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Chemical Control of Post-Harvest Diseases of Some Fruits

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Abstract: Studies of the post harvest disease of apple, orange and lemon fruits collected from local Saudi markets in Riyadh, were carried out. The following organisms were recorded and found to be pathogenic to their respective hosts; *Alternaria alternata*, *Aureobasidium pullulans*, *Diplodina* sp. and *Fusarium tricinctum* from apple fruits; *A. alternata*, *Geotrichum candidum* and *Penicillium* sp from orange fruits; *A. alternata*, *A. citri* and *G. candidum* from lemon fruits. The efficacy of some fungicides and chemicals was tested against the post harvest diseases caused by these pathogens. Al the tested fungicides and chemicals were less effective against the diseases caused by the two species of *A. alternata* ad *G. candidum*. The diseases caused by Aureobasidium pullans and *Diplodina* sp. on apple and *Penicillium* frequentations on orange were greatly reduced when the fruits were treated with bavistin, benlate, dithane M-45 and sodium bicarbonate. Benlate and dithane M-45 were also effective against the disease caused by *Fusarium tricinctum* on apple fruit. In general, the tested fungicides and chemicals proved more effective when used as pre-infection treatment than that of post-infection treatment.

Key words: chemical control, post-harvest diseases, apple, orange and lemon

Introduction

Fresh fruits are vulnerable to parasites attack because of their high moisture content. Substantial losses during storage and marketing of these commodities are the role rather than exceptio (Eckert, 1969). Adisa and Fajola (1982) have stated that the infection is established before harvest in the field and the disease develop after harvest during marketing and storage due to handling techniques and process. Apple (*Mlus sylvestris* Mill), lemon (*Citrus lemon* L.) and sweet orange (*Citrus semensis* L.) fruits are among the important fruits in the Kingdom of Saudi Arabia.

Fungicides were examined for their effect on fungal growth on grapes (Xu-ling, *et al.*, 1998), Pears (Sholberg, and Meheriuk, 1991) and ginger rhizomes (Grech and Swatt, 1990). Smilanick *et al.* (1999) studied the control of commercial post-harvest practices on their efficacy. They found that sodium carbonate, potassium carbonate, sodium bicarbonate, ammonium bicarbonate and potassium bicarbonate were all fungistatic because spores of *Penicillium* digitatum treated with these salts were equal and superior to the other salts for control of green mould on lemons and organs inoculated 24 h before treatment.

Couey (1989) reviewed the use of heat treatment for control of post-harvest diseases of fruits by vapour heat and water treatment for the control of fungal infections.

The present work was undertaken to determine the fungal organisms responsible for the spoilage of the three fruits during storage and marketing in central region of Saudi Arabia. Also, the study tended to assay *in vivo* the efficacy of some fungicides and chemicals in controlling the diseases caused by the isolated fungi.

Materials and Methods

The isolation of fungi from the collected diseased specimens and the pathogenicity tests on the healthy fruits were carried out in the laboratory by the same method as suggested by Abou-Heilah (1985) in previous work.

Five fungicides/chemicals, known for their fungicidal property of reducing storage decay of fruits were used both in post and pre-infection treatments for controlling the disease. Healthy fruits of apple, lemon and sweet orange of approximately the same size were used in these experiments. The fungicide/chemical dips were prepared as follows:

Bavistin: Broad-spectrum fungicide with systemic and curative action for use in vines, fruit, hops arable crops, ornamentals and vegetables, as well as in tropical and subtropical crops. Active ingredient: Cabendazim (50 %) {2-(Methoxy-cabamoyl)-benzimidazole}. Manufactured by BASF Aktiengesellschaft, Germany. 0.2% solution of Bavistin was prepared in distilled water and fruits were dipped in this solution for 10 minutes.

Benlate: Active ingredient 50 % Methyl (Butylcarbomoyl) -2-Benz imidazole carbonate. Manufactured by Dupont Company. USA. 0.2% solution of benlate was prepared as in Bavistin water and fruits were dipped in this solution for 10 minutes.

Dithane M-45: Active ingredient 80 % Mancozeb [Manganese dithiocarbonate) (Polymeric complex in the zinc salt). Manufactured by Rohm and Hass S.R.L. Company, Italy. 0.2 solution of Dithan was prepared as in Bavistin water and fruits were dipped in this solution for 10 minutes.

