

# Antifungal Activity of Apiaceae Family plants against *Aspergillus fumigates* and *Fusarium solani*

sakshi tripathi (✉ [sakshitripathi678@gmail.com](mailto:sakshitripathi678@gmail.com))

Sam Higginbottom University of Agriculture Technology and Sciences <https://orcid.org/0000-0001-8921-5259>

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## Research Article

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# Abstract

The study's objective was to determine whether ten plants from the Apiaceae family used in traditional medicine had any antifungal properties against the fungi *A. fumigates* and *F. solani*. The selection of the plants was based on their alleged ethnobotanical applications. The antifungal activity of several plant extracts in methanol, ethanol, hexane and ethyl acetate against *A. fumigates* and *F. solani* was tested. We employed the Agar well diffusion method to assess the antifungal effectiveness. Extracts' Minimum inhibitory concentrations (MIC) were established. Plant extracts in methanol and ethanol were more efficient than those in hexane and ethylacetate. The findings indicated that *Coriander sativum* L., *Pimpinella anisum* L., *Bunium persicum* L. and *Cuminum cyminum* L. had the strongest antifungal effects. Comparatively little activity was seen for the extract of *Carum carvi* L. and *Centella asiatica* L. against *A. fumigates* and *F. solani*. Extracts' MIC values were found to range from 0.36 µg/ml to 0.14 µg/ml. Extracts with the largest zone of inhibition may be a source of antifungal compounds that can be used to treat human infection. We come to the conclusion that the remarkable fungicidal characteristics of these extracts support their traditional usage as an antiseptic, medicinal and preservative.

## Introduction

The Apiaceae family, which has 3780 species in 434 genera, is one of the most important groups of flowering plants. The characteristics of Apiaceae species that are most frequently observed include their fragrant herbaceous nature, alternating leaves with sheathing bases, hollow stem, petite flowers and indehiscent natural products or seeds with oil ducts (Eman et al. 2021). Apiaceae family plants are used for distinctive purposes such as pharmaceuticals, nutrition, beverages, species, cosmetics, fragrances and industrial uses. A few plants from this family are utilized as home remedies in ethnomedicine to treat a number of conditions affecting the digestive, endocrine and reproductive systems (Saniasiaya et al. 2017). A number of earlier investigations on plants in the Apiaceae family have shown their value as possible sources of organic agrochemicals as well as their biological activity, including their anticancer, analgesic, diuretic and anti-obesity characteristics. Apiaceae seeds can enhance organic activity, physical and chemical qualities and nutritional value.

Table 1  
Apiaceae species' ethnomedical applications

| Botanical name                  | Local name | Medicinal use                                                                                              | References                                                                      |
|---------------------------------|------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| <i>Anethum graveolens</i> L     | Dill       | It is helps you to maintain healthy vision, skin, immune system.                                           | Ishikawa et al. (2002), Rădulescu et al. (2010), SaidAl-Ahl et al. (2015)       |
| <i>Trachyspermum ammi</i> L.    | Ajwain     | It is used for hypotensive, bronchodilatory, hepatoprotective and anti- nociceptive activities.            | Chahal et al. 2017, Himani et al. 2019                                          |
| <i>Coriander sativum</i> L.     | Coriander  | It may help to lower your blood sugar, and to treat infection caused by bacteria and fungi.                | Bhuiyan et al. (2009), Mahendra and Bisht (2011), Rajeshwari and Andallu (2011) |
| <i>Cuminum cyminum</i> L        | Cumin      | Diarrhea, diabetes, cancer and chronic illnesses are all treated with it.                                  | Hajlaoui et al. (2010), Koppula and Choi (2011), Sowbhagya (2013)               |
| <i>Foeniculum vulgare</i> Mill. | Fennel     | It helps to improve the symptoms of anemia and used in treating respiratory and gastrointestinal Disorders | Díaz-Maroto et al.(2006),Díaz Maroto et al. (2005),Ghanem et al. (2012).        |

