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

N. A. ONUNKA, and U. N. EKWENYE

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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^{0}C and relative humidity of 90% while 4^{0}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.

INTRODUCTON

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 (Purseglove 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^{0}C Bora and Milthope (1962) and it is said that above 29^{0}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. Obigbesan (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 pollymyxa* reduces potato to yellow sticky mass with distinctly fruity odour. (Raymond 1981).

Some soil borne pathogens for example *Fusarium solani* attack potato tubers even before they are harvested (Turkensteen 1987).

Barts and Kelman (1984) associated the ring rot of potato with *Erwinia carotovora* spp atroceptica. Bhatti *et al* (1984) also implicated *Pseudomonas slonaceae* in the brown rot of potato in Panjab.

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. (1966). The problem associated with potato storage is quite enoumous and thus has constituted major set back in cultivation of the corp. This is because potato stores best at 4^{0}C and our room temperature here in Nigerian more than 20^{0}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.

N. A. ONUNKA , National Root Crops Research Institute, Umudike, Nigeria
U. N. EKWENYE, Department of Biological Sciences, Federal University of Agriculture, Umudike, 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 (dehydrated), 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 scapel 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^{0}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 tubes 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^{0}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 dxtrose 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*

PDP and CDB were used to determine the effe of temperature on the growth of pathogens. Th following temperatures were investigated: 10^{0}C 20^{0}C, 30^{0}C, 35^{0}C, and 40^{0}C. 200ml of each mediu was poured into each flask inoculated with a thre day old culture and incubated for 12 days. Growt for each temperature was determined by harvesting flasks at a time at an interval of 3 days. The weigh of the fungal mycelium was recorded and the averag of the mycelium growth in the 3 flasks was taken For the control, sterile agar discs were inoculate into conical flasks containing each medium an incubated at the same temperature together with th other flasks containing the inoculum.

Effect of pH on growth of pathogen:

Potato and carrot extract broths were dispensed int conical flasks and for each pH value a total of fiv flasks were used for the two media twenty flask were used. The pH value investigated were 2,4,6,8 and 10. Inoculation was made with a 3 day ol culture and incubated at 30^{0}C. Fungal mycelium wa harvested at a 3 – day interval.

Environmental effects on decay development

i). *Effect of temperature:* 12 healthy tubers were sterilized and aseptically inoculated wit a three-day old culture as earlier described These were incubated at temperatures of 5^{0}C 10^{0}C, 15^{0}C, 20^{0}C, 25^{0}C and 30^{0}C for seve days. For the control, healthy tubers were aseptically inoculated both with sterile aga discs and incubated at the same temperature with treated tubers. After 7 days the tubers were cut across through the point o inoculation and extent of decay determined by measurement using a ruler.

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 decay 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 characteristics 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 macrocondia (c) Septate hyphae.

From the pathogenicity test, the tiss

inoculated with isolated pathogen 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).

DISCUSSIÓN

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 (Oknonklwo *et al*, 1995).

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

%RH. at	Vapour Pressure 25°C (mm Hg)	%Wtg H_2SO_4 per 100g of solution	Distilled Water (ml)	Sulphuric Acid (ml)
100	23.756	0 i.e distilled water only	500	
95	22.568	11.02	445	55
90	21.380	17.19	415	85
75	17.817	30.14	350	150
60	14.254	38.35	300	190

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

Days	Media and Mycelia and dry Wt in (Mg)			
	CDB	PDB	PCB	CD
3	50	60	15	8
6	80	87	25	10
9	100	166	42	14
12	150	192	59	120

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

Temp. °C	Days of incubation and mycelia Dry Wt. (Mg)			
	3	6	9	12
10	9	10	15	15
20	65	70	120	140
30	109	130	150	200
35	70	85	125	170
40	20	40	30	20

TABLE IV: EFFECT OF pH ON THE GRWOTH OF THE PATHOGEN

pH values	Days of incubation and mycelia Dry Wt. (Mg)			
	3	6	9	12
2	40	55	70	95
4	125	240	290	360
6	50	105	240	280
8	75	120	170	188
10	55	100	130	172

TABLE V: EFFECT OF TEMPERATURE AND RELATIVE HUMIDTY ON TUBER DECAY BY THE PATHOGEN.

Temp. ^{0}C	Dist. of Decay (mm)	%RH	Dist. of Decay (mm)
10	5	100	30
15	13	95	25
25	27	90	27.5
30	30	75	17.5
35	25	60	7
40	-	-	-

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. *Fusarim solani* grew at the temperature range of 20-35^{0}C with an optimum at 30^{0}C. Bartz and Kelman (1984) observed that the severity of *Erwinia carotovora* on stored tuber was greater at 20 – 23^{0}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 humilities of 60-100% with the storage problems of Irish potato in Nigeria by Ifenkwe 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 crop at the temperature of 4^{0}C which is the best since it effectively reduces the growth of pathogens. Low temperature storage (2-4^{0}C) reduces tuber loss due to bacteria and fungi infection (Burton, 1966).

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

In many tropical countries such as Nigeri effective storage can be achieved under ambien conditions with the use of more sophisticate techniques and equipment required to obtaine 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 an identified as *Fusarium solani* potato dextrose brot and potato carrot broth supported good myceli growth of *Fusarium solani* with the least growt occurring on Czapek dox broth. The fungus grew well at the temperatur range of 20 – 35^{0}C with optimum at 30^{0}C Maximum rot occurred at 30^{0}C. Relative humidity of 60 – 100% favoured rot development wit maximum at 90%. Pathogens enter the tissue of hos through wounds of the surface during harvesting transportation and handling. It is recommended tha bruised tubers should be immediately used, and no stored, also tubers should be handled carefully t 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^{0}C is best for the storage of tubers for minimum rot development.

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