International Journal of Sustainable Biome and Life Care
Volume No. 3; Issue No.1, October 2026, Pages 37-42
https://doi.org/10.31632/ijsblc.2026.v03i01.005

International Journal of Sustainable Biome and Life Care
Online ISSN: 2581-4877
Journal homepage https://ijsblc.org



Original Article

Antifungal Effects of *Azadirachta indica* Leaf and Seed Extracts Against Pathogenic Moulds

Abbatar Yawudima[1], Maimuna Abdullahi Bula[1] Maryam Muhammad Buba[1], Debajyoti Bose[2]

[1]Department of Biological Sciences, Yobe State University, 1144 Damaturu, Nigeria
[2]Department of Microbiology, Yobe State University, 1144 Damaturu, Nigeria

**Corresponding Author's Email: debajyotibose@gmail.com*

Abstract

Pathogenic moulds pose significant threats to human health, agricultural crops, and stored food and animal feed, while certain toxigenic fungal species can also produce harmful mycotoxins. These concerns have increased interest in exploring plant-based antifungal agents. Neem (*Azadirachta indica A. Juss*.) is a medicinal plant rich in various bioactive compounds and has attracted considerable attention for its antimicrobial and antifungal properties. This review highlights published findings on the antifungal activity of neem leaf and seed extracts against various pathogenic and plant-associated fungi, including *Aspergillus spp., Fusarium, Alternaria, Rhizoctonia, Sclerotinia, Penicillium spp*., and *dermatophytes*. The findings suggest that antifungal effectiveness depends on several factors, including the plant part used, extraction solvent, extract concentration, and fungal species tested. Overall, neem leaf and seed extracts demonstrate considerable potential as natural antifungal agents. However, further research involving standardized extraction procedures, toxicity assessments, and well-controlled experimental studies is necessary to establish their safety and effectiveness for therapeutic and agricultural applications.

Keywords: *Antifungal Activity; Aspergillus Species; Azadirachta Indica; Leaf Extract; Pathogenic Moulds; Penecillium Species; Plant Extracts; Seed Extract*

Introduction

Fungi are important biological organisms, but some species cause disease in humans and plants and may contaminate food and agricultural products. Neem researchers reported antifungal activity as well as broader antimicrobial effects, including activity against *Candida* and effects on fungal biofilms (Biswas *et al*., 2002; Polaquini *et al*., 2006; Wylie & Merrell, 2022). Neem has also been investigated against plant-associated fungi and oomycete pathogens, though these findings should not be assumed to apply equally to all moulds (Ramos *et al*., 2007). The broader reviews by Saleem *et al*. (2018), Subapriya and Nagini (2005), Kharwar *et al*. (2020); Wylie and Merrell (2022) provide background on neem phytochemistry and antimicrobial evidence. Related work includes reports on neem and Candida (Okemo *et al*., 2001; Polaquini *et al*., 2006), seed-borne fungi (Nwachukwu & Umechuruba, 2001), and fungal endophytes (Verma & Kharwar, 2006).

Azadirachta indica A. Juss., a member of the *Meliaceae*, is a medicinal and multipurpose tree. Its leaves, seeds and seed oil contain secondary metabolites investigated for antimicrobial activity. Extracts may be aqueous or organic, and results depend on extraction conditions and the test organism

Received on :29th July 2026; Revised version received on :26th September 2026; Accepted: 28th September 2026

(Mahmoud *et al*., 2011; Moslem & El-Kholie, 2009). Reviews of neem phytochemistry emphasize the diversity of constituents and the need for standardized studies (Biswas *et al*., 2002; Saleem *et al*., 2018; Kharwar *et al*., 2020; Wylie & Merrell, 2022).

Phytochemical Basis of Neem's Antifungal Activity

Neem's antifungal activity has been reported in relation to several chemical classes, including limonoids and other triterpenoid constituents. Seed-oil fractions containing compounds such as 6-deacetylnimbin, azadiradione, nimbin, salannin and epoxyazadiradione showed activity as mixtures, whereas isolated compounds did not all show appreciable activity on their own (Govindachari *et al*., 1998). Neem leaf hexane extracts and selected fractions have also shown activity against plant-pathogenic fungi (Govindachari *et al*., 1999*)*. These findings highlight the importance of not attributing the effects of a crude extract to a single compound and demonstrate how solvent selection and fractionation can influence its biological activity (Govindachari *et al*., 1996, 2000; Álvarez-Caballero & Coy-Barrera, 2019). Earlier chemical work also investigated azadirachtin isolation (Govindachari *et al*., 1996), while antifungal studies tested seed-coat extract (Verma *et al*., 1998) and neem leaf extract against dermatophytes (Venugopal & Venugopal, 1994; Dube & Tripathi, 1987).

