UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
OPEN ACCESS

Ci. e Nat., Santa Maria, e86053, v. 47, 2025 • https://doi.org/10.5902/2179460X86053
Submitted: 12/09/2023 • Approved: 09/02/2025 • Published: 11/07/2025

Chemistry

Chemical study and investigation of the larvicidal activity of metabolites produced by the endophytic fungus *Colletotrichum siamense*

Estudo químico e investigação da atividade larvicida de metabólitos produzidos pelo fungo endofítico *Colletotrichum siamense*

Orivaldo Teixeira de Menezes Júnior[I], Lívia Soman de Mendeiros[II], Ricardo Aparecido Rodrigues Neponuceno[III], Antonia Queiroz Lima de Souza[I], Helder Lopes Teles[III], Camila Martins de Oliveira[III]

[I] Universidade Federal do Amazonas, Manaus, AM, Brasil
[II] Universidade Federal de São Paulo, São Paulo, SP, Brasil
[III] Universidade Federal de Rondonópolis, Rondonópolis, MT, Brasil

ABSTRACT

Microorganisms can produce a wide range of secondary metabolites with different activities, including larvicidal activities. *Colletotrichum* is a widespread fungal genus, and some species of this genus can establish mutualistic interactions with plants. In this study, the endophytic fungus *Colletotrichum siamense* was isolated from the hemiparasitic plant *Passovia stelis* to evaluate the chemical profile of the microorganism and its larvicidal activity against *Aedes aegypti*. This mosquito is one of the main transmitters of arboviruses, and the use of synthetic insecticides to fight the mosquito has generated resistance in its populations. For the larvicidal tests, the organic extract of fungal metabolites was obtained by partitioning with ethyl acetate after the cultivation of *C. siamense* in potato dextrose broth. The assay results indicated that the *C. Siamense* extract was active against *Aedes aegypti*, with an LC50 of 248 µg/mL after 72 hours of treatment. The extract was then subjected to chemical dereplication via the Global Natural Products Social Molecular Networking (GNPS) platform. The metabolites culmorin and cytochalasin D were found in the extract, the latter of which is representative of a biosynthetic class with previously reported activities against *Ae. aegypti* larvae.

Keywords: *Colletotrichum siamense*; Molecular networking; Cytochalasin

RESUMO

Os microrganismos são capazes de produzir uma variedade de metabólitos secundários que apresentam diversas atividades biológicas, dentre elas a larvicida. *Colletotrichum* é um gênero fúngico amplamente

difundido no mundo, sendo que algumas espécies podem estabelecer interações mutualísticas com plantas. A partir da planta hemiparasita *Passovia stelis* foi isolado o fungo endofítico *C. siamense* usados nesta pesquisa, com o objetivo de avaliar o perfil químico e sua atividade larvicida contra de *Aedes aegypti.* Este mosquito é um dos principais transmissores de arboviroses e o combate a ele por meio de inseticidas sintéticos tem gerado resistência em suas populações. Para a realização dos ensaios larvicidas, obteve-se o extrato orgânico de metabólitos fúngicos através de partição com acetato de etila, do cultivo de *C. siamense* em caldo de batata dextrose. Os resultados dos ensaios indicaram que o extrato de *C. siamense* foi ativo contra larvas *Aedes aegypti*, tendo uma CL_{50} de 248 µg/mL para um tratamento de 72 h. Este foi então submetido à desreplicação química utilizando-se a plataforma *Global Natural Products Social Molecular Networking* (GNPS). Foram anotados no extrato os metabólitos: culmarina e citocalasina D, sendo o segundo representativo de uma classe biossintética com atividades já reportadas contra larva de *Ae. aegypti*.

Palavras-chave: *Colletotrichum siamense*; Molecular networking; Citocalasina

1 INTRODUCTION

Microorganisms can produce a wide range of secondary metabolites with high chemical diversity, and only an estimated 5% of the species have been described in terms of metabolic potential, demonstrating the need for further exploration (Barbero et al., 2017; Segaran; Sathiavelu, 2019). Among these microorganisms are endophytes because they symbiotically inhabit the internal tissue of plants (Li et al., 2018).

