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RESEARCH ARTICLE

MYCOLOGICAL ASSESSMENTS OF POSTHARVEST ROT OF IRISH POTATO TUBERS FROM SELECTED MARKET WITHIN KADUNA METROPOLIS, NIGERIA

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ABSTRACT

The mycological assessments of postharvest rot of irish potato from selected market within Kaduna metropolis, Nigeria were carried out. Fifteen (15) tubers of irish potato showing symptom of rot were collected from (4) four different market, totaling sixty (60) samples all together. The selected markets were; Ungwan rimi, Malali, Chechenia and Kaduna State University (KASU) school markets. Segment of the tissue from the margins of the spoilt irish potato were cut with sterile scalpel and were placed on the prepared sabouraud dextrose agar plate (SDA) in petri-dishes and were incubated at 28±2ºC for 5days. The mycelia of fungi isolates were viewed under the microscope using 4X and 40X magnifications. Pathogenicity test were carried out on heathy tubers. The fungi identification were made using identification atlas. Fungi such as *Rhizopus stolonifer, Fusarium oxysporum, Aspergillus niger, Aspergillus flavus, Penicillium* sp *and Mucor racemosus* were isolated with different frequencies from the sampled potato. Irish potato from Ungwan rimi market had *R.stolonifer* 6(40.0%) *F.oxysporum* 4(26.7%) *A.niger* 2(13.3%) *A.flavus* 1(6.7%) *Penicillium* species 2(13.3%). Irish potato from Malali market had *R. stolonifer* 4(26.7%) *F.oxysporum* 3(20.0%) *.A.niger* 2(13.3%) *A.flavus* 3(20.0%) *Penicillium* sp 2(13.3%) *M.racemosus* 2(13.3%), Irish potato from Chechenia market had *R.stolonifer* 6(40.0%) *F.oxysporum* 4(26.7%) *A.niger* 2(13.3%) *Penicillium* sp 2(13.3%) *M.racemosus* 1(6.7%). Irish potato from Kasu market had *R.stolonifer* 5(33.3%) *F.oxysporum* 3(20.0%) *A.niger* 3(20.0%) *A.flavus* 2(13.3%) *Penicillium* sp 1(6.7%) *M.racemosus* 1(6.7%) respectively. The results from the pathogenicity test showed that fungi induced different level of decay with *R.stolonifer* as the most virulent fungus followed by *F .oxysporum* and *M.racemosus* as the least virulent fungus. This study showed that many fungus have been found to cause storage rot of irish potato within selected markets of the metropolis. This pathogen leads to the enormous loss of potato tubers. In order to prevent the fungi causing rot in irish potato preventive measures such as adequate storage facilities and segregation of rotten irish potato tubers from healthy ones should be duly exercised.

INTRODUCTION

Potato is generally considered to have originated from the region between latitude 10°N and 20°S at an altitude of 2000 meters but to be precise in Bolivia (Lang 2001). FAO (2008) identified the centre of origin to be between Mexico and Chile but specifically suspected the Andean highland of Bolivia or Peru, where the presence of wild species of the crop serves as clues. Among crops Irish potato (*Solanum tuberosum* L.) ranks fourth in the world in terms of economic importance (Horton, 2002). Developing countries account for 25% of the world potato production. Potato is indigenous to South America and is believed to have been brought to England in 1586. It first become an important food crop in Ireland and was reintroduced into South America from that country, hence the name Irish Potato Hoffler and Ochieng (2008). It is now grown extensively throughout the world and is one of the important agricultural crops, world production reached a record of 320million tonnes in 2007 and production in the developing countries has almost doubled since 1991, with a corresponding increase in consumption (Hoffler and Ochieng 2008). The intake of potatoes is recommended for people suffering from hyperacidity, because they possess base-forming properties. Potato juice relieves stomach pains (Salami, 2007). Potato requires high altitude about 1000-1800 meters above sea level, and low temperature of 15°C or less. In Nigeria the crop is grown in Jos and Manbilla Plateau, with altitude of at least 1400 meters above sea level and a temperature about 10-20°C. Potato is produced in several northern states such as in Borno,

