



POST HARVEST FUNGAL DISEASES OF PAPAYA FRUIT

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ABSTRACT

In India, fruits have been found to be infected with several diseases in the field as well as more ever in the transport and storage. Perishable nature of fruits, improper physiological maturity, time and technique of harvesting during packaging and transporting leads to post-harvest losses in fruits. This results into enormous qualitative and quantitative losses of fruits in the market. The fruit infection phase of the disease can result in serious economic loss. A post-harvest fruit and food loss constitutes a vast complex of physical and biological changes due to microorganisms like fungi and bacteria. Considering fact an alarming percentage of fruits get spoiled due to parasitic and saprophytic fungi, present study was undertaken to understand responsible fungi to cause papaya fruit rot. In the present research work, numbers of fungi were isolated with respect to different varieties of papaya fruits. These fungi are *Alternaria alternata*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Botryodiplodia theobromae*, *Colletotrichum gloeosporioides*, *Curvularia lunata*, *Fusarium equiseti*, *Fusarium moniliforme*, *Fusarium solani*, *Fusarium oxysporum*, *Gloeosporium papaya*, *Macrophomina phaseolina*, *Phoma* sp., *Phomopsis caricae*, *Penicillium digitatum*, *Phytophthora nicotianae* and *Rhizopus stolonifer*

Keywords: Perishable nature of fruits, papaya, storage fungi, post-harvest loss

INTRODUCTION

The papaya (*Carica papaya* L.) is a tropical American fruit. It is grown worldwide in tropical and subtropical climates. According to a recent papaya production report (2020), India is the world's largest producer of papaya which have produced 13.9 million tonnes (mt) per year, or 43% of global papaya production (Koul et al., 2022). *Carica papaya* L. originated in southern Mexico, the Philippines, and Central America (Gonsalves, et al., 2007 and Fuentes and Santamaria, 2014). Due to its low cost and excellent nutritional value papaya is known as a "common man's fruit". Phytonutrients are present in papaya leaves, and unripe and ripe fruits. Papaya is adored among all other fruits for its thiamine, folate, riboflavin, niacin, vitamins A, B1, B2, and C, and fiber content (Karunamoorthi et al., 2014).

Papaya contain the principal sugars include glucose (29.8 g/100 g), sucrose (48.3 g/100 g), and fructose (21.9 g/100 g). Chemical assessment of papaya revealed the presence of essential elements, such as potassium (223 mg), sodium (8 mg), phosphorus (10 mg), calcium (20 mg), iron (0.25 mg), zinc (0.08 mg), copper (0.05 mg), manganese (0.04 mg), and magnesium (21 mg) per 100 g of fresh ripened fruit. Papaya fruits also contain folate (37 µg), thiamin (0.023 mg), riboflavin (0.027 mg), niacin (0.357 mg), pantothenic acid (0.191 mg), and macular carotenoids (1.2–6.4 mg), such as β-carotene and β-cryptoxanthin, along with major pigments such as lycopene (5.7 mg) per 100 g of fresh fruit (Koul et al., 2022).

In India, fruits have been found to be infected with several diseases in the field as well as very significantly in the transport and storage. Post-harvest losses in fruits might be due to perishable nature of fruits, improper physiological maturity, time and technique of harvesting during packaging and transporting (Issarakraisala et al. 1992). These are responsible for enormous qualitative and quantitative losses of fruits in the market. The fruit infection phase of the disease can result in serious economic loss (Benkee and Sharma,

2013). A number of fungal genera such as *Aspergillus*, *Penicillium*, *Alternaria* and *Fusarium* are known to produce mycotoxins under certain conditions (Sing et al., 2017) that spoils the quantity and quality of fruits. Fungal contamination occurs during improper handling of fruits at field, postharvest handling, storage and transport and causes deterioration of fruits and thus affects financial benefits. Therefore, the aim of the study was to identify the kind of fungi responsible for post-harvest diseases of papaya fruits during storage condition.

