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Effect of aqueous extract of organic supports on inhibiting *Fusarium solani* in vitro

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1. Abstract:

This study aimed to reveal the effectiveness of organic supports, vermicompost, cow dung and peat moss in inhibiting the fungus *Fusarium solani*, which causes root rot disease of the watermelon plant, in the laboratory. The pathogenicity of the pathogenic fungus isolates was tested on the seeds of the Sugar Baby variety watermelon. The pathogenic fungus isolate was selected and its symbol is B6. The pathogenic index and severity of infection were recorded as 5 and 100, respectively. The results of the effectiveness of the aqueous extract of the non-sterilized organic supports showed a significant difference in the effectiveness of the aqueous extracts of the tested organic materials at three concentrations of 5%, 10%, and 15% in inhibiting the growth of the pathogenic fungus *F.solani*. The aqueous extract of peat moss showed the highest inhibition rate of the pathogenic fungus, reaching between 60.00 - 65.00%, followed by the aqueous extract of vermicompost with an inhibition rate of 48.88 - 55.55%. The aqueous extract of fermented cow dung gave an inhibition rate of 41.11-56.66% with a significant difference from the control treatment (fungus only) with an inhibition rate of 0.0%. When the aqueous extract of the supplements was sterilized, no significant differences appeared between the treatments and the treatment of the pathogenic fungus. The results of isolating the fungi associated with the organic supplements using the dilution method showed that a number of fungi associated with the organic supplements appeared in the dilution extract of the organic supplements with a significant difference between the treatments. The fungi isolated from the supplements showed antagonism against the fungus causing wilt and death of the watermelon plant *Fusarium solani* after 7 days of inoculation on the PDA medium and at different degrees.

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The fungus *Trichoderma* ssp, the fungus *Cladosporium* ssp. and the fungus *Penicillium* ssp. gave an antagonism degree of 2 degrees.

I. Introduction

The Cucurbitaceae family includes vegetable species such as squash, watermelon, and cucumber that are susceptible to infection by the fungus Fusarium ssp. It is one of the most important genera of plant pathogenic fungi, which causes great losses to different plant families (Iraqi et al., 2014). The fungus F.solani infects different varieties of watermelon and other cucurbits, including cucumber, watermelon, zucchini, and squash (Sabahi et al., 2023). The fungus F.solani causes wilt disease, which poses a major threat to plants, as symptoms cannot be distinguished in its early stages. Symptoms of vascular wilt disease may be accompanied by rotting of the roots of infected plants, changing the color of the roots to brown, with softening of the infected tissues, becoming tender and decomposing, with spots, necrosis, or stains on the roots that vary in size and number, and the color ranges from reddish to brown, with yellowing and wilting of the leaves, stunted growth, and decreased production (Williamson and Dhingra, 2021; Lahlali et al., 2022). Infected plants suffer from a disturbance in the transfer of nutrients to the different parts of the plant due to damage to vascular tissues, which may result in early death of the plant due to the presence of the pathogen within the plant tissues (Islam et al., 2012; Cohen et al., 2022).

The addition of organic fertilizers in a well-studied manner ensures high crop production by improving soil properties, increasing root growth and the activity of beneficial microorganisms in organic fertilizers, which in turn suppress pathogens (Abou EL- Magd et al., 2006 Ayoola; and Makinde, 2009). The decomposed animal manure (sheep, cows, poultry, horses) contained 6 species of fungi that act as biological control agents against the fungus Pythium ophanidermatum. In an experiment on the effect of cow manure and the extent of inhibition of the growth of the cause of cucumber root rot disease, the fungus Fusarium solani f. sp. cucurbitae, the manure extract led to a decrease in conidia germination and the growth rate of fungal mycelium. The fungus was inhibited after 7 hours of the experiment. Inhibition of fungal growth on PDA medium. The results were recorded after two days, as the inhibition rate reached

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55%, after three days it reached 60.5%, and after five days 56.5% (Basak et al., 2002). The efficiency of natural vermicompost is also attributed to the presence of many types of beneficial microorganisms that inhibit a number of pathogens. For this reason, the trend towards using vermicompost that contains nutrients and improves the physical, chemical and biological properties of the soil has increased, which improves the increase in agricultural production (Al-Khafaji and Al-Amri, 2022). The effect of peat moss, whose effect was tested on the sweet basil plant Ocimum basilicum L., in protecting against infection with the fungus F. oxysporum f. sp. was studied. basilici and the results showed its ability to reduce the severity of infection with Fusarium wilt disease on the plant. However, when the plant was fertilized with sterile peat, this led to a decline in the effect of manure in suppressing the pathogenic fungus. The use of fertilization with peat, whether sterile or not, enhanced the growth of plants (Reuveni et al., 2002). Peat was used to induce resistance against Fusarium crown and root rot disease in tomato caused by the fungi *Fusarium oxysporum f.sp. lycopersici* and *Pythium oligandrum*. The results showed a significant decrease in the severity of infection with pathogens, a decrease in the incidence of infection, and an increase in the plant's resistance to the pathogenic fungus. The reason for the resistance may be due to the formation of barriers at the sites where the pathogenic fungus attempts to penetrate to prevent the entry of pathogens into the vascular tissue, which is rich in callose-enriched materials that lead to thickening of the cell wall and control of osmotic pressure (Pharand et al., 2002). Mixing peat moss with the soil led to a reduction in the rate of development of Fusarium wilt disease on watermelon Cucumis melo L. The percentage of plant resistance in the peat moss treatment ranged between 25 and 75% (Cohe et al., 2008).

