

Full Length Research Paper

Use of indigenous plant extracts for the protection of mechanically injured sweet potato [*Ipomoea batatas* (L.) Lam] tubers

Amienyo, C. A. and Ataga, A. E.*

Department of Plant Science and Biotechnology, University of Port Harcourt Port Harcourt, Nigeria.

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Protection of mechanically injured Sweet potato (*Ipomoea batatas* (L.) Lam) tubers from fungal rot with extracts of some indigenous plants namely; *Alchornea cordifolia*, *Annona muricata*, *Allium sativum*, *Gacinia cola* and *Zingiber officinale* was investigated. The following fungi; *Aspergillus flavus* link Ex fr, *Aspergillus niger* Van Tieghern, *Botryodiplodia theobromae* (Pat) novel, *Fusarium solani* Mart Sacc. Desm, *Fusarium oxysporum* schlecht and *Rhizopus stolonifer* Ehrenb ex link were isolated from rotted tissues and found to cause rots of sweet potato tubers. The water extracts of these plants suppressed fungal growth in culture and reduced rot development in the tubers when inoculated with the fungi. The highest percentage inhibition of 73.33% was obtained with the use of *Z. officinale* extract on *F. oxysporum* while *A. sativum* extract caused 6.91% inhibition of *F. solani*. Rot development caused by *B. theobromae* was reduced by 45.64% with the use of *A. cordifolia* while *Z. officinale* gave the highest inhibition of 70.99% on *R. stolonifer* inoculated tubers.

Key words: Plant extracts, rot fungi, rot inhibition, sweet potatoes.

INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam] is a dicotyledonous plant belonging to the family Convolvulaceae. The family includes about 45 genera and 1000 species, with only *I. batatas* of economic importance as food. Sweet potato ranks seventh among the world's major crops with an annum production of over 100 million tonnes (Nwoko-cha, 1992).

Sweet potato is an important staple food crop, particularly in Northern Nigeria where most of it is produced. It is one of the six important root and tuber crops grow in Nigeria. The other root crops are cassava, Yam, Irish potato, Cocoyam and Ginger. Within Sub-Sahara Africa, sweet potato is the third most important root tuber crop after cassava (*Manihot esculenta*) and Yam *Discorea* spp. (Ewell and Matura, 1991). Nigeria produces about 0.2% of the world's sweet potato (Agbo and Ene, 1994). The production of sweet potato in Nigeria can be improved by increasing productivity and avoiding crop failures caused by storage rots (Echerenwa and Umechuruba,

2004). The fungi reported to be associated with rotting of sweet potato include *Monilochaetes infuscans*, *Fusarium oxysporum*, *Ceratocysts fimbriata*, *Rhizopus stolonifer*, *Macrophomina phaseolina*, *Fusarium solani* and *Botryodiplodia theobromae* (Clark and Hoy, 1994). Onuegbu (2002) implicated *Penicillium* sp., *Certocystis fimbriata*, *Diaporthe batatalis*, *Aspergillus niger* and *Aspergillus flavus*, as fungi responsible for decay of Sweet potato tubers. Oyewale (2006) reported fungi associated with post harvest fungal rots to include *Mortierella ramanniana*, *Rhizopus stolonifer*, *Mucor pusillus*, *Botrytis cinerea*, *Erysiphe polygoni* and *A. flavus*. These fungi create local discolouration and disruption of surrounding tissues of infected tubers (Snowdon, 1991), resulting in changes in appearance, deterioration of texture and possibly flavour or taste. Rot fungi causes post harvest losses, reduction in the market value and misfortune to farmers. Fungicides such as Dichloronitroanline are used to protect tubers against *Rhizopus* soft rot (Clark and Moyer, 1988). However, the use of synthetic fungicides apart from their potential danger to both the farmer and environment (Obagwu et al., 1997), are unaffordable by most farmers. Recent studies on the use of plant extracts have opened a new avenue for the control of plant diseases. These plants extracts have been reported to be safe, non-phytototoxic to man, but effective against plant pathogens (Shi-

*Corresponding author. E-mail: aeataga@yahoo.com.
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vpuri et al., 1997). In Nigeria plant extracts have been used to control fungal diseases of plants such as cowpea (Amadioha and Obi, 1998), banana (Okigbo and Emoghene, 2004) and Yam (Okigbo and Nmeke, 2005).

The aim of this study, therefore, is to identify the fungi causing sweet potato tuber rots and to investigate the efficacy of using five local plant extracts in protecting the rot of sweet potato tubers in storage.

MATERIALS AND METHODS

Source of sweet potato tubers

Rotted Sweet potato tubers were collected from markets in Port Harcourt. These were packaged in polyethylene bags and taken to the laboratory in the Department of Plant Science and Biotechnology, University of Port Harcourt. Healthy tubers were also collected from the markets.

