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Mycoflora responsible to storage rots and loss of sweet potato in Telangana

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Survey of post-harvest rots and fungi, which associated with stored sweet potato, has been carried out in various districts of local markets of Telangana. Fungal pathogens, which caused post-harvest loss, were isolated and identified by using standard methods. Pathogenicity test was performed to determine the ability of fungal pathogens to bring about spoilage (rot) in healthy tubers. Assessment of post-harvest loss was measured by calculating the percentage of severity of rot. In this present study, *R. oryzae* is the most destructive fungal pathogen causing severe loss about 92.57% *and F. moniliforme*, *F. solani, M. phaseolina, T. paradoxa* and *M. sterilia* are predominant fungal pathogens during storage period of sweet potato at ambient conditions.

Keywords : Mycoflora, storage rots, sweet potato

INTRODUCTION

Sweet potato (*Ipomea batatas* L.) is one of the most important crops worldwide including wheat, rice, maize, potato and cassava. It is an alternative source of bioenergy, with an annual production area of 8.0 million hectares and a total global production of 106,569 million tons (Jiang *et al.* 2019; Nedunchezhiyan *et al.* 2012). Its storage roots and leaves can be used as a staple food, animal feed, and supplementary food such as chips and starch production (Paul, *et al.* 2020; Wang *et al.* 2020). Therefore, this crop is now regarded as a high-priority crop targeted for reducing food insecurity and malnutrition in many countries (Sugri *et al*. 2020). Sweet potatoes possess many positive health benefits including sources of anthocyanins, phenolic compounds and other bioactive compounds (Kano *et al*. 2005). Different species of sweet potatoes have gained popularity in many countries as a result of their health benefits.

Furthermore, sweet potato is an excellent source of nutrients, including vitamins, potassium, iron, calcium, and minerals with medicinal value owing to its anti-cancer, anti-diabetic, and anti-inflammatory activities (Clark *et al.* 2013; Sun *et al.* 2020; Bovell-Benjamin, 2007; El Sheikha and Ray , 2017; Paul *et al.* 2018).Due to its high nutritional value, sweet potatoes are susceptible to many fungal pathogens. However, few reports are available on the fungi associated with spoilage of sweet potatoes during post-harvest storage (Ray *et al*., 2000;Salami and Popoola, 2007 ;Agu *et al*. 2015; Paul . *et al*. 2018).

The aim of this study to survey of post-harvest rots and its responsible fungi encountered on sweet potato collected from various districts of local markets of Telangana. In this study, the fungi causing storage rots on sweet potato have been isolated, identified and tested for its pathogenicity. In addition, the percentage of weight loss of sweet potato, due to destruction of fungal pathogens, was done in order to assess disease (rot) severity during storage at ambient temperature.

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MATERIALS AND METHODS

Collection of rotted sweet potato

Samples of rotted sweet potato were collected into fresh polythene bags from different local markets and storage godowns of various districts of Telangana. Care was taken to avoid completely rotten vegetables in order to avoid secondary growth of the fungi. The disease symptoms were carefully recorded. Samples of rotted tubers were surface sterilized with 70% alcohol for 60 sec or 0.01 % sodium hypochlorite solution for two minutes and washed thrice with sterile distilled water and blotted dry with sterile filter paper. The infected parts were sliced into small cubes and plated onto Petri dishes having different media. Triplicates were maintained. The plates were incubated at 28±2°C for 3 days. Petri dishes were observed daily and colonies of fungi were chosen.

Media Preparation

PDA media (200g of potato, 20g sucrose/ dextrose, 20g agar) was measured using a weighing balance and diluted with 1000ml of distilled water in a conical flask and heated in an autoclave for 60 minutes at 110°C. After heating, the media was allowed to cool for 15 minutes, 8g of streptomycin was added to prevent bacterial growth and the media was poured into sterilized petri dishes and left to solidify under aseptic conditions.

