EVALUATION OF GARLIC (*ALLIUM SATIVUM*) AND UZIZA (*Piper guineense*) ON THE CONTROL OF TUBER ROT FUNGI OF POTATO AND CARROT

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ABSTRACT

Tuber rot in potato and carrot are major diseases occurring wherever potatoes and carrots are grown. This study investigated the control of tuber rot fungi of potato and carrot using extracts from garlic (*Allium sativum*) and uziza (*Piper guineense*). The following fungi; *Aspergillus niger*, *Aspergillus flavus*, *Fusarium solani* and *Geotrichum candidum* were isolated from rotted potato tubers while *Fusarium solani*, *Fusarium oxysporium*, *Geotrichum candidum* and *Rhizoctonia carotae* were isolated from rotted carrots. The pathogenicity test conducted showed that these organisms caused rots of potato and carrots. Aqueous extracts of garlic and uziza suppressed fungal growth and reduced rot development in the infected potato tubers and carrots. The highest percentage inhibition of 91.70% was obtained with the use of *P. guineense* extract on *G. candidum* on potato tubers while in Carrot 87.06% was obtained with a mixture of extracts from *P. guineense* and *A. sativum* on *F. oxysporium*. The use of extracts from *A. sativum* and *P. guineense* has great potentials in extending the shelf life of potato and carrot.

**Key words:** Potato, carrots, Tuber rot, shelf life, *Allium sativum*, *Piper guineense*

INTRODUCTION

Irish potato is one of Nigerian staple foods. It is a very rich source of starch and it has a high calorific value. The carrot is widely known as a vegetable that is easy to grow, delicious and highly nutritious. Though potatoes and carrots are very cheap in the production areas, they are relatively more expensive in other urban cities and this is due to lack of adequate transportation and preservation techniques in the country. Tuber rot in potato and carrot are major diseases occurring wherever potatoes and carrots are grown. Most of these rots cause substantial reduction in yield or quality (Zitter and Loria, 2002) and losses in transit and storage particularly in the warm regions where temperature is high and there are no facilities available for cold storage (Bdliya and Dahiru, 2006). Tuber rot in potato and carrot is caused by a variety of bacteria and fungi each causing its own type of rot. In potato the evident rots are the dry rot cause by *Fusarium spp*, soft rot by *Erwinia caratovora*, pink rot by *Phytophthora erythroseptica* and ring rot by *Corynebacterium sepedonicum* and in carrots are soft rot, dry rot and crater rot cause by *Rhizoctonia carotea* while sclerotina rot is cause by *Sclerotina sclerotiorum*, and gray mould rot by *Botrytis cinerea*. The activities of these microorganisms lead to the changes in appearance, deterioration of texture and possibly flavour or taste of the potato or carrot (Amienyo and Ataga, 2007).

Recent studies on the use of plant extracts have opened a new opportunity for the control of tuber diseases. *Allium sativum* and *P. guineense* are widely used in the control of clinical microbial isolates but rarely used on fungi associated with tuber rot in potato and carrot. The aim of this study is to carry out an evaluation of *A. sativum* and *P. guineense* in the control of tuber rot fungi of potato and carrot.

MATERIALS AND METHODS

Sample collection

Rotted potato tubers and carrots were collected from Gwagwalada market, Abuja. These were packaged in polyethylene bags and taken to the microbiology laboratory in University of Abuja immediately. *A.sativum* (bulb), *P. guineense* (seed), healthy potato tubers and carrots used for this study were purchased from the same market. Samples were selected and placed on the shelf to rot.
Isolation of organisms

Samples were washed with clean water and the diseased portion of the potato tuber and carrot were cut under aseptic condition into small bits into a sterile dish with the aid of sterile scissors (Ijato, 2011). The cut diseased bits were sterilized with 70% ethanol were then placed on Sabouraud Dextrose Agar (SDA) plates. The inoculated plates were then incubated at room temperature (28°C) for 7 days. The fungal colonies grown on the incubated plates were sub-cultured into fresh plates of SDA until pure culture was obtained. Microscopic examination was used after examining the colony characteristics for identification.

Pathogenicity test

Fresh, healthy potato tubers weighing 40±2g and carrots weighing 52±1g 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 ± 2°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 of 14 days at room temperature, the tubers were examined for infection and disease development.

Preparation of plant extracts

*Allium sativum* (bulb) and *P. guineense* (seed) were dried and grounded separately. Thirty grams of each sample was added into 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. 10ml of each extract was added into 90ml of sterile distilled water to make 10% of the extract. For 10% mixture of *A. sativum* and *P. guineense* extract, the extract was made up of 5ml of *A. sativum* extract and 5ml of *P. guineense* extract.
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 potato tubers and carrots were washed with water and surface sterilized with 70% ethanol. The potato tubers and carrots were divided into four (4) groups. The first group was soaked in 10% *A. sativum* extract, the second group in 10% *P. guineense* extract, the third group in 10% mixture of *A. sativum* and *P. guineense* extract, the fourth group was used as the control and was soaked in sterile distilled water and all were allowed to stand in the solution for 3 min. The potato tubers and carrots were removed from the extract and distilled water (for control) and incubated at room temperature for 24 hour. Using a 4mm cork borer, discs were removed from the treated tubers and replaced with 4mm discs of a 5 day old culture of each test fungi. Vaseline jelly was used to completely seal each hole. The inoculated potato tubers and carrots were placed in sterile sealed containers and incubated at room temperature (28 ± 2°C) for 14 days. After the incubation period, the potato tubers and carrots were incised horizontally with sterile knife. The length of ‘unrotten’ portion from each hole was measured over the total surface length with a metre rule. Percentage inhibition was obtained using the expression below.

\[
\text{% inhibition} = \frac{\text{length of ‘unrotten’ portion}}{\text{Total surface length}} \times 100
\]

Statistical analysis

The treatments were subjected to variance analysis (one-way ANOVA) via an SPSS. Mean separations were carried out using Duncans Multiple Range tests (DMRT) at P < 0.05.