MATERIALS AND METHODS

Study of associated fungi Collection of samples:

Infected fruits of different mango varieties viz. Alphonso, Kesar, Nilam, Daseri and Langra; papaya varieties viz. Co-I, Co-II, Taiwan, Washington and Local; banana varieties viz., Jalgaon, BV1, BV2, BV3 and Local; grapes varieties viz., Bhokari, Sharad, Thomson, Gulabi and Perlette were collected in pre-sterilized plastic bags from Mantha market.

Isolation of fungi from collected samples:

Small pieces, measuring 2 mm² each of infected tissue, were cut off from fruits with the help of sterile sharp knife. Pieces of diseased fruit were washed with tap water and surface sterilized with 1% Sodium hypochloride solution for 2 min, washed twice with sterilized distilled water and then dried using sterile filter paper. The pieces were separately transferred to sterilized petri-dishes containing potato dextrose agar (PDA) medium and incubated at 25°C for 10 days.

Identification of isolated fungi:

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 medium (Gams *et al.*, 1998). Pure colonies of fungal isolates were identified according to Ellis (1971).

EXPERIMENTAL RESULTS

Co-I, Co-II, Taiwan, Washington and Local varieties of papaya were collected from different parts of Marathwada region in order to study fungi associated with them and results are summarized in table 1. From table 1 it is clear that, Washington variety showed maximum incidence of fungi as compared to other papaya varieties. On Washington variety *Aspergillus niger*, *Phomopsis caricae* and *Phytophthora nicotianae* showed abundance of occurrence while, on Taiwan only *Aspergillus niger* showed its quantitative dominance of occurrence. *Fusarium equiseti*, *Phomopsis caricae* and *Phytophthora nicotianae* occur on all papaya varieties except Taiwan. On Col-I variety *Colletotrichum gloeosporioides* and *Fusarium oxysporum* showed dominance of occurrence. Present study confirms the role of fungal pathogens in deterioration of papaya fruit during storage following observation of other workers, viz. *A. niger*, *F. moniliforme*, *Curvularia lunata* by Baiyewu and Amusa 2005); *Colletotrichum gloeosporioides* by Shivakumar *et al* (2002); *A. flavus*, *Botryodiplodia* sp, *Alternaria* sp and *Rhizopus* sp by Eckert and Ogawa (1985).

Symptoms of Papaya fruit rot

1) *Alternaria alternata* rot

The disease is characterized by grey, brown, circular to semicircular patches covered with mycelial growth. The affected fruits turn black and bear the fungal sclerotia. Affected fruits develop typical yellowing at the site of infection and showed blackening of the tissues with grayish mycelium when cut open. Infection from the centre of the fruit to the periphery and fruits fail to ripen by remaining hard and unfit for papain extraction or consumption.

2) *Aspergillus* rot (*Aspergillus* spp.)

Several species of *Aspergillus* are found to be associated. Symptoms of *Aspergillus niger* appear at first as water soaked spots on fully ripened and injured fruits. The spots enlarge to about 2-3 cm in diameter within 2 days and the centre turns black due to the presence of profuse conidial heads surrounded by white scanty fungal growth. The fruit gets decayed within 5-7 days with profuse exudation of the sap.

3) *Colletotrichum gloeosporioides* rot (Anthracnose of papaya)

Anthracnose is the major post-harvest disease of papaya. It is caused by *Colletotrichum* species. Five different species have been reported as pathogens of papaya fruit. This includes *Colletotrichum capsici*, *Colletotrichum Cercinuans*, *Colletotrichum dematium*, *Colletotrichum gloeosporioides* and *Colletotrichum papaya*. Of these, *Colletotrichum gloeosporioides* is the frequently encountered and reported pathogen.

