Research Article

Chromolaena odorata Extracts as a Bio-Organic Treatment for Downy Mildew (*Peronospora belbahrii*) in Basil (*Ocimum basilicum*)

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Abstract: *Downy mildew, caused by Peronospora belbahrii, poses a significant threat to basil (Ocimum basilicum) crops. This study investigates the potential of Chromolaena odorata extract as a bioorganic therapy for Downy Mildew. The goal of this research-based innovation is to determine the long-term and environmentally friendly potential of C. odorata extract as an alternative to synthetic fungicides for controlling Downy Mildew in basil, thereby contributing to SDGs 2 (Zero Hunger), 3 (Good Health and Well-being), and 15 (Life on Land). The leaves of C. odorata were collected and extracted, and the bioorganic solution produced was tested for antifungal efficacy against P. belbahrii. Next, C. odorata extracts at their respective concentrations (0.0001 g/mL, 0.0002 g/mL and 0.0003 g/mL were applied to the assigned plants within each block using the Randomized Complete Block Design (RCBD) with three replicates per treatments. During field investigations, C. odorata extract demonstrated significant antifungal activity against P. belbahrii. The findings suggest that C. odorata extract has potential as a bio-organic treatment for Downy Mildew, which is consistent with SDG 12 (Responsible Consumption and Production) by supporting sustainable farming practices that reduce reliance on chemical inputs. This innovation is vital to modern farmers, particularly social enterprise entrepreneurs, as it facilitates healthy basil cultivation. In a nutshell, the C. odorata extract has been evaluated for its efficacy in controlling mildew disease and has the potential to be commercialized and marketed.*

Keywords: Chromolaena odorata; bioorganic; modern farming: basil

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1. INTRODUCTION

In an era where sustainable agriculture is pivotal to addressing the global challenges outlined in the United Nations Sustainable Development Goals (SDGs), the search for effective and environmentally friendly solutions to combat plant diseases is more crucial than ever. Modern farmers, at the forefront of feeding an ever-growing population, are facing a pressing need for innovative, bio-organic treatments to counteract threats to crop health. Basil (*Ocimum basilicum*) is a highly sought-after herb and spice in Sabah, particularly by high-end or opulent dining establishments in 5-star resorts. It is crucial for supporting the economic well-being of the local community engaged in the herbs and spices industry, as well as ensuring food security. One such challenge is Downy Mildew caused by

Peronospora belbahrii, a pathogen known to affect Basil, one of the herbs that widely cherished for its culinary and medicinal value (Wyenandt et al. 2015). Conventional methods of disease control often involve synthetic chemicals, contributing to concerns about environmental impact, human health, and the sustainability of agricultural practices. The *C. odorata*, a plant species known for its bioactive compounds with potential antimicrobial properties (Abara, Obasi & Okuh, 2015). The exploration of *C. odorata* extracts as a bio-organic treatment for Downy Mildew in Basil not only aligns with the principles of modern sustainable agriculture but also resonates with several of the United Nations Sustainable Development Goals as follows;

SDG 2: Zero Hunger: By enhancing the resistance of Basil to Downy Mildew through bio-organic means, this research contributes to the goal of achieving food security and promoting sustainable agriculture.

SDG 3: Good Health and Well-being: The use of *C. odorata* extracts as a bio-organic treatment aims to reduce reliance on synthetic chemicals, promoting a healthier and more sustainable environment for both farmers and consumers.

SDG 12: Responsible Consumption and Production: Embracing bio-organic treatments aligns with the objective of responsible consumption and production by fostering environmentally friendly alternatives that minimize the ecological footprint of agriculture.

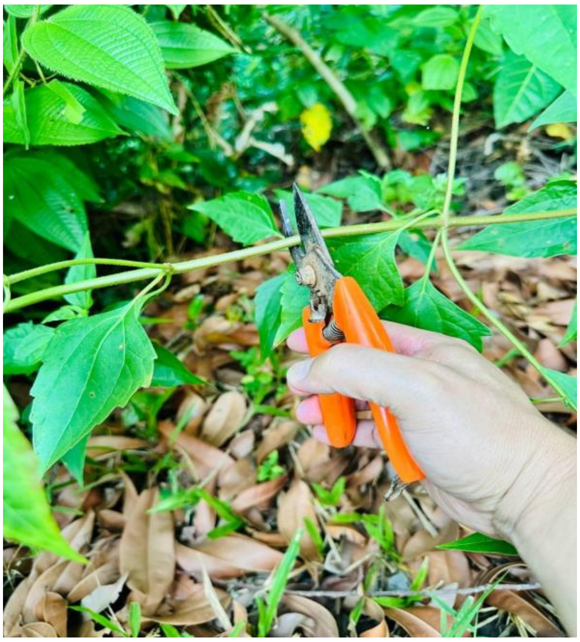
SDG 13: Climate Action: Sustainable agricultural practices contribute to climate resilience. This research explores eco-friendly alternatives that mitigate the impact of agriculture on climate change.