| Botanical name              | Local name           | Medicinal use                                                                                                                                                                                | References                                                      |
|-----------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| <i>Daucus carota</i>        | Carrot               | It can improve immune function, reduce the risk of some cancers and promote wound healing and digestive health.                                                                              | Feng et al. (2019), Michael et al. (2015), Silva et al. (2007). |
| <i>Pimpinella anisum</i> L. | Anise                | Used in traditional medicine as an analgesic for migraines as well as an aromatic, a disinfectants, and a diuretic. Treatment of respiratory tract problems and bronchial asthmatic attacks. | Orav et al. (2008), Pavlova et al. (2006)                       |
| <i>Bunium persicum</i>      | Kala jeera           | As appetizer, carminative, For children earache, cough; to ease digestion, to help indigestion and vomiting, gastritis.                                                                      | Hassan et al. (2018)                                            |
| <i>Carum carvi</i> L.       | Caraway              | Galactologue, carminative, pneumonia and gastrointestinal disorders.                                                                                                                         | Fang et al. (2010)                                              |
| <i>Centella asiatica</i> L. | Gotu Kola/<br>Brahmi | Neuroprotective, used for wound healing, memory enhancing,                                                                                                                                   | Shinomol et al. (2010)                                          |

In the developing countries, including India, Infectious diseases accounts for significant portion of health problems. Microorganisms have developed resistance to numerous anti-microbial, which has caused significant clinical problems in the management of infectious disease (Bansod et al. 2008; Davies 1994). Due to careless use of commercial antimicrobial drugs frequently used to treat infectious disease the resistance of life forms increased. The researchers were forced by the situation to look for novel antimicrobial compounds from different sources including medicinal plants (Bansod et al. 2008; Bauer et al. 1996).

*Aspergillus fumigates* may be known organism belonging to species *Aspergillus*. This organism develops as a result of the spread of a particular disease in immune-compromised individuals and causes allergic reactions (Greenberger et al. 2002; Sharaf et al. 2021). Aspergillosis refers to the broad variety of ailments caused by members, of the *Aspergillus* genus and is brought on by contaminated hospital environments, surgical tool coordination immunization, inhalation of hazardous substances, air conditioners, and mechanical ventilation (Haiduven et al. 2009; Correa et al. 2010; Sharaf et al. 2021). It appears that the antifungal drugs now in use only partially successfully treat infections (Gallien et al. 2008). There has been an increase in the occurrence of *Aspergillus* strains in hospital settings (Snelders et al. 2008; Linden

et al. 2009). Modern targets had to be identified, and untapped antifungal specialists had to be developed as useful alternatives that would be powerful antifungal drugs (Abad et al. 2007; Sharaf et al. 2021). *Fusarium solani* are causative operators of extreme plant illnesses that are mindful for critical financial misfortunes in crops around the world each year (Scherin et al. 2013; Ellis and Munkvold 2014; Avanco et al. 2013).

Additionally, mycotoxin and their secondary metabolites have a variety of harmful effects (carcinogenic, mutagenic, teratogenic or oestrogenic consequences) which can lead to acute or chronic sickness in both people and animals (Zain 2011, da Cruz et al. 2013, Assuncao et al. 2016; Adam et al. 2019). There is constant need to manage mycotoxin generation and fungal development because of their detrimental effects on both human and animal health as well as the need to ensure the security of food and nutrition. Determining the antifungal activity of ten plant extracts against *A. fumigates* and *F. solani* is the goal of the current investigation.

## Materials And Methods

### Plant material

The Lucknow local market was visited to obtain the plant leaves used in this investigation. With the assistance of Central Institute of Medicine and Aromatic plants, Lucknow, and other literature survey comparisons, the plant leaf was recognized and verified.