Sterilization

Petri dishes, beakers, cork-borer, test tubes, and metallic materials were sterilized using hot air oven at a temperature of 160 Degree Celsius for 1 hour. The wire loops were also sterilized with the spirit lamp until red hot and allowed to cool before using 70% alcohol to wipe the work tops to prevent contamination.

Isolation of Fungi

The isolation technique used was the same as that used by (Odebode and Unalchuvu, 1997; Chiejina, 2008). Samples of rotted tubers were surface sterilized with 70% alcohol for 60 sec or 0.01 % sodium hypochlorite solution for two minutes and washed thrice with sterile distilled water and blotted dry with sterile filter paper. The infected parts were sliced into small cubes and plated onto Petri dishes having different Potato Dextrose Agar (PDA) media. Triplicates were maintained. The plates were incubated at 28±2°C for 3 days. Petri dishes were observed daily and colonies of fungi were chosen. The isolated fungi were purified using single spore technique, and then kept in a refrigerator on PDA slants in McCartney bottles (Gams et al. 1998). Morphological and cultural characters of organisms were also recorded. Pure colonies of fungal isolates were identified according to (Ellis, 1976 ; Domsch *et al*. 1980; Nagamani *et al*. 2006) and confirmed their pathogenecity as per Kochs postulates

Pathogenicity Test

A pathogenicity tests were carryout using techniques of (Usharani, 1982; Brunda Devi and Bhadraiah, 2017; Okigbo, et al. 2009). Fresh and healthy tubers of sweet potato were washed with tap water and surface sterilized with 70% ethanol /0.1% ethanol solution. A sterilized cork borer was used to cut the tuber and then the pure culture of each fungal isolates were introduced into the open cut and replaced with the core. Vaseline jelly was smeared to completely weal the hole. These were kept for seven (7) days. On establishment of disease symptoms, inoculum from the infected tuber were taken and caultured. Pure cultures were identified according to (Barnett and Hunter, 1999; Nagamani *et al*. 2006; Aziagba, et al. 2015. The symptoms were identical to those of naturally infected tubers. Morphological characteristics of conidia and mycelia of the fungi that were re-isolated from inoculated tubers confirmed Koch's postulates.

Identification

The pure culture isolates obtained from the diseased pepper fruits were used for identification purposes. Each isolate was subjected to colony and microscopic examinations during which their structural features were observed. Identification of fungi was based on the growth patterns, colour of mycelia and microscopic examinations of vegetative and reproductive structures according

to Barnett and Hunter (1999); Nagamani *et al.* (2006); Aziagba *et al*. (2015).

Severity of post-harvest weight loss

The percentage severity of rot was determined by removing the rotted portions from the whole sweet potato tubers and then taking the final weight of the individual sweet potato tuber. The percentage severity of rot (Sr %) was calculated (Usharaani, 1982; Frank, 2014).

$$Sr\ (\%) = \frac{W - w \times 100}{w}$$

Where,
Sr =The percentage severity of rot

W = Initial weight of whole healthy sweet potato tuber

w = Final weight after removing rotten portion from rotted sweet potato tuber.

Statistical Method

The completely randomized experimental design and appropriate replicates were adopted in all measurements. Data were subjected to Analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Survey of post-harvest diseases of sweet potato and morphology of post-harvest fungal pathogens

A large quantity of fruits and vegetables are infected by fungi in the pre- and post-harvest state in the field, as well as in transit and storage. Post-harvest decays of fruits and vegetables account for significant levels of post-harvest losses. It is estimated that about 20–25% of the harvested fruits and vegetables are decayed by pathogens during post-harvest handling even in developed countries. In developing countries, post-harvest losses are often more severe due to inadequate storage and transportation facilities. The post-harvest diseases of fruits and vegetables encountered at several stages in the chain of post-harvest grading, packing, transport, storage and marketing are of considerable importance. It is opined that market diseases include defects, blemishes and decays found on fresh fruits and vegetables at commercial and consumer level. In India 20-30% loss of the perishables are in the marketing chain (FAO, 1977). Post-harvest losses were found to be around 15 % during transport, 2 % due to poor packing, 4 % due to poor quality and 3 % due to miscellaneous causes. Post-harvest diseases destroy 10-30 % of the total yield especially in perishable crops.

