MICROORGANISMS ASSOCIATED WITH POST-HARVEST ROT OF FRAFRA POTATOES [*solenostemon rotundifolius* (Poir.)] IN BONGO-SOE, UPPER EAST REGION, GHANA.

Abstract

Investigations into the microorganisms associated with the postharvest rot of *Solenostemon rotundifolius* (Frafra potato) was carried out at the laboratory of the Department of Horticulture and the Pathology laboratory of the Faculty of Agriculture, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. Four hundred (400) tubers of black cultivar and four hundred (400) tubers of brown cultivar of *Solenostemon rotundifolius* tubers were used. In all, eight hundred tubers were used for the study. The findings of this study showed that the microorganisms identified to be responsible for causing rot in *Solenostemon rotundifolius* tubers were six in number. *Colletotrichum gloeosporioides* was identified to be responsible for 30.76 % of rots observed, followed by *Aspergillus niger*, 23.07 %, *Curvularia lunata*, 19.23 %, *Aspergillus flavus*, 11.54 %, *Trichoderma sp* and *Penicillium sp* both recorded 7.70 % of rots observed. Mechanical injury during harvesting, transportation and storage of *Solenostemon rotundifolius* tubers should be prevented or reduced since mechanical injuries can pave the way for tuber infection by the rot causing microorganisms identified in this study.

1.0 Introduction

According to Tindall, 1983, *Solenostemon rotundifolius* (Frafra potato) belongs to the family Labiatae (lamiaceae). Frafra potatoes are herbaceous perennials normally cultivated as annuals (National Research Council, NRC, 2006). In Ghana, the crop is mainly cultivated in the guinea and Sudan savannah agro-ecological zones (Opoku-Agyeman *et al*., 2004). The

areas of cultivation mainly cover the Upper East and Upper West regions of Ghana. However, the crop can also be cultivated in the moist semi deciduous forest ecology of Ghana (Opoku-Agyeman *et al.,* 2004).

Solenostemon rotundifolius is an important food security crop (Burkill, 1995 and National Research Council, 2006). Apart from cultivation of frafra potatoes for consumption, the crop also has medicinal, industrial and sociocultural importance in areas of its cultivation in Ghana (Abapol 1997 and Tetteh *et al.* 1997).

In spite of its importance, frafra potato cultivation appears to be declining in Ghana due to problems encountered by farmers during cultivation. Tindal (1983) indicates that one important problem of frafra potato tubers is post-harvest loss during storage. Tetteh *et al.* 1997 also indicated that one of the major causes of postharvest loss of frafra potatoes that contributes to the decline in cultivation in Ghana is spoilage (rotting) of tubers in storage.

Postharvest spoilage (rot) is a major contributor to postharvest losses of all root and tuber crops. According to Amusa (1999), rots from microbial infestation of healthy tubers normally reduce the table quality of such tubers and render them unappealing to consumers.

Roots and tubers have been subjected to several diseases by several post-harvest rot causing organisms including viruses, fungi, bacteria, nematodes etc. For instance in yam (*Dioscoreae Sp*), the microorganisms commonly associated with storage rots include: *Sclerotium rolfsii*, *Colletotrichum gloeosporioides*, *Aspergillus spp*, *Botryoidplodia theobromea*, *Curvularia verruculosa*, *Rhizoctonia solani, Penicillium spp* and *Fusarium moniliforme* (Nwankiti and Okpala, 1981; Green, 1994). Also in Sweet potatoes (*Ipomoea batatas*), pathogens commonly associated with storage rots include: *Ceratocystis fimbriata* (a fungus that causes Black rot), *Fusarium* (a fungus that causes Fusarium surface rot and Fusarium root rot), *Rhizopus stolonifer* (a fungus that causes Rhizopus soft), *Diplodia gossypina* (a fungus that

causes Java black rot), *Erwinia chrysanthemi* (a bacteria that causes Bacterial soft rot, also known as bacterial stem and root rot), *Monilochaetes infuscans* (a fungus that causes scurf, also known as soil-stain), *Macrophomina phaseoli* (a fungus that causes Charcoal rot) (Sikora *et al.*,1995). However, for *Solenostemon rotundifolius*, no published research work has been cited on the microorganisms associated with post-harvest rot until recently. Mohammed *et al*., (2013) indicates that the following microorganisms are associated with post-harvest rot of *Solenostemon rotundifolius* in Nigeria; *Aspergillus niger*, *Fusarium oxysporum*, *Penicillium expansum* and *Rhizopus stolonifer*. However, no research work has been cited on the microorganisms associated with post-harvest rot of *Solenostemon rotundifolius* in Ghana. This research work therefore has the overall objective of identifying the microorganisms associated with post-harvest rot of frafra potatoes in Bongo-soe, Upper east region of Ghana.

2.0 Materials and methods

2.1 Geographical location of the experiment

The research work was carried out at the laboratory of the Department of Horticulture and the Pathology laboratory of the Faculty of Agriculture, Kwame Nkrumah University of science and Technology (KNUST), Kumasi, Ghana.