Given the importance of the fungus *Fusarium solani* and the great losses it causes to the watermelon crop, this study aimed to use the efficiency of organic supplements in inhibiting the pathogenic fungus under laboratory conditions.

II. Materials and methods

Collection, isolation and diagnosis of fungi isolated from the bases of stems and roots of the watermelon plant

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samples of watermelon plants infected with wilt disease were collected from several areas in 100 Iraq, namely Baghdad - Abu Ghraib, Anbar - Ameriya Fallujah, Diyala - Khalis and Salah al-Din - Al-Ishaqi and Al-Dujayl during the 2022 planting season, which showed symptoms of yellowing and wilting.

The watermelon plant parts were washed well with running water to remove the dust attached to them, then the root area and the crown area were cut into small pieces (0.5 cm) and the pieces were sterilized superficially with a 6% sodium hypochlorite solution (1% free chlorine) for 2 minutes and washed well with sterile water, and the watermelon plant parts were planted on the Water Agar (WA) medium in plastic plates with a diameter of (9 cm). The plates were incubated at a temperature of 25±2 C in the incubator for three days and after the fungi grew from the infected plant parts for 3 days. The fungal isolates were morphologically identified according to the approved taxonomic key (Booth, 1977) and the specifications mentioned by Leslie and Summerell (2006).

Testing the pathogenicity of *Fusarium* spp isolates in the germination of Suger baby sorrel seeds in the laboratory The pathogenicity of the fungal isolates was tested on aqueous agar medium (WA), and a piece of the fungus was transferred using a cork cutter measuring 0.5 cm from the edge of the 5-day-old *Fusarium* spp colony to the center of a plate containing WA medium with 3 replicates for each isolate and incubated in the incubator for 3 days at a temperature of 25 °C. 10 Sugar baby sorrel seeds were planted in each petri dish after being superficially sterilized with sodium hypochlorite solution at a concentration of 1% free chlorine for 2 minutes at a distance of 1 cm from the edge of the fungal colony growth, leaving control plates for each isolate (fungus only) and for seeds only. The plates were incubated at 25°C in the incubator until the seeds were fully germinated in the control treatment. The length of the discoloration area appearing on the seedlings as a result of infection with the pathogenic fungus was calculated, and the germination percentage was calculated. To determine the most pathogenic isolate, the disease severity was calculated, and the pathological index described by Sneh et al. (2004) and the axis by Kareem and Hassan (2015) were used to calculate the severity of infection.

Testing the effectiveness of the aqueous extract of organic supports in the growth of the pathogen in the laboratory :

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The effectiveness of the aqueous extract of organic supports, vermicompost, cow dung and peat moss, was tested by the food poisoning method before sterilizing the medium and after sterilizing it in an autoclave and according to the method of Sabet et al. (2013) as follows

Testing the effectiveness of the aqueous extracts of organic supports without sterilization:
Take a weight of 50 g of the organic support and mix it with 200 ml of sterile distilled water for each treatment of fertilizers separately in a glass flask and shake the mixture well, then leave the mixture for 20 minutes, after which the aqueous extract was filtered through three layers of sterile medical gauze. The plates were incubated at 25 °C until the completion of fungal growth in the control treatment colony, and two perpendicular diameters of the growth of fungal colonies were measured to calculate the percentage of inhibition

Testing the effectiveness of aqueous extracts of sterilized organic supports :
The aqueous extracts of the organic supports obtained as in the previous paragraph were sterilized with the nutritional medium at three concentrations (5%, 10%, 15%) in an autoclave for sterilization purposes. The nutritional media were then poured into the dishes, and after the nutritional medium solidified, a piece of the pathogenic fungal colony was transferred to the center of the dish with a diameter of 0.5 cm, with three replicates for each treatment, in addition to making plates for comparison. The plates were incubated at a temperature of 25 °C until the growth was complete in the colony of the comparison treatment. Two perpendicular diameters of the growth of the fungal colonies were measured to calculate the percentage rate of inhibition

$$\text{percentage rate of inhibition} = \frac{C-P}{C} \times 100$$

Isolation of fungi associated with organic supports using dilution method

Fungi associated with organic supports were isolated using dilution method. 1 g of each type of organic supports was weighed and added to 9 ml of sterile distilled water and the basic concentration was calculated and shaken well. Then dilutions were performed for each organic support by adding 1 ml of the basic concentration to the second tube containing sterile distilled

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water. Thus, a series of dilutions were performed to dilution 106 and left for 20 minutes. 1 ml was taken from each dilution of 104, 105, 106 and added to a Petri dish, then the PDA medium was poured after adding an antibiotic to the medium, and 3 replicates were made for each concentration of the three treatments, then placed in the incubator. After 3 days, the colonies were counted to calculate the number of colonies present in one dish and for each replicate. Then, the fungi were purified in Petri dishes containing PDA medium, and the dishes were incubated at a temperature of 5 days. The fungal species were identified based on the shape and color of the colony, the structure of the spores and other structures, according to what was mentioned by Ellis (1971) and Dosch (1980).

Number of colonies = Number of colonies in the dish × the reciprocal of the dilution.

