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PLANT EXTRACTS AS ANTIFUNGAL FACTORS AGAINST POSTHARVEST CUCUMBER FRUIT ROT

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ABSTRACT: *Eight plant extract materials were involved in these studies to control cucumber fruit rot disease i.e., Cinnamon, Ginger, Thyme, Marjoram, Clove, Garlic, Galls and Nigella. The most aggressive fungal pathogen isolates from seven pathogenic fungi were tested in these trials i.e., Fusarium moniliforme (isolate 2), Fusarium oxysporium (isolate 1), Fusarium solani (isolate 1), Fusarium subglutinans (isolate 1), Botrytis cinerea (isolate 3), Sclerotinia sclerotiorum (isolate 3) and Macrophomina phaseolina. Three concentrations of each plant extract i.e.3, 5 and 10% were used in these experiments. All plant extracts were effective in growth inhibition of the seven fungal pathogens and various in effects with the three tested concentrations. The most effective plant extract was Garlic at the three tested concentration followed by Thyme on most of the tested fugal pathogen in petri dish under laboratory conditions. All tested plant extracts were affected on disease index; Galls followed by Thyme were the most effective extracts at 3% concentration. At 5% concentration the great effect was noticed in case of Clove on the four Fusarium.spp and S. sclerotiorum, while Garlic at the same concentration on M.phaseolina and Marjoram on B.cinearea, they reacted with 0.0 % DI. The same effects were noticed on Un- wounded cucumber fruits at 10% concentration. All tested plant extracts were great affected wounded cucumber fruits at all three tested concentration with variable effects between the tested eight plant extracts.*

Key words: *Cucumber fruit rot, biocontrol, plant extracts.*

INTRODUCTION

Postharvest Cucumber (*Cucumis sativus* L.) fruit rot pathogens causes severe damage and have widely losses to vegetable growers annually, this important disease caused by several pathogenic fungi, i.e *Fusarium moniliforme*, *Fusarium solani, Fusarium subglutinans, Fusarium oxysporum and Macrophomina phaseolina* (Reddy and Reddy 1989), *Botrytis cinerea* (Zhukovskaya *et al.* 1984 and Wasfy 1967), *Sclerotinia sclerotiorum* (Bedlan 1986 and Bedlan 1991) and *Macrophomena phaseolina* (Rath *et al.* 1990 and Maklad 2004).

Fungicides are necessary to manage plant diseases and to maintain high crop yields. However; indiscriminate utilization of these fungicides has frequently resulted in adverse ecological effects, as disturbing the environmental stability of soils and making plants still more susceptible to diseases (Mancini *et al.*, 2008). National Academy of Sciences (NAS) report (Research Council, board of Agriculture 1987) on pesticide residues on food indicated that fungicides pose more of a carcinogenic risk than insecticides and herbicides together. Increasing public concern on environmental issues requires alternative disease management systems which are less fungicides based on naturally occurring compounds (Cuthbertson and Murchie, (2005). This concern has encouraged researchers to look for other solutions to synthetic pesticides. Recently there has

been considerable interest in GRAS (generally regarded as safe) compounds.

Researchers have revealed the plant extracts as source of natural fungicides that make good efforts for new fungicides development (Arokiyaraj *et al.* 2008 and Brindha *et al.* 2009). Meanwhile, various spices and herbs have been utilized for centuries as preservatives for foods and medicinal purposes, some of them possess antifungal potential in combination and are considered as alternatives to conservative antifungal agents (Nwaopara *et al.* 2008). These plant extracts are generally assumed to be more acceptable and less hazardous than synthetic compounds. Many plants are used as insecticides, molluscicides and rodenticides (Daoud *et al.* 1990; Evan 1992; Anwar *et al.* 1992 and Poswal *et al.* 1993).The use of plants or plant products as fungicides is a great importance and needs more attention (Bodde 1982). Various plant products like gum, oil, resins etc. are used as fungicidal agents (Dwivedi *et al.* 1990 and Daoud *et al.* 1990).

Ark and Thompson 1959 showed that garlic extracts contain a potent fungicide. They were able to effectively protect peaches against brown rot (*Monilinia fructicola*). The garlic extract, oil (Singh *et al.* 1984) and juice (Harun and Labosky 1985) showed fungicidal properties against Fusarium of watermelon. (Khalil and Dababneh 2007) evaluated the inhibition of four medicinal plant extracts against *Penicillium* sp., *Fusarium oxysporum*, *Rhizoctonia solani* and *Verticillium* sp. indicated considerably inhibition for each fungi. Antifungal activity of *Thymus vulgaris*, *Satureja hortensis*, *Anthem grareolens* and *Mentha sativa* were evaluated against *Fusarium graminearum*. The result showed the essential oils decreased the mycotoxin production and growth rate (Hoseiniyeh Farahani *et al,* 2012). The antifungal activity of Shatangju (*Citrus reticulate* Blanco) essential oil at different concentrations was investigated against the mycelia growth and spore germination of *Penicillium digitatum*. The results indicated the oil at a higher concentration (10 µL/mL) considerably inhibited both the mycelia growth and spore germination. Morsy *et al.* (2009) investigated the effect of different plant extracts on the growth rate of *F. oxysponun*, *F. solani*, *Sclerotium rolfsii*, *R. solani* and *Macrophomina phaseolina*. The results indicated that plant extracts of onion and garlic decreased the growth rate of *F. solani*, *F. oxysponun* and *S. rolfsii*. The maximum inhibition effect on *F. oxysporum* was observed when garlic extract was applied at 1.5ml/plate.

