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Full Length Research Paper

Isolation and classification of fungi associated with spoilage of post-harvest mango (*Mangifera indica* L.) in Saudi Arabia

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A survey was conducted between May and July to assess the extent of loss in mangoes at wholesale and consumer levels caused by fungal spoilage during post-harvest. Mango fruits were purchased from different markets in Saudi Arabia, and the degree of losses due to fungal spoilage was assessed at the different levels of marketing. Fungal spoilage was found to be the highest at the consumer level and least at the wholesale level. *Aspergillus flavus* rot, *Aspergillus niger* rot, and *Penicillium* spp. rot were the commonest diseases affecting the mango fruits.

Key words: *Aspergillus*, *Penicillium*, rot and spoilage.

INTRODUCTION

Fruits are widely cultivated in large quantities in different parts of the world. One of the factors compromising the economic value of fruits is the reduction in their shelf-life due to post-harvest disease. The recommended quantity of fruits to be consumed by a normal healthy adult is 230 g/day, while the current per capita consumption of fruits is reported to be less than 160 g/day (Veeraragavathatham et al., 1996). Mango originated from India and Southeast Asia; it is one of the most important fruits cultivated in tropical countries. Mango cultivation has now extended to several other parts of the world including Africa, the Americas and the Caribbean region. Mango is one of the most popular fruits in the tropical region and is increasingly being consumed in the developed countries (Diedhiou et al., 2007). Post- harvest losses in fruits can be attributed to several factors, the most important of which is post-harvest disease. The post-harvest losses of fresh mango fruits are reported to be 25 - 40% in India and 69% in Pakistan; and microbial decay accounts for 17.0 - 26.9% of the total post-harvest losses in Asian countries (Prabakar et al., 2005). The percentage loss of fruit over the marketable period has been reported to be the highest for mango (Mandal and Dasgupta, 1981). The potential of mango as a commercial crop is markedly limited because of its high perishability, which results in considerable wastage (Mootoo, 1992). In addition, mango fruits are susceptible to post- harvest diseases, extremes of temperature, and physical injury (Crucifix and Pilgrim, 2001). Mango fruit diseases of major concern to producers are anthracnose caused by *Colletotrichum gloeosporioides* (Penz.) and stem-end rot caused by *Botryosphaeria parva* (Swart et al., 2002). Several factors affect mango production with post-harvest losses being one of the major constraints (Theodosy and Elde, 2011). In Saudi Arabia, mango is imported from different tropical countries, sold at different levels of marketing and consumed as a fresh fruit.

The objectives of this study were to assess the extent and nature of fungal spoilage in fresh mangoes imported to Saudi Arabia and to identify the main causative factors.