The secondary metabolites produced by endophyte fungi can be precursors of efficient insecticides and larvicides against *Aedes aegypti*, which are the main transmitters of yellow fever, chikungunya, zika, and dengue (Pilz-Junior et al., 2019). The need to control this mosquito and subsequently prevent and reduce the transmission of these diseases has led to several strategies, such as the use of synthetic insecticides. However, these products generate toxic and nonbiodegradable waste that can contaminate the environment and cause undesirable effects on nontarget organisms (BarabadI et al., 2019; Knakiewicz et al., 2020). In addition, the continuous use of these insecticides has increased resistance in vector populations and thus reduced their efficiency (Wang et al., 2019). In this context, fungal metabolites are excellent alternatives because of their broad bioactivity.

The greatest diversity of endophytic fungi in the terrestrial environment is found in tropical and subtropical forests, as these ecosystems are the richest in plant species. Moreover, areas with high plant endemicity naturally exhibit a wide variety of endophytic species (Banerjee, 2011; Orlandelli et al., 2012). The hemiparasite plant *Passovia stelis* (L.) Kuijt, 2011 (Lorantahaceae) is common in the Amazon region (Arruda et al., 2012). In the present study, this plant was used to isolate the endophytic fungus *Colletotrichum siamense*.

Colletotrichum is a fungal genus belonging to the Glomerellaceae family and the Sordariomycetes class, which includes some of the most common species of foliar endophytes in terrestrial plants. Several species of *Colletotrichum* are described as phytopathogenic since they infect plants and cause tissue destruction and diseases, such as anthracnose, which has devastating effects on many economically important crops (Vieira et al., 2014; Ma et al., 2018; Kim; Shim, 2019). In contrast, hundreds of endophytic species of this fungal genus can establish mutualistic interactions with plants, thus making the host plant stress resistant through the production of active substances (Ma et al., 2018).

In a literature review, Kim and Shim (2019) reported 109 metabolites obtained from *Colletotrichum* that exhibit diverse biological activities, such as antioxidant, anti-inflammatory, insecticidal, antimicrobial, and cytotoxic activities. In the study by Munasinghe et al. (2017), indole-3-acetic acid was isolated from an endophytic fungus identified as *C. siamense*, which is the same species applied in the present study. This acid showed antifungal activity against phytopathogenic *Cladosporium cladosporioides* and antioxidant activity. However, it is reportedly one of the most important natural auxins of the tryptophan pathway that regulates plant growth.

The analysis of the chemical nature of metabolites produced by fungal cultures is essential for the discovery of new bioactive substances. Dereplication, which is based on molecular networking, has proven to be an efficient approach for this purpose,

as it enables the rapid and precise identification of known compounds and potential new molecules. This technique utilizes the spectral similarity between the *MS*/*MS* fragmentation patterns of samples and those found in the *Global Natural Products Social Molecular Networking* (GNPS) database (Wang et al., 2016; Aron et al., 2020), facilitating chemical characterization and avoiding redundant efforts.

In this context, the present study aimed to evaluate the larvicidal activity and chemical profile of the endophytic fungus *C. siamense*. To achieve this, molecular dereplication was employed, using high-resolution tandem mass spectrometry (HRMS/MS) data processed on the GNPS platform. This approach allowed for an in-depth analysis of the fungal extract composition and its potential application in the control of *Ae. aegypti* larvae.

2 MATERIALS AND METHODS

2.1 Isolation and identification of the fungus

The endophytic fungus *C. siamense* was isolated from *P. stelis* according to an adaptation of the methodologies described by Maier et al. (1997) and identified through macro- and micromorphological similarities. *P. stelis* was collected on the campus of the Federal University of Amazonas - UFAM (3°05'26.6"S and 59°57'52.6"W), Manaus, Amazonas, Brazil, and exsiccate were deposited in the herbarium of this institution with registration No. 11.422.

