ISSN No. 2394 - 7837

ARTICLE

Survey of Commonly Used Fruits and Vegetables in Thiruvananthapuram District, Kerala Reveals the Occurrence of Mycotoxigenic Fungi

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Received 05/10/2014 Accepted 28/11/2014

Abstract

In this study we examined the occurrence of fungi in altogether 13 samples, comprising of commonly used vegetables and fruits, procured from different markets in Thiruvananthapuram district. Fungus was identified in all the samples analyzed with one species each in 11 samples and two species each in two samples. Rhizopus stolonifer and Mucor sp. were occurred in five samples each followed by Aspergillus sp. in four samples and Alternaria sp. in one. The fungal species identified in the study are known to produce mycotoxins that are highly toxic to humans. The results indicate potential risk in human beings due to the chronic exposure to mycotoxins originated from horticultural products. Further, the baseline information generated in the study would provide a basis for developing measures for controlling fungal spoilage of horticultural products marketed in Thiruvananthapuram district.

Keywords: Fungal spoilage, Fruits and vegetables, *Aspergillus sp., Alternaria sp., Rhizopus stolonifer, Mucor sp.*

Introduction

Spoilage of fruits and vegetables by fungi incur heavy economic loss, and also often causes mycotoxicosis in humans by the ingestion or inhalation of mycotoxins, the secondary metabolites produced by fungi under certain conditions (Peraica et al., 1999; Bennett and Klich, 2003; Williams et al., 2004). Worldwide, about 25% post harvest loss of fruits and vegetables has been estimated per annum due to microbial infection (El-Ghaouth et al., 2004). Microbial infection may occur at any stage of crop production and utilization, including post harvest processing, marketing or even after purchased by consumers (Barth et al., 2009). Several mycotoxins, mostly produced by species belonging to genus *Aspergillus, Claviceps, Fusarium, Mucor, Alternaria, Rhizopus* and *Penicillium* are known to contaminate staple fruits and vegetables worldwide (Bhatnagar et al., 2002; Bennett and Klich, 2003; Williams et al., 2004; Barth et al., 2009). Accurate and rapid identification of fungi associated with food spoilage has great clinical relevance and also help in designing control measures (Peraica et al., 1999; Williams et al., 2004; Cherian, 2004; Moss, 2008; Bhale, 2011). In this study we examined fungal species associated with commonly used fruits and vegetables marketed in Thiruvananthapuram district.

Materials and Methods

The fruits and vegetables examined in the study are enlisted in Table 1 together with the place of their procurement. Altogether 13 commonly used species, comprising of eight fruits and five vegetables, were sampled from different places in Thiruvananthapuram district (Table 1). The lot of fruit or vegetable available with the vendor at time of sampling was examined and three specimens with visible fungal lesions were sampled for each species. The collected specimens were brought to the laboratory in separate polythene bags, and were examined critically and lesion characteristics were noted. Tissues from lesions were excised with the help of sterilized scalpel and needle and were transferred onto glass slides. The tissues were stained with lactophenol cotton blue according to the method of Mc Clean and Ivimey, (1965), and were photographed using an Image Analyzer (Leica) at 40x magnification. The fungus observed in plant tissues were identified based on mycelial pattern, and spore and sporangial characteristics.

Results and Discussion

Characteristics of lesions observed in the samples examined and the fungal species identified in lesions following lactophenol cotton blue staining are presented in Table 1. Representative microphotographs of different fungal species identified in the study are given in Fig. 1. Fungus was identified in the lesions of all the samples analyzed with one species each in 11 samples and two species each in two samples. *Rhizopus stolonifer* and *Mucor sp.* were occurred in five samples each followed by *Aspergillus sp.* in four samples and *Alternaria sp.* in one (Table 1). Characteristics of the lesions differed markedly between fungi. The colour of mycelia was mostly grey in Mucor whereas it was black in *Rhizopus* and yellowish green in *Aspergillus*. Irrespective of the fungi and the sample examined, in most cases, the lesions were turned into a water soaked sunken depression at advanced stage of infection (Table 1).