In the present study post-harvest fungal diseases of sweet potato from different local markets of Telangana region of A.P., India was surveyed and presented in Table 1.

The fungi, which are predominant and frequently occurring during storage. *Marked fungi are new reports on sweet potato from Telangana.

Morphology of fungi

Very meager data is available on the identification and isolation of soil borne fungi associated with post-harvest storage of sweet potato in Telangana. Few reported work has been done on storage rots of sweet potato and its associated fungi by Ray and Punithalingam, 1996; Salami and Popoola, 2007; Agu *et al.* 2015. In the present study fungi associated with sweet potato tubers during post-harvest storage, were identified and isolated. Duration of storage, sweet potato samples were taken for microbiological analysis such as fungal characterization and identification (Table 2). After proper identification of isolates were tested for their disease-causing ability on healthy sweet potato samples.

Altogether 15 post-harvest diseases have been encountered during the survey on underground vegetable - sweet potato from local markets of different districts of Telangana region of A.P., India. This information clearly indicates that the local markets and godowns have good amount of mycoflora inoculum to cause post-harvest diseases besides causing severe losses to the market vendors and commercialists. It is interesting to note that some diseases are more prevalent and more common in many areas. Several fungi have been found to induce spoilage in stored underground vegetables. The most

Table 1: Post-harvest diseases of sweet potato and their respective causative pathogenic fungi isolated from various districts of Telangana.

Nature of infection (disease / rot)	Pathogen
Aspergillums rot	*Aspergillus flavus* Link
Aspergillus rot	*Aspergillus terreus*Thom
Java Black rot	*Botryodiplodia theobromae* Pat.
Byssoclamys rot	*Byssochlamys nivea* Westling
Surface rot	*Fusarium moniliforme* Sheldon
Surface rot	*Fusarium oxysporum .f. batatus* (Schl. ex Fr.) e. Anyd. Et Hans.
	Fusarium pallidoroseum (Cooke) Sacc.
Surface rot	*Fusarium solani*(Martius) Sacc.
Root rot (Dry rot).	**Macrophomina phaseolina*(Tassi) Goid.
Charcoal rot	**Monodictys fluctuata* (Tandon & Bilgrami)
Soft Rot	*Mucor varians* Povah
Mucor rot	*Penicillum decumbens* Thom
Blue mold rot	*Rhizopus oryzae* Fischer
Rhizopus soft rot	*Thielaviopsis paradoxa* (De Seynes)Hohn.
Soft rot	*Mycelia sterilia*
Soft rot	

important among them are *Fusarium* spp., *Mycelia sterilia*, *Rhizopus* spp., *Geotrichum candidum*, *Macrophomina phaseolina*, *Aspergillus flavus* and *Thielaviopsis paradoxa.* The morphology and microscopic featuresof the concerned pathogens of such post-harvest diseases are given in Table 2 and Fig.1

In the present investigation, about 15 pathogenic fungal species were isolated and identified from rotten sweet potato during post-harvest storage in various districts of Telangana (Table. 1). It is interesting to note that all fungal species are responsible for storage rots of sweet potatoes. Of these, *R. oryzae* considered as the most destructive fungal pathogen followed by *T. paradoxa* and *M. phaseolina. Aspergillus flevus* is the most virulent fungus among the fungi associated with storage rots of sweet potato tubers in Awk, Anambra State (Agu *et al*. 2015). The results of this study, in the case of *R. oryzae* the most virulent fungi caused soft rot, are in agreement with findings of (Salami and Popoola, 2007). However, the following rots and its responsible fungi were investigated. Such rots are *Aspergillus* rot caused by *A. falvus* and *A. terries*, Surface rot cited by three types of *Fusarium* species, except *F. solani* (Figure 1), which is causing Dry rot, Java block rot and *Byssochlamys* soft rots caused by *B. theobrome* and *B. nivea*, respectively and Java black rot caused by *Botryodiplodia theobromae* which is in agreement with the earlier work of (Pati, 2000; Ray and Punithalingam, 1996**)**. Moreover, *Macropho minaphaseolina* causing charcoal rot while *M. variens* is responsible for *Mucor* soft rot. Remaining soft rots caused by *Monodictys* species, *Rhizopus* species and *Mycelia sterilia*. Finally, *Penicillium decumbence* was responsible for blue mold rot of sweet potato in this work (Table1)

