

ARTICLE / INVESTIGACIÓN

Evaluation of the fungicidal activity of the aqueous extracts of some medicinal plants against *Fusarium* spp

Hussein Salim^{1*}, Majida Alsaady², Abdulsattar Al-zuhairi³ and Fahmy Kassoub¹

DOI. 10.21931/RB/2023.08.02.84

¹ Directorate of Diyala Agriculture, Ministry of Agriculture, Iraq.² College of Science, University of Baghdad, Iraq.³ College of Agriculture, University of Diyala, Iraq

Corresponding author: h_salim11111@yahoo.com

Abstract: To assess the performance of the aqueous extracts of *Rhus coriaria*, *Boswellia carterii*, *Nigella sativa* and *Aloe vera*. Three concentrations (5%, 10%, and 15%) for each extract were tested in vitro for their activity against three isolates of *Fusarium* spp. All extracts have a high inhibitory capacity against tested isolates. An inhibition percentage for selected isolates was increased with concentrations (5%, 10%, 15%). The concentration of *Rhus coriaria* extract 15 % resulted in a significant increase in inhibition percentage of mycelial growth of *Fusarium* sp.1 (63.17%), *Fusarium* sp2 (61.69%) and *Fusarium* sp3 (59.35%) compared to other concentrations, the concentration of *Boswellia carterii* extract 10% led to a significant increase in inhibition percentage of mycelial growth of *Fusarium* sp2 (82.45 %) compared to concentration 5% (73.67 %), the concentration of *Nigella sativa* extract 15% was recorded high inhibition percentage in *Fusarium* sp2 (66.15 %) compared to concentration 5% (22.21%). In contrast, concentrations 5% and 10% were recorded highest inhibition percentages in *Fusarium* sp3, reaching 31.73 % and 22.02%, respectively, compared to concentration 15% (4.90%).

Key words: *Rhus coriaria*, *Boswellia carterii*, *Nigella sativa*, *Aloe vera* and *Fusarium* spp.

Introduction

Plant diseases cause considerable damage during growth of plants, resulting in a reduction in yield and produce quality¹. *Fusarium* species exist in the soil both in the tropical and temperate regions. They survive in the soil as chlamydozoospores and mycelia; they attack the roots and settle in the xylem, leading to stunting, wilting, and plant death, thus leading to severe damage^{2,3}. The Wilting via *Fusarium* is a significant disease that damages sesame plants worldwide. Excessive use of chemical fertilizers causes environmental pollution besides affecting the quality of fruit³. There is a critical need to reduce the use of chemical pesticides to limit environmental pollution and improve plant growth; it has become indispensable to choose methods that are not harmful to the environment to enhance the health and validity of crops, so botanical extracts and some microorganisms are the best alternatives to these hazardous chemicals. *Rhus coriaria* L., the sumac plant, belongs to the family Anacardiaceae. Aqueous sumac extract includes anthocyanins, hydrolyzable tannins, flavonoids, isoflavonoids, terpenoids, butein, iridoid and derivatives of coumarin⁵. *Boswellia carterii*, commonly known as olibanum tree or frankincense, is a deciduous middle-sized tree belonging to the order Sapindales and the family Burseraceae^{6,7}. Black cumin (*Nigella sativa*) belongs to the family Ranunculaceae and is commonly known as black seed. *N. sativa* contains tannins, phloba tannins, flavonoids, transanethole, terpenoids, apiole and thymoquinone⁸. *Aloe vera* is from the Lilaceae family that contains 200 active compounds, including minerals, enzymes, vitamins, amino acids, salicylic acid, saponin, lignin, sugar and anthraquinones, besides over 75 component nutrients⁹. Bio-control already exists in nature, and it is an

eco-friendly approach and effective against various pathogens and pests. Besides, it can be successfully exploited in integrated disease and pest management². Our aim of the trial was to test the effect of aqueous plant extracts of viz. *Rhus coriaria*, *Boswellia carterii*, *Nigella sativa* and *Aloe vera* against three isolations of *Fusarium* sp.

Materials and methods

Plant collection and fungus isolation

A laboratory experiment was conducted at the plant pathology Lab in the Diyala Agriculture Directorate in 2020; the plant materials such as *R. coriaria*, *B. carterii*, and *N. sativa* were collected from the local market of Baqubah, Diyala, the *A. vera* plant was obtained from a house garden. The pathogenic fungi *Fusarium* sp1, *Fusarium* sp2 and *Fusarium* sp3 were isolated from sesame plant roots from three regions viz Salah Elden, Baghdad and Diyala, respectively.

Preparation of aqueous extracts

Each powder of *R. coriaria*, *B. carterii*, and *N. sativa* at a rate of 50 g was soaked in 200 ml distilled water for 24 hours; each of them and 50 g of *A. vera* gel were blended in the blender for homogeneity and mixing, then filtered through two layers of clothes, then placed in the centrifuge at a speed of 3000 RPM for 3-10 minutes and the supernatants were preserved in the refrigerator until use.

Citation: Salim H, Alsaady M, Al-zuhairi A, Kassoub F. Evaluation of the fungicidal activity of the aqueous extracts of some medicinal plants against *Fusarium* spp. *Revis Bionatura* 2023;8 (2) 84. <http://dx.doi.org/10.21931/RB/2023.08.02.84>

Received: 15 May 2023 / **Accepted:** 10 June 2023 / **Published:** 15 June 2023

Publisher's Note: Bionatura stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2022 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).



