POST-HARVEST DETERIORATION OF IRISH POTATO (*Solanum tuberosum* L.) BY MICRO-ORGANISMS

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ABSTRACT

Post harvest deterioration of Irish potato (*Solanum tuberosum* L) under storage was investigated in the laboratory and found to be caused by *Fusarium solani*. This fungus is a primary invader of the tubers and entry is through wounds arising from harvesting and handling. A range of growth media were used and potato dextrose broth supported the growth of the organism better than potato carrot broth and Czapek dox broth. The least growth was observed in Czapek dox broth.

Growth of this fungus was maximum at temperature of the 30°C and relative humidity of 90% while 4°C was found to be best storage temperature for the crop. A pH range of 2 – 10 supported the growth of the fungus with maximum growth occurring at pH of 4.

Keywords: Irish potato, micro organisms, growth media, temperature, relative humidity and pH.

INTRODUCTION

Irish potato (*Solanum tuberosum* L) belongs to the family of Solanaceae. It originated in the Andes highlands and probably in Peru or Bolivia where wild species were cultivated. Potato is a temperate crop though it is cultivated in mountainous areas in the tropics (Pursglove 1974). It grows in a cool moist climate in the temperate regions. The available information suggests that the optimum temperature for the tuber formation and growth in most varieties is about 15 – 20°C Bora and Milthope (1962) and it is said that above 29°C no tubers are formed Okonkwo et al (1995).

In Nigeria potato is grown in the Jos Plateau. This is because the Plateau has cold and moist climate similar to the regions which favour potato production. Osibegbasa (1976) reported that over 50,000 metric tonnes of potato was produced in Jos Plateau during the rainy months of April 1976. After harvesting the crop is transported by train or lorry to different parts of the country. During the harvesting, packaging, transportation and handling process, injuries are created both internally and externally which predispose them to decay by micro-organisms.

Considerable losses of vegetable such as carrots, potatoes and onions are caused by fungi and bacteria that produce soft rot of the host tissue. Under favourable conditions the tubers are reduced to soft mass held together only by the outer cork layer which the bacteria is unable to attack. The tubers infected with soft rot bacteria have slightly musty smell. They are usually secondary invaders. *Bacillus polymyxa* reduces potato to yellow sticky mass with distinctly fruity odour. (Raymond 1981).


In Nigeria, the proper storage of potato has received little attention compared to other advanced countries in Europe and America where sophisticated storage facilities are used such as refrigerated ware house and super markets, Hocker R.W. (1956). The problem associated with potato storage is quite enormous and thus has constituted major set back in cultivation of the crop. This is because potato stores best at 4°C and our room temperature here in Nigerian more than 20°C which is usually suitable for the growth of the fungi. Harvested crops meant for marketing are piled up in baskets and packed into lorries and trains. Under these conditions the tubers respire poorly and also cause tuber spoilage during storage. A good storage method ensures rapid removal of the products of respiration. Increase in temperature increases respiration Okonkwo et al (1995).

The objectives of this study are to:

i) Isolate and identify the micro-organisms causing decay of the potato tubers under storage.

ii) Ascertain some growth requirements of the organisms and determine environmental conditions that favour deterioration with a view to determining storage condition of Irish potato in Nigeria.
MATERIALS AND METHODS

Collection of Samples
The potatoes used for this study were obtained from super board stores and market gardens in
Port Harcourt and market garden along Aba-Owerri road, Aba. Reliable sources confirmed
that they were brought to these places from the Northern part of country. The materials
were purchased as the need for their use arose both healthy and diseased potatoes were
purchased and kept separately for the work.

Isolation of Causative organisms:
The media used in this study are potato
dextrose agar, potato carrot agar, cornmeal
agar (delihydrated), potato carrot broth, potato
dextrose broth, carrot dextrose broth and
Czapek dox broth. These media were
prepared according to the directions on the
labels. With a sterile scalpel small pieces of
the diseased tissues were cut from the
diseased tubers and quickly transferred to the
prepared medium in petri dishes. The plates
were incubated at 25°C (Booth, 1971) until
growth occurred; the pathogens were
subcultured in different media by picking the
advancing edge of the growth with a sterile
borer 10 mm in diameter.

