
Testing the effect of magnesium oxid nanoparticles in combating the *Penicillium digitatum*, which causes green leaf disease in range fruits

Rasha Saad Fawzi

Karkh Second Education Directorate, Ministry of Education, Iraq

Abstract: The study aimed to test the effect of the effectiveness of magnesium oxide nanoparticles in combating the fungus *Penicillium digitatum*, which causes green mold disease in orange fruits. The results of testing the pathogenicity of the fungus *Penicillium digitatum* showed a high infection rate compared to the control treatment (not treated with the fungus). Antagonism tests proved that the addition of magnesium oxide nanoparticles at concentrations of 1%, 2%, 4%, and 6% achieved inhibition of the growth of the fungus *Penicillium digitatum* on the PDA culture medium by 65.22%, 94.22%, 96.49%, and 100%. Respectively compared to the control treatment (pathogenic fungus alone), which amounted to 0.0%. Magnesium oxide particles were tested at a temperature of 25°C, and the results showed that all treatments led to the suppression of the activity of the *Penicillium digitatum* fungus. *Penicillium digitatum* in orange fruits and achieved a significant reduction in the percentage of disease incidence, reaching 0.0% compared to the control treatment without the fungus

Introduction

Diseases that affect plants after harvest are among the major problems that cause losses in fruits during storage in many countries of the world, reaching more than 25% of the harvested fruits, and losses sometimes in developing countries, including Iraq, reach more than this percentage (Saleh and Abdel Fattah, 2009). Chemical pesticides are used to combat post-harvest plant diseases in fruits and vegetables, and the continuous use of chemical pesticides has led to the emergence of strains of pathogens resistant to chemical pesticides (Janisiewicz and Korsten, 2002). In view of the negative effects caused by pesticides, researchers have turned to using alternative agents to reduce pathogens, which represents the suppression of the pathogen. This leads to excessive and frequent use of chemical pesticides and is safe for the environment (Turkkan, 2013; Zouari et al., 2016). In recent years, the use of nanomaterials has led to It has begun to expand before researchers due to its ability to combat diseases caused by pathogenic fungi. Nanotechnology is a modern technology, as the American physicist Richard Feynman was the first to announce its appearance in 1959 AD when he predicted the possibility of creating small-sized, high-precision technologies for their various scientific purposes (Al-Iskandarani, 2009).

Magnesium, mg, is considered one of the essential elements for plant growth and development. It is a non-toxic element for living organisms, as it plays an important role in plants' defense mechanisms in cases of environmental stress (Senbayram et al., 2015). This element is involved in increasing the susceptibility of plant defenses against plant pathogens through direct contact with the pathogen (Huber and Jones, 2013; and Cai et al., 2018). Magnesium oxide nanoparticles are considered safe materials recognized by the United States Food and Drug Administration (Bertinetti et al., 2009; Krishamoorthy et al., 2012). Studies have confirmed the effect of magnesium oxide nanoparticles in inhibiting types of plant-pathogenic fungi (Wain et al., 2012) and these particles were used as one of the nanoparticles against plant pathogens (Prasad et al., 2014; Parizi et al., 2014; Ahmed and Lee, 2015; El-raway, 2017). For the purpose of combating green mold disease caused by the fungus *Penicillium digitatum* on orange fruits after harvesting, the study aimed to

- ✓ Isolating the fungus *P. digitatum* from infected orange fruits, diagnosing it, and testing its pathogenicity.
- ✓ Testing and evaluating the efficiency of some nanomaterials, including magnesium oxide nanoparticles, in influencing pathogenic fungi and protecting fruits from infection.

Materials and working methods

Testing the pathogenicity of *P. digitatum*

Fruits that were healthy and free from scratches and wounds were selected, washed with regular washing powder and running water, then sterilized with 70% ethyl alcohol for 2 minutes and placed on sterile blotting paper. I cut each fruit with a single wound, 1 mm deep, on one of its sides with a sterile scalpel. I inoculated the fruits with a smear from a colony of a fungus growing in the

middle of a PDA planting at one week old. I used three replicates, with two fruits in each replicate. For comparison, I left the fruits without inoculation with the pathogenic fungus. The fruits were placed in polyethylene bags and incubated at room temperature. 25- +2 m. The fruits were examined daily to investigate whether the infection had occurred, and the mice were re-isolated from the infected fruits.

- Testing different concentrations of magnesium oxide nanoparticles to inhibit the growth of the fungus *P. digitatum* in vitro.

Different concentrations of magnesium oxide nanoparticles were prepared in the PDA culture medium (1, 2, 4, and 6%). A base solution of salicylic acid with a concentration of 20 g was prepared and sterilized by passing it through a membrane filter (Millipore) with holes with a diameter of 0.45 micrometers, the media was sterilized PDA in the incubator at a temperature of 121 M under a pressure of 1.5 kg/cm² for 20 minutes. Cool the medium to 40-45°C and add magnesium oxide nanoparticles to obtain the required concentrations. The flasks are shaken and the culture medium is poured into sterile Petri dishes with a diameter of 9 cm. For comparison, use... PDA planting medium alone. The plates were inoculated in their centers with a disk of the fungus *P. digitatum*, 0.5 cm in diameter, taken from the edges of a colony of fungi grown on PDA medium at 7 days old. The plates were incubated at a temperature of 25±2°C for 7 days.