Antibiotic capacity test of fungi isolated from organic supports against pathogenic fungi

The antibiotic

capacity of fungi obtained from the aqueous extract experiment against pathogenic fungi was tested to determine the antibacterial activity of fungi isolated from organic supports against the fungus causing wilt and death of sage plant, using the dual culture technique (DCT) on the PDA medium in Petri dishes with a diameter of 9 cm, by placing a 0.5 cm fungus disk taken from the edge of a fresh culture of the pathogenic fungus at five days old using a sterile cork piercer at a distance of 1 cm from the edge of the Petri dish on one side and on the opposite side of the dish, placing a 0.5 cm fungus disk taken from the edge of a fresh culture at five days old at a distance of 1 cm from the edge of the dish with three replicates for each fungal isolate isolated from organic supports, leaving control plates for the pathogenic fungus and a control plate for the fungi isolated from organic supports The plates were incubated at a temperature of 25 ± 2 °C. When the growth of the pathogenic fungus in the control treatment was complete, the inhibition percentage of the pathogenic fungus was calculated based on the grading set by Bell et al. (1982) as follows :

First degree = the growth of the fungus isolated from the organic supports covered the entire area .of the plate and no growth of the pathogenic fungus occurred

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Second degree = the growth of the fungus isolated from the organic supports covered two-thirds .of the area of the plate and the pathogenic fungus covered the remaining third

Third degree = the growth of the fungus isolated from the organic supports covered half the area .of the plate and the remaining half for the pathogenic fungus

Fourth degree = the growth of the fungus isolated from the organic supports covered one-third of the area of the plate and the growth of the pathogenic fungus covered two-thirds of the area of .the plate

Fifth degree = the growth of the fungus isolated from the tested organic supports did not occur .and the pathogenic fungus covered the entire plate

When the degree of antagonism is 2 or less, the fungus is considered a bio-resistant fungus against the pathogenic fungus. If the bio-fungus covers less than half of the plate, it is not considered a bio-fungus .

III. Results and discussion

Isolation and identification of fungi isolated from the bases of stems and roots of the watermelon plant

The results of isolation and identification of the fungus causing watermelon plant wilt disease in a number of Iraqi governorates showed that from plants that showed symptoms of vascular wilt disease and brown discoloration of the base of the stem, 100 fungal isolates were isolated from the crown area and roots of infected watermelon plants from different collection areas. The pathogenic fungus *Fusarium solani* appeared at a frequency of 56% .

The results showed that *Fusarium solani* colonies are characterized by the formation of white, yellowish-white, or pinkish-white mycelium, and the mycelium is divided by simple barriers. It was also noted that they form three types of conidia on a branched conidia, namely,macroconidia and microconidia. It was also found that the fungal colonies formed chlamydospores with a spherical or elongated shape surrounded by a thick wall with a smooth or rough surface. They are resistant to environmental conditions that are not suitable for the growth and reproduction of the fungus and are carried singly, in pairs, or in chains. I found that these characteristics are consistent with the characteristics of *Fusarium solani*, which were mentioned in many sources,

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including Leslie and Summerell (2006); Hussein and Juber (2015); Abdullah; and Kareem Khan; (2021) and others (2023). (Figure 1) *F. solani* is one of the most widespread fungi in watermelon cultivation areas and causes root and stem rot and plant wilt in Iraq (Abdullah and Kareem, 2021 Hussein; et al., 2024).

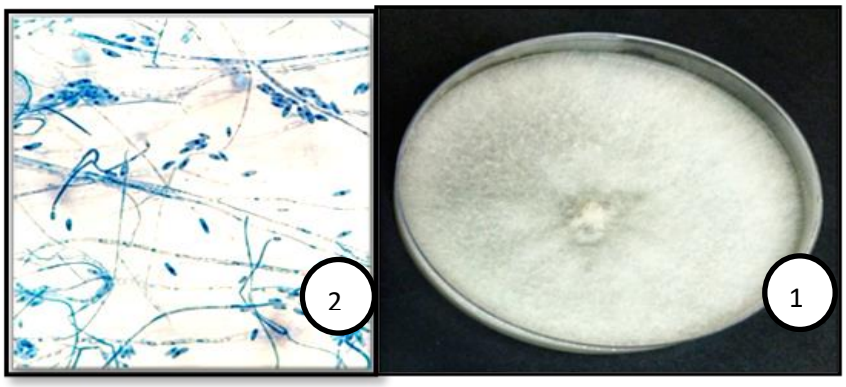

Image (1): (1) Fusarium solani colony (2) Mycelium of the pathogenic fungus Fusarium solani.F stained with methyl blue and macroconidia and microconidia

Testing the pathogenicity of *Fusarium solan*i isolates in germination of Suger baby seeds in the laboratory in Petri dishes

The results of the test of the pathogenicity of *Fusarium solani* (Figure 2) showed that the germination rate of the Suger baby seeds showed a difference in the ability of the pathogenic isolates to reduce the germination rate from 0.00 to 100% compared to the control treatment, which had a germination rate of 100%. Some isolates were significantly superior in preventing seed growth completely, with a germination rate of 0.00%. These are the fungal isolates bearing the symbol A8, B1, B6, B17, B23, B24, B26, B29, K48. These isolates were considered the most pathogenic, followed by the rest of the isolates, as the nine isolates of the pathogenic *Fusarium* solani were significantly superior to all the tested fungal isolates in the rate of pathogenicity index and severity of infection on Suger baby seeds. It reached 5, 100 respectively

The difference in the severity of infection and pathological evidence may be due to the ability of the isolates to produce Pectinases, Protases and Cellulases enzymes that decompose the plant cell wall and secrete metabolic compounds that are important in causing infection and that kill embryos and prevent seeds from germinating (Perincherry et al. 2020). Or the reason is due to the genetic difference of the isolates according to the different regions from which they were

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collected or the effect of the environmental conditions surrounding the fungus and have an impact on its spread and development in causing the disease (Zakaria, 2023).

