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Postharvest fungal diseases of some vegetables in the two main markets of Riyadh (Saudi Arabia)

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ABSTRACT

The postharvest diseases of some vegetables in the two main markets of Riyadh were studied. Fungi isolated from their respective hosts were: *Alternaria alternata*, *Drechslera spicifera*, *Epicoccum purpurascens* and *Trichocladium asperum* from egg plant fruits; *Alternaria alternata* and *Botrytis cinerea* from tomato fruits; *Alternaria alternata* from potato tubers; *A. alternata* and *Xylohypha* sp. from squash fruits; *Botrytis* sp. and *Cladosporium cladosporioides* from red pepper fruits; *Alternaria alternata*, *Botrytis* sp. and *Fusarium* sp. from broad beans, and *Botrytis* sp., *Alternaria radicina* and *Fusarium* sp. from okra fruits. Pathogenicity tests confirmed that the isolated fungi were pathogenic to their respective hosts and that locality had no effect on isolation frequency of these pathogens. Different rot symptoms are also described. Temperature and pH experiments showed that optimum temperature and pH value varied for different isolates of the fungi.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.), egg plant (*Solanum melongena* L.), red pepper (*Capsicum annuum* L.), squash (*Cucurbita maxima* Duchesne), broad beans (*Vicia faba* L.), okra (*Hibiscus esculentus* L.) fruits and potato tubers (*Solanum tuberosum* L.) are among the important vegetables in most of the world. These fruits and tubers are subject to attack by many fungi during storage and marketing, causing heavy losses.

Several workers of the Middle East and Indian sub-continent have investigated the diseases of tomato, egg plant, red pepper, squash, broad beans, okra and potato tubers in the stores and markets in areas where refrigerated storage and transport is not always available. Dry and soft rots of potato tubers during storage and marketing have been reported to be caused by species of *Fusarium*, *Rhizoctonia solani* Kuhn and *Rhizopus stolonifer* Ehrenb. ex Fr. (Thirumalachör 1953; Elarosi 1956; Elarosi *et al.* 1978; Kassim *et al.* 1980).

Postharvest disease organisms of tomato fruits in the stores and markets include *Alternaria alternata* (Fr.) Keissler, *Fusarium moniliform* Shield; *Geotrichum candidum* Link ex Pers., *Oospora lactisparasitica* Prit. & Porte. *Penicillium verruculosum* Peyrone; *Penicillium digitatum* (Fr.) Sacc., *Acremonium persicinum* (Nicot) W. Gams, *Rhizoctonia solani* and *Trichothecium roseum* Link. (El-Helaly *et al.* 1962; Abdel-

Rahim *et al.* 1973; Khanna & Chandra 1975; Jamaluddin & Tandon 1976; Kassim *et al.* 1980).

Egg plant fruits have been reported to be attacked by *Botrytis cinerea* Pers. ex Fr., *Chaetomium globosum* Kunze ex Fr., *Colletotrichum truncatum* (Schw.) Andrus & Moore, *Myrothecium roridum* Tode ex Fr., *Phytophthora parasitica* Dastur, *Pythium aphanidermatum* (Edson) Fitzp. and *Rhizopus stolonifer* (Westcott 1971; Jamaluddin & Tandon 1976).

Rots of red pepper fruits in stores have been caused by *Colletotrichum capsici* (Sydow) Butler & Bissy, *Cladosporium oxysporum* Berk & Curt; *Curvularia lunata* (Wakker) Boedijn, *Alternaria alternata*, *Phoma destructiva* Plowright and *Phytophthora capsici* Leonian (Westcott 1971; Panwar & Vyas 1974; Jamaluddin & Tandon 1976; Kassim *et al.* 1980). Gangopadhyay & Kapoor (1973) observed a fruit rot of squash caused by *Alternaria cucumerina* (E. & E.) Elliot.