### Drying and Grinding of Plant

The plants were cleaned and then chopped in to little bits with scissors and knives. They were kept for drying in a room without any exposure to light for about two weeks, however they may also be dried in an oven (at 40 to 50 °C) if necessary. After the plants have dried fully, make sure the powder is uniform in size and that the surface area is increased for improved extraction. To keep materials dry until extraction, they were kept in tightly closed plastic containers (Hassan et al. 2019; Kezetas et al. 2021).

### Fungal strain:

*A. fumigatus* and *F. solani* were acquired from Chandigarh's Microbial Type Culture Collection and Gene Bank. On potato dextrose agar, the fungus was cultivated at 25 °C. after 10 days, the fungus spores were harvested from cultures on agar plates (Poala et al. 2011; Naveen et al. 2012). The fungus suspension was kept -40 °C in 20% glycerol.

### Determination of antifungal activity:

Agar well diffusion was used to test plant extracts for their ability to inhibit the growth of fungus (Hassan et al. 2019; Eman et al. 2021). The Potato Dextrose Agar (PDA) medium was made in accordance with the standard composition provided by Himedia. 40 gm pf the medium was suspended in 1L of water, and the medium was autoclaved at 121 °C and 15 pressure for 15 minutes. Each plate was filled with 20ml of

the culture media after the sterilising media had been added using aseptic procedures into sterile glass petri dishes. After allowing three plates to properly solidify, the media was inoculated using the spread plate technique with the appropriate fungus isolates, *A. fumigatus* and *F. solani* on PDA media. For this, 100 ml of the culture broth of each isolated was added over the media and evenly spread using a sterile glass rod. Ten minutes after spreading, sterile microtips were used to pierce wells into the media plates, and each well was subsequently filled with 20 ml of the appropriate extract on separate plates. The samples were allowed to diffuse into the media through the well before the plates were parafilm sealed and incubated for 48 hrs at 27 °C (Fungus).

The plates had two wells one of the positive controls that was filled with fluconazole (Sanam et al. 2019) of 1200ppm concentration and the negative control that was filled with pure solvent in which samples were prepared. After 5-7 days of incubation, the plates were examined for the zone of inhibition, a clear area surrounding the well whose diameter was measured in millimeters and noted.

### **Minimum Inhibitory Concentration (MIC)**

MIC was calculated using various extracts concentrations (Gayoso et al. 2004; eman et al. 2021; Jeyasakthy et al. 2017). For MIC test, potato dextrose broth was used, the media was prepared as per the standard composition and autoclaved for sterilization. A series of six tubes was used, and one blank test tube starting from the highest concentration of antifungal agent followed by the lower ones. After the respective concentration of the antifungal agents were prepared in each tube, each tube containing the media and antifungal agent was loaded with 100ml of 24hr mold fungus that is *A. fumigatus* and *F. solani*. After addition of fungus culture the tubes were plugged and incubated at 35 °C for 24-48 hrs. the tubes were observed for the turbidity in the medium, which is an indication of fungal growth. The lowest concentration of the antifungal agent at which no turbidity was seen is taken as the MIC value for set of analysis.

## **Result**

The conventional utilize of plants as medicine give the premise for demonstrating which plant extract may be valuable for particular medical condition (Sunita et al. 2008). The reason for the current efforts is the increase in organism resistance to available drugs. Using a standard methodology, the agar well diffusion method was employed for antimicrobial screening (Franklin R. et al. 2013; Hassan et al. 2019). It is crucial to do scientific research on plants that have been traditionally utilized in medicine as possible sources of antimicrobial compounds. Against *A. fumigatus* and *F. solani*, every extract displayed varying degrees of antifungal activity.