This study was carried out to investigate the effect of 8 plant extracts antifungal activity against causal agents of postharvest cucumber fruit rot isolated from infected cucumber fruits.

MATERIALS AND METHODS

Survey of cucumber fruit disease:

Diseased samples of naturally infected cucumber (*Cucumis sativus* L.) fruits showing identical fruit rot (grey mould, fusarium rot and white rot) symptoms were collected from greenhouses. Samples were collected from different areas in Minufiya governorate i.e, El-Sadat, Queisna and Shebin El-Kom districts. The infections were estimated as percentages of diseased fruits comparing to total healthy ones.

Isolation purification and identification of the associated fungi:

The associated fungi with rotted cucumber fruits collected from different locations were isolated and identified. Small pieces of diseased fruits were cut, sterilized in 0.3% sodium hypochlorite solution for one minute, washed several times in sterilized distilled water and dried between two

sterilized filter papers. The sterilized pieces were directly transferred to Petri dishes containing Potato Dextrose Agar medium (PDA) containing penicillin (50 units/ml), 20 ppm tetramycin and 40 ppm streptomycin sulphate to avoid the bacterial contamination, then incubated at 25 °C for 3-7 days. Purification of the isolated fungi was carried out using hyphal tip and /or single spore techniques (Dhingra and Sinclair 1985). Fungal hyphal tips or single spores were taken from growing colonies, transferred to (PDA) medium slant tubes, incubated for 7 days at 20-25 °C.

The pure cultures of the growing fungi of the causal organisms and the associated fungi were then examined microscopically and identified at Agricultural Botany Department, Faculty of Agriculture, Minufiya University according to (Domsch *et al.*, 1980) and the key of imperfect fungi according to (Barnett and Barry 1972).

Pathogenicity test:

Inoculums of the selected fungi, i.e. *Botrytis cinerea* (3 isolates), *Sclerotinia sclerotiorum* (3 isolates), *Fusarium solani* (2 isolates), *Fusarium subglutinans* (2 isolates), *Fusarium oxysporum* (2 isolates), *Fusarium moniliforme* (3 isolates) and one isolate of *Macrophomena phaseolina* were prepared on Potato Dextrose Agar medium.

The pathogenicity of the isolated fungi was carried out using mature fruits of cucumber under laboratory conditions. The fruits were carefully chosen free from mechanical injury or diseases as far as possible. Wounded and unwounded fruits were then surface sterilized and inoculated with agar discs (4 mm in diameter) from cultures of each of the selected pathogenic fungi grown on Potato Dextrose Agar (7 days old) at the base of the fruit with each isolated fungus. Four replicates, 3 fruits of each, were used for each treatment. Each replicate was covered with stretch film in foam plate 5 x 15 x 25 cm in diameter on petri dishes.

The inoculated fruits were incubated at room temperature at about 22 – 25°C. The control treatment was left without fungal inoculation. Percentages and disease index of rotted fruits were recorded, 5 days after inoculation.

Disease assessments:

Disease parameters were determined on rotted fruits according to the disease index rating which was made to determine the average diameter of the infected areas on fruit surface. The following numerical rates were suggested to facilitate visual determination to give a satisfactory comparison:

0 = No rot.
1 = Scattered small rot.
2 = Rots coalescing and including about 25-50 % fruit area.
3 = More than 50% of the fruit area was infected.

Readings were converted to disease index according to the equation suggested by (Townsend and Heuberger., 1943) as follows:

$$\text{Disease index \%} = \frac{\sum(n \times r1) + (n \times r2) + (n \times r3)}{3N \times 100}$$

Where (n) is the number of fruits in each numerical rate; r1, r2 and r3 are ratings and (N) is the total number of inoculated fruits multiplied by the maximum numerical rate 3. Also the percentage of infected fruits was estimated.

Plant materials and extraction:

All powder plant materials involved in this study were collected and identified (English name, scientific name, Arabic name and used parts) in table (1). Powders of eight plant samples were used in this study. 100 gram of dry powder of each plant material was added to 1000 ml distilled water and mixed thoroughly then autoclaved with steam under pressure at 90° C for 20

minutes. The three replicates for each concentration provide with 4 cm disc sprayed with plant extract. Another replicate for each concentration was left as control provided with clear disc sprayed with water.

Three concentrations of each aqueous extracts i.e. 3, 5 and 10 % were used. The aqueous extracts were kept in dark glass bottled in refrigerator for further studies.