This is consistent with what Garcés González (2022) found, who found that the fungus *F. solani* caused a reduction in the percentage of germination, reaching 0.00%, and the highest percentage of infection reached 100% in the infection of the seedlings of the watermelon plant in the pot experiment .

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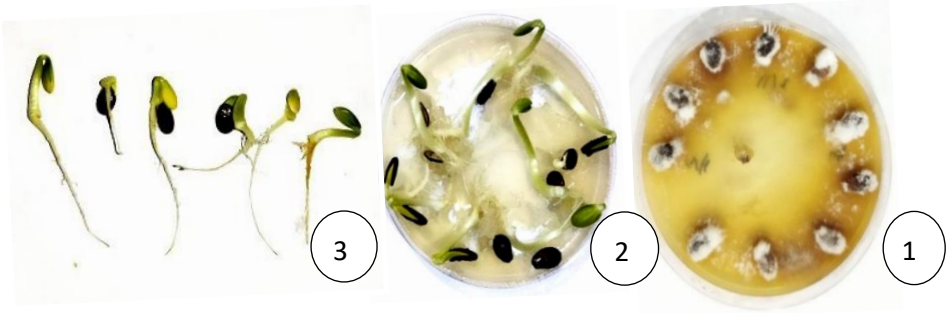

Image (2): Laboratory testing of the pathogenicity of the fungus *Fusarium solani* on the seeds of the watermelon plant (1) Isolate B6, highly pathogenic(2) Control treatment, seeds only (3) Seedlings showing symptoms of root discoloration as a result of infection with the pathogenic fungus *Fusarium solani*

Testing the effectiveness of aqueous extracts of organic supports on the growth of the pathogen Testing the effectiveness of aqueous extracts of organic supports without sterilization on the growth of the fungus *Fusarium solani*

The results of the effectiveness of the aqueous extract of non-sterile organic supports (Figure 3 and Table 2) showed a significant difference in the effectiveness of the aqueous extracts of the tested organic materials and at all tested concentrations in inhibiting the growth of the pathogenic fungus *F.solani* compared to the control treatment, as the aqueous extract of peat moss showed the highest inhibition rate of the pathogenic fungus, reaching between 60.00 - 65.00% with an average diameter of the pathogenic fungus colony growth of 3.1 - 3.6 cm at the tested concentrations (5, 10 and 15%). It was followed by the aqueous extract of vermocompost with an inhibition rate of 48.88 - 55.55% and an average diameter of the pathogenic fungus colony growth of 4.0 - 4.6 cm. The aqueous extract of fermented cow dung gave an inhibition rate of 41.11-56.66% with an average diameter of the pathogenic fungal colony growth of 3.9-5.3 cm, with a significant difference from the comparison treatment with an inhibition rate of 0.0% and an average diameter of the fungal colony growth of 9.0 cm. The reason for these differences in the inhibition rate of the fungus *F. solani* when using the extract of organic supports may be attributed to the type of organic support and the degree of decomposition of the organic support,

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in addition to the presence of beneficial microorganisms, including fungi that work to inhibit pathogens that work to limit the growth and spread of fungal mycelium, which means the presence of several types of fungi, depending on the type of organic support, that contributed to inhibiting the growth of fungi that are pathogenic to the plant (Gill et al., 2023). These results are similar to those obtained by Sabet et al. (2013), who found that the aqueous extract of non-sterilized fermented cow dung inhibited root rot fungi, including *F. solani*, on cucumber plants, and gave a 100% inhibition rate for the pathogenic fungus at a concentration of 15% .

Testing the effectiveness of aqueous extracts of sterile organic supports on the growth of *Fusarium solani*

The results of sterilization of aqueous extracts of organic supports on the nutritional medium (Figure 4 and Table 2) showed that there were no significant differences in the effect of the aqueous extract of organic supports on the growth of the pathogenic fungus *Fusarium solani,* and that all aqueous extracts of vermicompost supports, fermented cow dung and peat moss recorded a percentage of inhibition of the pathogenic fungus of 0.00% at three concentrations of 5%, 10%, and 15%. The reason for not inhibiting the pathogenic fungus may be due to killing the fungi accompanying the fertilizers as a result of sterilizing them with the nutritional medium. This result is consistent with what Reuveni and others (2002) reached, as it was found that sterilization of peat moss did not affect the suppression of the growth of the fungus *F. oxysporum f. sp. basilica*, which causes wilt disease on sweet basil plants. Peat contains beneficial fungi that inhibit the growth of the pathogenic fungus *F. solani* on watermelon plants and that unsterilized peat moss is more effective than sterilized peat moss (Cohen et al., 2008). Swain and Ray (2009) also indicated that beneficial microorganisms isolated from fermented cow dung were used in biological control and showed effectiveness in inhibiting the growth of the fungus *Fusarium oxysporum* by 25-34% and inhibiting the fungus Botryodiplodia theobromae by 100% on tubers of Yam (Dioscorea rotundata). Sabet et al. (2013) concluded that the aqueous extract of unsterilized cow dung gave a 100% inhibition rate of root rot fungi, including *Fusarium solani*, on cucumber plants for a 15% mixing ratio, which was superior to the 5% and 10% mixing ratios due to the presence of a number of fungi that inhibited the pathogenic fungus *F.solani* .