For example, Mahmoud *et al*. (2011) investigated aqueous, ethanolic and ethyl acetate neem leaf extracts against *Aspergillus flavus, A. fumigatus, A. niger, A. terreus*, *Candida albicans* and *Microsporum gypseum*. The researchers reported that the extracts inhibited the growth of the test organisms and that activity generally increased with concentration. Their findings also demonstrated that the solvent used for extraction can influence antifungal performance.

Antifungal Effects of Neem Leaf Extract

Neem leaves have demonstrated antifungal activity against a range of fungi. Mahmoud *et al*. (2011) tested aqueous, ethanolic and *ethyl acetate* leaf extracts at concentrations of 5%, 10%, 15% and 20% against several human-associated fungal pathogens. Growth inhibition generally increased with concentration, and the 20% *ethyl acetate* extract showed particularly strong activity under the study conditions. Other reports have examined neem leaf extracts against dermatophytes and dandruff-associated fungi (Dube & Tripathi, 1987; Niharika *et al*., 2010; Venugopal & Venugopal,1994). Because assay formats and extract preparations differ, comparisons should be made cautiously (Klančnik *et al*., 2010).

Earlier research examined neem extracts against dermatophytes, yeasts and moulds (Khan *et al*., 1988). Natarajan *et al*. (2003) tested leaf and seed extracts against *Trichophyton rubrum*, *T. mentagrophytes* and *Microsporum nanum* and reported a minimum inhibitory concentration of 31 µg/mL for neem seed extract against the dermatophytes tested. Such results support further investigation but do not establish that crude neem preparations are interchangeable with standardized antifungal products.

Antifungal Effects of Neem Seed Extract

Neem seeds are also a source of biologically active compounds. Moslem and El-Kholie (2009) evaluated ethanolic, hexane and methanolic extracts of neem seeds and leaves against *Fusarium oxysporum*, *Rhizoctonia solani*, *Alternaria solani* and *Sclerotinia sclerotiorum*. They reported inhibition of fungal growth, with the degree of inhibition varying according to extract type and concentration; *F. oxysporum* and *R. solani* were among the most sensitive organisms. Seed-oil and seed-coat preparations have also been investigated against phytopathogenic fungi (Govindachari *et al*., 1998; Verma *et al*., 1998). A more recent study evaluated a neem seed-extract formulation against strawberry anthracnose and gray mold pathogens (Motallebi & Negahban, 2024).

Research on dermatophytes has also suggested strong activity from neem seed extracts. Natarajan *et al*. (2003) reported a minimum inhibitory concentration of 31 micrograms/mL for the neem seed extract against the tested dermatophytes. A related study found that neem seed extract had a lower minimum

inhibitory concentration than neem leaf extract against several dermatophytes, suggesting that seeds may sometimes provide greater antifungal potency, depending on the organism and extraction method.

Research on toxigenic *Aspergillus* has investigated both fungal growth and aflatoxin production. Razzaghi-Abyaneh *et al*. (2005) reported concentration-dependent suppression of aflatoxin production by aqueous neem leaf and seed extracts, and Ghorbanian *et al*. (2008) examined neem leaf extract at different incubation times. A 2026 study reported that neem leaf extracts prepared with different solvents inhibited *A. flavus* and *A. parasiticus* and reduced aflatoxin biosynthesis under the experimental conditions tested (Ali *et al*., 2026). These findings support further investigation, but do not establish that neem extracts are a validated substitute for established controls.

Neem Extracts Against Pathogenic Moulds

Pathogenic moulds respond differently to neem extracts. Studies report activity against *Aspergillus*, *Fusarium*, *Alternaria*, *Rhizoctonia*, *Sclerotinia* and *Penicillium* species, but these organisms and endpoints are not interchangeable. Mossini *et al*. (2009) found that neem oil reduced growth and sporulation of *Penicillium verrucosum* and *P. brevicompactum in vitro*; it did not inhibit ochratoxin A production under the tested conditions. Mossini *et al*. (2004) separately reported inhibition of patulin production by *P. expansum* at higher concentrations of aqueous neem leaf extract. Neem oil has also been studied against *Aspergillus flavus* (da Costa *et al*., 2010), while seed-oil fractions have been assessed against plant-pathogenic fungi (Govindachari *et al*., 1998).