In vitro studies:-

The plant extracts were adopted with 3ml from each extract individual at (3,5 and 10%) to the solid media on the surface of the media in Petri dish, then the extract well spread on the surface tell complete absorption into media. The plates were inoculated with the inoculum disk (4mm) of the tested fungal pathogen at the centre of the dish.

In vivo studies:-

The plant extracts were prepared at the three tested concentrations (3, 5 and 10%) in deep jars. The un-wounded and wounded cucumber fruits were soaked individually in the target concentration for five minutes, then raised and leaved for air drying. The dry treated fruits were inoculated on surface with disk of the pathogen inoculum and left in foam plates and covered with stretch film for symptom appearance and noticed daily twice.

Results

Eight plant extract materials were involved in these studies to control cucumber fruit rot disease i.e., Cinnamon, Ginger, Thyme, Marjoram, Clove, Garlic, Galls and Nigella. The most aggressive fungal pathogen isolates from seven pathogenic fungi were tested in these trials i.e., *Fusarium moniliforme* (isolate 2), *Fusarium oxysporium* (isolate 1), *Fusarium solani* (isolate 1), *Fusarium subglutinans* (isolate 1), *Botrytis cinerea* (isolate 3), *Sclerotinia sclerotiorum* (isolate 3) and *Macrophomina phaseolina*. Three concentrations of each plant extract were used in these experiments (3, 5, and 10%).

In vitro Studies:

The plant extracts were tested against the seven fungal pathogens in petri dishes under laboratory conditions.

Table (1): Plant materials used in aqueous extracts for control of cucumber fruit rot postharvest diseases.

No.	*English name*	*Arabic name*	*Scientific name*	*Used parts*
1	*Cinnamon*	*القرفة*	*Cinnamum Zeylanicum*	*Cortex*
2	*Ginger*	*الزنجبيل*	*Zingiber officinalis L.*	*Rhizome*
3	*Thyme*	*زعتر*	*Thymus vulgaris L.*	*Leaves*
4	*Marjoram*	*بردقوش*	*Majorana hortensis L.*	*Leaves*
5	*Clove*	*قرنفل*	*Dianthus caryphlus L.*	*Cloves*
6	*Garlic*	*ثوم*	*Allium sativum L.*	*Cloves*
7	*Galls*	*عفص*	*Quercus infectoria L.*	*Fruits*
8	*Nigella*	*حبة البركة*	*Nigella sativa L.*	*Seed*

Plant extracts at 3% Concentration:

Data presented in Table (2) and indicated that all tested plant extract were effective on inhibition fungal growth in petri dishes for all tested isolates. The least effective plant extract at 3%concentration on fungal growth was Galls followed by Ginger (78.73 and 73.65 % respectively), while the most effective plant extracts 3% was Garlic (62.22%). The least effect of the tested plant extract 3% was noticed in case of Thyme on *Macrophomina phaseolina* and Garlic on *Macrophomina phaseolina* (100.00 and 97.78 % respectively), whereas the great effect was noticed in case of Garlic on *Fusarium solani* and Nigella on *Botrytis cinerea* (34.44 and 44.44 % respectively).

Plant extracts at 5% Concentration:

Data presented in Table (3) indicated that all tested plant extract were effective on inhibition fungal growth in petri dishes in all tested isolates. The least effective plant extract at 5 % Concentration on fungal growth was Galls followed by Thyme (66.19 and 64.13% respectively).The most effective plant extract at 5% was Garlic (46.19%). While the least effect of the tested plant extract at 5% was noticed in case of Thyme on *Macrophomina phaseolina* and Nigella on *Macrophomina phaseolina* (98.89 and 97.78 % respectively), whereas the great effect was noticed in case of Clove on *Sclerotinia sclerotiorum* and Garlic on *Fusarium solani* (27.77 and 27.78 % respectively).

Table (2): Effect of Plant extract at 3% on fungal growth.

Effect of plant extracts at 3% Concentration on fungal growth										
Fungus	*Cinnamon* القرفة	*Ginger* الجنزبيل	*Thyme* زعتر	*Marjoram* بردقوش	*Clove* قرنفل	*Garlic* ثوم	*Galls* عفص	*Nigella* حبة البركة	*Mean*	*Control*
Fusarium moniliforme	68.89	71.11	70.00	65.56	68.89	86.67	88.89	68.89	73.61	100.00
Fusarium oxysporium	61.11	67.78	68.89	77.78	71.11	67.78	83.33	70.00	70.97	100.00
Fusarium solani	78.89	70.00	64.44	71.11	76.67	34.44	68.89	77.78	67.78	100.00
Fusarium subglutinans	70.00	53.33	51.11	75.56	81.11	55.56	71.11	66.67	65.56	100.00
Botrytis cinerea	71.11	78.89	54.44	80.00	57.78	72.22	70.00	44.44	66.11	100.00
Sclerotinia sclerotiorum	70.00	76.67	91.11	64.44	47.78	68.89	72.22	76.67	70.97	100.00
Macrophomina phaseolina	72.22	97.78	100.00	55.56	77.78	50.00	96.67	94.44	80.56	100.00
Mean	70.32	73.65	71.43	70.00	68.73	62.22	78.73	71.27		
% LSD 5% Fungus			13.07							
% LSD 5% extract			13.97							