2.2 Reactivating the fungus and obtaining the extract

The endophytic fungus *C. siamense* was reactivated in Petri dishes containing potato culture medium (200 g/L broth), dextrose (20 g/L), and microbiological agar (15 g/L) (BDA). After eight days of growth, seven 7.70 mm diameter plugs of the fungus were transferred and cultured in five 500 mL Erlenmeyer flasks containing 300 mL of potato dextrose broth (Kasvi; 27 g/L H_2O) at 28°C in natural light. After this period,

the culture was filtered, and the broth was subjected to liquid–liquid partitioning with ethyl acetate (3 × 150 mL). The solvent of the organic phase was evaporated under reduced pressure to obtain the crude extract.

2.3 Evaluating larvicidal activity

The larvae of *Ae. aegypti* were obtained from a colony of the Rockefeller lineage maintained in the ArboControl Insectarium of the Laboratory of Pharmacology of the University of Brasilia (UnB) in accordance with the protocols established by the World Health Organization (World Health Organization, 2013). Larvicidal tests were conducted to evaluate the bioactivity of the extract of *C. siamense* against the larvae of *Ae. aegypti* and to determine its lethal concentration at 50% (LC50).

The selective assay was performed in 12-well plates, each containing 3 mL of distilled water and 10 third-stage larvae of *Ae. aegypti*. The extract was previously solubilized in dimethyl sulfoxide (DMSO) and then added to each well. The concentration of the extract after its addition to the wells was 250 µg/mL. The negative control was conducted with 5% aqueous DMSO, and the assay was conducted in quadruplicate. Mortality was recorded at 24, 48, and 72 hours, and the larvae that did not react to the mechanical stimulus (slight agitation in the water) were considered dead. To be considered active, the extract must cause a minimum mortality of 80% of the larval population (World Health Organization, 2013).

For the dose assay, the extract was subjected to the same experimental conditions described previously, with final concentrations of 250, 200, 150, 100, 75, 50, 25, and 12.5 µg/mL, to determine the smallest amount of extract capable of causing the death of 50% of the larval population. The LC_{50} values were determined by applying probit analysis to mortality data obtained for the tested concentrations (World Health Organization, 2013).

2.4 Chemical evaluation of extracts

The extracts were diluted in methanol to a final concentration of 200 µg/mL and analyzed on a Thermo Scientific QExactive® Hybrid Quadrupole-Orbitrap mass spectrometer. The analyses were performed in positive mode with *m/z* range of 115–1500, a capillary voltage of 3.4 kV, a capillary inlet temperature of 280°C, and an S 100 V lens. Five microliters of sample were injected. Stationary phase: Thermo Scientific Accucore C18 column 2.6 µm (2.1 mm × 100 mm); mobile phase: H_2O + 0.1% formic acid (A) and acetonitrile (B). Elution gradient (A/B): 95/5 to 2/98 in 15 min, held for 5 min; 2.98 to 95/5 in 1.2 min, held for 7.8 min, at a flow rate of 0.2 mL/min.

The *MS/MS* experiment was performed by collision-induced dissociation (CID) with a *m/z* range of 100-800, in which the collision energy ranged from 10-50 V. *MS* and *MS/MS* quality data were examined manually with Xcalibur software (version 3.0. 63), Thermo Fisher Scientific.

The spectral files were converted to mzXML format using the MS-Convert software, which is part of ProteoWizard (Palo Alto, CA, USA). Molecular network was created using the online workflow on the GNPS platform website (https://gnps.ucsd.edu/ProteoSAFe/static/gnps-splash.jsp, accessed 08/01/2021) for data acquisition. The *MS/MS* spectra were selected from the 6 highest intensity ions by scan, considering a range of ±50 Da across the spectrum.

All the *MS/MS* peaks within ±17 Da deviations of the precursor ions were filtered. The data were grouped with a tolerance of 0.02 Da for precursor ions, and 0.02 Da for fragment ions in the construction of “consensus” spectra (identical spectra for each precursor, which are combined to create the node to be visualized). Consensus spectra with fewer than two spectra were not considered. Connections between nodes were filtered for values greater than 0.7 of the cosine parameter, with compatibility for more than six peaks. For dereplication of the compounds, the generated lattice

spectra were consulted in the GNPS library using the same selection criteria for the analyzed samples.