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Table (2) Effect of aqueous extracts of non-sterile and sterile organic supports on the percentage of laboratory *Fusarium solani* to inhibit the pathogenic fungus

Transactions	Extract concentration	colony Average diameter of *F. Solani* (cm) for extract of supplements without sterilization	Inhibition percentage / without sterilization	Inhibition percentage / after sterilization
Vermocompost	%5	4.6	48.88	0
	%10	4.4	51.11	0
	%15	4	55.55	0
Cow dung	%5	5.3	41.11	0
	%10	4.9	45.55	0
	%15	3.9	56.66	0
Peat moss	%5	3.6	60	0
	%10	3.4	62.22	0
	%15	3.1	65	0
Comparison treatment	Without extract	9	0	0
LSD 0.05		0.097	0.486	N.S

*** Each number in the table represents the average of three replicates.**

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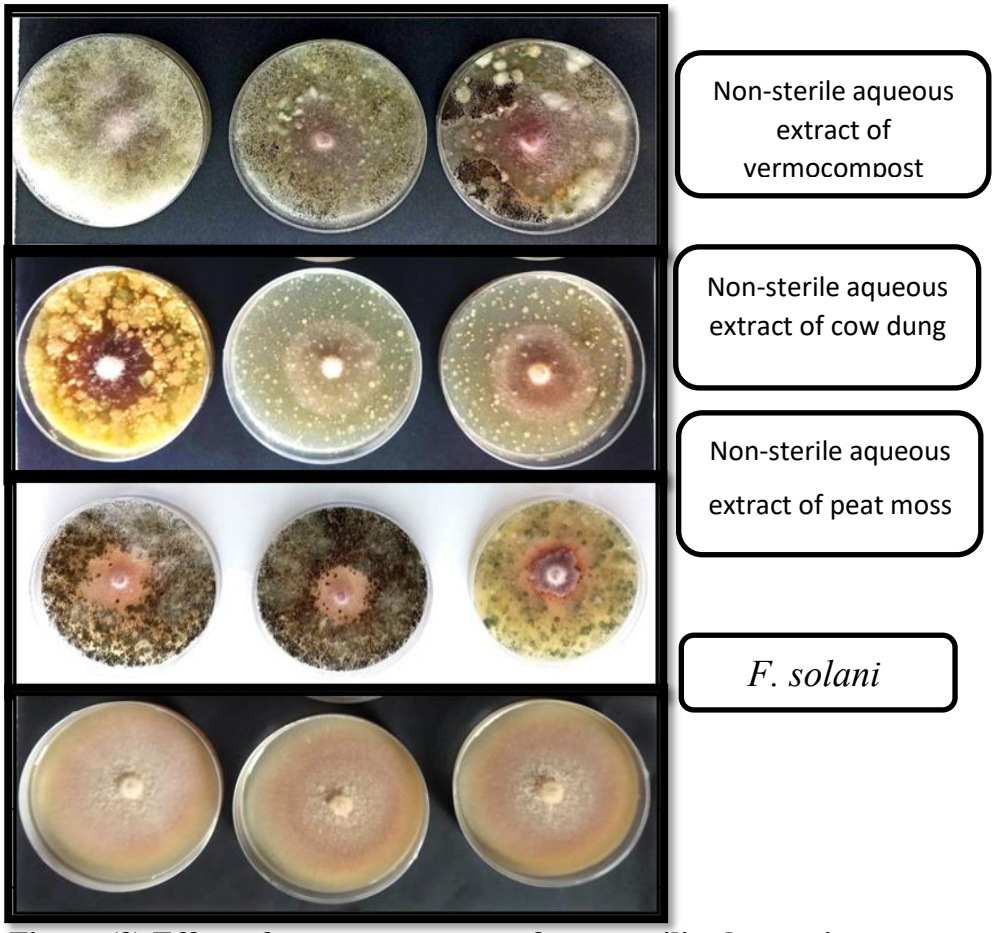

Figure (3) Effect of aqueous extracts of non-sterilized organic supports on the percentage of inhibition of the pathogenic fungus *Fusarium solani* on the PDA .