Table (3): Effect of Plant extract at 5% on fungal growth

Effect of plant extracts at 5%Concentration on fungal growth										
Fungus	Cinnamon القرفة	Ginger الجنزبيل	Thyme زعتر	Marjoram بردقوش	Clove قرنفل	Garlic ثوم	Galls عفص	Nigella حبة البركة	Mean	Control
Fusarium moniliforme	56.67	57.78	62.22	58.89	61.11	66.67	74.44	50.00	60.97	100.00
Fusarium oxysporium	65.56	60.00	66.67	70.00	62.22	43.33	72.22	55.56	61.95	100.00
Fusarium solani	71.11	55.56	43.33	55.56	63.33	27.78	65.56	68.89	56.39	100.00
Fusarium subglutinans	55.56	45.56	40.00	66.67	67.78	42.22	53.33	57.78	53.61	100.00
Botrytis cinerea	64.44	70.00	48.89	68.89	34.44	54.44	57.78	41.11	54.99	100.00
Sclerotinia sclerotiorum	56.67	61.11	88.89	43.33	27.77	55.56	60.00	61.11	56.81	100.00
Macrophomina phaseolina	72.89	96.67	98.89	46.67	65.56	33.33	80.00	97.78	73.97	100.00
Mean	63.27	63.81	64.13	58.57	54.60	46.19	66.19	61.75		
LSD 5% Fungus		14.42 %								
LSD 5% extract		15.42 %								

Plant extracts at 10% Concentration

Data presented in Table (4) indicated that all tested plant extract were effective on inhibition fungal growth in petri dishes in all tested isolates. The least effective plant extract at 10 % Concentration on fungal growth was Thyme followed by Ginger (51.75and 49.68 % respectively) whereas the most effective plant extract 10% was Garlic (28.09 %). The least effect of the tested plant extract 10% was noticed in case of Thyme on *Macrophomina phaseolina* followed by Thyme on *Sclerotinia sclerotiorum* (90.00 and 80.00 % respectively), whereas the great effect was noticed in case of Garlic on *Fusarium solani* and Clove on *Sclerotinia sclerotiorum* (16.67 and 22.22 % respectively). Data also indicated that there were significant differences between all tested Plant extract and their concentrations. Also, there were significant differences between the seven tested fungal isolates.

In vivo Studies:

Effect on Un-wounded cucumber fruit:

Plant extracts at 3% Concentration:

Data presented in Table (5) indicated that all tested plant extract at 3% Concentration were effective on disease index in un-wounded fruit of cucumber fruits infected with all tested isolates. The least effective plant extract at 3 % Concentration on disease index was Galls followed by Thyme (41.73and 41.65% respectively).

The most effective plant extract at 3% Concentration was Marjoram followed by Clove (24.97 and 27.94 %). The highest disease index in un-wounded fruit of the tested plant extract 3% was noticed in case of Cinnamon and Clove on *Macrophomina phaseolina* (66.67%), whereas the great

effect was noticed in case of Clove on *Fusarium subglutinans* and Marjoram on *Botrytis cinerea* (11.11 and 12.25 % respectively).*Macrophomina phaseolina* and *Sclerotinia sclerotiorum* were the least, affected pathogens by plant extracts they reacted by (51.97 and 51.21 % respectively). The most affected pathogen by plant extracts at 3% was *Fusarium subglutinans* (23.29%).All tested fungal pathogens were affected by all plant extracts. Galls followed by Thyme were the most effective extracts (41.73and 41.65% respectively).

Plant extracts at 5% Concentration

Data presented in Table (6) indicated that all tested plant extract were effective on disease index in un-wounded fruits of cucumber infected all tested isolates.

The least effective plant extract at 5 % Concentration on disease index overall tested fungal isolates was Cinnamon followed by Thyme (33.99and 33.51% DI, respectively), whereas the most effective plant extract 5% was Clove followed by Marjoram (10.58 and 12.88 % DI).The highest disease index in un-wounded fruit of the tested plant extract at 5% Concentration was noticed in case of Clove on *Macrophomina phaseolina* and Cinnamon on *Macrophomina phaseolina* (66.67 and 59.26 % DI respectively).whereas the great effect was noticed in case of Clove on *Fusarium subglutinans*, *Fusarium moniliforme*, *Fusarium oxysporium*, *Fusarium solani* and *Sclerotinia sclerotiorum* , Garlic on *Macrophomina phaseolina* and Marjoram on *Botrytis cinerea* (0.00 % DI).

Table (4): Effect of Plant extracts at 10 % on fungal growth.

