Osagie, 1992). A wide range of microorganisms have been isolated from post- harvest rots of yam, although relatively few of these have been shown to be appreciably pathogenic (Ogundana, 1972; Adeniji, 1970; Osagie, 1992).

Some biological control measures have been carried out using microorganism to control yam rot. Okigbo and Ikediugwu (2000) showed that *T. viride* displaced the naturally occurring mycoflora on the surface of the yam tuber. This single application of *T. viride* effectively controlled the normal tuber surface mycoflora throughout six months storage, greatly reducing rotting. Okigbo (2002) also used *Bacillus subtilis* to control pathogens that affects white yam (*D. rotundata*) and it was found that *B. subtilis* displaces the natural occurring mycoflora on the surface of yam tubers as was observed in yams with *T. viride*.

This work revealed that fungitoxic compounds were present in *X. aethiopica* and *Z. officinale* since they were able to suppress the growth of microorganisms tested. This agrees with earlier reports by some workers on effects of these plants on pathogens of other crops (Amadioha and Obi, 1998, 1999). The fruit of *X. aethopica* is used as a soup condiment, and is valued for its carminative effect and as a cough remedy (Irvine, 1961; Maurice, 1993). Many water soluble antifungal substances have been found in the leaves of many trees including Norway maple (Dix, 1974). Amadioha (1998) reported that leaf extract of *Carica papaya* was shown to effectively inhibit the growth of powdery mildrew fungi (*Erysiphe cichoracerarum*) *in vitro*, with the greatest inhibition level recorded with 100% cold-water extract. Amadioha and Obi (1998) demonstrated the fungitoxic activity of seed extract of *Azadirachta indica* (neem) and *X. aethiopia* against the anthraconose fungus (*Collectotrichum lindemuthianum*) of cowpea. Both hot and cold water extracts inhibited spore germination and significantly reduce the growth of *C. lindemuthianum* on PDA medium. Onifade (2002) also reported the control of *C. lindemuthianum* using neem seed, fruit leaf, bark and root extract, recording a 100% inhibition of spore germination and mycelial growth.

The result of this work has shown that both *X. aethiopica* and *Z. officinale* have potential to control post harvest yam rot. This can provide an alternative ways of reducing and controlling rot by farmers. Fungicides of plant origin are environmentally safe and nonphytoxic. The extract of these plant materials can be easily prepared by farmers.

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