The present work is particularly concerned with the study of postharvest fungal diseases of some vegetables in the two local markets of Riyadh. The aim of the work was to: (1) isolate and identify these fungi (2) determine the pathogenicity of the isolated fungi to their respective hosts (3) study the effects of temperature and pH on *in vitro* growth of the isolated fungi.

MATERIALS AND METHODS

Diseased specimens of fresh local tomato, egg plant, red pepper, squash, broad beans, okra fruits and potato tubers were collected from Otyka and Rabwah markets of Riyadh during the period October 1982 to April 1983, and brought to the laboratory for observation. The disease symptoms were noted and the pathogens isolated on potato dextrose agar (PDA), after surface sterilization of the disease specimens with 0·1% mercuric chloride solution for 2 min. The inoculated plates were incubated at 26°C. Pure cultures of the isolated fungi were obtained by the use of the single spore method or by the hyphal tip technique. Pure cultures were maintained in the laboratory on PDA slants.

The isolated fungi were determined using the key monograph and literature of Barnett & Hunter (1972), Booth (1971), Ellis (1971, 1976), Raper & Fennell (1965) and Raper *et al.* (1968). Some of the determinations were verified at the Commonwealth Mycological Institute, Kew, England. The fungi are maintained in the mycological collection at the Department of Botany, King Saud University.

Pathogenicity tests were carried out in the laboratory to confirm that the isolated organisms caused the observed symptoms. Healthy fruits or tubers were surface-sterilized and inoculated with their respective isolated organisms. Comparable small discs of one-week old PDA cultures were placed on the surface of each tuber or fruit, or under the surface layer in inoculation wounds. Controls were similarly treated without the test fungus. The fruits and tubers were kept separately in sealed polyethylene bags at room temperature (26 $\pm$ 2°C).

To study the effect of temperature on the growth of the isolated fungi, they were cultured on potato dextrose broth medium and incubated at temperatures ranging from 5 to 35°C. Twenty-five cm^3 of the medium were placed in 100 cm^3 flasks. Three replicates were used for each treatment. After one week, the fungal mats were collected, filtered and then dried at 120°C for 24 hours.

To study the effect of pH on linear growth, the isolated fungi were cultured on

PDA medium with pH values of 3, 4, 5, 6, 7, 8 and 9. These values were achieved by using concentrated sodium hydroxide and hydrochloric acid, and determined by using universal indicator paper. The cultures were then incubated at their optimum temperatures for one week; three replicates were used for each treatment.

RESULTS

ISOLATIONS

Results are shown in Table 1. Two species of fungi, *Alternaria alternata* and *Botrytis cinerea*, were isolated from tomato fruits collected from the Otyka local market. No fungus was isolated from tomato fruits collected from Rabwah market. *Alternaria alternata* was isolated from potato tubers obtained from both markets. Four fungi, *Alternaria alternata*, *Drechslera spicifera*, *Epicoccum purpurascens* and *Trichocladium asperum* were isolated from egg plant fruit. *Alternaria alternata* and *Drechslera spicifera* were isolated from Rabwah, and *Epicoccum purpurascens* and *Trichocladium asperum* from Otyka market. *Alternaria alternata* from Otyka and *Xylohypha* sp. from Rabwah market were found on squash fruits. Two species, *Botrytis* sp. and *Cladosporium cladosporioides* were isolated from red pepper fruit collected from Rabwah market. *Alternaria alternata* and *Fusarium* sp. were isolated from broad beans from Rabwah market and *Botrytis* sp. from Otyka market. Fungi isolated from okra fruit were, *Alternaria radicina* and *Fusarium* sp. from Otyka market, *Botrytis* sp. and *Cladosporium cladosporioides* from Rabwah market.

