



COULD AQUEOUS EXTRACT FROM CASTOR PLANTS BE THE SOLUTION TO EFFECTIVELY CONTROL THE PINK MEALYBUG NYMPHS?

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ABSTRACT

Objective: To evaluate under laboratory conditions the potential of the leaf extract of the species *Ricinus communis* L. regarding its insecticidal activity on nymphs of the pink mealybug and determine the Lethal Concentration 50 (LC50).

Theoretical reference: *Maconellicoccus hirsutus* is one of the key pests of several crops and has been diagnosed in more than 350 plant species. The species was reported for the first time in Brazil in 2010 in the State of Roraima, and has since spread to other Brazilian states causing considerable economic losses to the affected areas.

Method: The castor bean leaf extract was tested on *M. hirsutus* insects with varying concentrations. Application was done directly using an airbrush connected to a calibrated compressor. Evaluation occurred at 24, 48, and 72-hour intervals post-application.

Results and discussion: As the dosage of the extract was increased, a significant increase in the mortality rate of mealybugs was observed. The lethal concentration for 50 % of the *M. hirsutus* population (LC50) was calculated at 6.14%, with a confidence interval between 5.40 % and 7.02 % (m/v).

Implications of the research: The research proposes a sustainable approach to controlling pink mealybug nymphs, using an aqueous extract of *R. communis* leaves.

Originality/value: This article stands out for its innovation in exploring a sustainable approach to pest control, presenting an effective alternative to reduce dependence on chemical pesticides. This proposal is especially

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relevant to promote the adoption of more sustainable agricultural practices aligned with the principles of sustainable agriculture and providing benefits for both agricultural production and the environment.

Keywords: Alternative Management, Sustainable Agriculture, Alternative Control, *Maconellicoccus Hirsutus*, *Ricinus Communis* L.

PODERIA O EXTRATO AQUOSO DE PLANTAS DE MAMONA SER A SOLUÇÃO PARA CONTROLAR EFETIVAMENTE AS NINFAS DA COCHONILHA ROSA?

RESUMO

Objetivo: Avaliar em condições laboratoriais o potencial do extrato de folhas da espécie *Ricinus communis* L. quanto à sua atividade inseticida sobre a cochonilha rosada e determinar a Concentração Letal 50 (CL50).

Referencial teórico: *Maconellicoccus hirsutus* é uma das pragas chaves de diversas culturas e já foi diagnosticada em mais de 350 espécies de plantas, a espécie foi relatada pela primeira vez no Brasil em 2010 no Estado de Roraima, e desde então se espalhou para outros estados brasileiros trazendo perdas econômicas para as regiões afetadas.

Método: O extrato de folhas de mamona foi testado em insetos *M. hirsutus* em concentrações variadas. A aplicação foi feita diretamente com aerógrafo conectado a um compressor calibrado. A avaliação ocorreu em intervalos de 24, 48 e 72 horas após a aplicação.

Resultados e discussão: À medida que a dosagem do extrato foi aumentada, observou-se um incremento significativo na taxa de mortalidade das cochonilhas. A concentração letal para 50% da população de *M. hirsutus* (CL50) foi calculada em 6,14%, com um intervalo de confiança entre 5,40% e 7,02% (m/v). a utilização do extrato aquoso é eficaz no controle de *M. hirsutus* tornando-se uma alternativa para a redução de produtos sintéticos, de forma a reduzir impactos ambientais e aumentar os serviços ecossistêmicos.

Implicações da pesquisa: A pesquisa propõe uma abordagem sustentável para o controle de ninfas da cochonilha rosa, utilizando extrato aquoso de folhas de *R. communis*.

Originalidade/valor: Este artigo se destaca por sua inovação ao explorar uma abordagem sustentável no controle de pragas, apresentando uma alternativa eficaz para diminuir a dependência de pesticidas químicos. Essa proposta é especialmente relevante para promover a adoção de práticas agrícolas mais sustentáveis, alinhadas com os princípios da agricultura sustentável e proporcionando benefícios tanto para a produção agrícola quanto para o meio ambiente.