Out of 15 fungal pathogens, *F. moniliforme*, *F. solani*, *M. phaseolina*, *T. paradoxa* and *M. sterilia* were predominantly appeared during storage period of sweet potato (Brunda Devi *et al.* 2016).

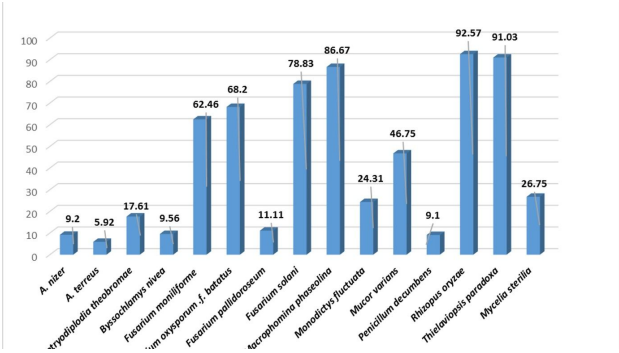
Table 2 : Fungal species and their morphological features

Fungal pathogens	Identification features of fungi at species level.
A. flevus	Colonies on CzSA variable, growing rapidly, 6 -7ccm to slow gro wing, 3 -4 cm in 10 days; conidial heds yellow when young, becoming dark y ellow-green in age, old one shows gray-green. Conidial heads radiate, splitting into poorly defined column, rarely exceeding 500 -600 µm, most commonly 300 -400 µm, smaller columnar heads up to 300x50 µm, with big conidial heads yellow in the centre, gree nish periphery; Conidiophores 0.5-1.5 mm long with colourless, 10 -65 µm in diam ; Phialides (6.5 - 10x3-5) arising on metulae (6-10x4-5.5). conidia globose to subglobose 4.5 -5.5x3.5-4.5.
A. terreus	Colonies spreading well on CzSA, attaining 3 -5cm in 10 days, p lain or with radial furrows, velvety, wood brown, reverse dull brown; exudate abber coloured, conidial heads long columna r 150 -500x 30 -505 µm ; conidiophores smooth colourless, 100 - 250x4.5-65 µm ;vesicles hemispherical, dome like , 10 -165 µm in diam, ph alides biseriate; metulae crowded. Parallel, 5-7.5x2-2.55 µm; Conidia globose to subglobose, smooth, 1.8-2.45 µm.
Botryodiplodia theobromae	Fungus grows profusely on PDA medium. Mycelium gray to black, pycnidia abundant, black, globose. 180 -260 µm in diameter; conidia elliptical, hyaline, single celled when young, one transverse septum develops at maturity, gradually become da rk, with longitudinal striations on the spores 21.8 – 28.6 × 12-13.5 µm.
Byssochlamys nivea	Ascocarp and asci without any endu ring peridium; asci naked, in clusters, globose, 8 - spored, usually ascal clusters surrounded by inconspicuous very scanty loose wefts of hyphae; ascospores ovoid to elliptical, hyaline, smooth; conidia forming in basipetal chains; ascocarp without peridium; asci in clusters, 8 -spored; ascospores elliptical, smooth, 4.5-5.6x2.8-3.55 µm.
Fusarium moniliforme	Colonies growing 4. 5 cm diam in 4 days on PSA, white at first, becoming pink, vonaceous to violet; microconidiophores single, lateral, subulate, phia lides from aerial hyphae; microconidia 1-2 celled, fusiform, ovate, 0 -septate mostly 8.4×2.4 (4 -18×1.5-4) µm, 1-septate mostly 17 ×2.9 (9-30×2-5) µm.
Fusarium oxysporum .f. batatus	Colonies reaching 4.5 cm diam in 4 dys at 25° C on PSA; aerial mycelium sparse to floccose, white or peach, but usually with a purple or violet tinge; sporodochia discrete, erumpent, orange; revers e colourless, dark blue to dark purple; conidiophores unbranched or sparsely branched, monophialidic; stroma white, plectenchymato us, smooth, e ffuse; microconidia usually abundant, mostly 0 -septate, oval, ellipsoidal, kidney shaped or straight, pointed at both ends, definitely or weakly pedicellate, 27 - 60×3-5; clamidospores mostly terminal, globose, smooth or roughened, 1 -celled 7.5-10µm, 2-celled 8-15×5-9µm; sclerotia forming in some, pale to green or deep violet
Fusarium pallidoroseum	Cottony, pinki sh colonies on PDA, often with reddish brown pigmentation on reverse side. It produces hyaline, septate hyp, various spore types m acro, micro con idia and chlamidospores. Macro conidia often sickle shaped and septate, micro conidia typically oval or ellipsoid.