Testing the effect of magnesium oxide nanoparticles on green rot disease in orange fruits at a temperature of 25°C.

I selected some healthy orange fruits free of wounds and scratches. They were washed with regular washing powder, then with running water, and sterilized with a 70% ethyl alcohol solution for two minutes. They were placed on sterile blotting paper and left at room temperature to dry. Then the fruits were cut with a sterile scalpel to a depth of 1 mm and a length of 2 mm. The experiment was conducted on Three replicates

1. Fruits inoculated with the spores of the fungus *P. digitatum*.
2. Fruits added with 20 microliters/wound of a solution of 0.2% magnesium oxide nanoparticles + the *P. digitatum* fungus.
3. Fruits with 20 microliters/cut of 0.2 magnesium oxide nanoparticles added without mushrooms.
4. Fruits without mushrooms.

Statistical analysis

The experiment was statistically analyzed according to a completely randomized design (CRD), and the means were compared using the least significant difference (L.S.D.) test at a probability level of 0.05.

Results and discussion

Testing the pathogenicity of the fungus *P. digitatum*

The results of testing the pathogenicity of the fungus *P. digitatum* showed a high infection rate compared to the control treatment (not treated with the fungus). The isolation of *P. digitatum* led to the occurrence of rot disease on orange fruits, as soft rotting areas appeared on the orange fruits covered with white growth at first, and as the infection progressed, these spots expanded and the white growth turned green as a result of large numbers of conidial spores of the fungus that causes the disease. This result is consistent with what Conway (2005) found. The initial symptoms of green mold appear in the form of soft, watery spots, and the color of the spots changes to olive. The fungus *P. digitatum* is considered an aggressive fungus, and green mold disease is one of the most important diseases that cause economic losses to orange fruits after harvesting (Tanaka, 2011).

Testing different concentrations of magnesium oxide nanoparticles to inhibit the growth of the fungus *P. digitatum* in vitro.

The results in Table (1) showed the effectiveness of magnesium oxide nanoparticles in inhibiting the growth of the fungus *P. digitatum* at concentrations (1, 2, 4, 6) after two weeks of incubation at a temperature of 25°C. The lowest percentage of inhibition of the fungus was 65.22 when using the concentration of 1% and Concentrations 2, 4, and 6 did not differ significantly (p = 0.05) among them, as the percentage of inhibition on the PDA culture medium reached 94.22, 96.49, and 100%, respectively.

Table (1) Testing different concentrations of magnesium oxide nanoparticles in inhibiting the growth of the fungus *P. digitatum* in vitro

the focus %	Inhibition rate %
1	65.22
2	94.22

4	96.49
6	100
Control	0.0
L.S.D at the level of 0.05	2.40

Testing the effect of magnesium oxide nanoparticles on green rot disease in orange fruits at a temperature of 25°C.

The results in Table (2) showed that treating orange fruits with a solution of magnesium oxide nanoparticles achieved a significant reduction ($P = 0.05$) in the percentage of disease incidence, reaching 0.0% compared to the comparison treatment without fungi. This result is consistent with many studies that show the superiority of using magnesium oxide nanoparticles in inhibiting pathogenic fungi. These results are consistent with a number of studies that indicate the high effectiveness of metal nanoparticles and their oxides in inhibiting many plant pathogens (Mohendra et al., 2012; Al-Jubouri, 2016). Scientists found that the use of 100 parts per million of silver oxide nanoparticles led to the inhibition of pathogens. Plant pathogenic fungi on PDA medium.

Table (2) Testing the effect of magnesium oxide nanoparticles on green rot disease in orange fruits at a temperature of 25°C.

Transactions	Disease incidence %
Orange fruits + magnesium oxide + mushrooms	0.0
Orange fruits + mushrooms	93.66
Orange fruits + magnesium oxide without mushrooms	9.33
Orange fruits Oranges without mushrooms	52.3
L.S.D at the level of 0.05	6.6

Conclusions and recommendations

Conclusions

Magnesium oxide nanoparticles showed high effectiveness in completely inhibiting the pathogenic fungus *P.digitatum* in laboratory experiments. Magnesium oxide nanoparticles proved successful in preventing orange fruits from being infected with green rot disease under refrigerated storage conditions at a temperature of 4°C.

Recommendations

1. Conduct further studies on magnesium oxide nanoparticles as they are safe materials in combating post-harvest diseases.
2. Conducting other studies on the use of magnesium oxide nanoparticles in combating post-harvest diseases on other fruits.

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