Effect of plant extracts at 10%Concentration on fungal growth										
Fungus	*Cinnamon* القرفة	*Ginger* الجنزبيل	*Thyme* زعتر	*Marjoram* بردقوش	*Clove* قرنفل	*Garlic* ثوم	*Galls* عفص	*Nigella* حبة البركة	*Mean*	*Control*
Fusarium moniliforme	*41.48*	*45.56*	*38.89*	*40.00*	*36.67*	*45.56*	*54.44*	*37.78*	*42.55*	*100.00*
Fusarium oxysporium	*38.89*	*43.33*	*56.67*	*50.00*	*44.44*	*23.3*	*53.33*	*44.44*	*44.30*	*100.00*
Fusarium solani	*51.11*	*46.67*	*27.78*	*45.56*	*43.33*	*16.67*	*50.00*	*50.00*	*41.39*	*100.00*
Fusarium subglutinans	*40.37*	*44.44*	*33.33*	*48.89*	*42.22*	*24.44*	*33.33*	*40.00*	*38.38*	*100.00*
Botrytis cinerea	*50.74*	*50.00*	*35.56*	*44.44*	*24.44*	*31.11*	*38.89*	*28.89*	*38.01*	*100.00*
Sclerotinia sclerotiorum	*47.78*	*45.55*	*80.00*	*27.78*	*22.22*	*30.00*	*42.22*	*44.44*	*42.50*	*100.00*
Macrophomina phaseolina	*48.52*	*72.22*	*90.00*	*38.89*	*46.67*	*25.56*	*61.11*	*72.22*	*56.90*	*100.00*
Mean	*45.56*	*49.68*	*51.75*	*42.22*	*37.14*	*28.09*	*47.62*	*45.39*		
LSD 5% Fungus			*11.62 %*							
LSD 5% extract			*12.42 %*							

Table (5): Effect of 3% plant extracts on disease index of the causal organisms of post-harvest Un-wounded fruit rot diseases of Cucumber under laboratory conditions.

Effect of 3% plant extracts on disease index										
Fungus	Cinnamon القرفة	Ginger الجنزبيل	Thyme زعتر	Marjoram بردقوش	Clove قرنفل	Garlic ثوم	Galls عفص	Nigella حبة البركة	Mean	Control
Fusarium moniliforme	25.00	29.63	33.33	22.22	23.81	33.33	33.33	29.63	28.79	41.67
Fusarium oxysporium	20.83	23.81	29.63	18.52	25.93	37.04	44.44	25.93	28.27	56.00
Fusarium solani	18.52	25.93	37.50	25.93	22.22	25.93	50.00	16.67	27.84	37.50
Fusarium subglutinans	25.93	28.57	28.57	16.67	11.11	22.22	31.03	22.22	23.29	44.00
Botrytis cinerea	50.00	16.67	40.74	12.25	25.00	31.03	29.16	56.00	32.61	55.56
Sclerotinia sclerotiorum	59.26	56.00	62.50	37.50	20.83	59.26	56.00	58.33	51.21	59.26
Macrophomina phaseolina	66.67	59.26	59.26	41.67	66.67	14.81	48.15	59.26	51.97	68.89
Mean	38.03	34.27	41.65	24.97	27.94	31.94	41.73	38.29		51.84
LSD 5% Fungus			12.88 %							
LSD 5% extract			13.77 %							

Table (6): Effect of 5% plant extracts on disease index of the causal organisms of post-harvest unwounded fruit rot diseases of Cucumber under laboratory conditions.

Effect of 5% plant extracts on disease index										
Fungus	Cinnamon القرفة	Ginger الجنزبيل	Thyme زعتر	Marjoram بردقوش	Clove قرنفل	Garlic ثوم	Galls عفص	Nigella حبة البركة	Mean	Control
Fusarium moniliforme	22.22	22.22	29.17	9.52	0.00	18.52	25.93	20.83	18.55	41.67
Fusarium oxysporium	18.52	20.83	22.22	8.33	0.00	14.81	37.04	18.52	17.53	56.00
Fusarium solani	16.67	20.83	25.93	7.04	0.00	7.40	40.74	7.41	15.75	37.50
Fusarium subglutinans	20.83	18.52	18.52	11.11	0.00	18.52	23.81	11.11	15.30	44.00
Botrytis cinerea	44.44	11.11	28.57	0.00	7.41	14.81	19.00	37.50	20.35	55.56
Sclerotinia sclerotiorum	56.00	37.50	58.33	20.83	0.00	41.67	45.83	50.00	38.77	59.26
Macrophomina phaseolina	59.26	48.15	51.85	33.33	66.67	0.00	41.67	48.15	43.63	68.89
Mean	33.99	25.59	33.51	12.88	10.58	16.53	33.43	27.64		51.84
LSD 5% Fungus			11.77 %							
LSD 5% extract			12.58 %							