Palavras-chave: Manejo Alternativo, Agricultura Sustentável, Controle Alternativo, *Maconellicoccus Hirsutus*, *Ricinus Communis* L.

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1 INTRODUCTION

The constant challenge of agriculture lies in mitigating the impacts caused by pests, with the pink mealybug (*Maconellicoccus hirsutus*) being a significant threat to the productivity and sustainability of crops. In this context, the pink mealybug, when feeding on plant sap, significantly weakens crops, leading to a reduction in production and restriction of the quality of agricultural products (REDDY *et al.*, 2023). Worldwide, *M. hirsutus* has been found attacking more than 350 species, including fruit, horticultural, ornamental, coffee, and cotton (ZHANG, 2005; MARTINS *et al.*, 2019).



The search for effective control methods gains relevance, especially given the growing concerns about sustainability in agriculture, as at the moment, only the microbiological agent *Cryptolaemus montrouzieri* Mulsant (Hemiptera: Coccinellidae) is registered for the control of *M. hirsutus* (MAPA, 2024). This has led to the inappropriate use of unregistered synthetic products, thus generating pest resistance, compromising control strategies, and harming natural enemies, resulting in the poisoning of surrounding fauna and pollution of water bodies. To mitigate these impacts, it is crucial to promote sustainable agricultural practices and the use of natural products, such as plants, that emerge as a source of alternatives for the control method (BAJWA *et al.*, 2020).

Some plants are recognized for their insecticidal potential in the form of extracts, such as pepper plants against mealybug (MARCHIORI *et al.*, 2023) and arugula against mites (CARRIÇO *et al.*, 2024), among others. Plants from the Euphorbiaceae family emerge with significant prominence in research dedicated to this purpose. Castor bean (*Ricinus communis* L.), for example, is known for its toxic effects and economic relevance and has gained increasing attention due to plant extracts being one of the alternatives to synthetic insecticides, due to the promising source of bioactive compounds, such as fatty acids and proteins, which demonstrate insecticidal properties (KOSAR, H; SRIVASTAVA, 2016). Therefore, this work aimed to evaluate the potential, under laboratory conditions, of using the extract from leaves of the species *R. communis* L, regarding its insecticidal activity on *M. hirsutus* and diagnose CL50 (lethal concentration).

2 METHODOLOGY

The experiment was carried out at the Agricultural Entomology and Acarology Laboratory of the Federal Institute of Education, Science, and Technology of Espírito Santo - Campus Itapina (IFES-Campus Itapina), located in the municipality of Colatina, with coordinates of 19°29'52.7" S 40°45'38.5" W (Fig. 1).