Poisoned food test

To assess the performance of extracts against the tested fungi, the technique of poisoned food using three concentrations of each extract 5, 10, and 15 % were prepared with PDA medium (Potato Dextrose Agar), then poured separately into petri plates (9 cm), the control treatment included only PDA medium, after the medium became solid, agar discs (6 mm) of *F. sp1*, *F.sp2* and *F. sp3* from the seven-day-old culture were transferred to a petri plates, then incubated at 25±2 Co for seven days. The tests were performed in three replications for each concentration against all of the fungi, and the diameters mean of fungus growth was measured. The inhibition ratio was calculated according to the following formula.

$$\% \text{ Inhibition} = (1 - \text{control colony} / \text{treatment colony}) \times 100.$$

Statistical analysis

The Statistical Analysis System (SAS (2012) program was used to detect the effect of different factors on study parameters. The least significant difference –LSD test (Analysis of Variation-ANOVA) was used to compare between means in this study¹⁰ significantly.

Results

The recorded results in Table (1) and Fig (1) revealed that *R. coriaria* concentrations led to a significant increase in the inhibition percentage of mycelial growth, where a concentration of 15 % was significantly superior in the inhibition percentage of *F.sp1*, *F.sp2* and *F.sp3*, which reached 63.17%, 61.69% and 59.35%) respectively. In comparison, a concentration of 10 % led to a significant increase in the inhibition percentage of mycelial growth of *F.sp1* (46.41%) compared to a concentration of 5 % (32.45%), whereas no significant differences between concentrations 5 and 10% for both *F. sp2* and *F. sp3*.

Table (2) and Fig (2) shows that a concentration of 10% of *B. carterii* resulted in a significant increase in the inhibition percentage of mycelial growth of *F.sp2* (82.45 %) compared to the concentration of 5% (73.67 %). In contrast, there were no significant differences between all concentrations in inhibition percentage of mycelial growth of *F.sp1* and *F.sp3*.

From Table (3) and Fig (3), *N. sativa* concentrations showed an increment in the inhibition percentage of mycelial growth of all fungi; a concentration 15% was recorded with a high inhibition percentage in *F.sp2* reached 66.15 %) compared to a concentration 5% (22.21%). In comparison, concentrations 5% and 10% were recorded as the highest inhibition percentage in *F.sp3*, reaching 31.73 %

and 22.02%, respectively, compared to concentration 15% (4.90%), whereas no significant differences between all concentrations in *F.sp1*.

A. vera concentrations showed an increment in inhibition percentage of mycelial growth of all fungi, with no significant differences between all concentrations (Table 4 and Fig 4).

Concentrations of <i>R. coriaria</i>	Isolates		
	<i>Fusarium sp1</i>	<i>Fusarium sp2</i>	<i>Fusarium sp3</i>
5%	32.45	32.77	32.90
10%	46.41	38.36	32.31
15%	63.17	61.69	59.35
LSD 0.05	11.53	9.908	13.16

Table 1. Effect of various concentrations of *R. coriaria* *in vitro* on growth inhibition of *Fusarium sp1*, *Fusarium sp2* and *Fusarium sp3*.

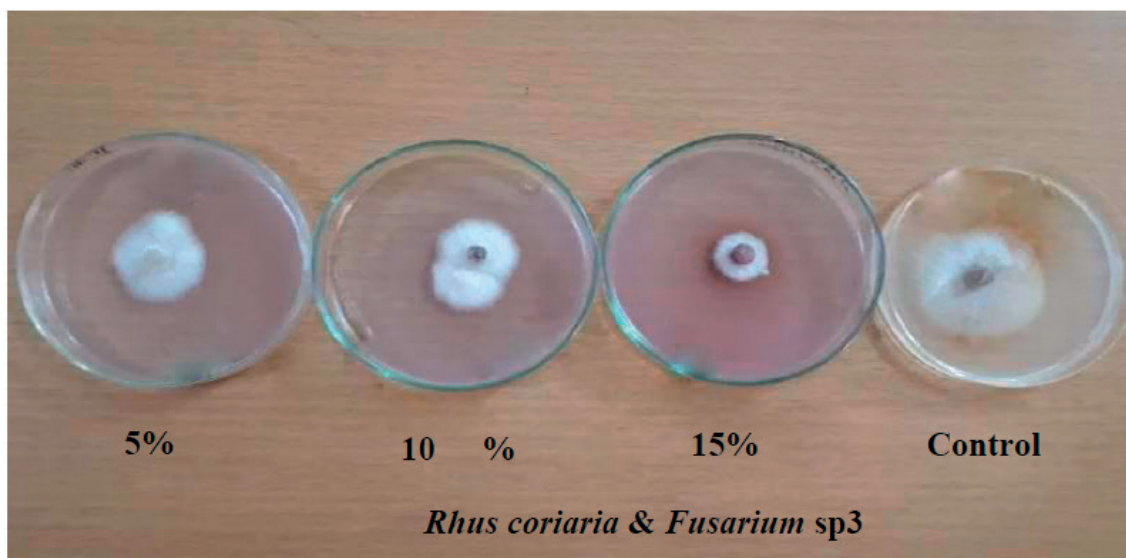
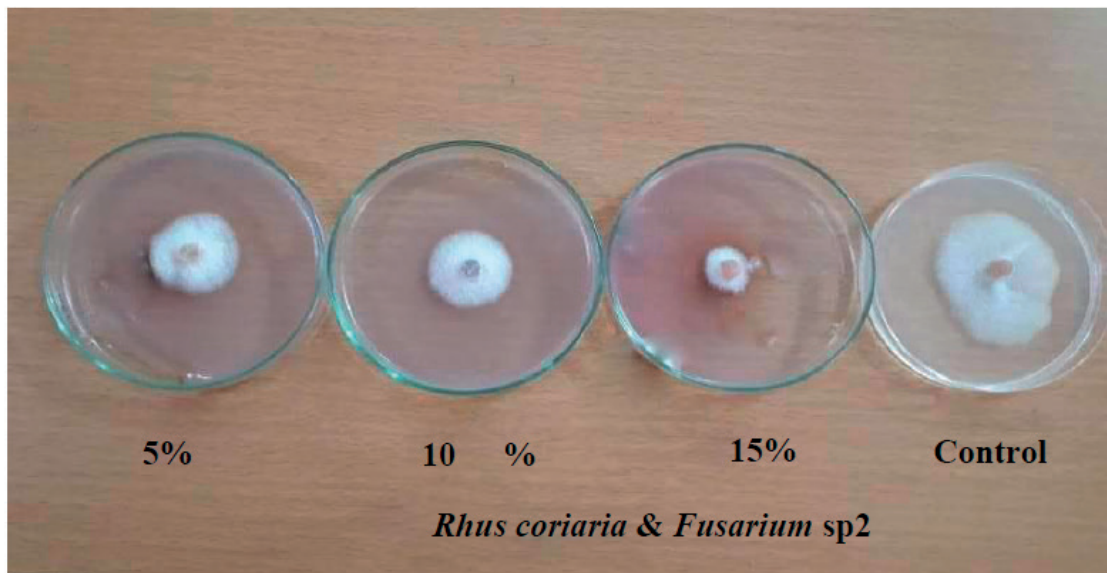
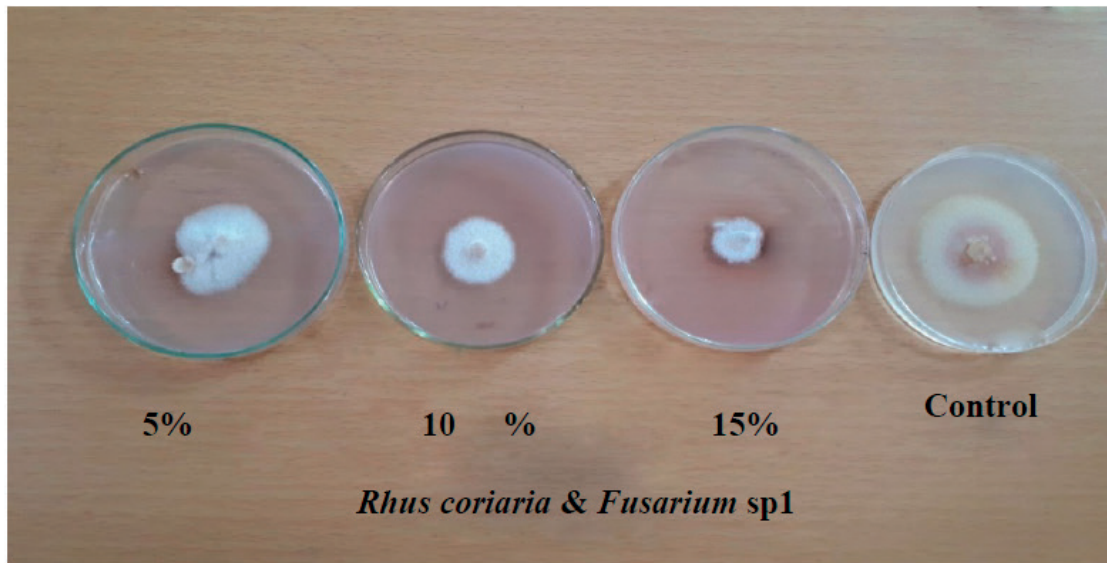