The literature therefore suggests that neem should be viewed as a promising source of antifungal compounds rather than as a universally effective fungicide. Differences between studies may reflect plant part, geographic origin, maturity, drying method, solvent, extraction time, concentration and fungal strain. Neem leaf and seed extracts have been investigated for effects on aflatoxin production by toxigenic *Aspergillus* (Allameh *et al*., 2002; Razzaghi-Abyaneh *et al*., 2005; Ghorbanian *et al*., 2008; Ali *et al*., 2026), while separate work examined patulin production by *Penicillium expansum* (Mossini *et al*., 2004). Evidence from seed-borne fungi provides useful context, but is not directly equivalent to testing human-pathogenic moulds (Nwachukwu & Umechuruba, 2001).

Proposed Methodology for an Experimental Study

A laboratory study can be designed to compare the antifungal effects of neem leaf and seed extracts against selected pathogenic moulds. Fresh neem leaves and mature seeds would be collected, authenticated and washed. The materials would be shade-dried and separately ground into powder. A suitable extraction solvent, such as ethanol, could be used to prepare standardized extracts. After filtration and concentration, different extract concentrations would be prepared.

Selected test moulds, for example *Aspergillus niger, Aspergillus flavus, Fusarium* species and *Penicillium* species, would be obtained from an approved microbiology laboratory. Antifungal activity could be assessed using an appropriate agar diffusion or poisoned-food technique, with a standard antifungal agent as a positive control and the extraction solvent as a negative control. Measurements such as inhibition-zone diameter or percentage mycelial growth inhibition would be recorded. Experiments should be performed using appropriate biological safety procedures and laboratory supervision. Statistical analysis could then be used to compare leaf and seed extracts at different concentrations.

The reviewed studies demonstrated measurable antifungal effects of neem leaf and seed extracts against several fungal groups. Leaf extracts inhibited human-associated fungi, including *Aspergillus* species, *Candida albicans* and *Microsporum gypseum*, with inhibition generally increasing as extract concentration increased; the 20% ethyl acetate leaf extract showed particularly strong activity under Mahmoud *et al*. (2011).

Table 1: *Summary of Reported Antifungal Effects of Neem Extracts Against Selected Fungi*

Neem Material	Selected Fungi	Extract/Condition	Reported Effect
Leaf	*A. flavus, A. fumigatus, A. niger, A. terreus*	Aqueous, ethanol and ethyl acetate	Growth inhibition; activity generally increased with concentration (Mahmoud *et al*., 2011; Ali *et al*., 2026).
Leaf + seed	*F. oxysporum, R. solani, A. solani, S. sclerotiorum*	Ethanol, hexane and methanol	Growth inhibition varied by extract and concentration (Moslem & El-Kholie, 2009; Govindachari *et al*., 1998).
Leaf + seed	*T. rubrum, T. mentagrophytes, M. nanum*	In-vitro extracts	Antifungal activity against tested dermatophytes; seed-extract MIC reported as 31 µg/mL (Natarajan *et al*., 2003).
Leaf + seed / leaf	*A. parasiticus, A. flavus*	Aqueous leaf/seed extracts; solvent leaf extracts	Aqueous leaf and seed extracts suppressed aflatoxin production; a separate study tested leaf extracts against *A. flavus* and *A. parasiticus* (Razzaghi-Abyaneh *et al*., 2005; Ali *et al*., 2026).
Leaf extract / neem oil	*Penicillium* species	Extract and oil preparations	Neem oil reduced growth and sporulation in tested species; neem leaf extract also affected patulin production in *P. expansum* (Mossini *et al*., 2004, 2009).

Sources: Mahmoud et al. (2011); Moslem and El-Kholie (2009); Natarajan et al. (2003); Razzaghi-Abyaneh et al. (2005); Govindachari et al. (1998); and Mossini et al. (2009).