The *Solenostemon rotundifolius* tubers were stored at the Horticulture Department laboratory whiles rot identification was carried out at the Pathology laboratory of the Faculty of Agriculture. The Tubers were stored from 2nd November, 2012 to 22nd March 2013.

2.2 Source of frafra potato (*Solenostemon rotundifolius*) tubers

The black and brown cultivars of frafra potato tubers were used for this research work. The tubers were all obtained from a single farm in Bongo-soe, in the Bongo district of the Upper East region of Ghana. The farm was monitored from planting to harvest. The tubers were

subsequently obtained on the day of harvest and transported on that same day to the location of the experiment.

A total of eight hundred samples of frafra potato tubers were used for the studies. This was made up of four hundred black cultivars and four hundred brown cultivars of wounded and non-wounded tubers. None of the tubers used for this research work showed any sign of rot. The tubers were stored in sixteen medium sized plastic bowls purchased from the Ayigya market in Kumasi. Fifty tubers were stored in each plastic bowl.

2.3 Identification of rot pathogens

Tubers showing visible signs of rot during the storage period (2nd November, 2012 to 22nd March 2013) were taken to the Pathology laboratory of the Faculty of Agriculture for identification of the possible microorganisms responsible for the rot. This was done fortnightly.

The procedure involved taking pieces of diseased tissues (2-5 mm square) from the margin of the necrotic lesion using a sterile scapel blade. The next step involved surface sterilizing the necrotic tissue segments and this was done by immersing the tissue segments in 10 % commercial bleach solution in a beaker. Duration of sterilization was one minute. Tissue segments were taken out of the sterilant solution in intervals of 10 seconds and blotted dry with a clean paper towel. This ensured that at least some of the segments were exposed to the sterilant for the appropriate period of time. The surface sterilized tissue segments were then plated on a medium, Potato dextrose agar (PDA), using a pair of forceps which was flamed sterilized periodically. The plates were sealed with a sellotape to prevent desiccation and contamination and then incubated in an incubator at room temperature until growth occurred. The plates were then observed daily for fungal growth from the tissues. The characteristics of the spore and mycelium were studied using a compound microscope. The characteristics

observed were used in identifying the rot organisms according to standards described by Mathur and Kongsdal (2003) and Barnett and Hunter (1972).

3.0 Results and discussions

In all, five genera of microorganisms were identified to be associated with post-harvest rot of stored frafra potato tubers. These are: *Curvularia sp., Colletotrichum sp., Aspergillus sp., Penicillium sp.* and *Trichoderma sp.*

The microorganisms identified to be responsible for causing Post-harvest rot in *Solenostemon rotundifolius* tubers were six in number. *Colletotrichum gloeosporioides* was identified to be responsible for 30.76 % of rots observed, followed by *Aspergillus niger*, 23.07 %, *Curvularia lunata*, 19.23 %, *Aspergillus flavus*, 11.54 %, *Trichoderma sp* and *Penicillium sp* both recorded 7.70 % of rots observed.

The percentage incidence of *Aspergillus niger* (15.38%)*, Curvularia lunata* (11.54%) and *Aspergillus flavus* (7.69%) was higher in the black cultivar as compared with the brown cultivar which had percentage incidence of 7.69%, 7.69% and 3.85% respectively. Also, the percentage incidence of *Colletotrichum gloeosporioides* (15.38%) and *Penicillium sp* (3.85%) was the same in both the black and brown cultivars of *Solenostemon rotundifolius* tubers used in this study. *Trichoderma sp* caused rot in only tubers of the brown cultivar with percentage incidence of 7.07%. In all, tubers of the black cultivar had more incidence of rot causing microorganisms (53.84%) compared with tubers of the brown cultivar which had a total incidence of 46.16%.

The identification of *Aspergillus niger and Penicillium sp.* confirmed the observations made by Mohammed *et al*. (2013). According to available literature, this is the first time *Colletotrichum gloeosporioides, Curvularia lunata*, *Aspergillus flavus*, and *Trichoderma sp* have been found to cause post-harvest rot in *Solenostemon rotundifolius* tubers. *Curvularia*

lunata, Colletotrichum gloeosporioides, Aspergillus niger, Aspergillus flavus, Penicillium sp and *Trichoderma sp.* have also been found to be associated with rot in other roots and tubers (Nwankiti and Okpala, 1981; Green, 1994, Rees *et al.,* 2003, Messiga *et al*. 2004). These microorganisms identified are wound pathogens that infect mechanically injured tubers and have been found to infect tubers in the field and later manifest in storage (Rees *et al*., 2003, Okigbo *et al*., 2010). These microorganisms can also infect tubers through diseased foliage, mother tubers or roots (Nmeka *et al*., 2005).

The skin of *Solenostemon rotundifolius* tubers is easily damaged (Mohammed *et al.,* 2013) and farmers make matters worse with poor practices that encourage mechanical injury on tubers during harvesting, transportation and even storage. This may therefore explain the presence of these microorganisms in the *Solenostemon rotundifolius* (frafra potatoes) tubers used in this study.

Table 1: Isolated microorganisms identified to be associated with Post-harvest rot in black and brown cultivars of frafra potato (*Solenostemon rotundifolius*) tubers.