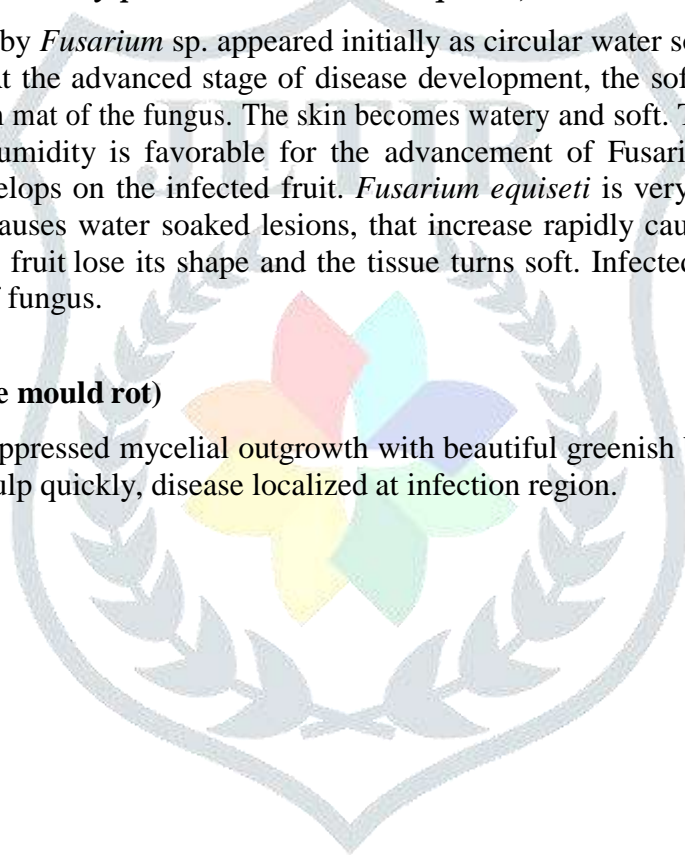
Initial symptoms appear as small round dark areas on the ripening portions of the fruits. As the fruits ripen, these spots enlarge rapidly forming circular, slightly sunken, water soaked, and lesions. As the lesions enlarge, the margins appear dark in colour while the central portion of the lesion turns brown or black. As the fungus develops it frequently produces large masses of spores in the central portions of the lesions causing them to turn light ripened or pink. The affected tissues become dirty brown, soft and finally rot. Infection may also occur when the fruit is immature and mummification and deformation of fruits take place.

4) *Fusarium* rot (*Fusarium oxysporum* and *Fusarium equiseti*)

Fusarium rot caused by *Fusarium* sp. appeared initially as circular water soaked lesion, which later became depressed. At the advanced stage of disease development, the soft rotted area was covered with a white mycelium mat of the fungus. The skin becomes watery and soft. The infected tissue loses its turgidity. High humidity is favorable for the advancement of Fusarial rot of papaya. White mycelial growth develops on the infected fruit. *Fusarium equiseti* is very common on fully ripen papaya fruit which causes water soaked lesions, that increase rapidly causing 100 per cent decay within 7-8 days. The fruit lose its shape and the tissue turns soft. Infected fruits get covered with white cottony mass of fungus.

5) *Penicillium* rot (Blue mould rot)

Initial small white suppressed mycelial outgrowth with beautiful greenish blue conidial compact mass, degrades the pulp quickly, disease localized at infection region.