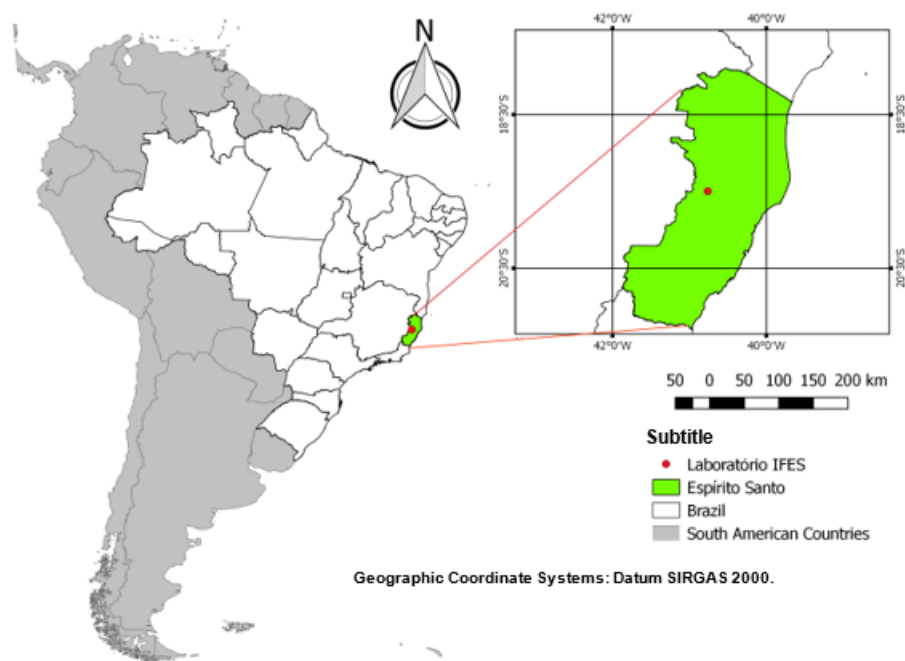


Figure 1: Map of the place where the experiments were carried out.



Source: adaptad of Marchiori *et al.*, (2023).

2.1 Breeding of the Pink Mealybug

The breeding approach adopted in this study follows the methodology proposed by Sanches & Carvalho (2011), being adapted in the IFES-Campus Itapina laboratory with the use of pumpkins in the initial stage of maturation as a food source for the pink mealybug according to Marchiori *et al.*, (2023). In the initial phase of pumpkin infestation, individuals collected in the field were used, coming from already-infested host plants. After the establishment of the initial colony, the process of multiplication of mealybugs began. When it was necessary to replace the pumpkins with new ones, it was decided to use pumpkins taken from the institute's experimental area, which follows agricultural practices without the use of chemical products. These pumpkins were placed in contact with those previously infested, enabling the transfer of newly hatched mealybug nymphs to the new fruits, taking advantage of the mobility of this phase. Breeding was kept in an air-conditioned room at $25 \pm 2^{\circ}\text{C}$, $\text{RH } 70 \pm 10\%$, and a 12-hour photophase.

2.2 Obtaining aqueous castor bean extracts

To prepare the extracts, castor bean leaves were collected in the Experimental Area of IFES-Campus Itapina. After being collected, the leaves were transported to the laboratory, where they underwent a washing procedure. This process involved immersing the leaves in a solution composed of sodium dichloroisocyanurate and distilled water in a ratio of 1:10, leaving them to rest for approximately ten minutes. Then, the leaves were carefully rinsed with distilled water and dried using cotton sponges. Subsequently, the leaves were subjected to the drying process in an oven with forced air circulation, maintained at a temperature of 40°C for 72 hours. After the complete drying process, the leaves were crushed with the help of a knife mill to obtain a fine powder.

2.3 Bioassays

To obtain the aqueous castor bean extract, the powder of crushed plant material (10 g) was transferred to an Erlenmeyer flask (100 mL) containing distilled water and Tween® 80 adhesive spreader (0.05 %) to obtain 100 mL of the initial 10 % (m/v) solution. The solution was maintained under homogenization on a transversal shaker (240 rpm) for 24 hours. After this period, the material was left to rest for approximately 30 minutes for decantation. Then, the supernatant was separated from the solid part through simple filtration with voile fabric and transferred to a volumetric flask, and the volume was adjusted to 100 mL.

The treatment consisted of ten repetitions and 12 pink mealybugs per repetition, totaling 120 insects. The individuals used were in the initial phase of development, we used nymphs as target individuals. The experimental units were kept in Petri dishes (10.0 x 1.2 cm), on coffee leaf discs with approximately 4 cm in diameter. The leaf discs were fixed to the Petri dish with a 0.5 cm layer of Agar-Agar solution and solid petroleum jelly around the disc to prevent insect escape, as described by Holtz *et al.* (2016). Each experimental unit was sprayed directly on the insects using an Alfa 2 model airbrush, connected to a calibrated compressor with a constant pressure of 1.3 psi and 2.0 mL of solution. Distilled water and the adhesive spreader Tween® 80 (0.05%) were used as controls. The insecticidal effect was evaluated 24, 48, and 72 hours after the activity. The experiment was conducted in a randomized design.