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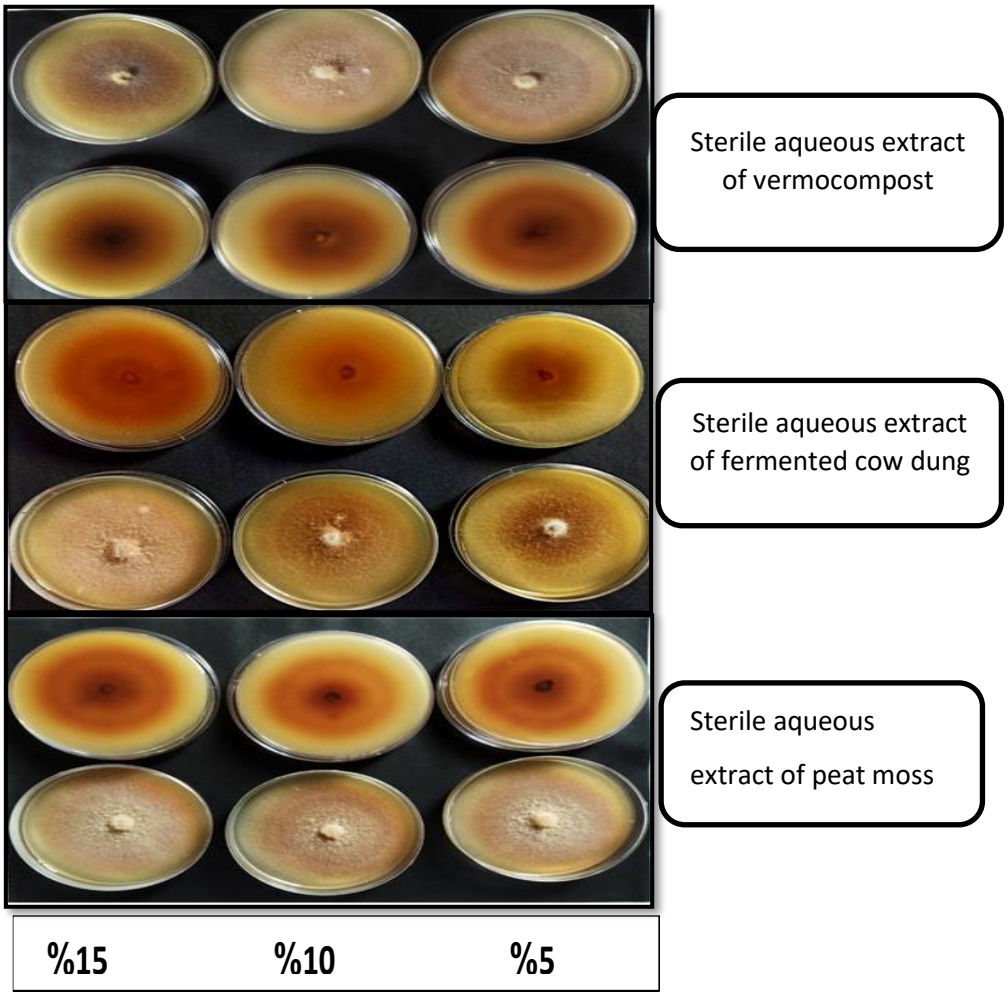

Figure (4) Effect of aqueous extracts of sterilized organic supports on the percentage of inhibition of the pathogenic fungus *Fusarium solani* on the PDA .

Isolation of fungi associated with organic supports by dilution method

The results of isolating fungi associated with organic supplements using the dilution method showed that a number of fungi associated with organic supplements appeared in the dilution extract of organic supplements with a significant difference between treatments (solar 5), and the dilution ratio of 10 4 for the extract of the vermocompost, fermented cow manure and peat moss treatments gave a density of 38 × 410, 16 × 410 and 17 × 410 colonies/gm respectively, while

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the dilution ratio of 10 5 for the extract of the vermocompost, fermented cow manure and peat moss treatments gave a density of 32 × 510, 9 × 510 and 23 × 510 colonies/gm respectively, while the dilution ratio of 10 6 for the vermocompost, fermented cow manure and peat moss treatments gave a density of 9 × 610, 7 × 610 and 9 × 610 Colony/gm respectively, it was found that the number of colonies in the vermicompost was higher in all dilutions 104, 105, and 106, then peat moss, then cow dung. The reason for the difference in the number of fungal colonies may be due to the difference in the stages of decomposition or production of the support and the temperature at which the process of producing organic supports passes. A number of genera were recorded that appeared in the vermicompost, 4 fungal genera: *Aspergillus* ssp., Trichoderma ssp., *Cladosporium* ssp., and *Penicillium* ssp. The reason for the presence of fungi in the aqueous extract may be due to the presence of these fungi with the earthworm's food and they are activated inside the worm's intestines. The activity of the bio-fungi may increase in the vermicompost because it is rich in organic materials, as the genera *Penicillium* ssp and *Trichoderma* ssp. were found. In fermented cow dung, 4 genera of fungi appeared in peat moss: *Aspergillus* ssp., *Penicillium* ssp., *Trichoderma* ssp., and *Rhizopus* ssp.

This is consistent with what Sabet et al. (2013) found that the aqueous extract of unsterilized cow dung gave 6 isolates belonging to the genus *Aspergillus* spp., 5 isolates belonging to the genus *Penicillium* spp., and one isolate belonging to the genus *Chaetomium* spp., The results showed that the supplements are protective materials against the pathogens of cucumber root rot. As for peat moss, four fungal genera were found in it, namely *Aspergillus* ssp., *Penicillium* ssp., *Trichoderma* ssp., and *Rhizopus* ssp. This is similar to what Tamura et al. (2008) found 3 fungal genera in peat moss, including *Penicillium* ssp. The aqueous extract of the organic supplement Vermocomost contains a number of fungal colonies, *Aspergillus niger*, and *Trichoderma* ssp. *Penicillium* ssp., *Cladosporium* ssp., and *Aspergillus flavus* (Senthil and Sivakami, 2018; Gudeta et al., 2022). 6 isolates were found to belong to the genus *Aspergillus* spp., 5 isolates to the genus *Penicillium* spp., and one isolate to the genus *Chaetomium* spp., The results showed that the fortifiers are protective materials against the pathogens of cucumber root rot, and that cow dung is effective in inhibiting the growth of the fungus that causes cucumber root rot disease, *Fusarium solani f. sp. cucurbitae*, in the laboratory (Devi et al., 2023).