The resulting molecular network was visualized and manipulated in the Cytoscape program version 3.8.2, following the adapted analysis methodology of Pilon et al. (2022).

3 RESULTS AND DISCUSSION

The selective assay revealed that the extract of *C. siamense* was active against third-stage larvae of *Ae. aegypti*, causing the death of 22.5%, 47.5%, and 85% of the larvae at 24, 48, and 72 hours, respectively. Once the larvicidal activity was confirmed, the dose assay with the extract showed a lethal concentration (LC_{50}) of 248 µg/mL against larvae of *Ae. aegypti* after 72 hours of treatment. In the positive control with DMSO, no larval death occurred, indicating that the observed larvicidal activity was caused by the fungal extract.

Several secondary metabolites with various bioactivities have been isolated from fungi of the genus *Colletotrichum*; however, to date, no reports have described the larvicidal activity of fungal extracts of this genus. Other genera are potential producers of larvicidal metabolites, such as *Phomopsis* and *Aspergillus*, the extracts of which can be active against third-stage larvae of *Ae. aegypti*, according to studies by Garcia et al. (2022) and Araújo et al. (2022), respectively. In the first study, the authors evaluated the larvicidal activity of 3-nitropropionic acid obtained from the extract of *Phomopsis* sp. isolated from *P. stelis*, obtaining an LC_{50} of 15.172 µg/mL. In the second study, the authors evaluated the larvicidal activity of *Aspergillus* sp. isolated from almonds of *Bertholletia excelsa*, obtaining an LC_{50} of 26.86 µg/mL.

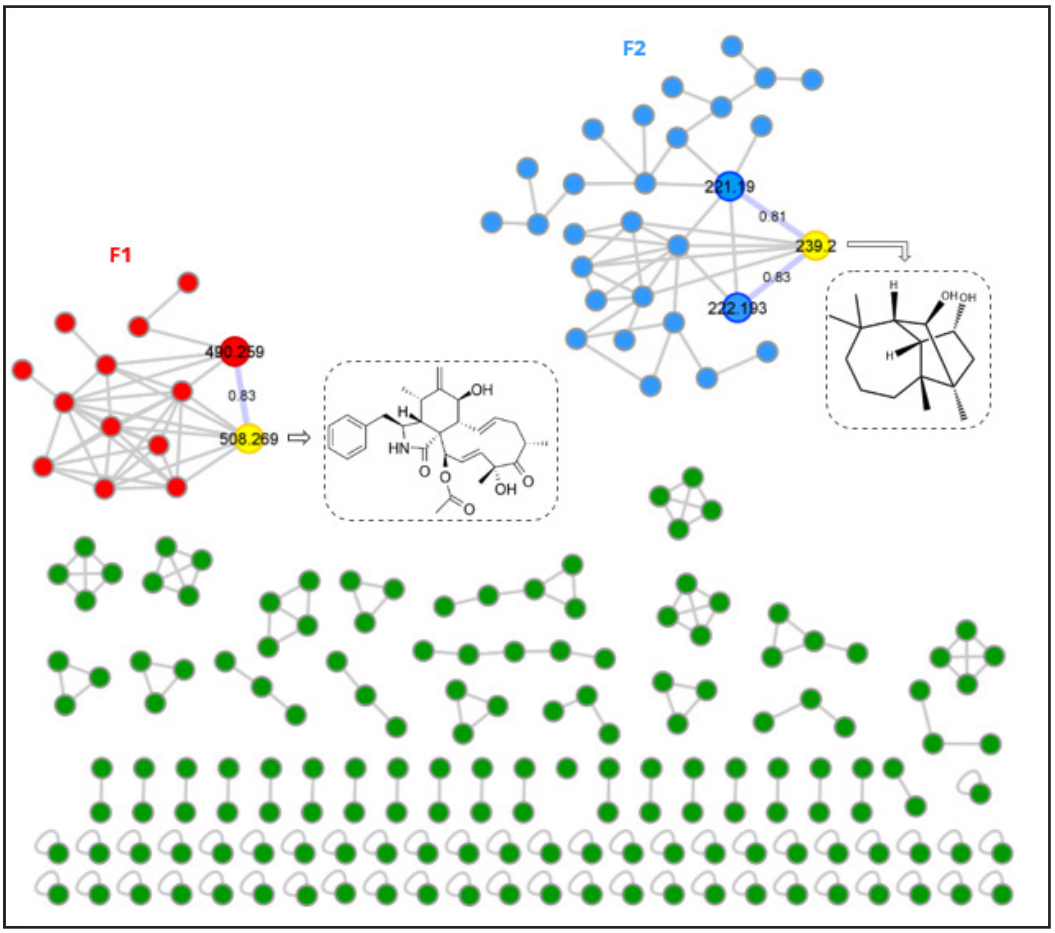
The value of the lethal dose found in this study for the extract of *C. siamense* demonstrates its unprecedented larvicidal potential against *Ae. aegypti*. Moreover, the analyses were carried out on the crude extract, with the expectation that the