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Kaduna, Kano and Sokoto during the colds and dry seasons. However production is concentrated in Jos plateau and accounted for over 75% of the total production in Nigeria (Lang, 2000).The production was encouraged by the British Colonial government during the Second World War as the tubers were needed to feed their armed forces in West Africa. Since then, the importance of potato has been widely realised such that it is now an important commodity in both local and international trade (Hawkes, 2001). Numerous cultivers exist but "twenty eye" and "smooth skin" are particularly suitable for west Africa. Although the potato cultivated worldwide belongs to just one botanical species Solanum tuberosum, come in thousand of varieties with great difference in size, shape, colour, texture, cooking characteristics and taste, the varieties include, Atahualpa, Nicola, Russet, Burbank, Lapin pulkula, Yukon Gold, Spunta and Maris bard (Kora *et al.,* 2003). Despite its nutritional importance, the tubers have short storage life, generally, less than four weeks in the tropics. Their skin is easily damaged during harvest and post-harvest handling leaving the crops highly perishable in microbial spoilage (Kora *et al*., 2003). Potato is an important source of dietary fibre and in Great Britain contributes 15% of the intake of food. Vitamin C is the main vitamin in potatoes. Fresh tubers have vitamin content in the range of 15-24mg per 100g fresh weight (Badiru *et al.,* 2005). An acceptable potato method should be able to take care of some issues that arise when potato is kept for a long time. These include the consequences of sprouting (which may not apply to seed potato damage due to high and very low temperatures, water and respiratory losses, mechanical injure which may precipitate further losses due to pathological factors (Horton, 2008). *Fusarium* dry rot of potatoes is a worldwide economic problem. There are many species of *Fusarium* reported to cause dry rot of potato Worldwide. The disease may cause greater losses of potatoes than any other-post harvest disease. Crop losses attribute to dry rot have been estimated to an average of 6 to 25% (Owunbiko *et al*., 2005). Salami(2007) identified *Rhizopusoryzae, Fusariumredolens, Butryodiplodiatheobromae, Fusarium oxysporum, Aspergillusniger and Penicilliums*pecies were responsible for postharvest rot of irish potato tubers. This research is aimed at carrying out the mycological assessment of spoilt irish potato from in selected markets within kaduna metropolis.

MATERIALS AND METHODS

Collection of Sample

Irish potato tubers of nicola variety showing symptoms of rot were randomly selected from four different markets namely,Chechenia market, Ungwanrimi market, Malai market,Kasu School market. The tubers were put singly into sterile polythene bags and brought to the microbiology laboratory of Kaduna State University, Kaduna for further mycological analysis.

Study Area

The study was conducted at the Department of Microbiology, Kaduna State University, Kaduna Kaduna State is located in the Northwest of Nigeria at 10.1590º north and 8.1339º east (Olukosi, 2005). The area has an average annual rainfall of 550mm, it is characterized by long dry season (October to February) and short rainy season (March to September). The average monthly temperature ranges from 21 to 39^0C and is lowest in December and January. Heat is more severe in February and a bit of March (Muhammad *et al*., 2004).

Isolation and Identification of Associated Fungi from Rot Irish Potato

The diseased tubers of irish potato were washed with tap water and wiped with cotton wool soaked in 70% alcohol. The tubers were cut through by means of sterile scaple. Slicing were done starting from the healthy portions. Pieces of 5 x 5mm were cut and plated on sabouraud dextrose agar (SDA) and incubated at room temperature for 5 days (Kora *et al.,* 2003). Representative colony types were purified by sub-culturing on fresh SDA plates. Pure cultures were transferred to slants of SDA and were grown singly on SDA for identification. The fungi were identified based on their colonial characteristics on culture plates and a sterile inoculating needle was used to pick portion of each mycelia aseptically and were placed on a clean microscope slide and tease in a drop of lacto phenol cotton blue. The isolates were identified by reference to Kora *et al.(*2003) and identification atlas (Bernward *et al*,. 1980).

Pathogenicity Test

Fresh and healthy tubers of irish potato were washed with tap water and surface sterilized with 70% ethanol. Cylindrical cores were removed from the tubers with help of 5mm cork borer. Four millimeter (4mm) agar discs containing 7days old cultures of the isolates were introduced into the holes and then sealed with the sterile vaseline. Controls were set up as described except that the inocula consist of uninoculated sabouraud agar blocks. All the treated tubers were put singly into sterile polythene bags and incubated at 28 ± 2ºC for 10 days. The tubers were cut through and examine for rot at the end of the incubation period (Kabiel*et al.,* 2008).