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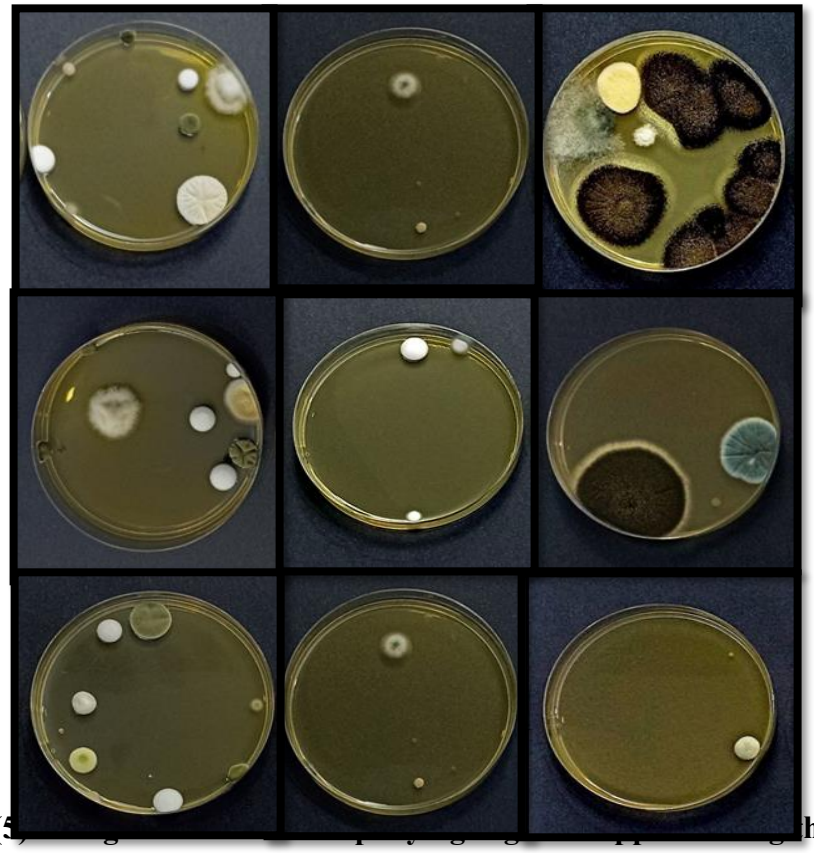

Image (5) ... the dilution method for organic supports.

Testing the antimicrobial capacity of fungi isolated from organic supports against the pathogenic fungus *Fusarium solani* by double culture method in the laboratory

The results of the antimicrobial activity test of the fungi isolated from the organic supports (Figure 6 and Table 3) showed that the fungi achieved degrees of antimicrobial activity against the fungus causing wilt and death of the watermelon plant *Fusarium solani* after 7 days of inoculation on the PDA medium and at different degrees, and that the fungus *Aspergillus* ssp. achieved an antimicrobial activity between 3 and the fungus *Penicillium* ssp. achieved an antimicrobial activity of 2 degrees, while the fungus *Rizopus* ssp. achieved an antimicrobial activity of 3 and that the fungus *Trichoderma* ssp. gave an antimicrobial activity of 2 degrees, and the fungus *Cladosporium* ssp. achieved an antimicrobial activity of 2 degrees, based on the five-point scale developed by Bell et al. (1982).

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The presence of fungi in vermicompost. *Trichoderma* ssp and *Cladosporium* ssp. These fungi gave an antagonism score of less than 2 degrees according to the Bell scale, each separately, in a study of antagonism against the fungus *Fusarium graminearum*, which causes wheat root rot in the laboratory, and are considered biological control fungi. This confirms what Akinnuoye-Adelabu et al. (2019) reached, and Jasim et al. (2021) obtained a number of fungi, including the fungus Aspergillus ssp., which was isolated from cow dung in Basra Governorate. These fungi gave an antagonism score of 3 against 5 types of bacteria in the laboratory, and are not considered fungi that give a significant degree of antagonism. And the inhibition of the pathogenic fungus *Fusarium solani* with a degree of antagonism of 3 degrees, according to what was mentioned by Bell (1982), is not considered a bio-resistance fungus .