compounds isolated from this extract may be more efficient, with lower lethal doses. This finding is corroborated in the study by Garcia et al. (2022), who demonstrated that the compound isolated from the crude extract of *Phomopsis* sp. (3-nitropropionic acid) had an LC_{50} of 15.172 µg/mL, which is relatively low and more suitable for large-scale applications. Notably, 3-NPA is a potent mycotoxin from Ascomycetes that mimics succinic acid in the Krebs cycle, causing muscular and respiratory paralysis (Souza, 2005). Therefore, it is highly cytotoxic, which explains its activity against larvae, bacteria and cell cultures. However, this is the first time that 3-NPA has been reported for the fungus *C. siamense*.

Once the larvicidal activity of the *C. siamense* extract was observed, the extract was analyzed by molecular networking to investigate the chemical nature of its active compounds. Molecular networking is used to evaluate the chemical profiles of extracts and allows the creation of molecular families between compounds in samples and those in the GNPS database. Molecular families are clusters of nodes with similar spectral profiles, and analogs can be inferred based on structural similarities.

The molecular network corresponding to the metabolites of *C. siamense* consisted of 936 nodes, where 1419 connections were established (Figure 1). This network was reduced by excluding some nodes to better visualize the molecular families of interest. Figure 1 shows that some families and nodes did not correspond to known substances in the GNPS, since they did not establish connections with standards in this database. This result may indicate the existence of known analogs to the compounds that were annotated but not deposited on the platform, or metabolites that have not been described in the literature.

Figure 1 – Molecular network of metabolites in the extract of *Colletotrichum siamensis*



Note: The yellow nodes refer to the GNPS spectral library standards, in which m/z 508.269 is cytochalasin D and m/z 239.2 is culmorin. The other nodes refer to compounds found in the extract of *Colletotrichum siamensis*. The reds nodes form family 1 (F1), which has a spectral similarity with cytochalasin D and the blue nodes form family 2 (F2), which has a spectral similarity with culmorin. Source: Authors (2022)

Cytochalasin D ($C_{30}H_{37}NO_6$) m/z 508.269 $[M+H]^+$ was putatively annotated in the F1 family from the GNPS library, with similarity corresponding to a cosine of 0.83 with the node of m/z 490.259 $[M+H]^+$, which is related to the molecule found in the extract of *C. siamense*. The larvicidal activity of cytochalasins against *Ae. aegypti* has already been reported by authors such as De Masi et al. (2017), whose results indicated that cytochalasin A, which was isolated from the endophytic fungus *Pyrenophora semeniperda*, caused 100% mortality of the first-stage larvae of *Ae. aegypti* at a concentration of 250 ppm and 93.3% mortality at 100 ppm. Cytochalasin D is recognized for its anticancer activities, as it inhibits actin polymerization and induces depolymerization of actin