Plant extracts at 10% Concentration

Data presented in Table (7) indicated that all tested plant extract at 10% concentration were effective on disease index in un-wounded fruits of cucumber infected all by tested fungal isolates. The least effective plant extract 10 % on disease index was Galls followed by Thyme and Cinnamon (24.86, 23.88 and 23.43% DI respectively). The most effective plant extract at 10% concentration was Garlic and Marjoram followed by Clove (3.70 and 7.41 % DI). The highest disease index in un-wounded fruit of the tested plant extracts at 10% was noticed in case of Clove on *Macrophomina phaseolina* and Cinnamon on *Macrophomina phaseolina* (66.67 and 59.26 % DI respectively).whereas the great effect was noticed in case of Clove on *Fusarium subglutinans*, *Fusarium moniliforme*, *Fusarium oxysporium*, *Fusarium solani* and *Sclerotinia sclerotiorum* , Garlic on *Macrophomina phaseolina* and Marjoram on *Botrytis cinerea* (0.00 % DI).

Effect on wounded cucumber fruit Plant extracts at 3% Concentration

Data presented in Table (8) indicated that all tested plant extract were effective on disease index in wounded fruit of cucumber infected with all tested fungal isolates. The least effective plant extract at 3 % on disease index was Galls followed by Thyme (52.77and 46.93% DI respectively), while the most effective plant extract at 3% concentration was Marjoram followed by Ginger and Clove (29.12, 39.16 and 39.83 DI %). The highest disease index in wounded cucumber fruits that treated with the tested plant extract at 3% concentration was noticed in case of Clove on *Macrophomina phaseolina* and Garlic on *Sclerotinia sclerotiorum* (88.89and 78.00 % DI respectively),whereas the great effect was noticed in case of Garlic on *Macrophomina phaseolina,* Ginger on *Botrytis cinerea* and Cinnamon on *Fusarium solani* (18.52 DI).

Table (7): Effect of 10% plant extracts on disease index of the causal organisms of post-harvest unwounded fruit rot diseases of Cucumber under laboratory conditions.

Effect of 10% plant extracts on disease index										
Fungus	*Cinnamon* القرفة	*Ginger* الجنزبيل	*Thyme* زعتر	*Marjoram* برديقوش	*Clove* قرنفل	*Garlic* ثوم	*Galls* عفص	*Nigella* حبة البركة	*Mean*	*Control*
Fusarium moniliforme	12.25	14.81	19.05	0.00	0.00	0.00	22.22	14.81	10.39	41.67
Fusarium oxysporium	14.81	11.11	14.81	0.00	0.00	0.00	25.93	12.50	9.89	5 .00
Fusarium solani	12.50	.13.33	18.52	0.00	0.00	0.00	28.57	0.00	9.11	37.50
Fusarium subglutinans	13.33	12.50	14.81	0.00	0.00	0.00	14.81	0.00	6.93	44.00
Botrytis cinerea	29.63	7.04	20.83	0.00	0.00	0.00	7.41	26.00	11.36	55.56
Sclerotinia sclerotiorum	37.04	26.00	41.67	14.81	0.00	25.92	38.09	41.67	28.15	59.26
Macrophomina phaseolina	44.44	37.50	37.50	11.11	51.85	0.00	37.04	37.50	32.12	68.89
Mean	23.43	17.47	23.88	3.70	7.41	3.70	24.86	18.93		51.84
LSD 5% Fungus		8.60 %								
LSD 5% extract		9.19 %								

Table (8): Effect of 3% plant extracts on disease index of the causal organisms of post-harvest wounded fruit rot diseases of Cucumber under laboratory conditions.

Effect of 3% plant extracts on disease index										
Fungus	Cinnamon القرفة	Ginger الجنزبيل	Thyme زعتر	Marjoram برنقوش	Clove قرنفل	Garlic ثوم	Galls عفص	Nigella حبة البركة	Mean	Control
Fusarium moniliforme	28.57	33.33	37.04	25.00	33.33	55.56	45.83	33.33	36.49	51.85
Fusarium oxysporium	22.22	29.17	33.33	23.81	29.16	40.74	48.15	29.17	31.97	62.50
Fusarium solani	18.52	29.63	42.86	28.57	29.63	31.03	56.00	18.52	31.85	45.83
Fusarium subglutinans	26.00	37.50	37.50	19.05	22.22	44.44	44.44	26.00	32.14	59.00
Botrytis cinerea	56.00	18.52	44.44	20.83	38.09	40.74	33.33	59.00	38.86	62.96
Sclerotinia sclerotiorum	62.50	59.00	66.67	40.74	37.50	78.00	75.00	62.50	60.23	65.56
Macrophomina phaseolina	75.00	67.00	66.67	45.83	88.89	18.52	66.67	67.00	61.94	78.73
Mean	41.26	39.16	46.93	29.12	39.83	44.15	52.77	42.21		60.92
LSD 5% Fungus		12.88 %								
LSD 5% extract		13.77 %								

Plant extracts at 5% Concentration:

Data presented in Table (9) indicated that all tested plant extracts were effective on disease index in wounded fruit of cucumber infected with all tested fungal isolates.