Boric acid: 5 % solution in distilled water and the fruits were dipped in it for 2 minutes at 40°C.

Sodium bicarbonate: 3 % solution was made in warm distilled water and the fruits were dipped for 8 minutes. In pre-infection treatment, weighed fruits prior to inoculation were given dip in the test fungicides/chemicals and then kept separately for 24 h in sterile polyethylene bags at room temperature (26-30°C). After the lapse of this time this fruits were given a 2-cm long slit on the surface with the help of a sterilized knife. A small piece of the inoculum was placed inside the slit. The would was sealed with wax. The inoculated fruits were then separately placed in polyethylene bags at room temperature and 100% relative humidity for two weeks.

In post infection treatment, weighed fruits were first inoculated with their respective isolated fungi and then placed in polyethylene bags at room temperature and 100 % relative humidity for 24 h for disease development. After 24 h, the inoculated fruits were dipped in the dipping the fruits in sterile water. Each treatment was replicated three times using four fruits in each replication. To study the effect of temperature on rot development, inoculated fruits were incubated for two weeks at 0, 5, 10, 15, 20, 25, 30 and 35°C. At the end of the incubation period, the percentage rot in each treatment was recorded and calculated by the following equation formulated by Gaur and Chenulu (1982).

$$\text{Percentage rot} = \frac{W-w}{W} \times 100$$

Where,
W = Initial weight of the fruit.
w = Weight of fruit after the removal of infected portion.

Results and Discussion

Four fungi, viz; *Alternaria alternata* Fr. Keissler, *Aureobasidium pullulans* (de Bary) Arnaud, *Diplodina* sp. and *Fusarium tricinctum* (Corda) Sac (IMI No: 291 616)* were isolated from apple fruits; three fungi, viz; *A. alternata* (IMI No: 291 623)*, *Geotrichum candidum* Link (IMI No: 291 620)* from orange fruits and three fungi viz; *A. alternata* (IMI No: 291 619)*, *A. citri* (Ellis & Pierce) emend and *G. candidum* (IMI No: 291 22)* were isolated from lemon fruits. The pathogenicity tests confirmed that the isolated fungi were pathogenic to their respective hosts. Chemical treatments are usually given after harvest to reduce the pathogenic decay of fruits during transit, storage and marketing. The results with tested gungicides and chemicals are shown in Tables 1, 2 & 3. The percentage loss caused by *G. candidum* was very high both in orange and lemon fruits. All the tested fungicides and chemicals were less effective against the diseases caused by the two species of Alternaria and *G. candidum*. The percentages of diseases caused by the other pathogenic fungi were greatly reduced by the tested fungicides/chemicals though boric acid was less effective in its action against the tested fungi. Gaur and Chenulu (1982) has reported that bavistin, benlate and dithane M-45 when used at 1000 ppm inhibit the post-harvest diseases of citrus and potato tubers caused by various fungi. They found that boric acid was ineffective against the pathogenic fungi growing on

Table 1: Percentage loss of apple fruits after treating the fruits with fungicides/chemicals

Fungi Fungicides/ Chemicals	*Alternaria alternata*		*Aureobasidium pullulans*		*Diplodina* sp.		*Tricinctum tricinctum*	
	PR*	PO**	PR	PO	PR	PO	PR	PO
Bavistin	22.8	24.2	4.3	9.2	4.5	5.9	12.5	14.0
Benlate	12.6	14.1	5.5	6.0	8.4	9.1	7.0	8.3
Boric acid	26.2	28.9	15.1	14.5	16.6	18.2	14.7	16.1
Dithane M-45	16.2	19.0	4.6	5.7	5.1	6.7	9.4	10.9
Sodium bicarbonate	20.5	27.5	8.7	10.9	5.0	7.6	13.2	17.0
Control (Inoculated not treated)	34.4	33.9	36.4	31.3	26.9	26.9	21.2	26.7

*PR = Pre-infection treatment **PO = Post-infection treatment

Table 2: Percentage loss of oranges fruits after treating the fruits with fungicides/chemicals