filaments formed during shape changes in platelets and various cancer cells. It is also a frequent metabolite isolated from phytopathogens (e.g., *Colletotrichum* spp.) and ascomycetes such as *Xylaria* and *Phomopsis* family F2, and the culmorin ($C_{15}H_{26}O_2$) at *m/z* 239.200 $[M+H]^+$ was the putative molecule annotated from GNPS. In this family, nodes referring to metabolites of *C. siamense*, at *m/z* 221.190 $[M+H]^+$ and *m/z* 222.193 $[M+H]^+$, presented cosine scores of 0.81 and 0.83, respectively, suggesting similarity with the annotated structure. To date, no studies in the literature have evaluated the larvicidal activity of culmorin against larvae of *Ae. aegypti.* However, it is important to highlight two observations: 1. During the production of *Colletotrichum* conidia in the anamorph phase, two types of colloidal substances that aggregate the conidia are observed, one black and the other orange. It is possible that the orange colloidal substance is responsible for the production of culmorin. 2. Culmorin is considered an emerging toxin; however, it has already been studied as a food pigment, and is not cytotoxic (Gruber-Dorninger, et al., 2017).

The annotation of both substances with cosine scores above 0.7 demonstrated the possible presence of analogs of these families in the extract, especially cytochalasin, as this class is described in the literature as being active against *Ae. aegypti*. Therefore, the probable presence of analogs of these compounds in the fungal extract may have caused the observed larvicidal activity.

4 CONCLUSIONS

The results of this study highlight the larvicidal potential of the endophytic fungus *C. siamense* extract against third-stage *Ae. aegypti* larvae. Chemical analysis of the GNPS library revealed the presence of cytochalasin D, which is recognized for its larvicidal activity and coumarin. These findings support the viability of the extract as a promising alternative for mosquito control, particularly given the increasing resistance to synthetic insecticides. Thus, this study contributes to the search for more effective

and sustainable biological solutions. Future studies should focus on evaluating the larvicidal activity of isolated compounds from *C. siamense* to optimize lethal doses and develop new strategies for vector control.

ACKNOWLEDGMENTS

The authors thank INCT-BioNat (Instituto Nacional de Ciência e Tecnologia em Biodiversidade e Produtos Naturais), project number 465637/2014-0, for the financial support, and Laila Salmen Espindola for conducting the larvicidal assay.

REFERENCES

Araújo, I. F., Marinho, V. H. S., Sena, I. S., Curti, J. M., Ramos, R. S., Ferreira, R. M. A., Souto, R. N. P., & Ferreira, I. M. (2022). *Larvicidal activity against Aedes aegypti and molecular docking studies of compounds extracted from the endophytic fungus Aspergillus* sp. *isolated from Bertholletia excelsa* Humn. & Bonpl. *Biotechnology Letters, 44*, 439–459.

Aron, A.T., Gentry, E.C., McPhail, K.L. et al. (2020). Reproducible molecular networking of untargeted mass spectrometry data using GNPS. *Nature Protocols, 15*, 1954–1991.

Arruda, R., Fadini, R. F., Carvalho, L. N., DelClaro, K., Mourão, F. A., Jacobi, C. M., Teodoro, G. S., van den Berg, E., Caires, C. S., & Dettke, G. A. (2012). Ecology of neotropical mistletoes: An important canopydwelling component of Brazilian ecosystems. *Acta Botanica Brasilica, 26*(2), 264–274.

Barbero, M., Artuso, E., & Prandi, C. (2018). Fungal anticancer metabolites: Synthesis toward drug discovery. *Current Medicinal Chemistry, 25*(2), 141–185.

Barabadi, H., Alizadeh, Z., Rahimi, M. T., Barac, A., Maraolo, A. E., Robertson, L. J., Masjedi, A., Shahrivar, F., & Ahmadpour, E. (2019). Nanobiotechnology as an emerging approach to combat malaria: A systematic review. *Nanomedicine, 18*, 221–233.