Figure 1. Effect of various concentrations of *R. coriaria* *in vitro* on growth inhibition of *Fusarium* sp1, *Fusarium* sp2 and *Fusarium* sp3

Concentrations of <i>B. carterii</i>	Isolates		
	<i>Fusarium</i> sp1	<i>Fusarium</i> sp2	<i>Fusarium</i> sp3
5%	79.96	73.67	76.54
10%	84.02	82.45	78.39
15%	84.35	80.11	81.96
LSD 0.05	NS	6.585	NS

Table 2. Effect of various concentrations of *B. carterii* *in vitro* on growth inhibition of *Fusarium* sp1, *Fusarium* sp2 and *Fusarium* sp3.

Concentrations of <i>N. sativa</i>	Isolates		
	<i>Fusarium</i> sp1	<i>Fusarium</i> sp2	<i>Fusarium</i> sp3
5%	56.53	22.21	31.73
10%	51.19	35.77	22.02
15%	50.66	66.15	4.90
LSD 0.05	NS	34.14	14.73

Table 3. Effect of various concentrations of *N. sativa* *in vitro* on growth inhibition of *Fusarium* sp1, *Fusarium* sp2 and *Fusarium* sp3.

Concentrations of <i>A. vera</i>	Isolates		
	<i>Fusarium</i> sp1	<i>Fusarium</i> sp2	<i>Fusarium</i> sp3
5%	59.03	55.33	60.41
10%	54.42	58.25	58.26
15%	59.96	55.32	58.95
LSD 0.05	NS	NS	NS

Table 4. Effect of various concentrations of *A. vera* *in vitro* on growth inhibition of *Fusarium* sp1, *Fusarium* sp2 and *Fusarium* sp3.

Discussion

The methanolic extract of *Rhus coriaria* showed the highest inhibition in the fungi *Aspergillus flavus*, *Candida albicans* and *Penicillium citrinum*¹¹. (12) reported that *Rhus coriaria* extract inhibited the growth of *Penicillium citrinum*, *Aspergillus flavus* and *Candida albicans*. (13) stated the superior inhibitory activity of *Rhus Mueller* against *Fusarium oxysporum* f. sp. lycopersici. The antimicrobial activity of *R. coriaria* extract against food pathogens has been proved in numerous of *in vitro* studies¹⁴. *Rhus coriaria* extract has more effective antifungal activity than the standard antifungal Nystatin¹⁵. The presence of phenolic and flavonoid constituents in *R. coriaria* suppresses enzyme actions and cellular membrane functions of pathogenic fungi¹⁶.