Fungi Fungicides/ Chemicals	*Alternaria alternata*		*Geotrichum candidum*		*Penicillium* freuentans	
	PR*	PO**	PR	PO	PR	PO
Bavistin	14.0	16.8	47.1	55.7	2.1	2.9
Benlate	11.8	16.6	48.4	53.1	3.6	2.3
Boric acid	15.8	14.8	43.6	61.7	14.0	16.2
D/thane M-45	12.5	18.7	54.1	58.0	4.4	7.6
Sodium bicarbonate	17.4	18.1	48.9	61.6	11.5	9.3
Control (Inoculated not treated)	32.0	38.5	60.2	65.8	16.8	23.1

*PR = Pre-infection treatment **PO = Post-infection treatment

Table 3: Percentage loss of lemmon fruits after treating the fruits with fungicides/chemicals

Fungi Fungicides/ Chemicals	*Alternaria alternata*		*Geotrichum citri*		*Goetrichum candidum*	
	PR*	PO**	PR	PO	PR	PO
Bavistin	18.9	19.5	10.6	16.6	38.2	40.6
Benlate	19.6	20.3	18.4	18.6	41.7	39.6
Boric acid	26.5	27.2	20.6	19.2	46.6	47.9
D/thane M-45	15.0	17.6	15.3	18.7	42.7	40.2
Sodium bicarbonate	20.6	21.2	23.6	20.9	52.6	53.7
Control (Inoculated not treated)	35.0	32.5	28.5	26.6	70.7	66.2

*PR = Pre-infection treatment **PO = Post-infection treatment

Table 4: Effects of temperature on rot development by pathogen on mature ripe fruits

Hosts	Pathogens	Rot development at different temperature							
		0°C (PI)	5°C (PI)	10°C (PI)	15°C (PI)	20°C (PI)	25°C (PI)	30°C (PI)	35°C (PI)
	Alternaria alternata	0.6	1.2	2.0	2.4	9.3	9.4	20.5	16.4
Apple	*Aureobasidium pallulans*	0.9	1.3	2.1	2.5	2.9	4.7	6.6	7.5
	Diplodina sp.	0.7	0.8	1.8	1.8	21.2	16.0	14.0	6.6
	Fusarium tricinctum	0.7	1.3	2.0	2.0	5.6	15.2	8.8	6.4
	A. alternata	0.4	0.4	2.7	3.7	8.4	13.6	18.7	11.0
Orange	*Geotrichum candidum*	0.6	0.9	5.2	26.0	53.7	85.9	88.6	54.2
	Penicillium frequentans	2.4	8.3	14.3	24.4	27.0	40.9	68.1	77.5
	A. alternata	0.4	1.3	9.5	14.3	17.0	20.2	22.7	16.0
Lemon	*A. citri*	0.6	0.8	6.2	8.3	14.5	14.5	25.0	14.8
	Geotrichum candidum	0.8	0.9	11.7	25.6	34.8	90.6	71.1	46.5

PI = Perentage of Infection.

citrus and potato tubers. Sumbali and Mehrotra (1983) have reported that sodium bicarbonate gave maximum control of fruit rot of apple caused by Gliocladium roseum, pear rot by Sclerotium rolfsii and peaches rot by Aspergillus niger. The effectiveness of sodium bicarbonate appears to be due to the accumulation of alkaline residues in potential infection sites on the fruits. Agarwala and Sharma (1968) have also reported its effective use against Rhizopus stolonifer and *Penicillium* expansum rot of apple and by Kaushik *et al.* (1972) against *Pestalotia psidii* rot of ripe guava fruits. Effective against potato rot caused by *Rhizopus arrhizus.* However, its frequent use can't be recommended because of its very pronounced toxic effect.

The present results confirm the findings of the above mentioned investigations. In general, the tested fungicides and chemicals proved more effective when used as pre-infection treatment than that of post-infection treatment. It seems that pre-infection treatment give more protection to the fruits against various fungi. The effects of temperature on rot percentage are shown in Table 4. At 4°C the percentage of disease was negligible. With increase in temperature, the disease percentage also increased. The percentage of disease at 25 and 30°C (Table 4) started decreasing. However, in the case of *Penicillium* frequentans or orange the percentage inclined to increase. This observation might support the fact that the *Penicillium* is a thermophillic fungus, which can grow at high temperature and thus can cause severe rot on orange fruits at high temperature. *Penicillium* frequentans also produced rot on citrus fruits at 9 and 5°C. Adisa and Fajole (1982) have also reported that *Penicillium* spp. can cause rot on citrus fruits at 0-5°C.

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