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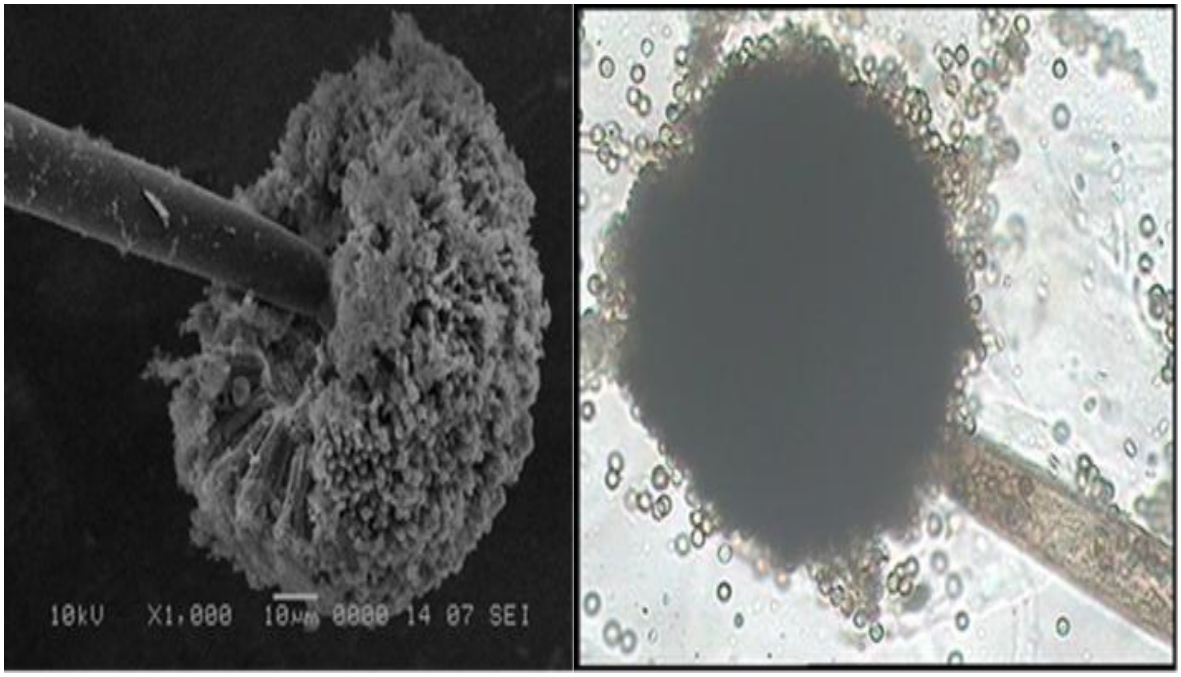

Figure 1. Microscopic and electronmicroscopic images of *Aspergillus niger*.

MATERIALS AND METHODS

A survey was conducted to assess the extent of loss in mango fruits caused by fungal rots during post-harvest. 100 samples were purchased in all, from different markets in Saudi Arabia. The samples were sorted to identify infected mangoes, which were then transferred into sterile polythene bags, labeled, and assessed in the laboratory. The loss due to fungal rots was assessed at weekly intervals for three months (May to July 2012). 85% out of 100 samples were infected. The prevalence was calculated using the following formula:

$$\text{Prevalence \%} = \frac{\text{Number of locations with diseased mangoes}}{\text{Total number of locations}} \times 100$$

During the survey, infected mango fruits from different fruits market of Saudi Arabia were collected in sterile polythene bags, labeled and taken to the laboratory. Fungal species were isolated from each spoiled fruit, incubated at 28°C for 10 days, and identified using Potato Dextrose Agar (PDA). Pure colonies of fungal isolates were classified according to the conventional guidelines of fungus identification (Ellis, 1971; Samson and Varga, 2007). The pathogenicity of the isolated fungal species was confirmed by inoculating them in 250 ml Erlenmeyer flasks containing 5% fresh uninfected mango peels under aseptic conditions, to induce rotting. The inoculated flasks were incubated at 28°C in a rotary incubator shaker with shaking at 150 rpm for five days.

RESULTS AND DISCUSSION

Overall, the prevalence of mango spoilage due to disease was determined to be 85%. The fungal species isolated from the infected mangoes were *A. flavus*, *A. niger* and *Penicillium* spp. (Figures 1 and 2). Mangoes affected with *A. niger* rot showed brown circular spots with depressions, which then enlarged into darker lesions. Mangoes infected with *Penicillium* spp. rot showed a large number of bluish green spores (Tables 1 and 2). *Aspergillus* spp. infection was noted widely among all the examined spoiled mangoes. The point of entry of the pathogenic fungi was believed to be injured and weakened areas of the mango flesh. *A. niger* var. Tieghem (IMI No. 29005) was isolated from a spoiled ripe mango.

The severity of *A. flavus* infection was tested at different temperatures by incubating mango fruits inoculated with the fungus, and the severity of *A. flavus* rot was found to be highest at 35°C and 100% relative humidity (RH) (Gadgile and Chavan, 2010). After harvest, mangoes are susceptible to infection by several fungi such as *A. flavus*, *A. niger*, and *Penicillium* spp. Artificial infection studies have shown that fruits are susceptible to infection at all stages of ripeness (Palejwala et al., 1987).