PATHOGENICITY TESTS

Inoculation of egg plant fruits with the isolated fungi produced the following rot symptoms: *Alternaria alternata* infection resulted in dark black lesions with the surface covered with black masses of spores and mycelium. Lesions were dark brown and about 2 cm in diameter after egg plant fruits had been inoculated with *Drechslera spicifera*. *Epicoccum purpurascens* symptoms were irregular brown to dark brown spots surrounded by dark margins. *Trichocladium asperum* produced light brown lesions covered with white mycelium.

Okra fruits inoculated with *Alternaria radicina* showed black irregular spots with conidia and mycelium present at the margins. *Botrytis* sp. produced a grey soft rot and *Cladosporium cladosporioides* formed blue–green lesions with brownish margins. *Fusarium* sp. produced localised pinkish spots covered with pink mycelium on okra fruits.

Red pepper fruits inoculated with *Botrytis* sp. produced the same type of symptoms as on okra fruits. *Cladosporium cladosporioides* produced deep and large circular olive green to blue green spots on pepper fruits. The spots were covered with fluffy mycelial growth. *Alternaria alternata* produced localised black lesions when potato tubers were inoculated. The symptoms produced by *A. alternata* on squash fruits resembled those on potato tubers. *Xylohypha* sp. developed pinkish elongated spots with brown margins on squash fruits. The spots were covered with white mycelium.

Tomato fruits inoculated with *Alternaria alternata* developed dark black sunken

Table 1. Fungi isolated from different vegetable fruits and tubers collected from two local markets in Riyadh

Fungi	Tomato		Potato		Egg plant		Squash		Red pepper		Broad beans		Okra	
	Otyka	Rabwah	Otyka	Rabwah	Otyka	Rabwah	Otyka	Rabwah	Otyka	Rabwah	Otyka	Rabwah	Otyka	Rabwah
1. *Alternaria alternata*	+	−	+	+	−	+	+	−	−	−	−	+	−	−
2. *Botrytis* sp.	+	−	−	−	−	−	−	−	−	+	+	−	−	+
3. *Drechslera spicifera*	−	−	−	−	−	+	−	−	−	−	−	−	−	−
4. *Epicoccum purpurascens*	−	−	−	−	+	−	−	−	−	−	−	−	−	−
5. *Trichocladium asperum*	−	−	−	−	+	−	−	−	−	−	−	−	−	−
6. *Xylohypha* sp.	−	−	−	−	−	−	−	+	−	−	−	−	−	−
7. *Cladosporium cladosporioids*	−	−	−	−	−	−	−	−	−	+	−	−	−	+
8. *Alternaria radicina*	−	−	−	−	−	−	−	−	−	−	−	−	+	−
9. *Fusarium* sp.	−	−	−	−	−	−	−	−	−	−	−	+	+	−

+ Growth.
− No Growth.

spots with dark green margins. Masses of spores were present on the surface of the spots. A greyish green rot of tomato fruits was caused when fruits were inoculated with *Botrytis cinerea*. A velvety greyish mycelium was present on the surface of the fruits.

It may be mentioned that the symptoms in the pathogenicity experiments correspond to the symptoms on the vegetable fruits when brought from the two markets. This shows that the isolated fungi were pathogenic to their respective fruits.

TEMPERATURE EFFECTS ON GROWTH

Fungal growth (dry weight in mg) is shown in Figs 1 to 5. It was observed that the approximate optimum temperature was: 15°C for the growth of *Cladosporium cladosporioides* (okra isolate); 20°C for *Botrytis* sp., *B. cinerea*, (broad beans isolate), *Alternaria alternata* (squash isolate), *A. radicina*, *Epicoccum purpurascens* and *Xylohypha* sp.; 25°C for *Alternaria alternata* (tomato, potato and broad bean isolates), *Botrytis* sp. (red pepper isolate), *Cladosporium cladosporioides* (red pepper isolate), *Fusarium* sp. and *Trichocladium asperum*; and 30°C for *Alternaria alternata* (egg plant isolate), *Botrytis* sp. (okra isolate) and *Drechslera spicifera*.