RESULTS

Table 1 showed the result obtained from rotirish potato samples collected from KASU market. Out of the fifteen samples collected, *R.stolonifer* had 5(33.3), *F.oxysporum* 3(20.0), *A.niger* 3(20.0), *A.flavus* 2(13.3), *Penicillium* sp1(6.7) and *M. racemosus* 1(6.7) occurrences (Table1). The result from the rot irish potato samples obtained from Ungwanrimi market showed that *R.stolonifer* had 6(40.0*), F. oxysporum* 4(26.7), *A.niger* 2(13.3), *A.flavus*1(6.7) and *Penicilliums*p 2(13.3) occurrence (Table 2) . Table 3 showed the result obtained from Malali market with *R.stolonifer* having 4(26.7*), F.oxysporum* 3(20.0), *A.niger* 2(13.3), *A.flavus* 3(20.0), *Penicillium* sp 1(6.7) and *M.racemosus* 2(13.3) occurrences. Table 4 showed the fungal isolates from Chechenia market with their corresponding frequency and percentages. *R.solonifer* had 6 (40.0), *F.oxysporum* 4(26.7), *A.niger* 2(13.3*), Penicillium* sp 2(13.3) and *M.racemosus* 1(6.7) occurrences. The colonial and microscopic appearance of all the isolates from all the spoilt tubers examined were recorded. *R.stolonifer* appeared white, brownish grey to blackish and microscopically appeared with sporangiospores. *F.oxysporum* had a colonial appearance showing violet purple pigment and a microscopic appearance showing hyaline and septate hypha. *A.niger* appeared having a velvet dark brown to black colour and a microscopic appearance showing large, globe, dark brown conidial heads. *A.flavus* showed a greenish yellow surface with a white border

Table 1. Fungal Species Isolated from Rot Irish Potato Collected from KASU Market

Fungi Species	Number of Isolates	Percentage (%)
Rhizopus stolonifer	5	33.3
Fusarium oxysporum	3	20.0
Aspergillus niger	3	20.0
Aspergillus flavus	2	13.3
Penicillium sp	1	6.7
Mucor racemosus	1	6.7
Total	15	100

Table 2. Fungal Species Isolated from RotIrish Potato Samples Collected from UngwanRimiMarket

Fungi Species	Number of Isolates	Percentage (%)
Rhizopus stolonifer	6	40.0
Fusarium oxysporum	4	26.7
Aspergillus niger	2	13.3
Aspergillus flavus	1	6.7
Penicillium sp	2	13.3
Total	15	100

Table 3. Fungal Species Isolated fromRot Irish Potato Collected from MalaliMarket

Fungi Species	Number of Isolates	Percentage (%)
Rhizopus stolonifer	4	26.7
Fusarium oxysporum	3	20.0
Aspergillus niger	2	13.3
Aspergillus flavus	3	20.0
Penicillium sp	1	6.7
Mucor racemosus	2	13.3
Total	15	100

Table 4. Fungal Species Isolated from RotIrish potato Collected from Chechenia Market

Fungi Species	Number of Isolates	Percentage (%)
Rhizopus stolonifer	6.7	26.7
Fusarium oxysporum	4	20.0
Aspergillus niger	2	13.3
Penicillium sp	2	6.7
Mucor racemosus	1	13.3
Total	15	100

colonially and microscopically showing septate hypha with long conidiophores. *Penicillium* species appeared having a white fluffy luxuriant growth and microscopically appeared having a septate hypha with conidiospores. *R.racemosus* had a colonial appearance of white to belge and are fast growing, it has a non septate broad hypha with visible sporangiophores, sporangia and spores microscopically (Table 5). Table 6 showed the pathogenicity test which revealed the ability of all the isolates to cause disease in healthy tubers and the corresponding diameters (mm) showing the level of rot. Irish potatofrom KASU market had*stolonifer* with 49mm, *F.oxysporum* 40mm, *A.niger* 40mm, *A.flavus* 35mm, *Penicillium* sp 33mm, *M.racemosus* 24mm. While irish potato from Ungwan rimi market had*R. stolonifer*with 50mm, *F.oxysporum* 44mm, *A.niger* 31mm, *A.flavus* 21mm, *Penicillium* sp 27mm, *M.racemosus* 24mm. Malali market irish potato had*R. stolonifer*with 48mm, *F.oxysporum* 43mm, *A.niger* 33mm, *A.flavus* 37mm, *Penicillium* sp 29mm, *M.racemosus* 21mm. While irish potato from Chechenia market showed *R. stolonifer*with 52mm, *F.oxysporum* 41mm, *A.niger* 36mm, *Penicillium* sp 30mm and *M.racemosus* 26mm respectively.