The least effective plant extract at 5 % concentration on disease index was Galls followed by Thyme (40.34and 36.23% DI respectively), while the most effective plant extracts at 5% concentration was Marjoram followed by Clove (16.33and 18.65% DI).

The highest disease index in wounded cucumber fruits that treated with the tested plant extracts at 5% concentration was noticed in case of Gallson *Sclerotinia sclerotiorum* followed by Cinnamon on *Macrophomina phaseolina* (62.96and 59.26 % DI respectively).whereas the great effect was noticed in case of Clove on *Fusarium subglutinans*, *Fusarium moniliforme* and *Fusarium oxysporium* followed by Marjoram on *Botrytis cinerea* (0.00 and 4.76 % DI respectively).

Plant extracts at 10% Concentration

Data presented in Table (10) indicated that all tested plant extract were effective on disease index in wounded fruit of cucumber infected with all tested fungal isolates.

The least effective plant extract at 10 % on disease index was Galls followed by Thyme (31.13 and 27.86% DI respectively), while the most effective plant extracts at 10% concentration was Marjoram followed by Garlic (6.42and 6.88% DI). The highest disease index in wounded cucumber fruits that treated with the tested plant extracts at 10% concentration was noticed in case of Clove on *Macrophomina phaseolina* followed by *Galls on Sclerotinia sclerotiorum* (66.67 and 50.00 % DI respectively).whereas the great effect was noticed in case of Clove on (*Fusarium subglutinans*, *Fusarium moniliforme*,

Fusarium oxysporium, *Fusarium solani*, *Botrytis cinerea* and *Sclerotinia sclerotiorum*) , Garlic on (*Macrophomina phaseolina*, *Fusarium subglutinans*, *Fusarium moniliforme* , *Fusarium solani* and *Botrytis cinerea*) and Marjoram on *Fusarium subglutinans*, *Fusarium moniliforme* and *Botrytis cinerea* (0.00 % DI).

Table (9): Effect of 5% plant extracts on disease index of the causal organisms of post-harvest wounded fruit rot diseases of Cucumber under laboratory conditions.

Effect of 5% plant extracts on disease index										
Fungus	*Cinnamon* القرفة	*Ginger* الجنزبيل	*Thyme* زعتر	*Marjoram* بردقوش	*Clove* قرنفل	*Garlic* ثوم	*Galls* عفص	*Nigella* حبة البركة	*Mean*	*Control*
Fusarium moniliforme	25.00	25.93	29.63	12.25	0.00	25.92	29.63	25.00	21.67	51.85
Fusarium oxysporium	20.00	22.22	25.00	11.11	0.00	22.22	37.50	23.81	20.23	62.50
Fusarium solani	18.52	23.81	29.17	16.67	8.33	29.63	45.83	9.52	22.69	45.83
Fusarium subglutinans	23.81	25.00	23.81	7.04	0.00	22.22	25.00	14.81	17.71	59.00
Botrytis cinerea	45.83	12.25	29.63	4.76	14.81	33.33	25.93	41.00	25.94	62.96
Sclerotinia sclerotiorum	57.14	41.00	59.26	25.00	18.52	55.56	62.96	51.81	46.41	65.56
Macrophomina phaseolina	59.26	51.81	57.14	37.50	88.89	11.11	55.55	50.00	51.41	78.73
Mean	35.65	28.86	36.23	16.33	18.65	28.57	40.34	30.85		60.92
LSD 5% Fungus			12.58 %							
LSD 5% extract			13.45 %							

Table (10): Effect of 10% plant extracts on disease index of the causal organism of post-harvest wounded fruit rot diseases of Cucumber under laboratory conditions.

Effect of 10% plant extracts on disease index										
Fungus	*Cinnamon* القرفة	*Ginger* الجنزبيل	*Thyme* زعتر	*Marjoram* بردقوش	*Clove* قرنفل	*Garlic* ثوم	*Galls* عفص	*Nigella* حبة البركة	*Mean*	*Control*
Fusarium moniliforme	18.52	16.67	20.83	0.00	0.00	0.00	18.52	16.67	11.40	51.85
Fusarium oxysporium	16.67	13.33	18.82	0.00	0.00	11.11	25.00	14.81	12.47	62.50
Fusarium solani	12.50	16.67	22.22	3.70	0.00	0.00	37.04	0.00	11.52	45.83
Fusarium subglutinans	15.00	19.05	19.05	0.00	0.00	0.00	20.83	8.33	10.28	59.00
Botrytis cinerea	29.63	8.33	23.81	0.00	0.00	0.00	18.51	30.00	13.79	62.96
Sclerotinia sclerotiorum	33.33	30.00	45.83	19.05	0.00	37.04	50.00	44.44	32.46	65.56
Macrophomina phaseolina	45.83	44.44	44.44	22.22	66.67	0.00	48.00	45.83	39.68	78.73
Mean	24.50	21.22	27.86	6.42	9.52	6.88	31.13	22.87		60.92
LSD 5% Fungus			10.87 %							
LSD 5% extract			10.17 %							

