Knowledgeable Research *ISSN 2583-6633* Vol.02, No.05, December, 2023
An International Peer-Reviewed Multidisciplinary Journal

Knowledgeable Research
ISSN 2583-6633
Vol.02, No.05, December,2023
http://knowledgeableresearch.com/

Antifungal Efficacy of Neem and Garlic Extracts Against *Fusarium oxysporum*

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DOI: https://doi.org/10.57067/kr.vol.2.i05/904

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Abstract: *Fusarium oxysporum is a soil fungus that causes serious wilt disease in crops like tomato, chickpea, watermelon, and banana. Because chemical fungicides raise concerns about residues, resistance, and environmental harm, researchers have explored plant-based alternatives. This paper reviews published lab studies testing Neem (Azadirachta indica) and Garlic (Allium sativum) extracts against F. oxysporum, mainly using the poisoned food technique, diffusion assays, and MIC tests, and outlines the standard testing protocol used.*

Across studies, both extracts inhibit fungal growth in a dose-dependent way: neem can reach 100% inhibition at 50–75% concentration, while garlic reaches similar or better results at much lower concentrations, thanks to its compound allicin. The paper discusses why results vary between studies and what this means for eco-friendly disease management.

Keywords: *Fusarium oxysporum; Azadirachta indica; Allium sativum; antifungal activity; botanical fungicide; mycelial growth inhibition*

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[*]Corresponding Author: Sunil Kumar Singh
Received Date: 15.12.2023
Publication Date: 31.12.2023

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1. Introduction

Fusarium oxysporum is a common soil fungus. Most strains are harmless, but several host-specific strains attack crops aggressively, including tomato wilt (*Fusarium lycopersici*) and chickpea wilt (*Fusarium ciceri*). The fungus blocks water flow inside roots and stems, causing wilting, internal browning, and death, with yield losses of 30–80% or more in bad outbreaks [1]. Because it survives in soil for years as resting spores, it is hard to remove through crop rotation or field cleanup alone.

Wilt is usually managed with crop rotation, resistant varieties, soil solarization, biological agents like *Trichoderma*, and chemical fungicides (carbendazim, benomyl, mancozeb, copper compounds). But heavy reliance on chemicals is increasingly questioned due to resistant fungal strains, chemical residues, harm to non-target organisms, and stricter regulations.

Neem is a tropical tree long used in traditional medicine and pest control. Beyond repelling insects, it has direct antifungal effects, likely by damaging fungal cell membranes and interfering with cell-wall formation [2].

Garlic's main active compound, allicin, forms only when its tissue is damaged. Allicin and related sulfur compounds attack a wide range of microbes by reacting with proteins, disrupting fungal membranes and walls, blocking sugar metabolism, and causing oxidative stress inside fungal cells [3, 4].

2. Materials and Methods

Fresh Neem (*Azadirachta indica*) leaves or seeds and Garlic (*Allium sativum*) bulbs were collected, cleaned, dried, and ground into fine powder. Aqueous extracts were prepared by soaking the powder in distilled water (1:10 w/v) for 24–48 h, followed by filtration. Garlic extracts were prepared fresh prior to use to preserve allicin activity. Stock extracts were stored under refrigerated conditions and diluted to the desired concentrations.

A pure culture of *Fusarium oxysporum* was maintained on Potato Dextrose Agar (PDA) medium and periodically sub-cultured. Phytochemical screening of the extracts was conducted to identify major bioactive constituents, including alkaloids, flavonoids, tannins, saponins, terpenoids, glycosides, and sulfur-containing compounds. Antifungal assays were performed using a Completely Randomized

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Design (CRD) with a minimum of three replicates per treatment. The experimental data were analysed using Analysis of Variance (ANOVA) to determine the significance of treatment effects.

3. Results and Discussion

Neem extracts (leaf, seed, twig) consistently contain terpenoids, phenols, flavonoids, glycosides, alkaloids, tannins, and saponins [2], with limonoids such as azadirachtin and nimbin considered its key active ingredients. Garlic extracts mainly contain sulphur compounds (allicin and related thiosulfates), along with flavonoids, saponins, and alkaloids [3, 4].

Table 1. Phytochemicals reported in neem and garlic extracts.

Phytochemical Class	Neem Extracts	Garlic Extracts
Alkaloids	Present	Present
Flavonoids	Present	Present
Tannins	Present	Variable / Low
Saponins	Present	Present
Terpenoids / limonoids	Present — characteristic	Absent
Glycosides	Present	Present
Phenolic compounds	Present	Present

Both extracts inhibit Fusarium growth more strongly as concentration rises a clear dose-response pattern seen consistently across chickpea, tomato, watermelon, onion, and potato studies, supporting that both plants contain genuinely fungus-killing, not just growth slowing, compounds.