Neem leaf and seed extracts showed antifungal activity against plant-pathogenic fungi and dermatophytes. Moslem and El-Kholie (2009) reported inhibition of *Fusarium oxysporum*, *Rhizoctonia solani*, *Alternaria solani* and *Sclerotinia sclerotiorum*, with effects varying by extract and concentration. Natarajan *et al*. (2003) reported a minimum inhibitory concentration of 31 µg/mL for neem seed extract against the dermatophytes they tested.

The reviewed evidence further showed that antifungal activity depended on extraction solvent, plant material, concentration and fungal species. A study of neem leaf and seed aqueous extracts reported concentration-dependent suppression of aflatoxin production by *Aspergillus parasiticus* (Razzaghi-Abyaneh *et al*., 2005), while a 2026 study examined neem leaf extracts against *A. flavus* and *A. parasiticus* (Ali *et al*., 2026). Neem oil reduced growth and sporulation in tested *Penicillium* species, but did not inhibit ochratoxin A production in that experiment; neem leaf extract was separately reported to inhibit patulin production by *P. expansum* at higher concentrations (Mossini *et al*., 2004, 2009). Overall, the results summarized in Table 1 indicate potential, not uniform effectiveness across fungi or extract conditions.

Discussion

The evidence reviewed indicates that both neem leaves and seeds possess antifungal potential. However, the evidence does not establish that one plant part is consistently superior: performance depends on the fungal species, extraction method and concentration. Different studies use different formulations and endpoints, so comparisons should be cautious (Mahmoud *et al*., 2011; Moslem & El-Kholie, 2009; Natarajan *et al*., 2003; Wylie & Merrell, 2022).

Neem has potential advantages as a natural antifungal resource because it is widely available and contains multiple bioactive constituents. Nevertheless, laboratory antifungal activity does not automatically establish clinical effectiveness or safety in humans. Further research is needed to standardize extracts, identify active compounds, establish effective concentrations, assess toxicity, and determine whether activity observed in vitro can be reproduced in real-world applications. Related work has also examined neem leaf extracts against fungal endophytes, supporting the need to distinguish activity against different fungal groups (Verma & Kharwar, 2006).

Conclusion

Neem (*Azadirachta indica*) leaf and seed extracts demonstrate promising antifungal activity against a variety of pathogenic fungi and moulds. Published studies have reported inhibition of organisms including Aspergillus, Fusarium, Alternaria, Rhizoctonia, Sclerotinia, Penicillium and dermatophytes. The effectiveness varies with plant part, solvent, concentration and fungal species. Neem therefore represents a promising natural source of antifungal compounds, but further standardized laboratory, toxicological and application-based studies are necessary before extracts can be recommended as replacements for established antifungal drugs or fungicides.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this work.

Acknowledgment

Authors are thankful to Yobe State University, Nigeria for academic support.

References

Ali, J., Ikram, M., Zahoor, M., & Alotaibi, A. (2026). Role of phytochemicals present in *Azadirachta indica* leaves extracts in controlling toxigenic fungi and inhibition of aflatoxins biosynthesis. *Discover Food*, *6*, 104. https://doi.org/10.1007/s44187-026-00845-9

Allameh, A., Abyaneh, M. R., Shams, M. R., Rezaee, M. B., & Jaimand, K. (2002). Effects of neem leaf extract on production of aflatoxins and activities of fatty acid synthetase, isocitrate dehydrogenase and glutathione S-transferase in *Aspergillus parasiticus*. *Mycopathologia*, *154*, 79-84. https://doi.org/10.1023/A:1015550323749

Álvarez-Caballero, J. M., & Coy-Barrera, E. (2019). Chemical and antifungal variability of several accessions of *Azadirachta indica* A. Juss. from six locations across the Colombian Caribbean coast: identification of antifungal azadirone limonoids. *Plants*, *8*(12), 555. https://doi.org/10.3390/plants8120555

Biswas, K., Chattopadhyay, I., Banerjee, R. K., & Bandyopadhyay, U. (2002). Biological activities and medicinal properties of neem (*Azadirachta indica*). *Current Science, 82*(11), 1336–1345. https://www.jstor.org/stable/24106000

da Costa, C. L., Geraldo, M. R. F., Arrotéia, C., & Kemmelmeier, C. (2010). In vitro activity of neem oil (*Azadirachta indica* A. Juss.) on *Aspergillus flavus* growth, sporulation, viability of spores, morphology and aflatoxins B_1 and B_2 production. *Advances in Bioscience and Biotechnology, 1*, 292–299. https://doi.org/10.4236/abb.2010.14038