pH EFFECTS

The results are shown in Table 2. It was observed that the optimum pH value was 5 for *Alternaria alternata* (tomato and broad bean isolates), *A radicina*, *Cladosporium cladosporioides* (red pepper isolates) and *Xylohypha* sp; 6 for *A. alternata* (egg plant

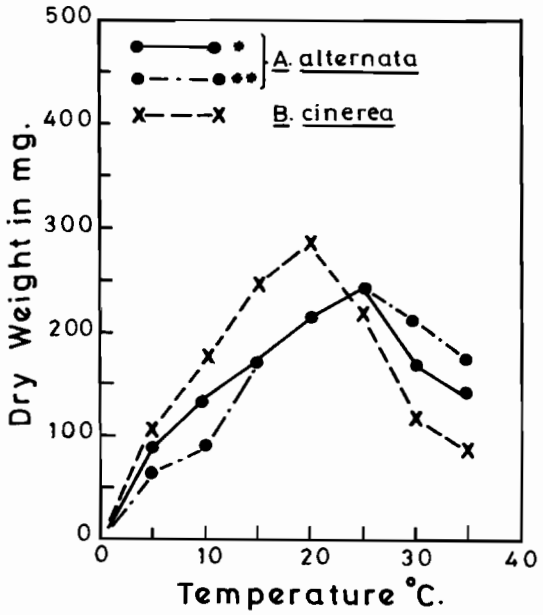

Fig. 1. Effect of temperature on the dry weight of the isolated fungi of potato tuber* and tomato** fruit rot.

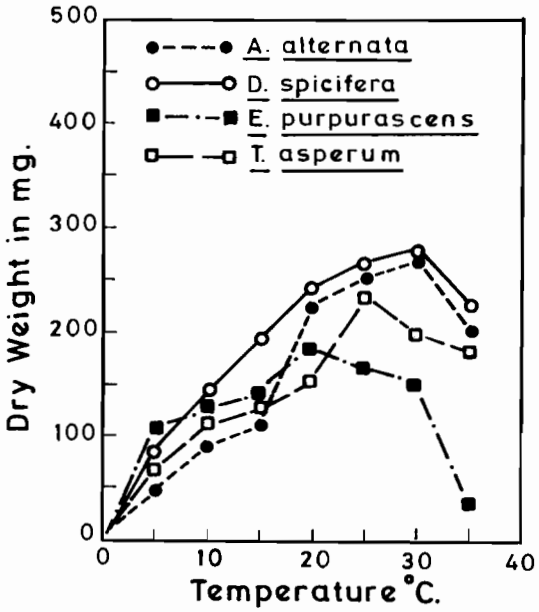

Fig. 2. Effect of temperature on the dry weight of the isolated fungi of egg plant fruit rot.

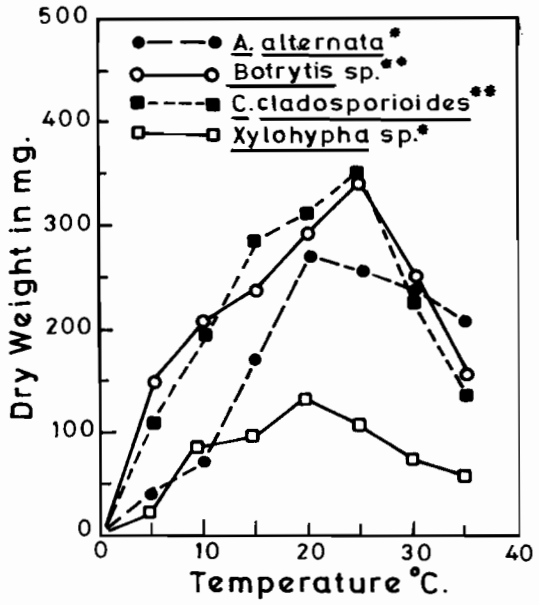

Fig. 3. Effect of temperature on the dry weight of the isolated fungi of squash* and pepper** fruit rot.