Neem leaf extract raised inhibition of chickpea wilt fungus from 45.09% at 10% concentration to 84.59% at 40% [5]. Against tomato wilt fungus, it reached complete (100%) inhibition at 50–75% concentration by day 7, beating guava and eucalyptus extracts tested alongside it [6], another study

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found 75% inhibition, ranking neem among the best of fifteen extracts tested [7]. This fits its likely mode of action: azadirachtin and related compounds gradually damage fungal membranes and block cell-wall formation, an effect expected to strengthen with higher doses [8].

Garlic bulb extract inhibited a potato-wilt strain by 90% at just 25% concentration the strongest result among four botanicals tested in that study [4] reflecting how reactive allicin is even in small amounts. Allicin attacks fungal proteins and enzymes directly, damaging membranes and walls, blocking sugar metabolism, and triggering oxidative stress [3, 4]. However, allicin is unstable and breaks down with heat and time, which likely explains why studies using essential oils or aged extracts found weaker garlic activity [4] than studies using fresh extract [6].

Table 2. Comparative inhibition of F. oxysporum by neem and garlic extracts.

Extract	Pathogen (host)	Concentration	Activity	Method
Neem leaf	*Fusarium ciceri* (chickpea)	10%	45.09% inhibition	Poisoned food
Neem leaf	*Fusarium ciceri* (chickpea)	20%	53.41% inhibition	Poisoned food
Neem leaf	*Fusarium lycopersici* (tomato)	50% v/v	100% (day 7)	Poisoned food
Neem leaf	*Fusarium lycopersici* (tomato)	75% v/v	100% (day 7)	Poisoned food
Garlic bulb	*Fusarium oxysporum* (potato)	25%	90.0% inhibition	Poisoned food

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Neem oil	*Fusarium oxysporum* (onion)	200 µl/mL	6.30 mm zone	Well diffusion

Results vary across studies due to differences in extraction method (water vs. alcohol vs. essential oil), plant part used, fungal strain, test method, and how concentration is measured (% v/v, mg/ml., or µg/ml.). This makes direct comparison difficult neem out performed garlic in chickpea and tomato studies while garlic was more potent than neem in a watermelon study. Using consistent units and reporting both percentage inhibition and actual growth measurements would help future comparisons.

In several studies, the strongest extract concentrations matched the performance of registered chemical fungicides like captan or mancozeb suggesting real potential as fungicide alternatives. However, lab results on agar do not guarantee the same performance in the field, where extract stability, soil interactions, application method, crop safety, and cost all matter. Combining neem and garlic pairing neem's membrane/wall disruption with allicin's enzyme-blocking action has barely been studied and is a promising direction for future work, along with developing stable garlic formulations that protect allicin from breaking down too soon.

References

1. Sustainable Management of Chickpea Wilt Incited by *Fusarium oxysporum*, *F. ciceri* Using Plant Extracts. Journal of Plant Pathology (2021). https://doi.org/10.1007/s42161-021-00776-7
2. Yang, X., Bai, S., Wu, J., Fan, Y., Zou, Y., Xia, Z., Ao, J., Chen, T., & Zhang, M. Antifungal Activity and Potential Action Mechanism of Allicin Against *Trichosporon asahii*. Microbiology Spectrum (2023). https://doi.org/10.1128/spectrum.00907-23
3. Efficacy of Allicin Against Plant Pathogenic Fungi and Unveiling the Underlying Mode of Action Employing Yeast-Based Chemogenetic Profiling. Applied Sciences (2020). https://doi.org/10.3390/app10072563
4. Effectiveness of Some Antagonistic Fungi and Botanicals Against *Fusarium solani* and *F. oxysporum*, *F. lycopersici* Infecting Brinjal and Tomato Plants. Asian Journal of Plant Pathology (2014). https://doi.org/10.3923/ajppaj.2014.18.25

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5. In vitro Screening of Plant Extracts and *Trichoderma harzianum* Against *Fusarium oxysporum* f. *lycopersici*. DOI:10.20546/ijcmas.2017.608.378
6. Evaluation of Possible Biological Control of *Fusarium concentricum* sp. Using Plant Extracts and Antagonistic Microbes In Vitro. (2022). https://pmc.ncbi.nlm.nih.gov/articles/PMC9106991
7. Tomato Plant Extract (*Lycopersicon esculentum*) Obtained from Agroindustrial Byproducts and Its Antifungal Activity Against *Fusarium spp* Frontiers in Sustainable Food Systems (2023). https://doi.org/10.3389/fsufs.2023.1323489
8. Aryal, B. Plant Extracts and Their Antifungal Activity Against *Fusarium oxysporum*. LAP LAMBERT Academic Publishing

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