The *B. carteri* extract demonstrated effectiveness against *Fusarium solani*, *Helminthosporium rostratum* and *Alternaria alternate* *in vitro*, where the scanning electron microscopy proved the existence of ultra-structural variations in a treated mycelia with extract of *B. carterii* comparison with mycelia which untreated¹⁷. An oil of *Boswellia serrata* led to inhibition of the following fungi such as *Fusarium verticillioides*, *Fusarium equiseti*, *F. oxysporum*, *Fusarium udum*, *Fusarium lateritium*, *Penicillium citrinum*, *Aspergillus ochraceous*, *Aspergillus geophila*, *Aspergillus brassicola*, *Aspergillus fumigatus*, *Aspergillus terreus*, *Curvularia tetramera*, *Penicillium expansum* and *Penicillium citrinum*¹⁸. The antifungal activity of the essential oil of *B. carter* against *Candida albicans*, *Aspergillus niger* and *Cryptococcus neoformansi* was the result of the presence of α -copaene, p-cymene, d-cadinene, b-caryophyllene and limonene with at various ratios¹⁹.

It can use *N. sativa* as an eco-friendly fungi-toxicant against *Macrophomina phaseolina* and *Fusarium oxysporum* because it has considerable potential as fungicidal²⁰. Antifungal activity of *N. sativa* oil was determined against eight fungi viz., *Fusarium oxysporum*, *Fusarium moniliforme*, *Fusarium semitectum*, *Fusarium nivale*, *Alternaria alternata*, *Aspergillus niger*, *Aspergillus flavus*, *Drechslera hawiensis*²¹. Proteins of *N. sativa* have a significant effect

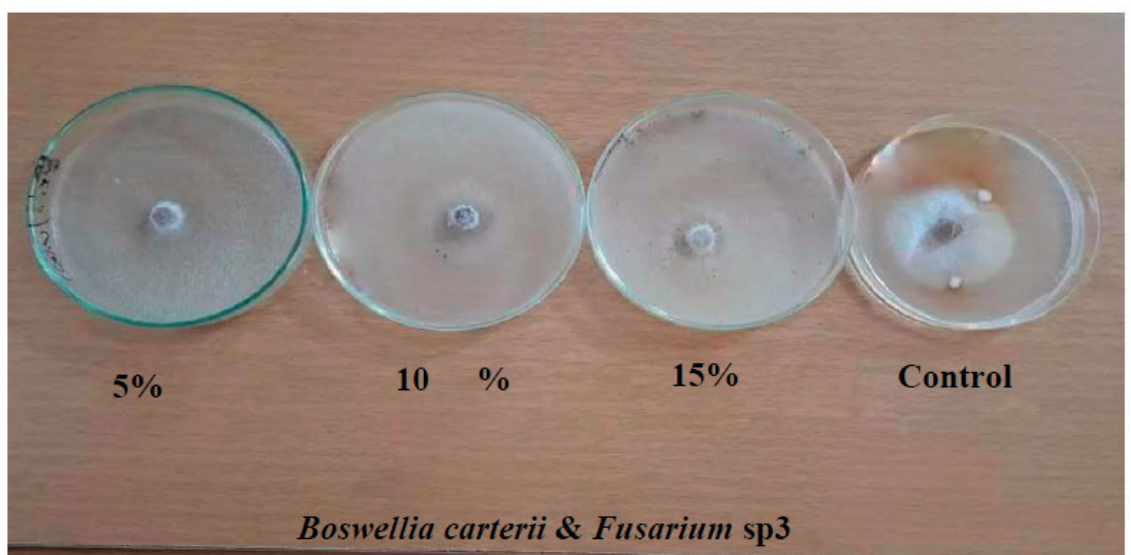
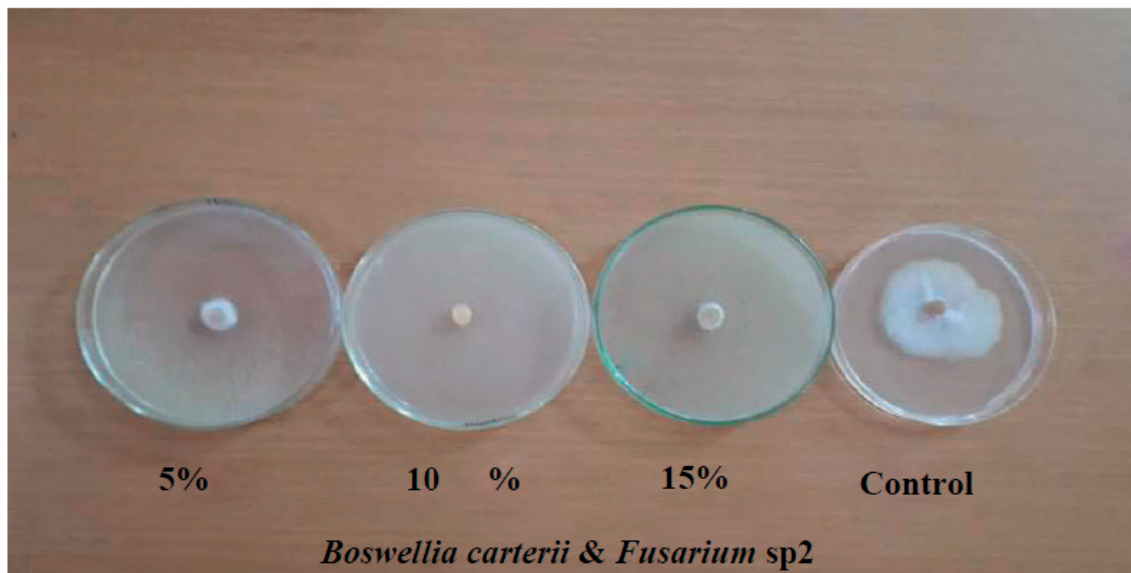
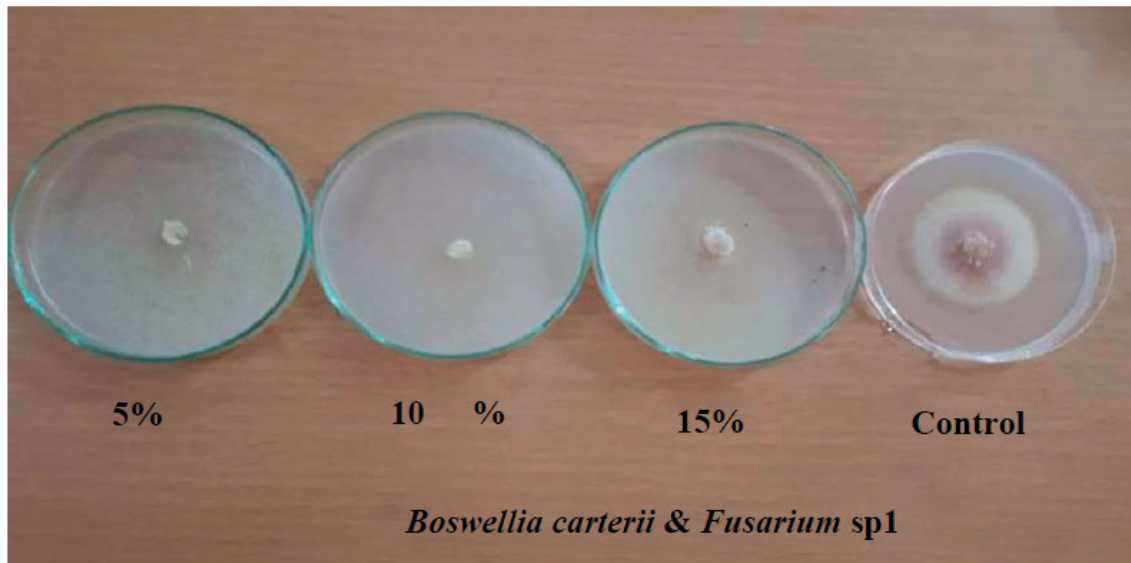