The fungi identified in the lesions of the plant samples surveyed in this study are reported in the fruits and vegetables sampled from different places in India and other coun-

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Table 1. List of fruits and vegetables analyzed in the study together with the place of collection, lesion characteristics and the fungal species detected in lesions

Sl. No.	Plant species*	Place of collection**	Spoilage pattern (macroscopic examination)	
			Nature of lesions	Fungal species
1	Lady's finger (*Abelmoschus esculentus* (L.) Moench; Vegetable)	Keezharoor	Large water soaked depressions with grey mycelia	*Mucor sp.*
2	Pineapple (*Ananas comosus* (L.) Merr. Fruit)	Peroorkada	Water soaked wrinkled lesions with white coloured mycelia	*Mucor sp.*
3	Jack fruit (*Artocarpus heterophyllus* Lam.; Fruit)	Keezharoor	White mycelia covering the entire fruit, which turn to black later	*Rhizopus stolonifer*
4	Bilimbi (*Averrhoa bilimbi* (L.); Vegetable)	Palode	Sunken depressions with light yellowish green colony	*Aspergillus sp.*
5	Cabbage (*Brassica olearaceae* (L.); Vegetable)	Vattapara	Black colonies with white edges and large fluffy mycelium	*Rhizopus stolonifer*
6	Lime(*Citrus aurantifolia* Christm. & Pranz; Fruit)	Kanjiramkulam	Sunken depression with whitish mycelium	*Rhizopus stolonifer*
7	Coconut (*Cocos nucifera* (L.); Fruit)	Parasala	Two types of lesions:extensive black mycelium and green mycelium with white edges.	*Aspergillus sp.* *Mucorsp.*
8	Tomato (*Lycopersicon esculentum* Mill.; Vegetable)	Venjaramoodu	Water soaked wrinkled lesions with whitish foamy-like mycelia	*Alternaria sp.* *Aspergillus sp.*
9	Banana (*Musa paradisiaca* (L.); Fruit)	Peroorkada	Sunken depressions with light yellowish green colony	*Aspergillus sp.*
10	Gooseberry (*Phyllanthus emblica* L.; Fruit)	Peroorkada	Black coloured mycelia on entire surface of the fruit	*Rhizopus stolonifer*
11	Pomegranate (*Punica granatum* (L.); Fruit)	Peroorkada	Black coloured mycelia on entire surface of the fruit	*Rhizopus stolonifer*
12	Tamarind (*Tamarindus indica* L.; Fruit)	Venjaramoodu	Grey coloured mycelia in lesions	*Mucor sp.*
13	Snake gourd (*Trichosanthes cucumerina* (L.); Vegetable)	Vattappara	Grey coloured mycelia in lesions	*Mucor sp.*

*Scientific name followed by the nature of the sample examined are in parenthesis

** All places are in Thiruvananthapuram district, Kerala

tries (Cherian, 2004; Moss, 2008; Bhale, 2011). Cherian, (2004) surveyed the fungi associated with the fruits and vegetables sampled from different places in Kerala. Akin to our findings, Cherian (2004) identified *Aspergillus, Rhizopus, Mucor*, *Alternaria* and *Aspergillus* species in banana, jack fruit, lady's finger and tomato respectively. However, the fungi obtained by Cherian (2004) in pineapple, gooseberry, lime, snake gourd and tamarind samples were different from those recorded in this study. The results suggest that different fungal species are associated with the spoilage of a food marketed in different places.

Over 300 mycotoxins have been reported wordwide and the severity of mycotoxicosis in humans depends on the type of mycotoxins ingested or inhaled and the extent of exposure (duration and dose) to them. The nature and extent of mycotoxin contamination of staple food vary from place to place (Bhatnagar et al., 2002). It is estimated that approximately 4.5 billion persons living in the developing countries are chronically exposed to largely uncontrolled amount of aflatoxins produced by *Aspergillus sp.* (Williams et al., 2004). All the fungi identified in the study are known to produce highly toxic mycotoxins (Peraica et al., 1999; Bhatnagar et al., 2002; Bennett and Klich, 2003; Barth et al., 2009). Chronic exposure to mycotoxins lead to several health disorders in humans, but are often remained unrecognized by medical professionals, until large number of persons in a locality are affected (Peraica et al., 1999). Therefore periodic monitoring of mycotoxogenic fungal species is essential to ensure the hygienic of the fruits and vegetables marketed in a locality.