Table 2  
Antifungal activity of Ten plant extract of Apiaceae family plants against *Aspergillus fumigatus*

| S. No.                                                | Plant Extract                   | <i>Aspergillus fumigates</i> /zone of inhibition (mm) |         |          |         |
|-------------------------------------------------------|---------------------------------|-------------------------------------------------------|---------|----------|---------|
|                                                       |                                 | M                                                     | E       | H        | EA      |
| 1                                                     | <i>Anethum graveolens</i> L     | 5±1.4                                                 | 11±1.4  | 3.5±2.1  | 3.3±1.7 |
| 2                                                     | <i>Trachyspermum ammi</i> L.    | 9±1.4                                                 | 11±1.4  | 5.25±1.0 | 4.2±0.8 |
| 3                                                     | <i>Coriander sativum</i> L.     | 19±0.2                                                | 17±1.8  | 9.8±0.5  | 2.9±1.5 |
| 4                                                     | <i>Cuminum cyminum</i> L        | 14±0.8                                                | 11±1.6  | 4.7±6.6  | 9±1.4   |
| 5                                                     | <i>Foeniculum vulgare</i> Mill. | 8.5±0.7                                               | 15±0.7  | 11±4.2   | 3.9±5.5 |
| 6                                                     | <i>Daucus carota</i>            | 6.4±0.4                                               | 10±0.7  | 7.31±1.4 | 4.2±2.5 |
| 7                                                     | <i>Pimpinella anisum</i> L.     | 7.6±2.7                                               | 16±1.4  | 1.65±2.3 | 3.4±1.1 |
| 8                                                     | <i>Bunium persicum</i>          | 15±1.1                                                | 11±0.9  | 4.5±3.1  | 1.7±0.4 |
| 9                                                     | <i>Carum carvi</i> L.           | 11±1.4                                                | 4.5±1.2 | 2.0±0.84 | 9.8±0.3 |
| 10                                                    | <i>Centella asiatica</i> L.     | 11±0.6                                                | 10±0.8  | 1.2±1.6  | 4.7±0.5 |
| 11                                                    | Solvent(negative control)       | No zone                                               | No zone | No zone  | No zone |
| 12                                                    | Fluconazole(positive control)   | 20±5.2                                                | 19±3.0  | 19±3.8   | 18±3.9  |
| M: methanol; E: ethanol; H: hexane; EA: ethyl acetate |                                 |                                                       |         |          |         |

**Table 3.** Antifungal activity of Ten plant extract of Apiaceae family plants against *Fusarium solani*

| S. No.                                               | Plant species                   | <i>Fusorium solani</i> / zone of inhibition (mm) |          |          |           |
|------------------------------------------------------|---------------------------------|--------------------------------------------------|----------|----------|-----------|
|                                                      |                                 | M                                                | E        | H        | EA        |
| 1                                                    | <i>Anethum graveolens</i> L     | 8.25±0.3                                         | 9.7±0.4  | 2.2±3.1  | 2.6±0.5   |
| 2                                                    | <i>Trachyspermum ammi</i> L.    | 7.85±1.8                                         | 1.3±1.8  | 6.1±0.9  | 1.25±1.7  |
| 3                                                    | <i>Coriander sativum</i> L.     | 14.7±2.4                                         | 11.1±1.5 | 10.3±1.3 | 2.1±2.9   |
| 4                                                    | <i>Cuminum cyminum</i> L        | 13.1±2.9                                         | 11.5±2.1 | 4.1±5.7  | 4.1±2.8   |
| 5                                                    | <i>Foeniculum vulgare</i> Mill. | 11.5±1.3                                         | 13.8±0.8 | 3.9±0.9  | 1.05±1.5  |
| 6                                                    | <i>Daucus carota</i>            | 3.65±0.77                                        | 5.75±0.9 | 7.7±3.2  | 1.65±0.35 |
| 7                                                    | <i>Pimpinella anisum</i> L.     | 2.3±3.25                                         | 11.7±0.4 | 12.1±1.5 | 3.9±0.4   |
| 8                                                    | <i>Bunium persicum</i>          | 9.7±0.42                                         | 7.1±1.3  | 6.2±8.7  | 6.3±5.5   |
| 9                                                    | <i>Carum carvi</i> L.           | 2.25±1.2                                         | 2.75±2.3 | 1.75±0.9 | 0.7±0.9   |
| 10                                                   | <i>Centella asiatica</i> L.     | 9.7±0.7                                          | 8.9±0.7  | 3.4±1.7  | 1.05±1.5  |
| 11                                                   | Solvent(negative control)       | No zone                                          | No zone  | No zone  | No zone   |
| 12                                                   | Fluconazole(positive control)   | 15.6±2.8                                         | 13.9±2.3 | 14.9±3.4 | 14±3.4    |
| M: methanol; E: ethanol; H: hexane; EA: ethylacetate |                                 |                                                  |          |          |           |