The local plants; *Alchornea cordifolia* (bark), *Annona muricata* (leaves) *Allium sativum* (bulb), *Zingiber officinale* (rhizome) and *Gacina cola* (fruits) used in this study were collected from vegetable gardens around Port Harcourt. These plants were verified and authenticated in the Herbarium unit of the University of Port Harcourt, Nigeria.

Isolation of fungi associated with rotted potato tubers

Rotted potato tubers were washed in tap water, and cut into sections with sterilized scarpel. The sections were surface sterilized in 1% sodium hypochlorite and rinsed with several changes of sterile distilled water. Ten sections of the sterilized tubers were plated out on potato dextrose agar incorporated with streptomycin. The plated Petri dishes were incubated at room temperature ($28 \pm 2^\circ\text{C}$) for 7 days and observed daily for fungal development. The developing fungi were identified and pure cultures were prepared and stored in slants for further use.

Pathogenicity test

Fresh, healthy sweet potato tubers were washed with tap water, rinsed with distilled water and surface sterilized with 70% ethanol. Cylindrical discs were removed from the tuber with a sterile 4 mm cork borer. A disc of a five days old culture of the isolated fungi was transferred into holes created in the tubers.

Vaseline was used to completely seal each side and pieces of cotton were placed on the Vaseline. The inoculated tubers were placed in separate airtight containers and incubated for 14 days at room temperature ($28 \pm 2^\circ\text{C}$). The same procedure was used for the control except that discs of uninoculated PDA were placed in the holes created in the tubers (Amienyo and Ataga, 2006). After incubation period, the tubers were examined for infection and disease development.

Preparation of plant extracts

The following local plants. *A. cordifolia* (bark); *A. muricata* (leaves) *A. sativum* (bulb); *Z. officinale* (rhizome) and *G. cola* (fruits) were dried and grounded separately. Thirty grams of each sample was added to 15 ml of distilled water in separate flasks. This was vigorously stirred and left to stand for 24 h. The sample was filtered with a whatman filter paper (No.1) and the filtrate used as the extract.

Effect of plant extract on fungal growth

Flat bottom flasks were used for the assay. Different percentages of the extract solution were poured into separate flask containing sterilized potato dextrose broth. With a sterile cork borer, the different fungi were inoculated into separate flasks and incubated at room temperature ($28 \pm 2^\circ\text{C}$) for 7 days.

After the incubation period, mycelium from different broths was taken on to pre-weighed filter paper, oven dried at 85°C and reweighed, until a constant weight was obtained. The changes in weight were noted. For the control, no plant extract was added to the potato dextrose broth.

Effect of plant extract on rot development

The method of Udo et al. (2001) was used to determine the effect of extract on rot development. Freshly harvested healthy tubers were washed with water, surface sterilized with 1% sodium hypochlorite solution and rinsed in five changes of sterile distilled water. The tubers were soaked in 10% plant extract and allowed to stand in the solution for 3 min. In the control, tubers were soaked in sterile distilled water for 3 min. The tubers were removed from the extract and water (for control) and incubated at room temperature for 24 h. Using a 1.1 cm cork borer, discs were removed from the extract treated and water treated control tubers, and replaced with 1.1 cm discs of a 5 day old culture of each test fungi. Vaseline jelly was used to completely seal each hole. The inoculated potato tubers were placed in sterile sealed containers and incubated at room temperature ($28 \pm 2^\circ\text{C}$) for 14 days.

After the incubation period, the tubers were incised horizontally with sterile knife. The length of rotted portion from each hole was measured over the total surface length with a metre rule. Fungitoxicity was determined in form of percentage growth inhibition was calculated according to the formula of Okigbo and Nmeke (2005).

$$\text{Growth inhibition (\%)} = \left\{ \frac{(\text{LC} - \text{LT})}{\text{LC}} \right\} \times 100$$

Where LC = average length of unrotted portion of control and LT = average length of unrotted portion with treatment.

Table 1. Occurrence of fungi isolated from diseased sweet potato tubers.

Isolates	Occurrence %
<i>Aspergillus flavus</i>	3.1 ± 0.05
<i>Aspergillus niger</i>	15.3 ± 1.2
<i>Fusarium oxysporum</i>	8.6 ± 0.7
<i>Fusarium solani</i>	3.4 ± 0.5
<i>Botryodiplodia theobromae</i>	49.1 ± 3.5
<i>Rhizopus stolonifer</i>	21.2 ± 2.1

*Means of five surveys with 95% confidence limit.

RESULTS AND DISCUSSION

Six storage fungi were isolated from the rotted sweet potato tubers. The most frequently occurring fungi were *B. theobromae*, *R. stolonifer*, *A. niger*, *A. flavus*, *F. oxysporum* and *F. solani* (Table 1).