Figure 2. Effect of various concentrations of *B. carterii* *in vitro* on growth inhibition of *Fusarium* sp1, *Fusarium* sp2 and *Fusarium* sp3.

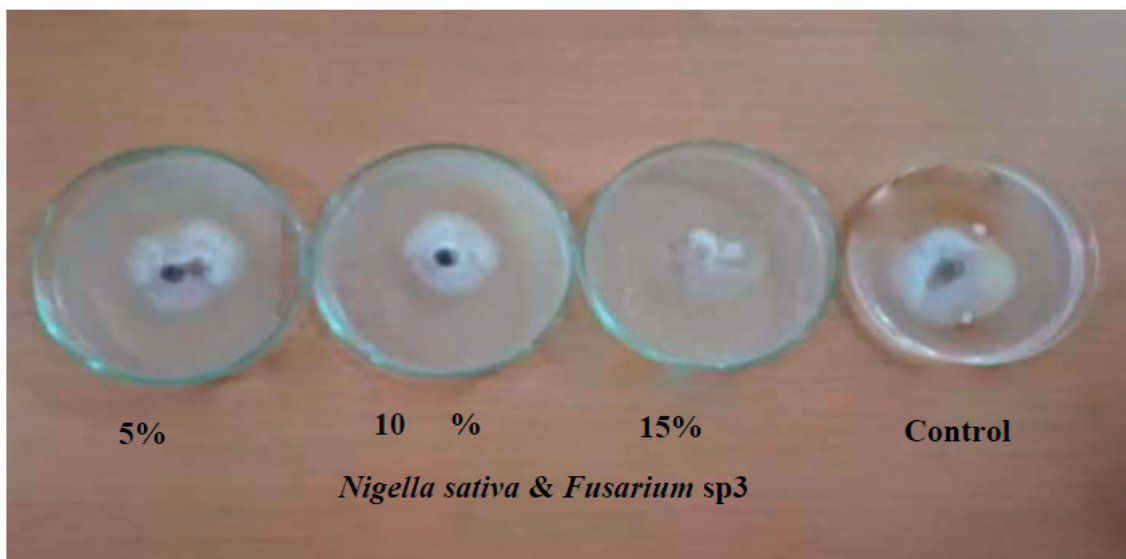
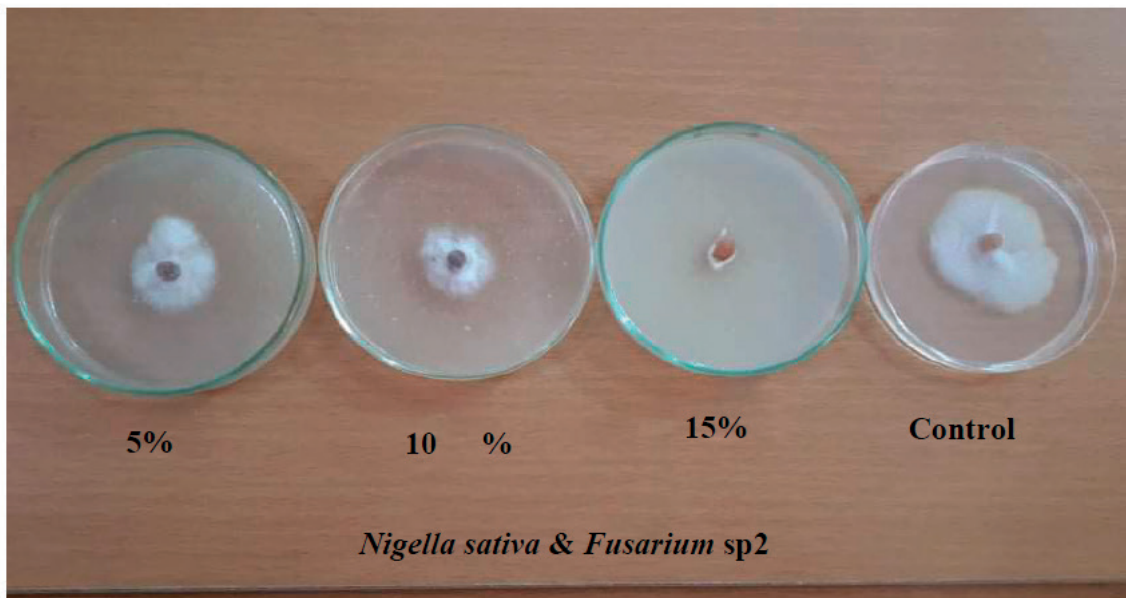
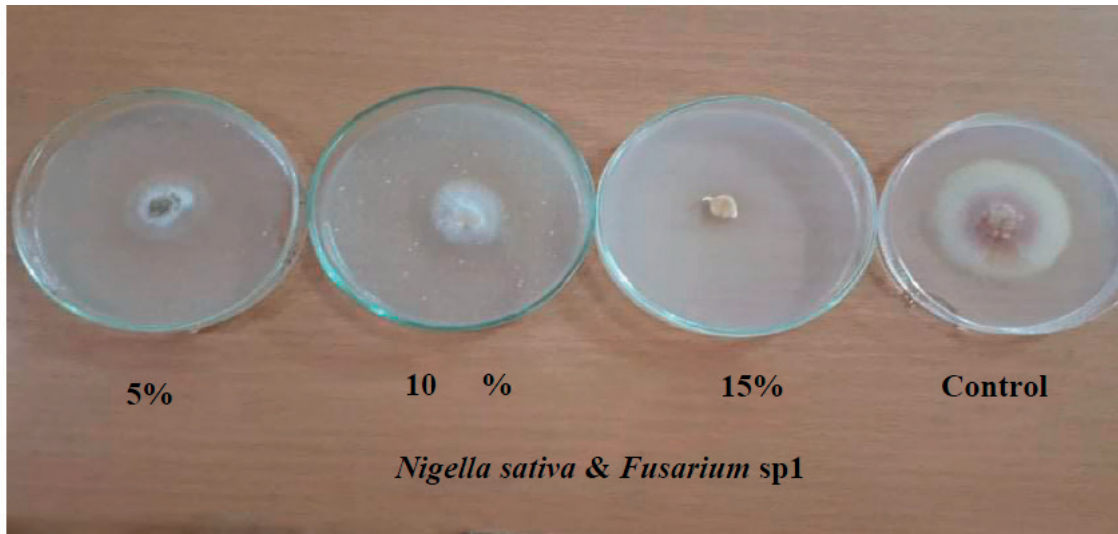