DISCUSSION:

There has been constant increasing of alternative search on efficient compounds for plant disease control, aiming at partial or total replacement of antimicrobial chemicals. Systematic investigation of biological interactions between microorganisms and plant products has been a valuable source of new and effective antimicrobial substances, which could have act differently on the microbial cell compared to other conventional antimicrobials. Plants synthesize secondary metabolites and some of them as well as their derivatives have antimicrobial. Among these secondary metabolites are found alkaloids, flavonoids, isoflavonoids, tanins, cumarins, glycosides, terpens and phenolic compounds (Simoes *et al.*1999). In agricultural studies, these compounds have broad-spectrum activities against fungi, nematodes, and insects (Lee *et al.* 1997; Wilson *et al.* 1997 and Calvet 2001).

The present study demonstrated by eight plant extracts to control cucumber fruit rot disease i.e., Cinnamon, Ginger, Thyme, Marjoram, Clove, Garlic, Galls and Nigella. Three concentrations of each plant extract were used in these experiments. The most aggressive fungal pathogen isolates from seven pathogenic fungi were tested in these trials i.e., *Fusarium moniliforme* (iso. 2), *Fusarium oxysporium* (iso.1), *Fusarium solani* (iso. 1), *Fusarium subglutinans* (iso.1), *Botrytis cinerea* (iso. 3), *Sclerotinia sclerotiorum* (iso. 3) and *Macrophomina phaseolina*.

In vitro Studies the plant extracts were tested against the seven fungal pathogens in petri dishes under laboratory conditions. All tested plant extracts were effective on inhibition fungal growth in petri dishes in all tested isolates. *In vivo* Studies all tested plant extracts were effective on disease index on Un-wounded and wounded cucumber fruits of cucumber infected for all tested isolates.

Analyses of various extracts concentrations of extracts showed that antifungal activity of this plant has an excellent inhibitory effect on the growth of fungi in this study.(Abdolmaleki *et al.*, 2008) Many reports showed that the essence contain volatile substance which indirectly affect the growth of *Botrytis cinerea*, *Sclerotinia sclerotiorum*, *Fusarium solani*, *Fusarium subglutinans*, *Fusarium oxysporum* and *M. phaseolina* as well as significantly prevent its development. Previous reports indicated that reduced fruit decay during post-harvest treatments with volatile compounds including raspberry and kiwifruit (Wang *et al.*, 2003 Williamson *et al.*, 2007). Antony *et al*, 2003 and Plaza *et al*, 2004 reported that the use of herbal essence in the control of post-harvest fruit disease has been proposed as a new method in recent years. These compounds not only haven't side effects, but also due to antioxidant properties, increase fruit quality and storage. Periods (Anthony *et al.*, 2003); plaza *et al*, (2004).

Non systemic, systemic fungicides and biological control agents are ineffective in controlling such infections. Natural fungicides volatiles may be useful in controlling latent infections.

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المستخلصات النباتية كمضادات للفطريات المسببة لعفن الثمار في الخيار بعد الحصاد.

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الملخص العربي

تم إستخدام ثمانية مستخلصات نباتية في مقاومة مرض عفن الثمار في الخيار وهي القرفة , الزنجبيل ، الزعتر ، البردقوش , القرنفل ، الثوم , العفص, وحبة البركة وذلك ضد أقوي عزلات الفطريات الممرضة التي تم عزلها من ثمار الخيار المصابة وهي *Botrytis cinerea, Sclerotinia sclerotiorum, Fusarium solani Fusarium subglutinans, Fusarium oxysporum, Fusarium moniliforme* and *Macrophomena phaseolina* . وقد تم إستخدام المستخلصات في ثلاثة تركيزات وهي ٣، ٥, ١٠ % وقد ثبت بالتجربة أن كل المستخلصات المستخدمة كانت ذات تأثير واضح في تثبيط نمو العزلات الفطرية المستخدمة في طباق البتري بالثلاثة تركيزات المستخدمة. كان مستخلص الثوم بتركيزاته المستخدمة الاكثر تأثيرا وتلاه الزعتر في تثبيط نمو الفطريات المختبرة تحت ظروف المعمل. كانت المستخلصات النباتية ذات تأثيرات واضحة في تقليل شدة الاصابة علي ثمار الخيار السليم وكان مستخلص القرنفل أكثرها تأثيرا تلاه مستخلص الثوم سواء بتركيزات ٣ أ, ٥ %. وكان مستخلص القرنفل أكثر تأثيرا علي الاربعة أنواع من *F.*spp ، *Sclerotinia sclerotiorum* بينما كان مستخلص الثوم أكثر تأثيرا علي فطر *Macrophomena phaseolin* , والبردقوش علي فطر *Botrytis cinerea* حيث كانت الاصابة (صفر). وقد زاد تأثير المستخلصات علي ثمار الخيار المجروحة والمعدية بالفطريات المختلفة المختبرة وكانت التأثيرات متباينة.