The antifungal activity of plant extracts is summarised in Table 2. The highest antifungal activity in plant extract was recorded 19mm in *Coriander sativum* (methanol) which was followed by *Pimpinella anisum* (ethanol) is 16mm and the least activity was recorded in *Centella asiatica* (hexane) is 1.2mm against fungus *Aspergillus fumigatus*. Antifungal activity of plant extract against *Fusorium solani* is summarised in Table 3. The highest antifungal activity in plant extract was recorded 13mm in *Foeniculum vulgare* (ethanol) which was followed by *Cuminum cyminum* (methanol) is 13mm and the least activity was recorded in *Carum carvi* (ethylacetate) is 0.7mm against fungus *fusorium solani*. Screening of plant extract which show maximum zone of inhibition can proceed for MIC testing. Table 4 show MIC of six plant extracts against *Aspergillus fumigatus* and three plant extracts against *Fusorium solani* obtained by the agar dilution method. Ethanol extract of *Pimpinella anisum* had lowest MIC of (0.17µg/ml) against *Fusorium solani* followed by ethanol extract of *Coriander sativum* and *Foeniculum vulgare* against fungus *Aspergillus fumigatus* and *Fusorium solani*. Methanol extract of *Bunium persicum* had highest MIC of (0.36µg/ml) against *A. fumigatus* followed by ethanol extract of *Foeniculum vulgare* and methanol extract of *Cuminum cyminum* against both fungus.

**Table 3.** Minimum Inhibitory concentration of selected plant extracts against *Aspergillus fumigatus*

| S.No.                   | Plant species                       | MIC  |
|-------------------------|-------------------------------------|------|
| 1                       | <i>Coriander sativum</i> L.(M)      | 0.22 |
| 2                       | <i>Coriander sativum</i> L.(E)      | 0.19 |
| 3                       | <i>Bunium persicum</i> (M)          | 0.36 |
| 4                       | <i>Cuminum cyminum</i> L (M)        | 0.26 |
| 5                       | <i>Foeniculum vulgare</i> Mill. (E) | 0.30 |
| 6                       | <i>Pimpinella anisum</i> L (E)      | 0.17 |
| M: Methanol; E: Ethanol |                                     |      |

Table 4  
Minimum Inhibitory concentration of selected plant extracts against *Fusarium solani*

| S.No.                   | Plant species                       | MIC  |
|-------------------------|-------------------------------------|------|
| 1                       | <i>Coriander sativum</i> L.(M)      | 0.20 |
| 2                       | <i>Cuminum cyminum</i> L (M)        | 0.18 |
| 3                       | <i>Foeniculum vulgare</i> Mill. (E) | 0.14 |
| M: Methanol; E: Ethanol |                                     |      |

## Discussion

Since ancient times, people have used herbs to treat many infectious disease. There is a growing body of scientific evidence supporting the healing potential of numerous medicinal plants. In many countries today, medicinal plants are used to treat a variety of infectious disorders. Because of the prevalence of drug-resistant fungi and the emergence of previously undiscovered pathogenic microbial strains, there is a growing interest in medicinal plants as beneficial agents in various parts of the world. Numerous medicinal plants have been subjected to in vitro testing against various fungal strains, and it has been found that the extract and pure components of these plants are remarkably effective (Mahady et al. 2008; Okla et al. 2021). Different fungi's responses to the same plant extract varied, indicating that different components in each extract may produce different modes of activity or that some fungi's metabolism may be able to adapt to or override the effects of the extracts (Xuan et al. 2003, Sunita et al. 2008).