Figure 3. Effect of various concentrations of *N. sativa* *in vitro* on growth inhibition of *Fusarium sp1*, *Fusarium sp2* and *Fusarium sp3*.

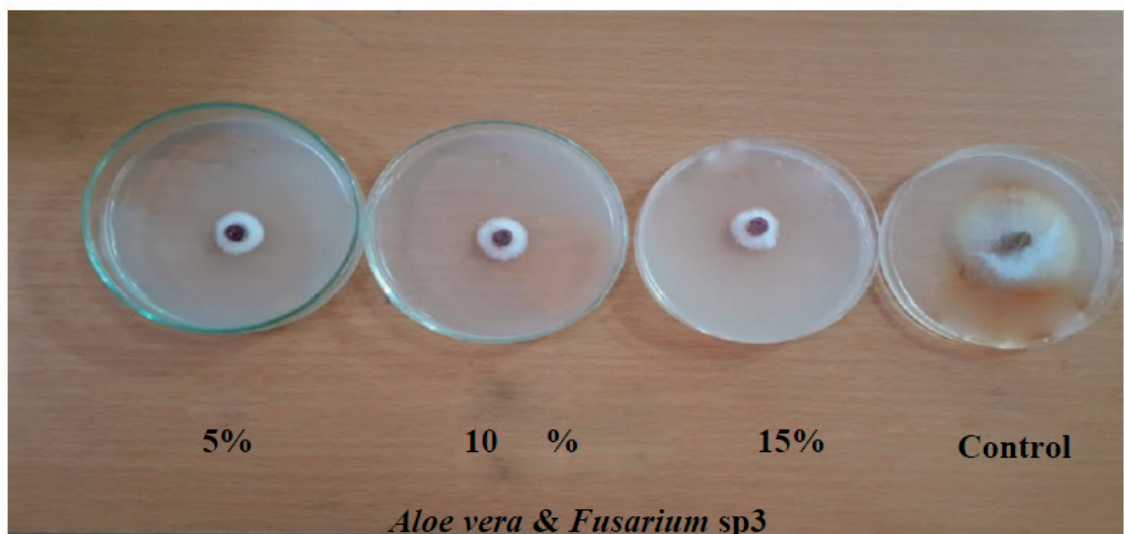
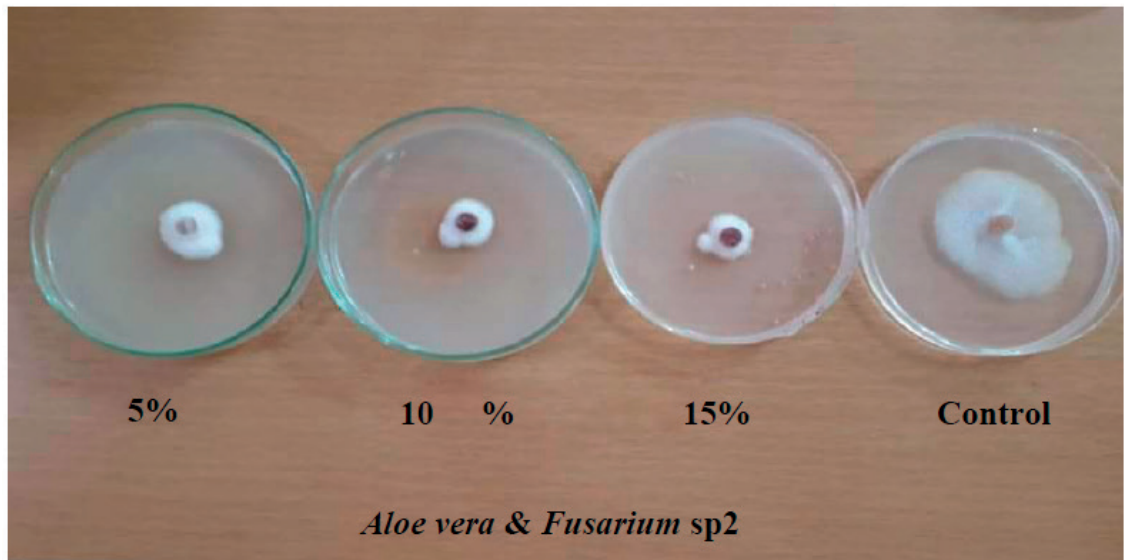
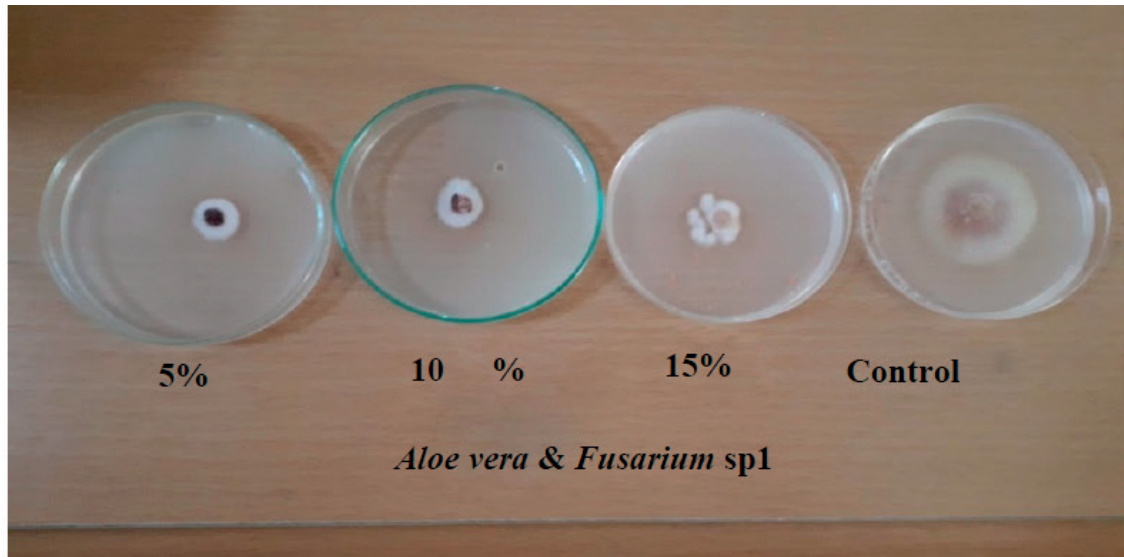