Banerjee, D. (2011). Endophytic fungal diversity in tropical and subtropical plants. *Journal of Microbiology, 6*(1), 54–62.

GruberDorninger, C., Novak, B., Nagl, V., & Berthiller, F. (2016). Emerging mycotoxins: Beyond traditionally determined food contaminants. *Journal of Agricultural and Food Chemistry, 65*, 7052–7070.

Garcia, A. C. G., Menezes Júnior, O. T., Mariano, L. A., Santiago, L. C., Araújo, Â. R., Monfardini, J. D., Simões, R. C., Oliveira, A. C., Roque, R. A., Tadei, W. P., Teles, H. L., & Oliveira, C. M. (2022). Endophytic fungus *Phomopsis* sp. as a source of 3nitropropionic acid with larvicidal activity against *Aedes aegypti* (Linnaeus 1762, Diptera: Culicidae). *Journal of the Brazilian Society of Tropical Medicine, 55*, 1–4.

Knakiewicz, A. C., Lutinski, J. A., Busato, M. A., Roman Junior, W. A., & Simões, D. A. (2020). Larvicidal activity of aqueous extracts of *Ilex paraguariensis* and *Ilex theezans* on *Aedes aegypti* (L.). *Ciência e Natura, 42*, 1–13.

Kim, J. W., & Shim, S. H. (2019). The fungus *Colletotrichum* as a source for bioactive secondary metabolites. *Archives of Pharmacal Research, 42*, 735–753.

Li, S., Zhang, X., Wang, X., & Zhao, C. (2018). Novel natural compounds from endophytic fungi with anticancer activity. *European Journal of Medicinal Chemistry, 156*, 316–343.

Ma, X., Nontachaiyapoom, S., Jayawardena, S. R., Yde, K. D., Gentekaki, E., Zhou, S., Qian, Y., Wen, T., & Kang, J. (2018). Endophytic *Colletotrichum* species from *Dendrobium* spp. in China and Northern Thailand. *MycoKeys*, 43, 23–57.

Maier, W., Hammer, K., Dammann, U., Schulz, B., & Strack, D. (1997). Accumulation of sesquiterpenoid cyclohexenone derivatives induced by an arbuscular mycorrhizal fungus in members of the Poaceae. *Planta, 202*(1), 36–42.

Masi, M., Cimmino, A., Tabanca, N., Becnel, J. J., Bloomquist, J. R., & Evidente, A. (2017). A survey of bacterial, fungal and plant metabolites against *Aedes aegypti* (Diptera: Culicidae), the vector of yellow and dengue fevers and Zika virus. *Open Chemistry, 15*, 156–166.

Munasinghe, V., Kumar, N. S., Jayasinghe, L., & Fujimoto, Y. (2017). Indole3acetic acid production by *Colletotrichum siamense*, an endophytic fungus from *Piper nigrum* leaves. *Journal of Biologically Active Products from Nature, 7*(6), 475–479.

Orlandelli, R. C., Alberto, R. N., Rubin Filho, C. J., & Pamphile, J. A. (2012). Diversity of endophytic fungal community associated with *Piper hispidum* (Piperaceae) leaves. *Genetics and Molecular Research, 11*(2), 1575–1585.

PilzJunior, H. L., Lemos, A. B., Almeida, K. N., Corção, G., Schrekker, H. S., Silva, C. E., & Silva, O. S. (2019). Microbiotapotentialized larvicidal action of imidazolium salts against *Aedes aegypti* (Diptera: Culicidae). *Scientific Reports, 9*(1), 1–8.

Pilon, A. C., Grande, M. D., Silvério, M. R. S., Silva, R. R., Albernaz, L. C., Vieira, P. C., Lopes, J. L. C., Espindola, L, S., & Lopes, N. P. (2022). Combination of GC–MS molecular networking and larvicidal effect against *Aedes aegypti* for the discovery of bioactive substances in commercial essential oils. *Molecules, 27*(5), 1–17.