Organism identified	**Black cultivar**	**Brown cultivar**	**Total percentage incidence (%)**
	Percentage incidence (%)	**Percentage incidence (%)**	
Colletotrichum gloeosporioides	15.38	15.38	30.76
Aspergillus niger	15.38	7.69	23.07
Curvularia lunata	11.54	7.69	19.23
Aspergillus flavus	7.69	3.85	11.54
Trichoderma sp	0.00	7.70	7.70
Penicillium sp	3.85	3.85	7.70
Total percentage incidence (%)	**53.84**	**46.16**	**100**

4.0 Conclusion

The findings of this study have shown that *Colletotrichum gloeosporioides, Aspergillus flavus*, *Aspergillus niger, Curvularia lunata, Penicillium sp* and *Trichoderma sp* were found to be responsible for the post-harvest rot of *Solenostemon rotundifolius* tubers in Bongo-soe, Upper East Region of Ghana.

5.0 Recommendation

Mechanical injury during harvesting, transportation and storage of *Solenostemon rotundifolius* tubers should be prevented or reduced since mechanical injuries can pave the way for tuber infection by the rot causing microorganisms identified in this study.

References

1. Amusa N. A. (1999). Concentric leaf spot of yam (*Dioscrorea sp*.) in South-western Nigeria. Mycopathologia, 148: 33-36.
2. Apabol, R. R. (1997). Assessment of the performance of some frafra potato (Coleus dysentericus – Baker) Accessions in Nyankpala area of Ghana. A Dissertation submitted to the Faculty of Agriculture, UDS, in partial fulfilment of the requirements for the award of BSc Agric. Technology.
3. Barnett H. L. and Hunter B. B. (1972). Illustrated Genera of Imperfect Fungi. 3rd Edition. Burgess Publishing Company.
4. Burkill, H. M. 1995. The Useful Plants of West Tropical Africa. J-L Vol. 3. Royal Botanic Gardens, Kew.

5. Green K. R. (1994). Studies on the Epidemiology of Yam Anthracnose. PhD Thesis, University of Reading.
6. Marthur S. B. and Kongsdal O. (2003). Common Laboratory Seed Health Testing Methods for Detecting Fungi, 2nd Edition. International Seed Testing Association. Switzerland.
7. Messiga A. J. N. A., Mwangi M., Bandyopadhyay R. and Nolte C. (2004). The status of fungal tuber rots as a constraint to cassava production in the Pouma district of Cameroon. Paper presented at the proceedings of the 9th Triennial Symposium of the International Society for Tropical Root Crops - Africa Branch, held from 31st October – 5th November 2004, at Whitesands Hotel, Mombasa, Kenya.
8. Mohammed A., Ishaku B. C. and Basiri B. (2013). Identification and control of Fungi associated with the post-harvest rot of *Solenostemon rotundifolius* (Poir) J.K. Morton in Adamawa State of Nigeria. Journal of Biology, Agriculture and Healthcare ISSN 2224-3208 (Paper) ISSN 2225- 093X (Online) Vol.3, No.5, 2013.
9. National Research Council, NRC, (2006). "Native Potatoes". Lost Crops of Africa: Volume II: Vegetables. pp. 268-285. National Academies Press. ISBN 978-0-309-10333-6. http://books.nap.edu/openbook.php?record_id=11763&page=269.
10. Nmeka I. A. and Okigbo R. N. (2005). Control of yam tuber rot with leaf extracts of *Xylopia aethiopica* and *Zingiber officinale.* African Journal of Biotechnology Vol. 4 (8), pp. 804-807, August 2005.
11. Nwankiti A. O. and Okpala E.U. (1981). Anthracnose of water yam in Nigeria. In: Proceedings of the 6th Triennial Symposium if the International Society for Tropical Root Crops, Peru, 1983.

12. Okigbo R. N., Agbata C. A. and Echezona C. E. (2010). Effects of Leaf Extracts of *Azadirachta indica* and *Chromolaena Odorata* on Post-Harvest Spoilage Fungi of Yams in Storage. Current Research Journal of Biological Sciences 2(1): 9-12, 2010.
13. Opoku-Agyeman M. O., Bennett-Lartey S. O., Vodouhe R. S., Osei C., Quarcoo E., Boateng S. K. and Osekere E. A. (2004). Morphological characterization of frafra potato (*Solenostemon rotundifolius*) germplasm from the savannah regions of Ghana.Plant genetic resources and food security in West and Central Africa. Regional Conference, Ibadan, Nigeria, 26-30 April, 2004 pp. 116-123
14. Sikora E. J. and James M. D. (1995).Field and Storage Diseases of Sweet Potatoes. http://www.aces.edu/pubs/docs/A/ANR-0917/. Accessed on 04/06/2013.
15. Tetteh J. P. and Guo I., (1997). Problems of Frafra potato (*Solenostemum rotundifolius* Poir.) production in Ghana. Ghana J. Agric. Sci.30. 107-113
16. Tindall H. D. (1983). Vegetables in the tropics. Macmillan Press, London, United Kingdom. 533 pp. Washington, D.C: IFPRI.