Pathogenicity test:
To prove that the micro-organism already
isolated were responsible for the decay,
healthy tubers were sterilized, using cotton
wool soaked in ethanol. Borer of 10mm
diameter was used to make a
cylindrical hole of 15mm deep into the tuber
2 – 3 discs of the culture were aseptically lifted with
sterile needle and put into the holes and finally
sealed up with Vaseline so as to prevent the entry of
other micro-organisms. As a control, similar
operation was performed on the healthy tubers but
place of growing (pathogens) similar discs of potato
dextrose agar medium was used. All the treated
tubers were separately incubated at 25°C. A cut was
separately made through the inoculated spot of the
treated tubers and the control after 7 days of
incubation. The pathogens were reisolated from the
decayed tissue and identified to be the ones
previously isolated.

i). Growth studies on the pathogens:
Effect of different media on the growth of the
pathogens. The effect of the following media on the
growth of pathogens were investigated: Potato carrot
broth (PCB), carrot dextrose broth (CDB), potato
dextrose broth (PDB) and Czapek dox broth (CD). The
above media were made out of their respective
compositions. They were sterilized and 200ml of
each dispensed into sterile flasks. The flasks were
then inoculated with a three day old discs of fungal
inoculum and incubated. The mycelia growing on
the different media were harvested and weighed at 3
days interval.

ii). Effect of temperature on the growth of pathogen:
PDB and CDB were used to determine the effect of
temperature on the growth of pathogens. The
following temperatures were investigated: 10°C,
20°C, 30°C, 35°C, and 40°C. 200ml of each medium
was poured into each flask inoculated with a three
day old culture and incubated for 12 days. Growth for each temperature was determined by harvesting 3
flasks at a time at an interval of 3 days. The weight of the fungal mycelium was recorded and the average of the mycelium growth in the 3 flasks was taken. For the control, sterile agar discs were inoculated into conical flasks containing each medium and incubated at the same temperature together with the other flasks containing the inoculum.

Effect of pH on growth of pathogen:
Potato and carrot extract broths were dispensed into
conical flasks and for each pH value a total of five
flasks were used for the two media twenty flasks
were used. The pH value investigated were 2, 4, 6, 8
and 10. Inoculation was made with a 3 day old
culture and incubated at 30°C. Fungal mycelium was
harvested at 3 – day interval.

Environmental effects on decay development.
i). Effect of temperature: 12 healthy tubers
were sterilized and aseptically inoculated with a three-day old culture as earlier described.
These were incubated at temperatures of 5°C,
10°C, 15°C, 20°C, 25°C and 30°C for seven
days. For the control, healthy tubers were
aseptically inoculated both with sterile agar
discs and incubated at the same temperature
with treated tubers. After 7 days the tubers were
incubated for measurement of the decay determined by
ii). Effect of relative humidity: twelve tubers
were sterilized as earlier described and
inoculated with a three-day old culture of the
pathogen. These were placed in the
dessicators above solutions previously
prepared to give relative humidities of 60%,
75%, 80%, 90% and 95% according to
Solomon (1957). (Table I).

A relative humidity of 100% was obtained with distilled water only. Extent of
delay was determined after 3 days interval by
measuring lengthwise from the point of
inoculation. For the control, the tubers were
inoculated with sterile agar disc and treated to
the same relative humidity.

RESULTS
The organism responsible for the
storage rot of potato was identified as Fusarium solani. The following
caracteristics helped with the identification of
the organism on light microscope.
(a) colour of mycelia (whitish mesh of
mycelia which turned gray with age)
(b) fruiting bodies, microconidia and
macroconidia (c) Septate hyphae.