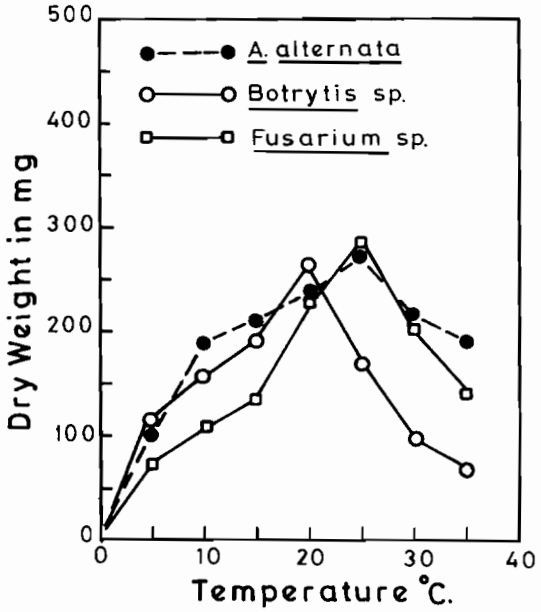

Fig. 4. Effect of temperature on the dry weight of the isolated fungi of broad beans fruit rot.

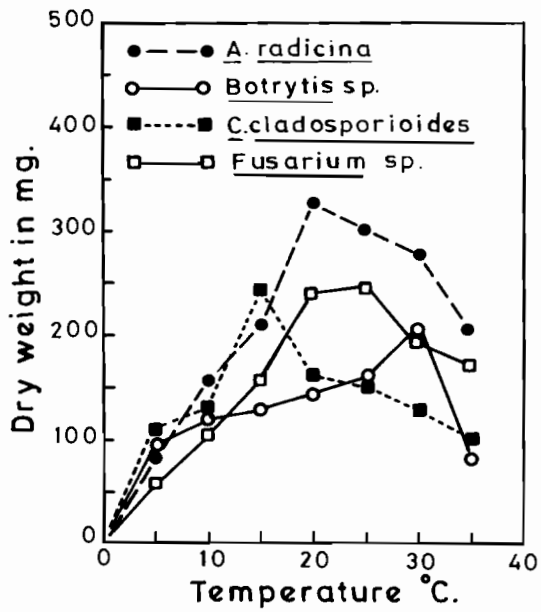

Fig. 5. Effect of temperature on the dry weight of the isolated fungi of okra fruit.

Table 2. Effect of hydrogen ion concentration on the linear growth (mm) of the fungi isolated from different vegetable fruits and tubers

Host	Pathogen	pH						
		3	4	5	6	7	8	9
Tomato	*Alternaria alternata*	12	50	66	61	59	57	55
	Botrytis cinerea	0	17	52	63	59	20	55
Potato	*Alternaria alternata*	13	19	46	42	55	35	29
Egg plant	*Epicoccum purpurascens*	19	20	39	30	25	24	20
	Drechslera spicifera	15	32	42	57	52	45	33
	Trichocladium asperum	19	26	52	56	57	84	60
	Alternaria alternata	18	21	61	63	62	62	60
Squash	*Xylohypha* sp.	11	13	75	67	66	62	60
Red pepper	*Botrytis* sp.	10	16	50	57	55	50	38
	Cladosporium cladosporioides	33	30	45	29	25	23	20
Broad bean	*Botrytis* sp.	20	20	52	68	59	60	50
	Alternaria alternata	14	25	70	66	55	53	50
	Fusarium sp.	15	20	80	76	76	75	75
Okra	*Alternaria radicina*	20	20	68	65	59	60	52
	Fusarium sp.	19	20	56	74	80	79	75
	Cladosporium cladosporioides	45	66	77	77	79	78	74

isolate), *Botrytis* sp; *B. cinerea*, and *Drechslera spicifera*; 7 for *Alternaria alternata* (potato isolate), *Cladosporium cladosporioides* and *Fusarium* sp. (okra isolate) and 8 for *Trichocladium asperum*.