Dube, S., & Tripathi, S. (1987). Toxicity of some plants against dermatophytes. *National Academy of Sciences, India, Science Letters, 10*(2), 45–48. https://ia903203.us.archive.org/9/items/in.ernet.dli.2015.202952/2015.202952.National-Academy.pdf

Ghorbanian, M., Razzaghi-Abyaneh, M., Allameh, A., Shams-Ghahfarokhi, M., & Qorbani, M. (2008). Study on the effect of neem (*Azadirachta indica* A. juss) leaf extract on the growth of *Aspergillus parasiticus* and production of aflatoxin by it at different incubation times. *Mycoses*, *51*(1), 35-39. https://doi.org/10.1111/j.1439-0507.2007.01440.x

Govindachari, T. R., Gopalakrishnan, G., & Suresh, G. (1996). Isolation of various azadirachtins from neem oil by preparative high-performance liquid chromatography. *Journal of Liquid Chromatography & Related Technologies*, *19*(11), 1729-1733. https://doi.org/10.1080/10826079608014000

Govindachari, T. R., Suresh, G., & Masilamani, S. (1999). Antifungal activity of *Azadirachta indica* leaf hexane extract. *Fitoterapia, 70*(4), 417–420. https://doi.org/10.1016/S0367-326X(99)00038-6

Govindachari, T. R., Suresh, G., Gopalakrishnan, G., Banumathy, B., & Masilamani, S. (1998). Identification of antifungal compounds from the seed oil of *Azadirachta indica*. *Phytoparasitica*, *26*(2), 109-116. https://doi.org/10.1007/BF02980677

Govindachari, T. R., Suresh, G., Gopalakrishnan, G., Masilamani, S., & Banumathi, B. (2000). Antifungal activity of some tetranortriterpenoids. *Fitoterapia*, *71*(3), 317-320. https://doi.org/10.1016/S0367-326X(99)00155-0

Khan, M., Schneider, B., Wassilew, S. W., & Splanemann, V. (1988). Experimental study of the effect of raw materials of the neem tree and neem extracts on dermatophytes, yeasts and moulds. *Zeitschrift fur Hautkrankheiten*, *63*(6), 499-502. https://europepmc.org/article/med/3407264#impact

Kharwar, R. N., Sharma, V. K., Mishra, A., Kumar, J., Singh, D. K., Verma, S. K., ... & Kusari, S. (2020). Harnessing the phytotherapeutic treasure troves of the ancient medicinal plant *Azadirachta indica* (Neem) and associated endophytic microorganisms. *Planta Medica*, *86*(13/14), 906-940. https://doi.org/10.1055/a-1107-9370

Klančnik, A., Piskernik, S., Jeršek, B., & Možina, S. S. (2010). Evaluation of diffusion and dilution methods to determine the antibacterial activity of plant extracts. *Journal of Microbiological Methods*, *81*(2), 121-126. https://doi.org/10.1016/j.mimet.2010.02.004

Mahmoud, D. A., Hassanein, N. M., Youssef, K. A., & Abou Zeid, M. A. (2011). Antifungal activity of different neem leaf extracts and the nimonol against some important human pathogens. *Brazilian Journal of Microbiology*, *42*(3), 1007-1016. https://doi.org/10.1590/S1517-838220110003000021

Moslem, M. A., & El-Kholie, E. M. (2009). Effect of neem (*Azardirachta indica* A. Juss) seeds and leaves extract on some plant pathogenic fungi. *Pakistan Journal of biological sciences*, *12*(14), 1045-1048. https://doi.org/10.3923/pjbs.2009.1045.1048

Mossini, S. A. G., de Oliveira, K. P., & Kemmelmeier, C. (2004). Inhibition of patulin production by Penicillium expansum cultured with neem (*Azadirachta indica*) leaf extracts. *Journal of Basic Microbiology, 44*(2), 106–113. https://doi.org/10.1002/jobm.200310332

Mossini, S. A., Arrotéia, C. C., & Kemmelmeier, C. (2009). Effect of neem leaf extract and neem oil on Penicillium growth, sporulation, morphology and ochratoxin A production. *Toxins*, *1*(1), 3-13. https://doi.org/10.3390/toxins1010003