From the pathogenicity test, the tissue
inoculated with isolated pathogens had symptoms similar to those observed on the earlier decayed tissues. The pathogens completely devastated the tissues of the tuber. The whole mass of tissue became soft, turned brown and emit a distasteful odour after 12 days. The skin of the tuber crumbled and large amount of liquid leaked out of the degraded mass.

From the growth studies carried out on the pathogens, the growth of the pathogen determined on the four media was found to be greatest on potato dextrose broth followed by carrot dextrose broth and the least growth was recorded on Czapek dox broth. (Table II). Results show that the pathogen grew well at the temperature ranges of between 20°C to 35°C with an optimum growth at 30°C (Table III). The result of the pH on the growth of the pathogen showed that *Fusarium solani* grew reasonably on a wide range of pH with a measurable growth occurring at pH as low as 2 and at pH as high at 10 with the greatest at 4 (Table IV). The greatest decay was obtained at the temperature of 30°C followed by 25°C and at 10°C the decay was minimal. The results of the study showed that the greatest decay of the tubers occurred at the relative humidity of 90% while the least occurred at 60% (Table V).

**DISCUSSION**

In Jos Plateau where the bulk of the potato is produced in Nigeria, the harvested tubers are stored in giant baskets and covered up with dry leaves until they can be transported to southern Nigeria for sale. Barns are rarely constructed for Irish potato, as is the case with yams in storage. This is because potatoes are not handy enough and decay within a comparatively shorter period of storage. The early decay is overcome by selling the tubers immediately after harvest and processing into other food products (Okonkwo et al, 1995).

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**TABLE I: COMPOSITION OF THE SOLUTIONS USED TO OBTAINED DIFFERENT LEVELS OF RELATIVE HUMIDITY**

<table>
<thead>
<tr>
<th>%RH at 25°C (mm Hg)</th>
<th>Vapour Pressure</th>
<th>%Wt H₂SO₄ per 100g of solution</th>
<th>Distilled Water (ml)</th>
<th>Sulphuric Acid (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>23.756</td>
<td>0 i.e distilled water only</td>
<td>500</td>
<td>55</td>
</tr>
<tr>
<td>95</td>
<td>22.568</td>
<td>11.02</td>
<td>445</td>
<td>85</td>
</tr>
<tr>
<td>90</td>
<td>21.380</td>
<td>17.19</td>
<td>415</td>
<td>150</td>
</tr>
<tr>
<td>75</td>
<td>17.817</td>
<td>30.14</td>
<td>350</td>
<td>190</td>
</tr>
<tr>
<td>60</td>
<td>14.254</td>
<td>38.35</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

Adopted from Solomon M-=E. (1975) control of relative humidity with potassium hydroxide, sulphuric acid and other solutions.

**TABLE II: EFFECT OF MEDIA ON THE GROWTH OF THE PATHOGEN**

<table>
<thead>
<tr>
<th>Days</th>
<th>Media and Mycella and dry Wt. in (Mg)</th>
<th>CDB</th>
<th>PDB</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>50</td>
<td>60</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>87</td>
<td>25</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
<td>166</td>
<td>42</td>
</tr>
<tr>
<td>12</td>
<td>150</td>
<td>192</td>
<td>59</td>
</tr>
</tbody>
</table>

**TABLE III: EFFECT OF TEMPERATURE ON THE GROWTH OF THE PATHOGEN**

<table>
<thead>
<tr>
<th>Temp. °C</th>
<th>Days of Incubation and mycella Dry Wt. (Mg)</th>
<th>3</th>
<th>6</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9</td>
<td>10</td>
<td>15</td>
<td>15</td>
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<tr>
<td>20</td>
<td>65</td>
<td>70</td>
<td>120</td>
<td>140</td>
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<tr>
<td>30</td>
<td>109</td>
<td>130</td>
<td>150</td>
<td>200</td>
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<tr>
<td>35</td>
<td>70</td>
<td>35</td>
<td>125</td>
<td>170</td>
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<tr>
<td>40</td>
<td>20</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