Table 2. Inhibition (%) of mycelial growth of fungi grown in potato dextrose broth incorporated with plant extracts.

Rot fungi	Plant extract (% inhibition of mycelial growth)					
	<i>Alchornea cordifolia</i>	<i>Annona muricata</i>	<i>Gacinia cola</i>	<i>Zingiber officinale</i>	<i>Allium sativum</i>	Control
<i>Apergillus flavus</i>	49.62b	24.43b	53.44a	44.64c	38.94b*	0
<i>Aspergillus niger</i>	63.86a	48.8a	37.96a	32.54c	87.96a	0
<i>Fusarium solani</i>	56.35b	25.4b	3.97c	58.74b	42.07b	0
<i>Fusarium oxysporum</i>	61.63a	32.44b	26.36a	61.49b	44.60b	0
<i>Botryodiplodia theobromae</i>	76.7a	65.79a	35.73a	80.46a	81.21a	0
<i>Rhizopus stolonifer</i>	56.00b	44.00a	41.6a	46.6c	28.8c	0

*Values in a column with the same letters are not significantly different at (P = 0.05).

Table 3. Effects of plant extracts on the development of rot on sweet potato tubers.

Plant extract	Fungi (% inhibition)					
	<i>Fusarium solani</i>	<i>Fusarium oxysporum</i>	<i>Aspergillus niger</i>	<i>Rhizopus stolonifer</i>	<i>Apergillus flavus</i>	<i>Botryodiplodia theobromae</i>
<i>Zingiber officinale</i>	51.71a	73.33a	39.09b	70.99a	28.15c	30.67c
<i>Annona muricata</i>	34.05b	30.10c	30.19c	37.73d	41.35b	40.56b
<i>Gacinia cola</i>	32.01c	31.01c	30.19c	46.89b	28.80c	40.94b
<i>Alchornea cordifolia</i>	22.12d	37.38b	44.09a	42.91c	46.61a	45.64a
<i>Allium Sativum</i>	6.91e	36.27b	44.09a	45.08b	46.55a	35.74a
Uninoculated	0	0	0	0	0	0

Means followed by the same alphabets are not significantly different (P = 0.05).

The pathogenicity test revealed that these six fungi induced rot in healthy sweet potato tubers. The most virulent of these fungi was *R. stolonifer* which destroyed the tubers completely within few days. Water extracts of *A. cordifolia*, *A. muricata*, *G. cola*, *Z. officinale* and *A. sativum* significantly (P = 0.05) inhibited the mycelial growth of these fungi. The mycelial weight decreased as the plant extracts inhibited the fungal growth in culture medium (Table 2).

All the plant extracts significantly reduced rot development caused by all the test fungi (Table 3). The degree of protection of the tubers from rot by different plant extracts varied and was highly significant (P = 0.05). The highest reduction in rot development was caused by extract of *Z. officinale* with percentage inhibition of 73.3, 71 and 51.7% on the growth of *F. oxysporum*, *R. stolonifer* and *F. solani* respectively. The extracts of *A. sativum solani* reduced rot caused by *F. solani* on sweet potato tubers with 6.9% inhibition when compared with the control which recorded unlimited tuber rot.

Several workers have reported tuber rot of sweet potato caused by several fungi in storage (Clark and Hoy, 1994; Onuegbu, 2002; and Oyewale, 2006). In this study, similar fungi were identified and found to cause rot of the tubers. In most cases, fungi gain entrance into Sweet potato tubers through natural openings and wounds crea-

ted during harvesting, transporting, handling and marketing. However, Okigbo and Nmeka (2006) noted that crop tubers at time of harvest may already be infested by pathogens derived from disease foliage, roots or mother tubers.

This study revealed that fungitoxic compounds were present in *Z. officinalis*, *A. muricata*, *G. cola*, *A. cordifolia* and *A. sativum* since they were able to inhibit the growth of the fungi tested. This agrees with earlier reports of Udo et al. (2001) on the inhibition of growth and sporulation of fungal pathogens on *I. batatas* and *Dioscorea* sp. by garlic extracts and Okigbo and Nmeka (2005) on the use of leaf extracts of *Xylopiya aethiopica* and *Z. officinale* to control yam tuber rot caused by *F. oxysporum*, *A. niger*, and *A. flavus*. It was indicated that the antifungal activities of the plant extracts did not stop *in vitro* but in the *in vivo* as well. Olufolaji (1999) also reported that wet rot of *Amaranthus* sp. Caused by *Choaphora cucurbitarum* could be controlled by using plant extracts as protective measures.

In conclusion, this study has shown that the five indigenous plant extracts used have the potential application in the protection of mechanically injured sweet potato plant against rot fungi especially rot caused by *R. stolonifer*. This can provide an alternative way of reducing and controlling rot by farmers as it is less expensive, environ-

mentally safe and easy to prepare.

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