2.4 Lethal concentration estimate (LC50)

A quantity of 2.0 mL of the extract was sprayed in each repetition. The sprays were made in 10.0 x 1.2 cm Petri dishes lined with cotton using an Alfa 2 airbrush as a sprayer, connected to a calibrated compressor at a constant pressure of 1.3 psi corresponding to an average volume of 1.62 mg/cm² procedure similar to that mentioned before. For each product, concentrations spaced on a logarithmic scale were used (between the limits of 0.01 % and 10 %), and the dosages were obtained using formula C1. V1 = C2. V2, as a control, only distilled water was used. The concentrations of aqueous extracts were 2.5, 5.0, 7.5, and 10.0% (weight/volume).

The experiment was evaluated 24, 48 and 72 h after the solutions were starved. Lethal concentrations were estimated using Probit analysis. In light of these results, the ideal dosage was estimated. The Polo Pc program was used for the analyses, and subsequently the graphs were generated in the R version 4.2.3 environment (R CORE TEAM, 2023).

3 RESULTS AND DISCUSSIONS

The results of the present study revealed a direct correlation between the dosage of aqueous castor bean extract and the effectiveness in controlling pink mealybug nymphs. As the dosage of the extract was increased, a significant increase in the mealybug mortality rate was observed. Not only scale insects, but also other key pests such as leaf-cutter ants had their population reduced with the use of extracts (PERON & FERREIRA, 2012). This trend demonstrates the dose-dependent response of the aqueous castor bean extract, suggesting that higher concentrations of the substance are associated with greater effectiveness in suppressing the mealybug population (Figure 2). This can be explained by the exposure of individuals, as *M. hirsutus* is protected by a powdery shell that tends to facilitate the absorption of toxins via the dermal route, a fact also corroborated by Holtz *et al.* (2019). However, it is worth noting that direct application, in addition to affecting the individual as a whole, also affects the plant discs used in the experiment, meaning that when a mealybug tries to feed, it will also be affected by solutions of aqueous extracts of the castor bean leaf.