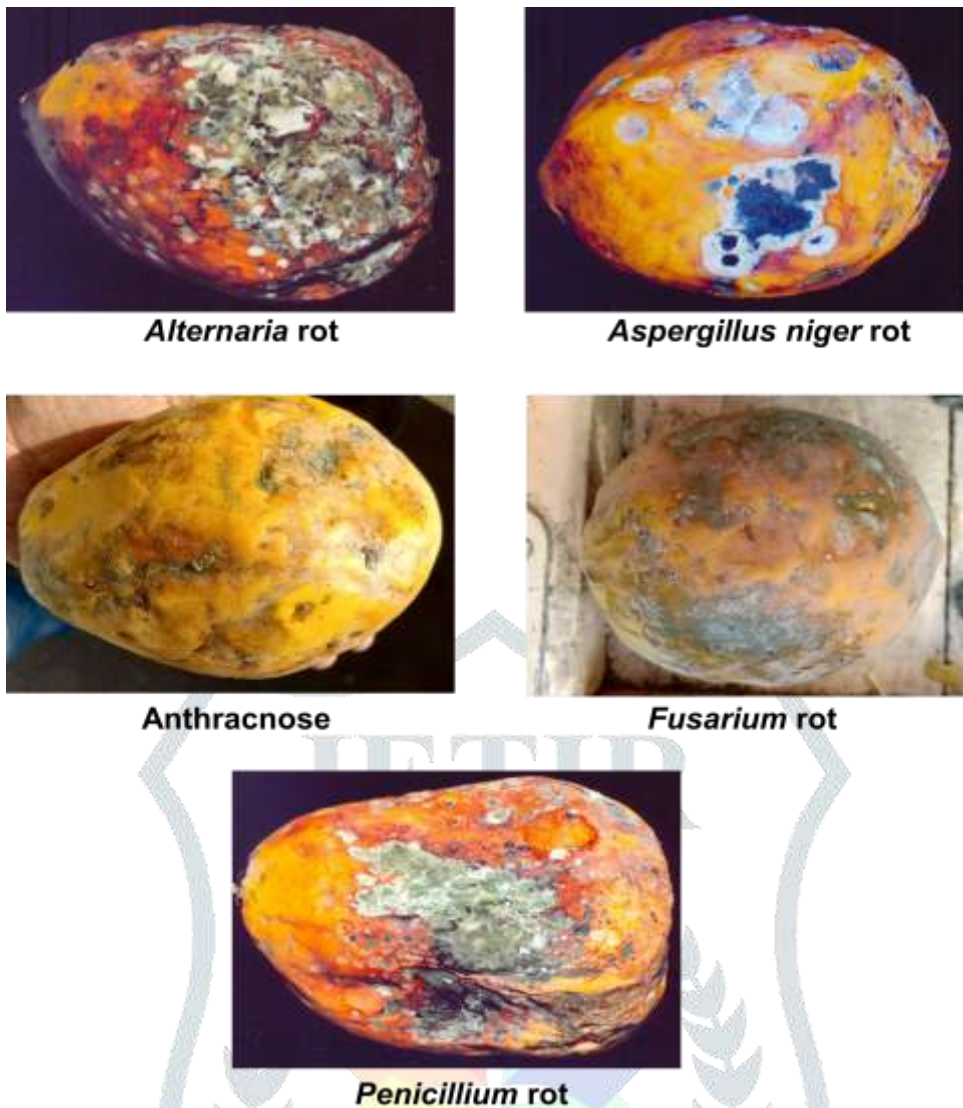


Fig 1: Post harvest fungal diseases of papaya fruits

Table 1: Isolation of fungi on different varieties of papaya fruits

Fungi	Papaya varieties				
	Co I	Co II	Taiwan	Washington	Local
<i>Alternaria alternata</i>	+	+	++	+	+
<i>Aspergillus flavus</i>	+	++	++	+	++
<i>Aspergillus fumigatus</i>	++	++	++	++	++
<i>Aspergillus niger</i>	++	++	+++	+++	++
<i>Botryodiplodia theobromae</i>	+	+	+	+	+
<i>Colletotrichum gloeosporioides</i>	+++	+	+	++	++
<i>Curvularia lunata</i>	+	+	++	+	+
<i>Fusarium equiseti</i>	+	+	--	+	+
<i>Fusarium moniliforme</i>	+	+	+	+	+
<i>Fusarium solani</i>	+	+	+	+	+
<i>Fusarium oxysporum</i>	+++	++	++	++	++
<i>Gloeosporium papayae</i>	++	+	+	++	+
<i>Macrophomina phaseolina</i>	++	+	++	++	+
<i>Phoma sp.</i>	++	+	+	++	+
<i>Phomopsis caricae</i>	++	--	--	+++	--
<i>Penicillium digitatum</i>	++	++	++	++	++
<i>Phytophthora nicotianae</i>	--	++	--	+++	+
<i>Rhizopus stolonifer</i>	++	++	++	++	++

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