Motallebi, P., & Negahban, M. (2024). Neem (*Azadirachta indica*) seed extract formulation for managing anthracnose and gray mould diseases in strawberry. *South African Journal of Botany*, *169*, 66-71. https://doi.org/10.1016/j.sajb.2024.04.027

Natarajan, V., Venugopal, P. V., & Menon, T. (2003). Effect of *Azadirachta indica* (neem) on the growth pattern of dermatophytes. *Indian Journal of Medical Microbiology*, *21*(2), 98-101. https://doi.org/10.1016/S0255-0857(21)03129-7

Niharika, A., Aquicio, J. M., & Anand, A. (2010). Antifungal properties of neem (*Azadirachta indica*) leaves extract to treat hair dandruff. *E-International Scientific Research Journal*, *2*(3), 244-252.

Nwachukwu, E. O., & Umechuruba, C. I. (2001). Antifungal activities of some leaf extracts on seed-borne fungi of African yam bean seeds, seed germination and seedling emergence. *Journal of Applied Sciences and Environmental Management, 5*(1), 29–32. https://utoronto.scholaris.ca/server/api/core/bitstreams/3dba67c0-77b5-4c7a-9795-ffaaf0a252fa/content

Okemo, P. O., Mwatha, W. E., Chhabra, S. C., & Fabry, W. (2001). The kill kinetics of *Azadirachta indica* A. Juss. (Meliaceae) extracts on *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans*. *African Journal of Science and Technology*, *2*(2), 113-118. https://doi.org/10.4314/jtmb.v3i1.35432

Polaquini, S. R., Svidzinski, T. I., Kemmelmeier, C., & Gasparetto, A. (2006). Effect of aqueous extract from Neem (*Azadirachta indica* A. Juss) on hydrophobicity, biofilm formation and adhesion in composite resin by *Candida albicans*. *Archives of Oral Biology*, *51*(6), 482-490. https://doi.org/10.1016/j.archoralbio.2005.11.007

Ramos, A. R, Falcao, L. L., Barbosa, G. S., Marcellino, L. H., & Gander, E. S. (2007). Neem (*Azadirachta indica* a. Juss) components: Candidates for the control of *Crinipellis perniciosa* and *Phytophthora* ssp. *Microbiological Research*, *162*(3), 238-243. https://doi.org/10.1016/j.micres.2006.06.004

Razzaghi-Abyaneh, M., Allameh, A., Tiraihi, T., Shams-Ghahfarokhi, M., & Ghorbanian, M. (2005). Morphological alterations in toxigenic Aspergillus parasiticus exposed to neem (*Azadirachta indica*) leaf and seed aqueous extracts. *Mycopathologia*, *159*(4), 565-570. https://doi.org/10.1007/s11046-005-4332-4

Saleem, S., Muhammad, G., Hussain, M. A., & Bukhari, S. N. A. (2018). A comprehensive review of phytochemical profile, bioactives for pharmaceuticals, and pharmacological attributes of *Azadirachta indica*. *Phytotherapy Research*, *32*(7), 1241-1272. https://doi.org/10.1002/ptr.6076

Subapriya, R., & Nagini, S. (2005). Medicinal properties of neem leaves: a review. *Current Medicinal Chemistry-Anti-Cancer Agents*, *5*(2), 149-156. https://doi.org/10.2174/1568011053174828

Venugopal, P. V., & Venugopal, T. V. (1994). Antidermatophytic activity of neem (*Azadirachta indica*) leaves in vitro. *Indian Journal of Pharmacology*, *26*(2), 141-143. https://doi.org/10.4103/IJPHA_1994262_141

Verma, D. K., Tripathi, V. J., Taneja, V., & Rana, B. K. (1998). Antifungal activity of the seed coat extract of *Azadirachta indica*. *Indian Journal of Pharmaceutical Sciences, 60*(5), 305–306.

Verma, V. C., & Kharwar, R. N. (2006). Efficacy of neem leaf extract against its own fungal endophyte *Curvularia lunata*. *Journal of Agricultural Technology*, *2*(2), 329-335. https://ijat-aatsea.com/pdf/Nov_v2_06/IJAT2006_24_16.pdf

Wylie, M. R., & Merrell, D. S. (2022). The antimicrobial potential of the neem tree *Azadirachta indica. Frontiers in Pharmacology*, *13*, 891535. https://doi.org/10.3389/fphar.2022.891535