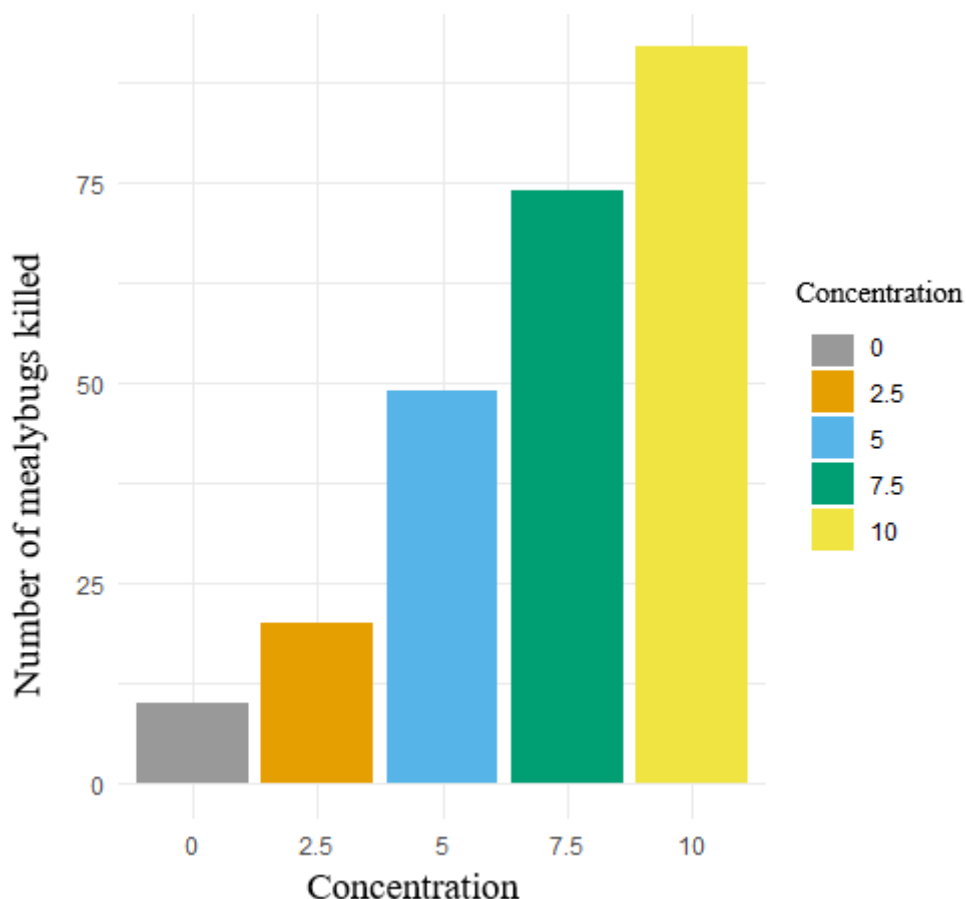


Figure 2. Relationship of extract concentration versus pink mealybug mortality. On the x-axis, extract concentrations are plotted against mealybug mortality on the y-axis.

Source: Author.

Therefore, discovering the lethal concentration (LC50) is extremely important in evaluating the effectiveness of a control agent, such as aqueous castor bean extract, on the mealybug population. The LC50 represents the concentration of the agent necessary to cause the death of 50 % of the target population in a given period of time. For this requirement, the data obtained in this study were analyzed using the Probit model, and the results indicate a good adaptation of the model to the observed data. The chi-square test (χ^2) with a value of 0.6085 suggests that the Probit model fits well with the experimental data, indicating a satisfactory agreement between the observed and expected results. The slope of the concentration-mortality curve was estimated at 2.24, revealing the relationship between the concentration of the aqueous castor bean extract and the mortality response of the pink mealybug.

The lethal concentration for 50% of the *M. hirsutus* population (LC50) was calculated at 6.14%, with a confidence interval between 5.40% and 7.02% (m/v), as shown in Figure 3. This estimate provides a reliable range for the concentration of aqueous castor bean extract required to cause the desired mortality in the target population. This tends to reinforce the toxic effects arising from the ricinin alkaloid, which is present in castor bean leaves (OLIVEIRA *et al.*, 2005).