Conclusions

The present study report the occurrence of mycotoxogenic

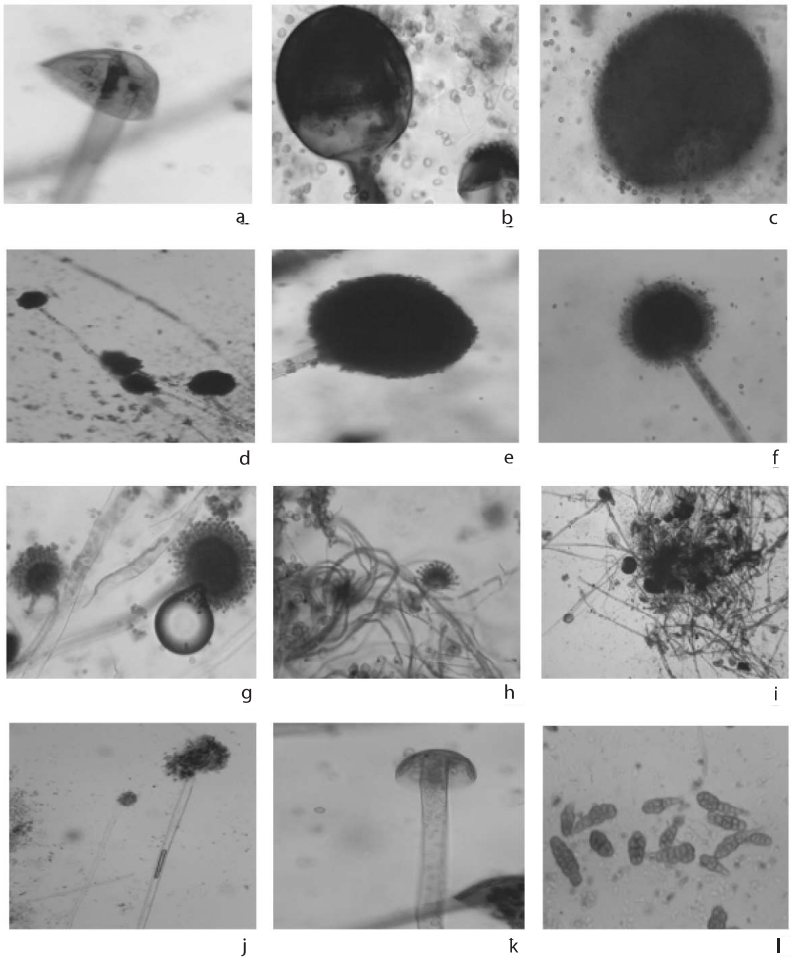

Figure 1. Microphotograph (40x) of lactopherol cotton blue stained mycelia identified in the lesions observed on various fruits and vegatables. The fungal species identified were *Rhizopus stolonifer* in Jack fruit (a), Cabbage (b), Lime (c), Gooseberry (d), Pomegranate (e); *Aspergillus sp.* in Bilimbi (f), Coconut (g), Banana (h); *Mucor sp.* in Lady's finger (i), Pineapple (j), Snake gourd (k) and *Alternaria sp.* in Tomato (l).

fungi in commonly used vegetables and fruits marketed in different places in Thiruvananthapuram district and point to the need of periodic analysis of fresh horticultural samples in order to avoid the potential risk of chronic exposure to mycotoxins. Further, the baseline information generated in the study would provide a basis for designing methods for controlling fungal species associated with vegetable and fruits spoilage in Thiruvananthapuram district.

Acknowledgement

We gratefully acknowledge the Principal and the Head, Department of Botany, Mar Ivanios College, Thiruvananthapuram for providing laboratory facilities, Mr. Shibu P. Varghese, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram for the assistance in fungal identification and the Head, Department of Botany, University of Kerala, Thiruvananthapuram for the help in microphotography.

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