Fusarium solani	Colonies reaching 7-8 cm in 10 days on PSA, green to bluish brown; mycelium sparse, floccose; sporodochia cream to buff; rev erse colourless to dark violet; conidiophores unbranched and branched, monophialidic, phialides with distinct collarette; phialides bearing microconidia long, slender, 15 -40×2-3 µm, macroconidia shorter, subcylindric, obclavate to doloform, 10-25×3-4 µm.
Macrophomina phaseolina	Colonies growing rapidly on PSA, with abundant submerged mycelium, aerial mycelium sparse; hyphae hyaline when young turning brown to black with age, branched with a slight constriction at the emergence of the branch and a septum beyond the constriction in each branch; micro -sclerotia abundantly produced, dark brown to black, spherical, compact, 100-200 µm.
Monodictys fluctuata	Colonies effuse, green, greenish -blue, lavender, dark grey - blakish brown or black ; conidiophores micron ematous, mononematous, strait, usually simple or spa -ringly branched, short, septate, hyaline to brown; conidiogenous cells monoblastic, terminal, cylindrical; conidia singly at apex of conidiophores, muriform. Conidia many celled, smooth or later verruculose, roughly superficial, size varying up to 40 µm in diameter.
Mucor varians	Colonies fast growing, often several cm high, white to yellow, becoming dark gray with development of sporangia. Mycelium in nad on the substratum, but witout rhizoids or stolons; sporangiophores forming a thick turf, springing from the mycelium; sporangia always erect; columella large, colourless or greyish or brownish;Sporangiospores not uniform, oval and elongate spore found in equal numbers, 4-6.2 x 3-4 µm.

Penicillum decumbens	Colonies growing 20 -30 cm on CYA in 7 days at 25C, sometimes 40mm diam; margins broad, deep; mycelium white or cream; conidiation light , greyish green to dull green or glaucous grey; reverse pale, dull yellow brown or olive. Conidiophores borne from a erial hyphae; stipes short 20 -6(-100) x1.8-2.2(2.5) µm; phialides 5 -8per vertical, rarely mor e, long and slender, ampulliform, 8 -11x2.2-2.5 5 µm ; conidia ellipsoidal pyriform in some isolates, 2.5 -3(-4) x 2-2.5(-3) µm;smooth, borne in short loose columns.
Rhizopus oryzae	Colonies growing rapidly and profusely on OA; Mycelium white, cottony, fe lt clearer and not extending far into the substrate, in early snoe white, at mature black, slolens little developed not forming no des regularly; rhizoides pale, with 4-8 branches, developed at nodes bearing sporangia sporangia bo rne on sporangiophores 12-285 µm wide , smooth, pale brown. Sporangiophores often prostate, rarely single, forming umbel or corymb on their stolons., 12-285 µm wide. Sporangia dark-brown, 85-250 µm high, 60-100 µm in width, smooth.
Thielaviopsis paradoxa	Colonies dark blakish b rown to black; conidiophores colourless to pale brown, up to 50×4-6 µm; phialoconidia endogenous in long chains, at first cylindri cal and colourless, becoming ellipsoidal and pale to mid golden brown, truncate at both ends, 7-14×3-6µm.
Mycelia sterilia	Mycelia sterilia , also known as sterile fungi, are fungi that do not produce any known spores, either ssexual or asexual.so it is very difficult to define it. It is characterized by their colony characteristics on culture media, including colony c olour, shape and surface texture.

