SHORT COMMUNICATION

*Machaerium opacum* Vogel (Fabaceae): phytochemical study and toxicity to *Atta sexdens* Linnaeus (Hymenoptera: Formicidae)

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**ABSTRACT**

In this work was described the phytochemical investigation of *Machaerium opacum* Vogel (Fabaceae) leaves as well as the insecticidal activity of its crude extract and fractions against *Atta sexdens* Linnaeus (Hymenoptera: Formicidae). The phytochemical study led to the identification of α-amyrin, β-amyrin, lupeol, phytol, isomucronulatol and rutin, described for the first time in *M. opacum* and mucronulatol. Insecticidal activity was assessed by the ingestion of the crude extract and fractions incorporated into an artificial diet at three different concentrations (0.2, 1.0 and 2.0 mg mL⁻¹). Statistical analysis revealed that all the samples of *M. opacum* at all concentrations tested showed significant results when compared to the pure diet control.

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1. Introduction
Leaf-cutting ants cause severe defoliation of plants, being considered as a serious pest for agriculture, especially when they attack cultivated areas (Montoya-Lerma et al. 2012). In spite of growing evidence of environmental damage and human health concerns, the main method of control of this pest consists of the use of synthetic insecticides (Isman 2020). Therefore, an intense search for alternative methods have been made and, in this scenario, some natural products, especially from plant extracts, have shown promise against leaf-cutting ants (Boulogne et al. 2012).

Previous studies conducted with the aim of finding new botanical insecticides have reported the potential of species such as *Azadirachta indica* A. Juss., *Tanacetum cine-rariifolium* (Trevis.) Sch. Bip., *Chenopodium ambrosioides* L., *Sophora flavescens* Ait., *Celastrus angulatus* Maxim., *Annona squamosa* L. and *Annona reticulata* L. (Isman 2020).

*Machaerium* Pers. is a Fabaceae genus composed of approximately 130 species, including those that are popularly known in Brazil as ‘Jacarandás’ (Filardi and Lima 2014). Some *Machaerium* species are widely used in traditional medicine and are considered to have multiple medicinal properties such as antimicrobial, cytotoxic, antiparasitic, anti-inflammatory and antioxidant (Amen et al. 2015; Muhammad et al. 2020). *Machaerium opacum* Vogel, popularly known as ‘Jacarandá-do-Cerrado’, is an arboreal species native to Brazil, occurring in the Caatinga and Cerrado regions, especially in the Midwest of the country (Filardi et al. 2020).

Therefore, this work aimed to perform the phytochemical study of *M. opacum* leaves and to evaluate the insecticidal activity of the crude extract and fractions of *M. opacum* against leaf-cutting ants *Atta sexdens* Linnaeus.

2. Results and discussion
The phytochemical investigation of *M. opacum* leaves provided seven compounds. The hexane fraction yielded a mixture of the terpenes α-amyrin (1), β-amyrin (2), lupeol (3) and phytol (4) (Figure S1, Supplementary Material). From the dichloromethane fraction, the isoflavonoids mucronulatol (5) and isomucronulatol (6) (Figure S1, Supplementary Material) were isolated; from the methanolic fraction, the flavonol rutin (7) (Figure S1, Supplementary Material) was isolated. All of these compounds, except for mucronulatol (Amen et al. 2015), are being reported for the first time in *M. opacum*.

All the fractions and the crude extract of *M. opacum* at all concentrations tested against *A. sexdens* showed statistic difference in comparison with the control, which presented $S_{50}$ higher than 25 days (Table S1, Supplementary Material). In general, the concentrations tested were not dose-dependent. The most expressive results were the treatments with MOFEH at 1.0 and 2.0 mg mL$^{-1}$ ($S_{50}$ on the 7th day for both); MOFEA at 2.0 mg mL$^{-1}$ ($S_{50}$ on the 8th day) and MOFE at 2.0 mg mL$^{-1}$ ($S_{50}$ on the 9th day).

These findings corroborate with previous results on other insects. For instance, Bezerra et al. (2019) found that extracts of *Machaerium opacum* presented antibiosis effects against *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae). In other sets of experiments, Melo et al. (2021) observed that the crude extract, fractions and isolated compounds from *Machaerium acutifolium* Vog. showed larvicidal activity against *Aedes aegypti* Lin.
The insecticidal effect of *M. opacum* to *A. sexdens* ants may be associated with the terpenes and flavonoids present in this species. According to González-Coloma et al. (2011), pentacyclic triterpenes have insect antifeedant effects and therefore apparently play a role in plant defense. Salatino et al. (1998) have shown that the triterpene lupeol, one of the components of the wax of *Didymopanax vinosum* E. March., strongly inhibits the foraging activity of *A. sexdens*. According to Tian and Mclaughlin (2000), the flavonoids mucronulatol and isomucronulatol, in addition to acacetin, secundiflorol and isovestitol, are the possible bioactive substances that make the wood of *Robinia pseudoacacia* L. resistant to deterioration agents, including insects.

**Disclosure statement**

The authors declare that there is no conflict of interest. The contribution of each author to develop this article is equivalent, and all of them read and approved the final manuscript.

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