DISCUSSION

A study of postharvest fungal diseases of some vegetables in the two markets of Riyadh was carried out from October, 1982 to April, 1983. A number of fungi were isolated from the diseased specimens of vegetable fruits. It was observed that the two markets did not play any role in determining the postharvest diseases and all the isolates were present in both markets.

The influence of the environment, particularly temperature and humidity plays a very important part in determining the nature and activity of the microflora. These factors not only have a direct influence on the growth of fungi, but can also affect fungal advancement indirectly by increasing or decreasing the resistance of the host (Prasad & Bilgrami 1973). Since the environment is more or less the same in both markets, there is no difference in the disease. It is also clear from temperature experiments that the optimum temperature for each isolate is different from the other as well as from the temperature of the market. The optimum temperature for the growth of *Alternaria alternata* (squash isolate) is 20°C, for tomato isolate 25°C and 30°C for egg plant isolate.

The source of the infections observed would seem to be in the field rather than the market. If the fruits are susceptible and temperature and humidity conditions are favourable, direct penetration and infection of the unripe fruits can occur. The

infection may then be quiescent or latent until fruits ripen. Infection will also occur without delay if the fruit epidermis is injured during harvest, transit or market but rapid growth may occur as the fruit ripens in the market. Such a pattern of disease development was observed for cigar end rot of bananas by Srivastava & Tandon (1971). Fruit injury or active fruit infections produce ethylene and may tend to ripen nearby 'sound' fruits, thereby hastening their ripening to some extent.

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دراسة بعض الامراض النباتية الناتجة عن تسويق الخضار بمدينة الرياض

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خلاصة

تم في هذا البحث اجراء دراسة ميدانية لأمراض الخضار في سوقين رئيسيين بمدينة الرياض ، حيث جمعت عينات مصابة من درنات البطاطس وثمار الطماطم والفلفل الأحمر والباذنجان والكوسة والفول والباميا . وقد تم عزل بعض الفطريات المسببة لأعفان هذه الدرنات والثمار ، فقد عزلت فطرة الترناريا الترناتا من درنات البطاطس ، وفطريات الترناريا الترناتا ، دريكسليرا سبيسيفيرا ، ايبيكوكام بيربوريسنس وترايكوكليديوم أسبيرام من ثمار الباذنجان ، وفطريات الترناريا الترناتا وبوترايتس من ثمار الطماطم ، وفطريات الترناريا الترناتا وزيلوهيفا من ثمار الكوسة ، وفطريات بوترايتس وكلادوسبوريوم كلادوسبوريويدس من ثمار الفلفل ، وفطريات الترناريا الترناتا ، بوترايتس وفيوزاريوم من قرون الفول ، وفطريات بوترايتس ، الترناريا راديسينا وفيوزاريوم من ثمار الباميا .

وقد أثبتت تجارب العدوى الصناعية على تلك الفطريات المعزولة قدرتها جميعا على احداث الاصابة لعوائلها ، بينما أوضحت النتائج بأن نسبة وجود هذه الامراض الفطرية على ثمار الخضراوات التي تم جمعها من السوقين كانت متقاربة مما يؤكد احتمال أن تلك الأسواق ليس لها دور في احداث المرض ، ومن المحتمل أن الاصابة قد حدثت في الحقل ولكن نمو الفطريات تطور أثناء نقل الخضروات وتسويقها .

وقد تم أيضا دراسة تأثير كل من درجات الحرارة والرقم الهيدروجيني على معدل نمو هذه الفطريات ، فوجد أن الدرجة المثلى لكل من درجة الحرارة والرقم الهيدروجيني تختلف باختلاف الفطريات المعزولة .