A few papers also compare the outcomes of several plant extracts the same organisms to demonstrate the activity of the extracts. It is dangerous to compare the data from this study to those from earlier distributions. First of all, it is known that plant extracts composition varies according to local meteorological and natural conditions (Sunita et al. 2008). Additionally, several extracts with the same common name may be found in various plant species. Second, the approach taken to track the movement of antimicrobials and the selection of test organisms differs amongst studies. Agar well diffusion techniques are a common technique used to test plant extract for antimicrobial activity.

The effectiveness of this approach is relatively low sensitivity and inexpensive because the test was advance weakened as before long as they diffused in to the agar (Sandra et al. 2016). In any case this method is one of the foremost utilized to decide antimicrobial movements; since it permit the study of vast number of samples (Cooper et al. 1963; Sandra et al. 2016). Additionally, different extracts evaluated had varying degrees of suppression of the test fungus. The findings suggested that the target fungi were only mildly inhibited by the extracts of *Centella asiatica* L., *Pimpinella anisum*, *Bunium persicum*, *Anethum graveleons* and *Carum carvi*. The strongest and most reliable plants at preventing the growth of the studied fungus were *Coriander sativum*, *Cuminum cyminum* and *Pimpinella anisum*. The differences in bioactive components and their concentration in each extract could explain the discrepancy in the antifungal activity of the plant species that were observed (Hadizadeh et al. 2009; El-Mergawi et al. 2018).

Lower MIC values were found in the leaf extracts *Pimpinella anisum* and *Foeniculum vulagre*. We can draw the conclusion that these extracts have strong fungicidal effects, supporting their traditional uses as antiseptics. Because plants lack an immune system, they must rely on alternative mechanisms to keep them safe from pathogen contamination (Alonso Paz 2000; Heinzen et al. 2004, Paola et al. 2011). These processes include the creation of bioactive chemical molecules as well as antifungal proteins and peptides in cases of fungal infection. Depending on the plant species, the plant tissue being studied, and environmental conditions, the quantity and quality of these active chemicals varies (Demo and Oliva 2008; Webster et al. 2008; Paola et al. 2011).

## Conclusion

According to the findings of this study, *Aspergillus fumigates* and *Fusorium solani* are both susceptible to the antifungal effects of plant extracts from the Apiaceae family. Methanol and ethanol extracts include effective antifungal compounds that can suppress the growth of fungus. Certain species have antifungal activity that is almost equal to that drug which is employed as a positive control. To determine the chemical identity of antifungal compounds responsible for antifungal activity, more research is necessary. Modern alternative active components, namely those with antifungal activity, may originate from distinctive plant-derived fungicides. The high concentration of active extracts in the tested species, chosen in accordance with readily available ethnobotanical data, confirms the legitimacy of this method for choosing plant species within the investigated area for a specific movement.

# Declarations

## Conflict of Interest

There is no conflict of interest.

## Ethical approval

There are no studies by any of the writers in this article that used humans or animals as subjects.

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## Figures



Figure 1

(a) Leave dry in room temperature (b) Powdered of leave (c) *A. fumigatus* and *F. solani* culture