Figure 4. Effect of various concentrations of *A. vera* *in vitro* on growth inhibition of *Fusarium sp1*, *Fusarium sp2* and *Fusarium sp3*.

on the fungal cell permeability²². *N. sativa* oil showed more efficacies in sporulating and reducing mycelial growth of *Aspergillus flavus*²³.

Aloe vera extract significantly affected the inhibition of mycelial growth of *Fusarium udum*, reaching 55.9%²⁴. Aloe vera extract has antifungal activity against *Fusarium oxysporum*, *Penicillium gladioli*, *Botrytis gladiolus* and *Heterosporium prunae*²⁵. (26) found that the Aloe vera is effective against *Fusarium oxysporum*, *Collectotrichum coccodes* and *Rhizoctonia solani*. Aloe vera extract can inhibit the growth of fungi such as *Alternaria alternata*, *Alternaria citri* and *Alternaria tenuissima*²⁷. Aloe vera extract had an antifungal effect on *Aspergillus glaucus*, *Aspergillus flavus*, *Candida albicans*, *Candida tropicalis*, *Trichophyton rubrum* and *Trichophyton mentagrophytes*²⁸. Aloe vera gel caused a significant reduction in the growth of pathogenic fungi viz., *Penicillium digitatum*, *Alternaria alternata*, *Aspergillus flavus*, *Aspergillus niger* and *Drechslera hawaiiensis* (Sitara et al. 2011).

Conclusions

The present investigation suggests that aqueous extracts such as *R. coriaria*, *B. carterii*, *N. sativa* and *A. vera* have great potential as a natural fungicide, but further studies are required.