RESULTS AND DISCUSSIONS

Fungal isolates

The fungal organisms isolated from the samples of rotten potatoes were identified as *Aspergillus niger, Aspergillus flavus, Fusarium solani* and *Geotrichum candidum* while fungi isolated from rotten carrots were *Fusarium oxysporium, Fusarium solani, Geotrichum*
candidum and Rhizoctonia carotae which were reported to be implicated in tuber rots (Amienyo and Ataga, 2007).

Pathogenicity test

The pathogenicity test on the fungi when inoculated into healthy potato tubers and carrot showed that these isolated fungi can induce rot (Table 1). The most virulent of these fungi was G. candidum which destroyed the tubers completely within six days than A. Flavus, A. Niger and Fusarium spp.

<table>
<thead>
<tr>
<th>Isolates</th>
<th>Potato</th>
<th>Carrot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>A. niger</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. flavus</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>G. candidum</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>F. solani</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Positive (+) negative (-): pathogenicity test result was positive for the fungi isolates and negative for the control.

Effect of plants extracts on tuber rots fungi

The treated potato tubers and carrots when inoculated with the respective test fungi and treated with the plant extracts, the degree of reduction or protection of the tubers from rot by the plant extracts varied and was highly significant (p<0.05) after incubation as shown in Table 2. The highest rot reduction in potato was seen with P. guineense which showed 91.70% reduction on G. candidum than A. Sativum (81.76%) on F. solani. A combination of P. guineense and A. Sativum also reduced potato tuber rot (84.47%) while A. flavus was the least susceptible to the extracts. However, there was no significant difference on the activities of all the extracts on A. flavus. The present result is similar with the findings of Okigbo et al. (2009) who recorded high rot reduction (62.80%) with A. sativum and also Udo et al (2001) reduced the growth and
sporulation of fungal pathogens on sweet potato and yam with garlic (*Allium sativum*).

**Table 2: Average percentage (%) inhibition of tuber rot on Potato and Carrot Extracts**

<table>
<thead>
<tr>
<th>Potato isolates</th>
<th>P. guineense</th>
<th>A. sativum</th>
<th>P. guineense + A. sativum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.niger</td>
<td>78.86a</td>
<td>72.56b</td>
<td>67.12c</td>
</tr>
<tr>
<td>A. flavus</td>
<td>49.58a</td>
<td>44.34a</td>
<td>41.62a</td>
</tr>
<tr>
<td>F. solani</td>
<td>66.52b</td>
<td>81.76a</td>
<td>84.47a</td>
</tr>
<tr>
<td>G. candidum</td>
<td>91.70a</td>
<td>62.27b</td>
<td>63.14b</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carrot isolates</th>
<th>F. solani</th>
<th>F. oxysporum</th>
<th>G. candidum</th>
<th>R. carotae</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>64.59b</td>
<td>85.61a</td>
<td>82.08a</td>
<td>71.93a</td>
</tr>
<tr>
<td></td>
<td>57.37b</td>
<td>83.57a</td>
<td>87.06a</td>
<td>62.50b</td>
</tr>
<tr>
<td></td>
<td>83.65a</td>
<td>62.50b</td>
<td>67.58b</td>
<td>62.50b</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

* Mean of data with the same letter on the same row are not significantly different by DMRT at P = 0.05

The highest rot reduction in carrot (87.06%) was observed with the combination of *P. guineense* and *A. sativum* on *F. oxysporum* than *A. sativum* on *F. solani* (85.61%). However all the extracts reduced rot of Carrot caused by *R. carotae* greatly with no significant difference and also *A. sativum* with a combination of *P. guineense* and *A. sativum* reduced rot of Carrot with no significant difference. However the lowest rot reduction was observed with *P. guineense* on *F. oxysporum* while the control recorded highly significant unlimited rot development. Studies by Ilondu and Iloh (2007) and also Eruteya and Odunfà (2009) have also confirmed that extracts of *P. guineense* prevented the growth of the fungi such as *A. Niger, Rhizopus stolonifer, Fusarium solani, Colletrichium sp., Pythium sp.* and *Cladosporium herbarium.*

The present study showed that *A. sativum* and *P. guineense* both have fungitoxic substance and potential to protect Potato and Carrot against rot fungi especially rot caused by...
G. candidum with a synergetic effect on F. oxysporum of Carrot by combining the two extracts. Several other works have confirmed the antimicrobial activity of garlic against a broad spectrum of fungal and bacterial organisms (Shashikanth et al., 1981; Gondwe et al., 1996; Shenge, 2002; Amodu, 2006). The antimicrobial properties of garlic have been attributed to the presence of an essential oil that contains allyl disulphide (C6H2 S2) diallyl disulphide (C6 H10 S2) and two or more sulphur-containing compounds (Shenge 2002; Obagwu, 2003).

The use of synthetic fungicides can be harmful to both farmers and the environment. This problem can be prevented by the use of biological methods which can provide an alternative way of reducing and controlling rot of tubers as it is less expensive, economically safe, non phytotoxic and easy to prepare.

REFERENCES