Table 3 : The means of the percentage of severity of post-harvest weight loss (rotten portion) caused by various rots and their respective fungal pathogens in sweet potato during storage at ambient conditions

Disease type	Sweet potato is inoculated by pathogens	Mean of Percentage Weight- loss (%)
Aspergillus rot	*A. flevus*	9.20
Aspergillus rot	*A. terreus*	5.92
Java Black rot	*Botryodiplodia theobromae*	17.61
Byssoclamys rot	*Byssochlamys nivea*	9.56
Surface rot	*Fusarium moniliforme*	62.46
Surface rot	*Fusarium oxysporum .f. batatus*	68.20
Surface rot	*Fusarium pallidoroseum*	11.11
Root rot	*Fusarium solani*	78.83
Charcoal rot	*Macrophomina phaseolina*	86.67
Soft rot	*Monodictys fluctuata*	24.31
Mucor rot	*Mucor varians*	46.75
Blue mold rot	*Penicillum decumbens*	9.10
Rhizopus soft rot	*Rhizopus oryzae*	92.57
Soft rot	*Thielaviopsis paradoxa*	91.03
Soft rot	*Mycelia sterilia*	26.75



In the present study, fungal pathogens such as *Botryodiplodia*, *Ceratocystis*, *Fusarium* spp., *Macrophomina* and *Rhizopus* spp. are in agreement with the findings of (Ray and Ravi, 2005; Paul *et al*. 2021).

Data from Table 3 and Fig.2 show that means of the percentage of post-harvest weight loss (rotten portion) of tubers caused by fungal pathogens which responsible for various post-harvest rots. Among 15 fungal pathogens, *Rhizopus oryzae* responsible for *Rhizopus* soft rot showed highest percentage of weight loss about 92.57% followed weight losses by *T. paradoxa*(91.03%), *M. phaseolina* (86.67%) while *A. terreus* had the least percentage of weight loss 5.92% (Edmunds and Holmes, 2009). This is similar to the finding of (Ray and Ravi, 2005). It is interesting note that *Macrophomina phaseolina* (Tassi) Goid.and *Monodictys fluctuata* (Bilgrami, 1963; Tandon, 1967) were identified as new fungal reports on sweet potato from Telangana.

CONCLUSION

In conclusion, *R. oryzae*, *T. paradoxa* and *M. phaseolina* are the most destructive fungal pathogen which causes severe loss during storage period of sweet potato at ambient conditions of various local markets of Telangana. These pathogens have led to enormous loss of sweet potato tubers despite its economic and nutritive value. Presence of the rot-causing fungi on these tubers most especially *R. oryzae*, *T. paradoxa* , *M. phaseolina* and *Aspergillus spp.* poses a serious threat to health of consumers as the organism could produce mycotoxins, which are lethal when consumed. Also, fungi cause a serious economic loss to farmers and sweet potato sellers in Telangana state. The present investigated data can provide insight for further research on how to adopt new post-harvest storage technology, which control post-harvest loss owing to rots, that will be affordable by the vegetable vendors and farmers in Telangana state.

REFERENCE

Agu K.C, Nweke, G.U., Awah, N. S., Okeke, B.C., Mgbemena, I.C.C., Okigbo, R.N., Ngenegbo, U.C. 2015. Fungi Associated with the Post-Harvest Loss of Sweet Potato. *Inter. J. Res. Stud. Biosci.* **3:** 32-37.