**TABLE IV: EFFECT OF pH ON THE GROWTH OF THE PATHOGEN**

<table>
<thead>
<tr>
<th>pH values</th>
<th>Day of Incubation and mycella Dry Wt. (Mg)</th>
<th>3</th>
<th>6</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>40</td>
<td>55</td>
<td>70</td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>125</td>
<td>240</td>
<td>290</td>
<td>360</td>
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<tr>
<td>6</td>
<td>50</td>
<td>105</td>
<td>240</td>
<td>280</td>
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<td>8</td>
<td>75</td>
<td>120</td>
<td>170</td>
<td>188</td>
</tr>
<tr>
<td>10</td>
<td>55</td>
<td>100</td>
<td>130</td>
<td>172</td>
</tr>
</tbody>
</table>
In spite of these precautionary measures taken to avoid decay of potatoes under storage, the tubers still store very poorly. Microorganisms constitute by far the most important storage problem in Nigeria. Others are high respiratory break down as respiration decreases with increase in temperature Okonkwo (1995). High moisture losses development of pithiness, low dry matter content and various chemical changes.

The results obtained from pathogenicity test implicated Fusarium solani as the causal organism for the decay of Irish potato tubers on storage. Fusarium causes rot and crown rot of storage legumes in the most productivity areas and is of major importance in the Northern United States.

Kommendal et al (1970) reported that Fusarium sp are ubiquitous in roots and stalk of corn and other plants, some species of Fusarium are known to be soil borne and it is suspected that the rampant invasion of tubers arise from the field.

Growth studies on Fusarium solani revealed that the natural media-potato dextrose broth general supported better growth and reproduction and frequently poorer in synthetic media. Fusarium solani grew at the temperature range of 20-35°C with an optimum at 30°C. Bartz and Kelman (1984) observed that the severity of Erwinia carotovora on stored tuber was greater at 20 – 23°C. The best growth for the fungus tolerated the range of pH of 2-12 with optimum at 5. The pH of potato extract is 5.2. Rot occurred at the relative humidities of 60-100% with the storage problems of Irish potato in Nigeria by Ifenke and Nwokocha (1978) implicated the rot of tubers to be the activities of a number of micro-organisms which include bacteria and fungi. No attempt was made to elucidate the primary invader or parasite of tubers. This study has further specified a primary invader of the tuber fungus Fusarium solani.

In view of the present financial condition of Nigerian potato farmers and the level of technology involved in providing the structures for the storage temperatures farmers should try to store these crops at the temperature of 4°C which is the best since it effectively reduces the growth of pathogens. Low temperature storage (2-4°C) reduces tuber loss due to bacteria and fungi infection (Burton, 1966).

In developed countries, this problem of storage has been reduced because these crops serve as major staple food but in Nigeria besides the economic recession that idea of constructing storage problem is not that can be handled by individual farmers, improved harvesting is recommended. As a general principle, only those root crops that are free from diseases and that have been carefully harvested should be stored. Slightly wounded tubers can be cured and handling of the tubers should be improved.

In many tropical countries such as Nigeria effective storage can be achieved under ambient conditions with the use of more sophisticated techniques and equipment required to obtained good storage temperature control.

CONCLUSION

In conclusion, the pathogenic micro-organism causing decay of the tuber of Irish potato (Solanum tuberosum) (L) under storage was isolated and identified as Fusarium solani potato dextrose broth and potato carrot broth supported good mycelial growth of Fusarium solani with the least growth occurring on Czapek dextrose broth. The fungus grew well at the temperature range of 20 – 35°C with optimum at 30°C. Maximum rot occurred at 30°C. Relative humidity of 60 – 100% favoured rot development with maximum at 90%. Pathogens enter the tissue of host through wounds of the surface during harvesting, transportation and handling. It is recommended that bruised tubers should be immediately used, and not stored, also tubers should be handled carefully to avoid wounding and should not be stored in heaps, as poor respiratory problems may arise and thus predispose the tubers to rot development. It has been found that temperature of 4°C is best for the storage of tubers for minimum rot development.

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