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Table (3) Testing the antimicrobial capacity of fungi isolated from organic supports against the pathogenic fungus *Fusarium solani* by double culture method in the laboratory

Type of organic fertilizer	Fungi	Fungal colony growth rate of fertilizer-associated fungi	degree of contrast
Vermocompost	*Aspergillus ssp.*	2.27	4
	Trichoderma ssp.	4.13	2
	Cladosporium ssp.	5.7	2
	Aspergillus ssp.	3.32	3
	Penicillium ssp.	4.17	2
dung Cow	*Trichoderma ssp.*	5.4	2
	Penicillium ssp.	4.53	2
moss Peat	*Aspergillus ssp.*	2.57	3
	Penicillium ssp.	3.63	3
	Trichoderma ssp.	4.1	2
	Rizopus ssp.	3.5	3
LSD 0.05	0.196		0.177

***Each contrast number represents the average of three repetitions.**

1= The growth of the fungus isolated from the organic supports covered the entire area of the dish and no growth of the pathogenic fungus occurred

2= The growth of the fungus isolated from the organic supports covered two-thirds of the .area of the dish and the pathogenic fungus covered the remaining third

3= The growth of the fungus isolated from the organic supports covered half the area of the .dish and the pathogenic fungus covered the remaining half

4= The growth of the fungus isolated from the organic supports covered one-third of the area of the dish and the growth of the pathogenic fungus covered two-thirds of the area of .the dish

5 = No growth of the fungus isolated from the tested organic supports and the pathogenic fungus covered the entire dish.

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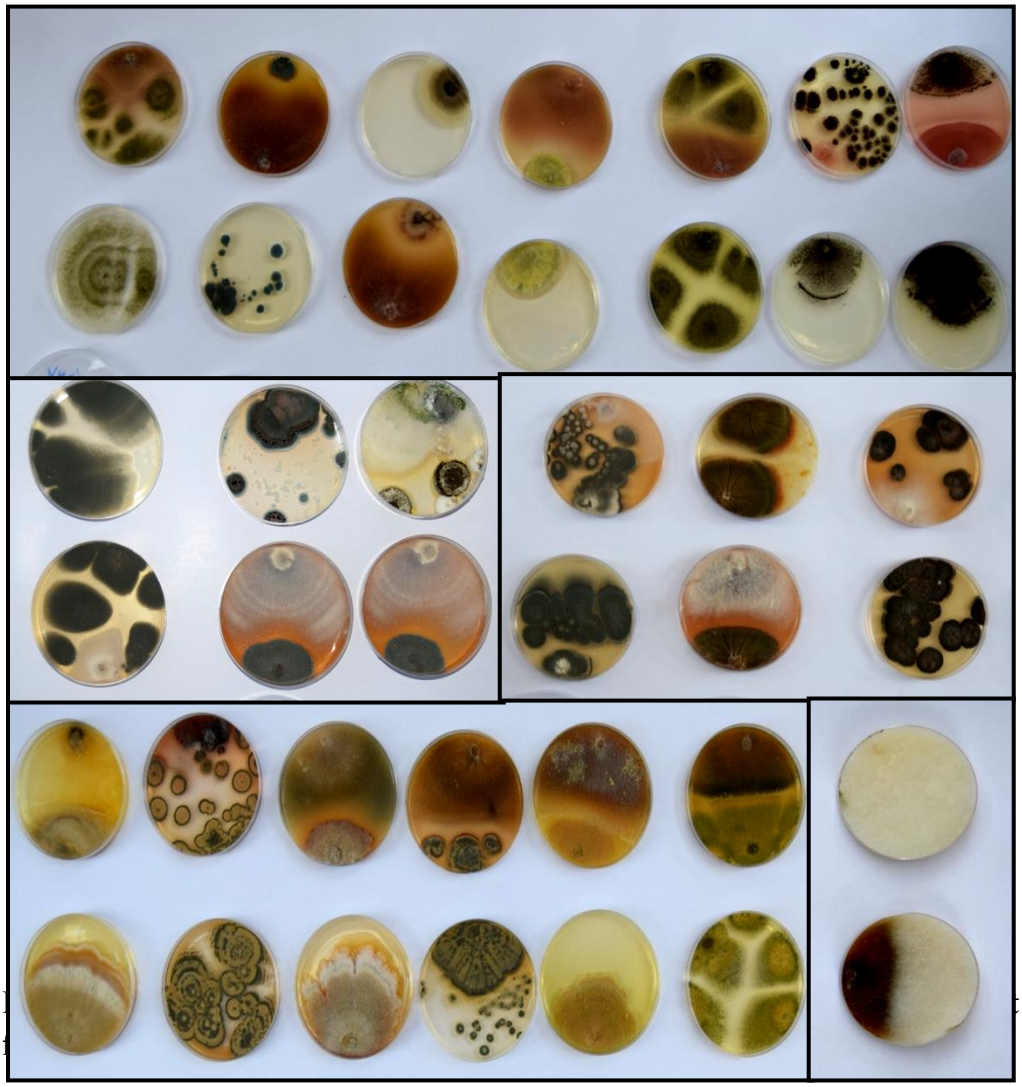

Antagonism of vermicompost-associated fungi against *F. solani*

Antifungal agent for cattle fermentation against *F. solani*

Antagonism of peat moss-associated fungi against *F. solani*

the pathogenic

Conclusions:

1- *Fusarium solani* is the most common fungus that infects the bases of stems and roots of the watercress plant.

2- Using organic supports, which are vermocompost, fermented cow dung and peat moss, which provide protection for the plant against the fungus that causes wilt and rot of the roots and stems of the watercress plant by stimulating the systemic resistance of the plant.

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3- The presence of fungi in the supports that gave the highest percentage of antagonism is one of the biological control factors due to its effect in inhibiting the pathogenic fungus and protecting plants from infection with fungal diseases.

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