Analysis of the spoilage at different time points between May and July revealed that the possibility of fungal infection was highest in the month of July. Additionally, our data on spoilage at different stages of marketing revealed that the spoilage was highest at consumer level and least at wholesale level. In post-harvest condition, mangoes get infected by several fungal diseases like *A. flavus*, *A. niger* and *Penicillium* spp.. *A. flavus* was investigated by incubating inoculated mango fruits at different temperatures, and at 35°C and 100%

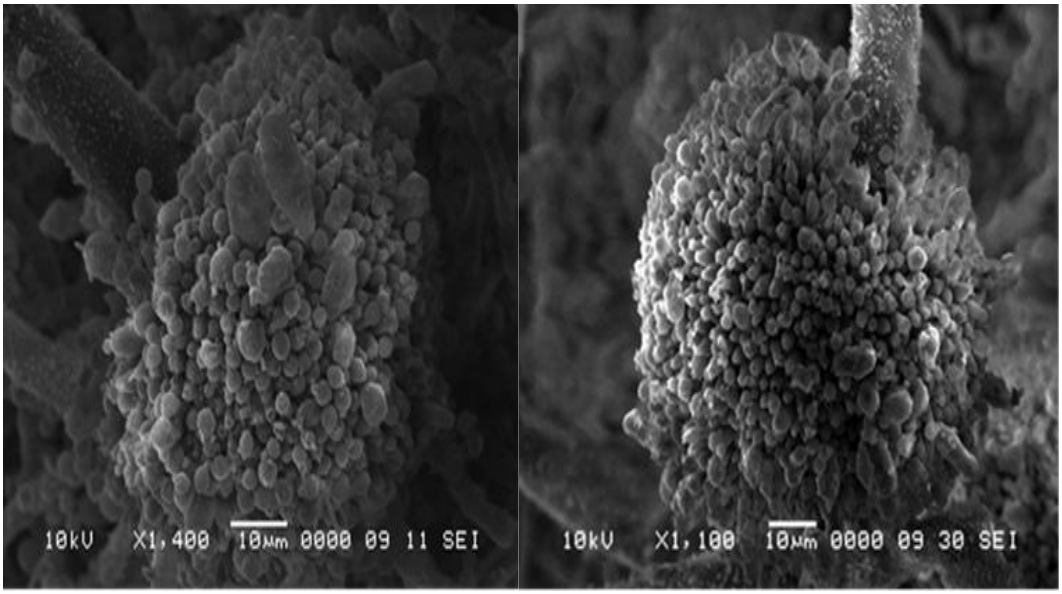

Figure 2. Electronmicroscopic images of*Aspergillus flavus* .

Table 1. Symptoms of post-harvest diseases in mango, as recorded between May and July, 2012.

Disease	Spoilage fungus	Symptoms
Aspergillus niger rot	*Aspergillus niger*	Brown circular spots, that enlarge to form darker lesions
Aspergillus flavus rot	*Aspergillus flavus*	Powdery yellow green spores
Blue- mould rot	*Penicillium* spp.	Bluish- green spores

Table 2. Prevalence of post-harvest diseases in mango, as recorded between May and July, 2012.

Disease	Spoilage fungus	Prevalence (%)
Aspergillus niger rot	*Aspergillus niger*	100
Aspergillus flavus rot	*Aspergillus flavus*	100
Blue- mould rot	*Penicillium* spp.	100

R.H *A. flavus* rot severity was maximum (Gadgile and Chavan, 2010).

Conclusion

Mangoes are highly perishable fruits and very prone to fungal infection. It is clear that fungal spoilage like *A. flavus* rot, A*. niger* rot, and Penicillium spp. were the commonest fungal diseases affecting mangoes, especially, in developing countries where storage and handling techniques are primitive. Our findings reveal that fungal spoilage of mango was highest in the month of July at consumer level and least at the wholesale level.

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