DISCUSSION

The fungi associated with storage rot of irish potato tubers in the selected markets within kaduna metropolis (Kasu, Ungwan rimi, Malali and Chechenia market) had fungi species such as *R. stolonifer, Aspergillus niger, A. flavus, F. oxysporum, Penicilliums*p*, M. racemosus* and *Alternaria alternata*. This is similar to the findings of Salami *et al.* (2007) who identified *Rhizopus oryzae, Fusarium redolens, Butryodiplodia theobromae, Fusarium oxysporum* and *Penicillium* sp as principal organism responsible for postharvest rot of irish potato tubers. The results of this study are in agreement with the findings of Muhammed *et al*. (2004) who revealed that fungi constitute a menace in storage rot of many agricultural commodities. It was observed that *R. stolonifer* is the most frequently isolated fungus from spoilt irish potato tubers within the selected markets within kaduna metropolis. It has been discovered that *F. oxysporum* is the most freqently isolated fungus from rotted irish potato tubers in southwestern, Nigeria as reported by Salami *et al*. (2007).

Table 5. Characteristics of Fungal Species Isolated from Rot Irish Potato from Different Markets

Fungal species	Colonial Appearance	Microscopic Appearance
Rhizopus stolonifer	White colony initially becoming brownish Grey to blackish.	Sporangiospores, smooth walled, non Septate, and powdery in appearance.
Fusarium oxysporum	Violet purple pigment	Hypha were hyline and septate.
Aspergillus niger	Velvet dark brown to black color	Large, globose, dark brown conidial heads which become radiate with age.
Aspergillus flavus	Greenish yellow surface with a white border	Septate hypha with long conidiophores which have a rough texture or spinny below the vesicle
Penicillium sp	White fluffy luxuriant growth	Septate hypha, hyaline with simple or branched conidiospores
Mucor racemosus	White to belge and are fast growing	Non or sparely septate with visible broad hphae, sporangiophore, sporangia and spores

Table 6. Pathogenicity Test of Fungi Isolates from the Selected Markets

Fungal Species	KASU Mrt.U/ Dm of Rot (mm)	RIMI Mrt. Dm of Rot(mm)	MALALI Mrt. Dm of Rot(mm)	CHECHENIA Mrt. Dm of Rot(mm)
Rhizopus stolonifer	49	50	48	52
Fusarium oxysporum	40	44	43	41
Aspergillus niger	40	31	33	36
Aspergillus flavus	35	21	37	-
Penicillium sp	33	27	29	30
Mucor racemosus	24	-	21	26

Key: Dm – Diameter; KASU – Kaduna State University; Mrt—Market.

It was observed that *R. stolonifer* was the most frequently isolated fungus from rotten irish potato tubers. This could be attributed to its ability to produce numerous spores as reported by Amienya*et al*. (2007). The results of pathogenicity test indicate that fungi induce different level of decay with *R. stolonifer* as the most virulent fungus. Similarly, Nwachukwu (2006) also reported *R.oryzae* as the most virulent among the fungi associated with storage rot of irish potato tubers in southwestern, Nigeria. The variations of the fungal isolates to cause different level of decay may be due to differences in their ability to utilize tuber components as food for growth. Postharvest rot of irish potato tubers may be due to its low pH, moisture content and nutritional compositions which make it susceptible to infection by fungi (Okonkwo, 2009). The high incidence of storage rot of irish potato encountered within kaduna metropolis could be related to prevailing climatic factors and storage conditions. It could also be attributed to handling procedures during harvest, transit, marketing and storage places. Postharvest loss of root ad tubers has been of serious problem to farmers and warring against food security as reported by Mohammed *et al*. (2007).

This study has showed that fungal spoilage is the greatest cause of rot of irish potato in storage. Colonization of the tubers by fungi will lead to reduction in consumption materials, market value and production of mycotoxins. Consumption of excess amount of mycotoxins can cause illness or death as reported by Mirocha *et al*. (2003).

Conclusion

This study has shown that many fungi have been found to cause storage spoilage of irish potato in kaduna. These pathogens lead to enormous loss of irish potato tubers despite its economic and nutritive value. The disease is of great economic importance to this country. Some of these fungi are capable of producing mycotoxins which are hazardous to the health of consumers. As such urgent attention is required to safe the menace and increases the economic yield of the produce. This will ensure substantial contribution of the irish potato to food supply and national economy.

Recommendations

In order to prevent the fungi causing rot in irish potato, the following recommendation are here by suggested.

- Early harvesting and proper storage condition should be adhered to.
- Physical damage to the tuber should be avoided since they serve as major point of entry of pathogens into the tubers.
- Segregation of rotten irish potato tubers from the healthy ones should be encouraged.
- Public enlightenment of fungi, mycotoxins and the health risk at the grass root levels should be wide spread.

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