Bibliographic references

1. Salim H.A., Simon S. and Lal A.A. Integrated diseases management (IDM) against tomato (*Lycopersicon esculentum* L.) Fusarium wilt. *J Environ Agric Sci*, 2017, 11: 29-34
2. Salim H.A. and Simon S. Effect of carbendazim and solarized soil with *Pseudomonas fluorescens* spent mushroom compost against *Fusarium oxysporum* f.sp. *lycopersici* in Tomato, European academic research, 2015, vol. II, Issue 12, p15997-16010
3. Salim H.A., Salman I.S., Jasim B.N. IPM Approach for the management of wilt disease caused by *Fusarium oxysporum* f. sp. *lycopersici* on tomato (*Lycopersicon esculentum*). *Journal of Experimental Biology and Agricultural Sciences*, 2016, 4: 742-747.
4. Wasniker A.R., Deshmukh M.R. and Sharma S.M. Toxicity of fungal metabolites on germination and growth of sesame. *Current Res-UAS Bangalore*, 1991, 23:185-186 .
5. Abu-Reidah I.M., Ali-Shtayeh M.S., Jamous R.M., Arráez-Román D., Segura-Carretero A.. HPLC-DAD-ESI-MS/MS screening of bioactive components from *Rhus coriaria* L. (Sumac) fruits. *Food Chem*, 2015, 166, 179-191.
6. Thulin M.. "Boswellia sacra in IUCN 2012". IUCN Red List of Threatened Species. Version 2012.2. International Union for Conservation of Nature and Natural Resources 1998.
7. Niebler J. and Buettner A. Identification of odorants in frankincense (*Boswellia sacra* Flueck.) by aroma extract dilution analysis and two-dimensional gas chromatography-mass spectrometry/olfactometry. *Phytochemistry* 109: 66-75 (2015).
8. Aftab A, Yousaf Z, Javaid A, Rabbani A, Ahmed S, and Khan F. *Nigella sativa* from traditional to contemporary medicine- a review. *Intl. J. Biol. Biotechnol*, 2018, 15: 237-254.
9. Park YI and Jo TH. The perspective of industrial application of Aloe vera. In: *New Perspective on Aloe*. (Eds.): Y.I. Park and S.K. Lee. Springer Verlag, New York, USA, 2006, pp: 191-200. ISBN: 0387317996.
10. SAS. Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA ,2012.
11. Singh S. Genesis and development of DPPH method of antioxidant assay. *J. Food Sci. Technol.* 2011, 48, 412-422 .
12. Onkar S, Mohammed A, Nida A. New antifungal aromatic compounds from the seeds of *Rhus coriaria* L. *Int. Res. J. Pharm*, 2011, 2, 188-194 .
13. de Rodríguez D.J., Trejo-González F.A., Rodríguez-García R., Díaz-Jimenez M.LV., Sáenz-Galindo A., Hernández-Castillo F.D., Peña-Ramos F.M. et al. Antifungal activity in vitro of *Rhus muelleri* against *Fusarium oxysporum* f. sp. *Lycopersici*. *Ind. Crops Prod*, 2015, 75, 150-158 .
14. Nasar-Abbas S.M and Halkman A.K. Antimicrobial effect of water extract of sumac (*Rhus coriaria* L.) on the growth of some food borne bacteria including pathogens. *Int. J. Food Microbiol*; 2004, 97: 63-69 .
15. Ertürk O. Antibacterial and antifungal effects of alcoholic extracts of 41 medicinal plants growing in Turkey. *Czech J. Food Sci* , 2010, 28, 53-60.
16. Gabr S. A. and Alghadir A. H. Phytochemical Analysis and In vitro Antifungal Activities of Bioactive Fractions from Leaves of *Rhus coriaria* (SUMAC), *Journal of Pure and Applied Microbiology*, 2015, Vol. 9(Spl. Edn. 1), p. 559-565.
17. Al-Otibi F., Alharbi R. I, Albasher G., Almeer R. and Alsaggabi N. S. Antifungal Potential of Aqueous Extract of *Boswellia carteri*, Fatimah et al. *J Pure Appl Microbiol* , 2019, 13(4), 2375-2381 .
18. Venkatesh HN, Sudharshana T.N, Abhishek R.U, et al. Antifungal and antimycotoxigenic properties of chemically characterized essential oil of *Boswellia serrata* Roxb. ex Colebr. *Int. J. Food Prop* 20(sup2);, 2017, 1856-68.
19. Powers C.N, Osier J.L, McFeeters R.L. et al. Antifungal and cytotoxic activities of sixty commercially-available essential oils. *Molecules* , 2018, 23(7). <https://doi.org/10.3390/molecules23071549> .
20. Aftab A., Yousaf Z., Javaid A., Riaz N., Younas A., Rashid M., Shamsheer H.B. and Chahel A.A. Antifungal activity of methanolic extracts of *Nigella sativa* against *Fusarium oxysporum* and *Macrophomina phaseolina* and its phytochemical profiling by GCMS analysis. *Intl. J. Agric. Biol*, 2019, 21: 569-576 .
21. Sitara U, Niaz I, Naseem J and Sultana N. Antifungal effect of essential oils on in vitro growth of pathogenic fungi, *Pak. J. Bot.*, 2008, 40(1): 409-414.
22. Shokri H.. A review on the inhibitory potential of *Nigella sativa* against pathogenic and toxigenic fungi. *Avicena J. Phytomed* 6: 2016, 21-33 .
23. Amrouche A, Benmehdi H, Moussaoui A, Mebarki K, Chaoufi A, Saneba A, Lazouni A, Chabane H. and Sari D.. Evaluation of the antifungal activity of some oils from Algerian medicinal plants against *Aspergillus flavus* strain produced aflatoxins, *Journal of Applied Pharmaceutical Science*, 2011, 01 (08): 48-53.
24. Devi T. R. and Chhetry G.K.N. Evaluation of antifungal activities of certain plant against *Fusarium udum* Butler causing wilt in pigeonpea (*Cajanus cajan* (L.) Millsp.), *International Journal of Scientific and Research Publications*, 2012, Volume 2, Issue 6 :1-4 .
25. Cassian O.R, Parvu M, Vlase L. and Tamas M. Antifungal activity of Aloe vera leaves. *Fitoterapia* , 2007,78(3): 219-222 .
26. Jasso de Rodriguez D, Hernandez-Castillo D, Rodriguez-Garcia R and Angulo-Sanchez JL. Antifungal activity In vitro of Aloe vera pulp and liquid fraction against plant pathogenic fungi. *Industrial Crops and Products*, 2005, 21(1): 81-87 .
27. Bajwa R and Shafique S. Appraisal of antifungal activity of Aloe vera. *Mycopath*, 2007 , 5(1): 5-9 .
28. Cooposamy R.M. and Magwa M. L. Traditional use, antibacterial activity and antifungal activity of crude extract of Aloe excelsa. *African Journal of Biotechnology*, 2007, 6(20): 2406-2410.
29. Sitara U, Hassan N. and Naseem J. Antifungal activity of Aloe vera gel against plant pathogenic fungi, *Pak. J. Bot.*, 2011, 43(4): 2231-2233 .