Segaran, G., & Sathiavelu, M. (2019). Fungal endophytes: A potent biocontrol agent and a bioactive metabolites reservoir. *Biocatalysis and Agricultural Biotechnology, 21*, 1–17.

Vieira, W. A. S., Michereff, S. J., Morais Jr, M. A., Hyde, K. D., & Câmara, M. P. S. (2014). Endophytic species of *Colletotrichum* associated with mango in northeastern Brazil. *Fungal Diversity, 67*, 181–202.

Wang, M., Carver, J. J., Phelan, V. V., Sanchez, L. M., Garg, N., Peng, Y., Nguyen, D. D., Watrous, J., Kapono, C. A., LuzzattoKnaan, T., Porto, C., Bouslimani, A., Melnik, A. V., Meehan, M. J., Liu, W. T., Crüsemann, M., Boudreau, P. D., Esquenazi, E., SandovalCalderón, M., Kersten, R. D., Pace, L. A., Quinn, R. A., Duncan, K. R. & Bandeira, N. (2016). Sharing and community curation of mass spectrometry data with Global Natural Products Social Molecular Networking. *Nature Biotechnology, 34*(8), 828–837.

Wang, M., Carver, J., Phelan, V. et al. (2016). Sharing and community curation of mass spectrometry data with Global Natural Products Social Molecular Networking. *Nature Biotechnology, 34*(8), 828–837.

Wang, Z., Perumalsamy, H., Wang, X., & Ahn, Y. (2019). Toxicity and possible mechanisms of action of honokiol from *Magnolia denudata* seeds against four mosquito species. *Scientific Reports, 9*(411), 1–19.

World Health Organization. (2013). *Guidelines for efficacy testing of spatial repellents*.

Authorship contributions

1 – Orivaldo Teixeira de Menezes Júnior

Master's degree in Science and Technology for Amazonian Resources from the Federal University of Amazonas (UFAM).
https://orcid.org/0000-0002-3568-476X • junior.menezes011@gmail.com
Contribution: Conceptualization, Methodology, Validation, Data curation, Formal analysis, Investigation, Visualzation, Writing - original draft, Writing – review & editing

2 – Lívia Soman de Mendeiros

PhD in Organic Chemistry from the Federal University of São Carlos.
https://orcid.org/0000-0001-8743-3340 • livia.soman@unifesp.br
Contribution: Conceptualization, Methodology, Validation, Data curation, Resources

3 – Ricardo Aparecido Rodrigues Neponuceno

Master's degree in Environmental Management and Technologies from the Federal University of Mato Grosso (UFMT).
https://orcid.org/0000-0001-6723-4635 • ricardo-neponuceno@hotmail.com
Contribution: Writing - review & editing

4 – Antonia Queiroz Lima de Souza

PhD in Biological Sciences from the Federal University of São Carlos.
https://orcid.org/0000-0001-5602-8617 • antoniaqlsouza@gmail.com
Contribution: Methodology

5 – Helder Lopes Teles

PhD in Chemistry from the Chemistry Institute of Araraquara-UNESP.
https://orcid.org/0000-0001-9341-4605 • heldtele@yahoo.com.br
Contribution: Methodology, Software, Data Curation, Formal Analysis, Investigation, Resources, Writing - original - draft, Writing - review & editing

6 – Camila Martins de Oliveira

Post-doctorate in Chemistry from the University of São Paulo.
https://orcid.org/0000-0001-7273-3017 • camila.oliveira@ufr.edu.br
Contribution: Conceptualization, Methodology, Software, Data curation, Formal Analysis, Investigation, Resources, Supervision, Project administration, Writing - original - draft, Writing - review & editing

How to quote this article

Menezes Júnior, O. T., Mendeiros, L. S., Neponuceno, R. A. R., Souza, A. Q. L., Teles, H. L., & Oliveira, C. M. (2025). Chemical study and investigation of the larvicidal activity of metabolites produced by the endophytic fungus *Colletotrichum siamense*. *Ciencia e Natura*, 47, e86053. DOI: 10.5902/2179460X86053. Disponível em: https://doi.org/10.5902/2179460X86053