Aziagba, B. O., Okeke, C. U., Ezeabara, C. A., Ilodibiam, C. V., Uka, C. J. 2015. Macro morphological observations in *Capsicum* varieties cultivated in Awka Anambre State South Eastern Nigeria. *Amer. J. Life Sci. Res*. **3 :** 30-34.

Barnett, H. L., Hunter, B. B. 1999. Illustrated Genera of Imperfect Fungi. 4th edition. The American Phytopathological Society. St. Paul, Minnessota, USA. 218.

Bilgrami, K.S. 1963. D.Sc Thesis. Allahabad University, Allahabad.

Bovell-Benjamin, A.C. 2007. Sweet Potato: A Review of its Past, Present, and Future Role in Human Nutrition. In: *Advances in Food and Nutrition Research*. Elsevier B.V. Amsterdam, The Netherlands. **52:** 1–59.

Brunda Devi, K., Bhadraiah, B. 2017. Study of Carrots for their Storage Environment and its Effect on Biochemical Changes during Pathogenesis Cited by Post-harvest Fungi and their Control by using Low Cost Method which Prolonged Shelf-life. *Inter. J. Sci. Res.* **6**:1812-1819.

Brunda Devi, K., Pavan Kumar, P., Rajender Singh, D.S.R., Bhadraiah, B. 2016. Study on Fungi Associated with tuber Vegetables during Storage in Markets of Telangana State, India. *Inter. J.curr. Microbiol. App.Sci.* **5:** 919-929.

Chakraborty, C., Roychowdhury, R., Chakraborty, S., Prostuti Chakravorty and Debjit Ghosh. **2017.** A Review on Post-Harvest Profile of Sweet Potato. *Inter. J. Curr. Microbiol. Appl. Sci.* **6** :1894-1903.

Chiejina, N. V. 2008. Mycoflora of some salad vegetables. *Biologic. Res*. **6**: 392-39.

Clark, C.A., Moyer, J.W. 2013. Black rot. In : *Compendium of Sweet potato Diseases, Pests, and Disorders*. APS Press: St. Paul, MN, USA. 29–33.

Domsch, K. H., Gams, W., Anderson, T. H. 1980. *Compendium of soil Fungi*. Academic press, New York, USA.

Edmunds, B. A., Holmes, G. J. 2009. Evaluation of alternative decay control products for control of post-harvest *Rhizopus* soft rot of sweet potatoes. Online. *Plant Health Progress* doi:10.1094/PHP-2009-0206-01-RS.

Ellis, M.B. 1976. More Dematiaceous Hyphomycetes CMI, Kew, Surrey, UK. pp.507

El Sheikha, A.F.; Ray, R.C. 2017. Potential Impacts of Bioprocessing of Sweet Potato: Review. *Crit. Rev. Food Sci. Nutr.* **57**: 455–471.

F A O. 1977. Analysis of of an FAO survey of Post-harvest crop losses in developing countries. AGPP Misc. 27. FAO, Rome.

Frank, C. 2014. Roles of Fungal Rots in Post-Harvest Storage losses in some Nigerian varieties of *Dioscorea* species. British Microbiol. Res. J. **4**: 343-350.

Gams, W., Hockstora, E. S., Aptroot, A. 1998. CBS course of Mycology. 4th Ed. Central Bureau Voorschimmel cultures, Baan, The Netherlands.

Jiang, L., Jeong, J.C., Lee, J.S., Park, J.M., Yang, J.W., Lee, M.H., Choi, S.H., Kim, C.Y., Kim, D.H, Kim, S.W. 2019. Potential of *Pantoea dispersa* as an Effective Biocontrol Agent for Black Rot in Sweet Potato. *Sci. Rep.* **9**:16354.

Kano, M., Takayanagi, T., Harada, K., Makino, K., Ishikawa, F. 2005. Antioxidative activity of anthocyanins from purple

sweet potato *Ipomoera batatas* cultivar Ayamurasaki. Bioscience Biotechnology and Biochemistry. **69**:979-988.