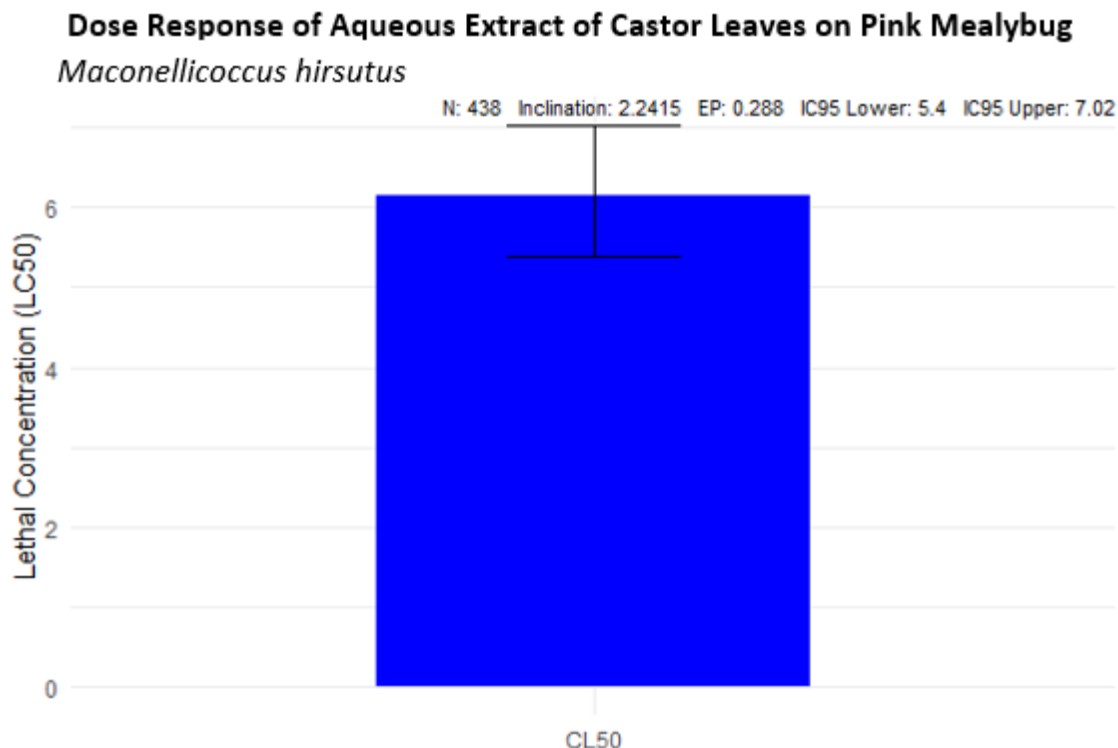


Figure 3: Lethal response concentration of castor leaf aqueous extract. The concentrations used in the test are plotted on the x-axis and fifty percent of the lethal concentration is on the y-axis.

Source: Author.

Consistent discrepancies were observed between treatments incorporating castor bean extract and the control group, highlighting its efficacy in various contexts (Figure 2). When testing several aqueous extracts for the control of the *Aedes Aegypti* (Diptera: Culicidae) mosquito, Santos *et al.* (2016) concluded that the *R. communis* extract was the most efficient, resulting in 100% larval mortality at all concentrations tested. The observed result is in line with our study which as the concentration increases, mortality increases (Figure 2), obtaining an LC50 between 6.14%, with a confidence interval between 5.40% and 7.02% (m /v) (Figure 3). This was also corroborated by Lima *et al.* (2013), highlighting the extract as the most suitable for controlling whitefly nymphs, *Bemisia tabaci* (Hemiptera: Aleyrodidae), in pumpkin plantations. Furthermore, Pavarini *et al.*, (2010) observed that the use of this extract caused a significant repellent effect against the banana borer, *Cosmopolites sordidus* (Coleoptera: Curculionidae). These convergent results reinforce the versatility and potential of castor bean extract as an effective and broad-spectrum alternative for controlling different agricultural pests.

A residual effect of the extract on the applied leaves was also observed in the test. In the place where the dead individuals were found, a sticky appearance was observed, which leads us to state that in addition to the effect on mealybug mortality, this extract demonstrated bioactivity at the site of application. The extract was observed for 15 days and maintained a strong and active odor similar to that observed by Carvalho *et al.* (2015). The authors observed that even 30 days after application, the extracts did not differ from the synthetic products, but the impact of the extracts was negligible compared to the chemical products. This tends to help maintain environmental balance, as it reduces residues of synthetic products in the soil, plants, and beneficial individuals that help provide ecosystem services. This fact was also diagnosed



by Torres *et al.* (2006) who stated that the use of extract-based products is a viable alternative to compose control practices in integrated pest management.

4 CONCLUSION

The determination of the LC₅₀ of the aqueous extract of castor beans reveals its effectiveness in controlling mealybugs in tests carried out in the laboratory, providing a sustainable alternative and reducing dependence on chemical pesticides, promoting more ecological agriculture. These findings highlight the significant contribution of the extract as an effective tool in integrated decision management.

ACKNOWLEDGEMENTS

We thank the Espírito Santo Research and Innovation Support Foundation (FAPES) and the National Council for Scientific and Technological Development (CNPQ) for the financial support granted, contributing significantly to the carrying out of this research. We also thank the Federal Institute of Espírito Santo (IFES), Campus Itapina, for the availability of essential resources and infrastructure for the development of this study.

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