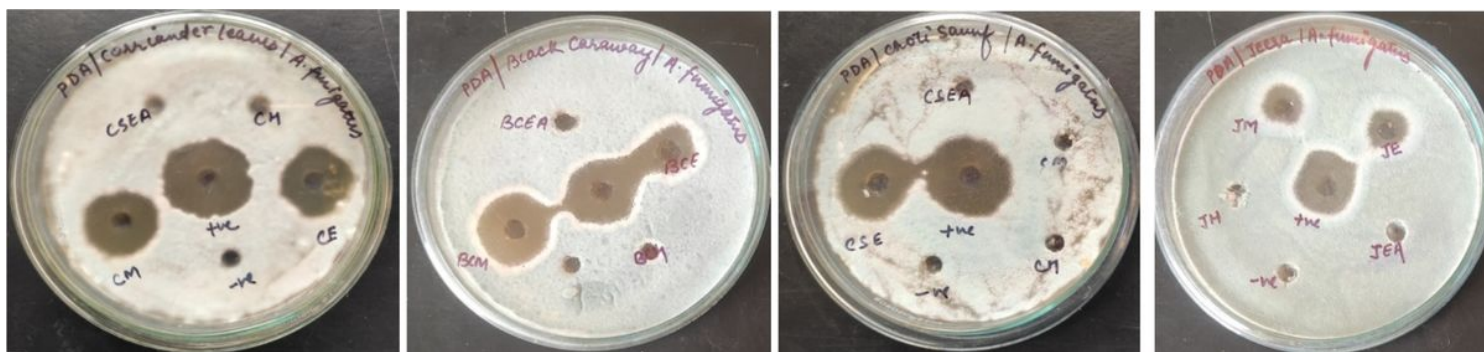
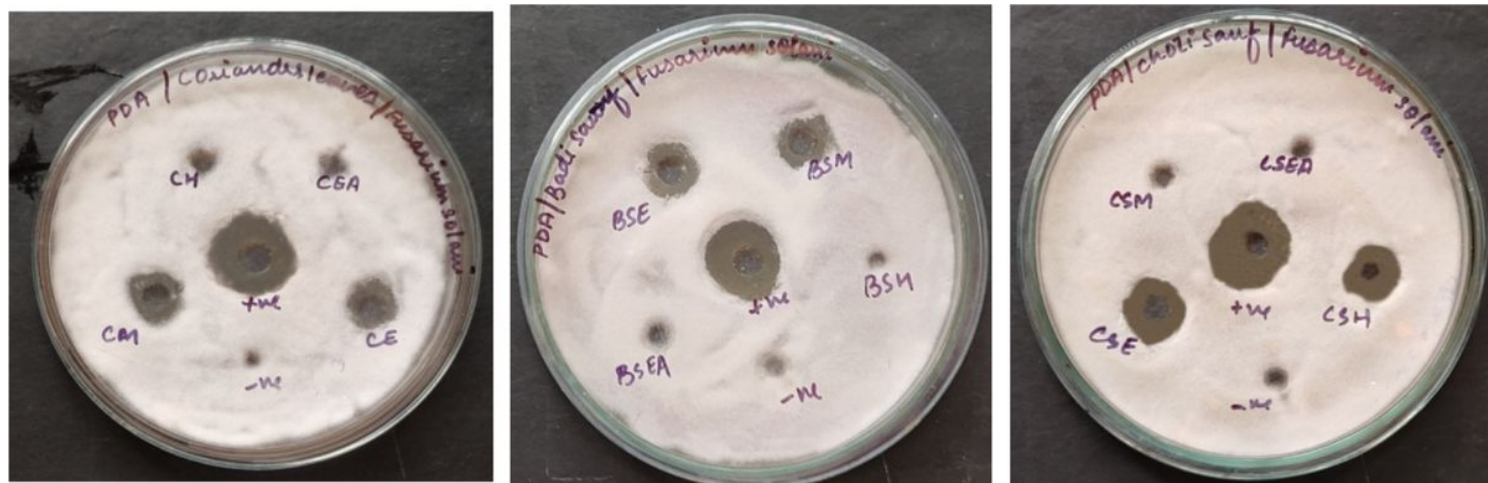


Figure 2

Antifungal activity of plant extracts against fungus *A. fumigatus*



**Figure 3**

Antifungal activity of plant extracts against fungus *F. solani*