Nagamani, A., Kunwar, I. K., Manoharachary, C. 2006. *Hand Book of Soil Fungi*. I. K. International Pvt. Ltd.

Paul, N.C., Park, S., Haifeng Liu, Ju Gyeong Lee, Gui Hwan Han, Hyunsiik kim, Hyunkyu, S. 2021. Fungi Associated with Postharvest Diseases of Sweet Potato Storage Roots and In Vitro Antagonistic Assay of *Trichoderma harzianum* against the Diseases. *J. Fungi*. **7** :927.

Nedunchezhiyan, M., Byju, G., Jata, S.K. 2012. Sweet Potato Agronomy. *Fruit Veg. Cereal Sci. Biotechnol.* **6**:1–10.

Odebode, A. C., Unachulwu, N. E. 1997. Effect of storage environment on carrot root rot and biochemical changes during storage. *Z Lebensm Unters Forsch A.* **205**: 277-281.

Okigbo, R. N., Ramesh, P., Achusi, C. T. 2009. Post-Harvest Deterioration of Cassava and its Control Using Extracts of *Azadirachta indica* and *Aframomum melegueta*. *Electronic J. Chem*. **6**: 1274-1280.

Pati, S.P., Ray, R.C. 2000. Physiology of post-harvest spoilage of sweet potato (Ipomoea batatas L.). *J. Mycopathol. Res.* **38**:59-64.

Paul, N.C., Nam, S.S., Kachroo, A., Kim, Y.H. Yang, J.W. 2018. Characterization and Pathogenicity of Sweet Potato (*Ipomoea batatas*) Black Rot Caused by *Ceratocystis fimbriata* in Korea. *Eur. J. Plant Pathol*. **152**:833–840.

Paul, N.C., Park, W., Lee, S., Chung, M.N., Lee, H.U., Yang, J.W. 2020. Occurrence of Sweet potato (Ipomoea batatas) Wilt and Surface Rot Disease and Determining Resistance of Selected Varieties to the Pathogen in Korea. *Plants* **9**:497.

Ray, R. C., Punithalingam, E. 1996. Spoilage of sweet potato tubers in tropics. II. Java black rot by *B. theobromae* pat. Growth studies and mode of infection. *Adv. Horticult. Sci.* **10**:151-157

Ray, R. C., Ravi V. 2005. Post Harvest Spoilage of Sweet potato in Tropics and Control Measures. *Crit. Rev. Food Sci. Nutr.* **45**:623-644.

Salami, A.O., Popoola, O.O. 2007. Thermal control of some post-harvest rot pathogens of Irish potato (*Solanum tuberosum* L.) *J. Agricult. Sci*. **52**: 17 – 31.

Sugri, I., Maalekuu, B.K., Gaveh, E., Kusi, F., Lamini, S. 2020. Assessment of Low-Cost Postharvest Techniques to Reduce Storage Losses in Sweet Potato. *Sustain.Agric. Res.* **9**: 17.

Sun, Y., Li, M., Wang, Y., Li, L., Wang, M., Li, X., Xu, M., Loake, G.J., Guo, M., Jiang, J. 2020**.** *Ceratocystis fimbriata* Employs a Unique Infection Strategy Targeting Peltate Glandular Trichomes of Sweet potato (Ipomoea batatas) Plants. *Phytopathology* **110**: 1923–1933.

Tandon, R.N. 1967. Observations on storage disease of certain fruits. *India Phytopath*. **20**: 1-10.

Usharani, 1982. Thesis on pre- and post- harvest diseases of some underground vegetables. Dept. Of Botany, Osmania University, Hyderabad, A.P., India.

Wang, C.J. Wang, Y.Z., Chu, Z.H., Wang, P.S., Liu, B.Y., Li, B.Y., Yu, X.L., Luan, B.H. 2020. Endophytic *Bacillus amyloliquefaciens* YTB1407 Elicits Resistance against Two Fungal Pathogens in Sweet Potato (*Ipomoea batatas* (L.) Lam.). *J. Plant Physiol.* **253**:15326