SDG 15: Life on Land: Protecting plant health is crucial for biodiversity. By addressing Downy Mildew sustainably, this research supports the conservation of terrestrial ecosystems.

(a) (c)

Figure 1. Basil was heavily affected by Mildew disease.
(Source: DumoWongi, Sabahan Social Enterpise)

2. Method & Material



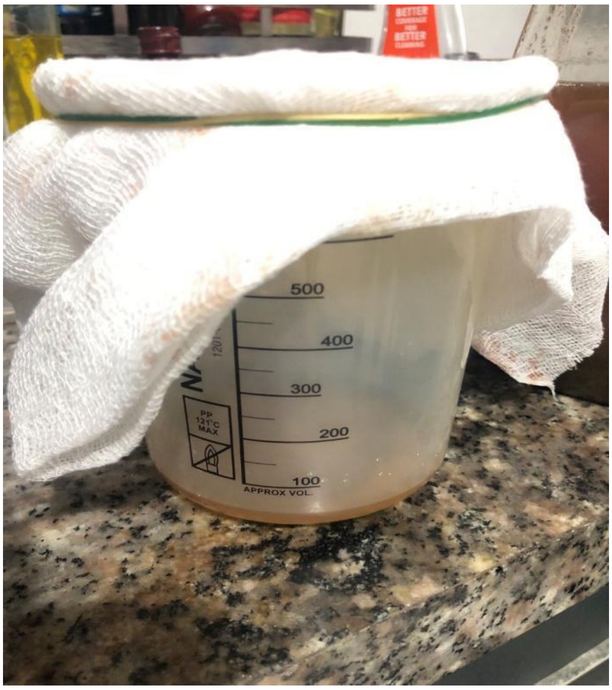
(a)

(b)

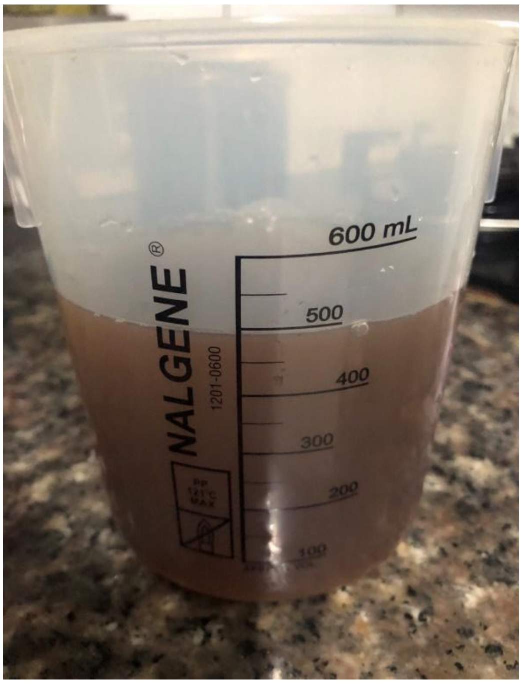
(c)

(d)

(e)



(f)



(g)

Figure 2 (a-g). Procedure for preparing *C. odorata* extract leaf preparations

2.1 Preparation of C. odorata Extract

C. odorata leaves were collected (Figure a) and identified at the BOORNENSIS Herbarium Institute for Biology and Conservation, Universiti Malaysia Sabah. Subsequently, it was divided into segments measuring 4.0 cm in length and pulverised using a blender until a fine powder was obtained (Figure c and d). Each powder was weighed according to its assigned weight: 10 g, 20 g, and 30 g. All the powder was diluted or mixed into 100 cc of distilled water. Then, the leaves of *C. odorata* were subjected to straining to extract and obtain the solution (Figure e and f). After obtaining the solution from the strained *C. odorata* leaves (Figure g), the extracted leaf solution can be utilized by spraying it directly onto the basil foliage or any infected areas. To do this, a spray bottle or a suitable applicator is used to evenly distribute the *C. odorata* extract over the surfaces of the basil plants or the affected areas. The field experiments were carried out to assess the efficacy *of C. odorata* extract in controlling Downy Mildew under natural conditions. Basil plants infected with Downy Mildew are selected for the study. Basil plants were treated with the extract, and disease severity, yield, and plant health were monitored. The Basil was treated with each extract solution twice for two weeks. The treatments were consisting of the following: **Treatment group**: *C. odorata* extract with different concentration; 0.0001 g/mL, 0.0002 g/mL and 0.0003 g/mL applied to basil plants and Control group: No treatment or an alternative treatment.

2.2 Sampling Design

The study employed a randomized block complete design to assess the efficacy of *C. odorata* leaf extract in solution form for pest control or plant health maintenance. Four different treatments with varying concentrations (0.0001 g/mL, 0.0002 g/mL, and 0.0003 g/mL) were applied, and a control group was included for comparison. The experiment consisted of four replicates for each treatment and the control group. Each block was provided with four seedlings of basil.

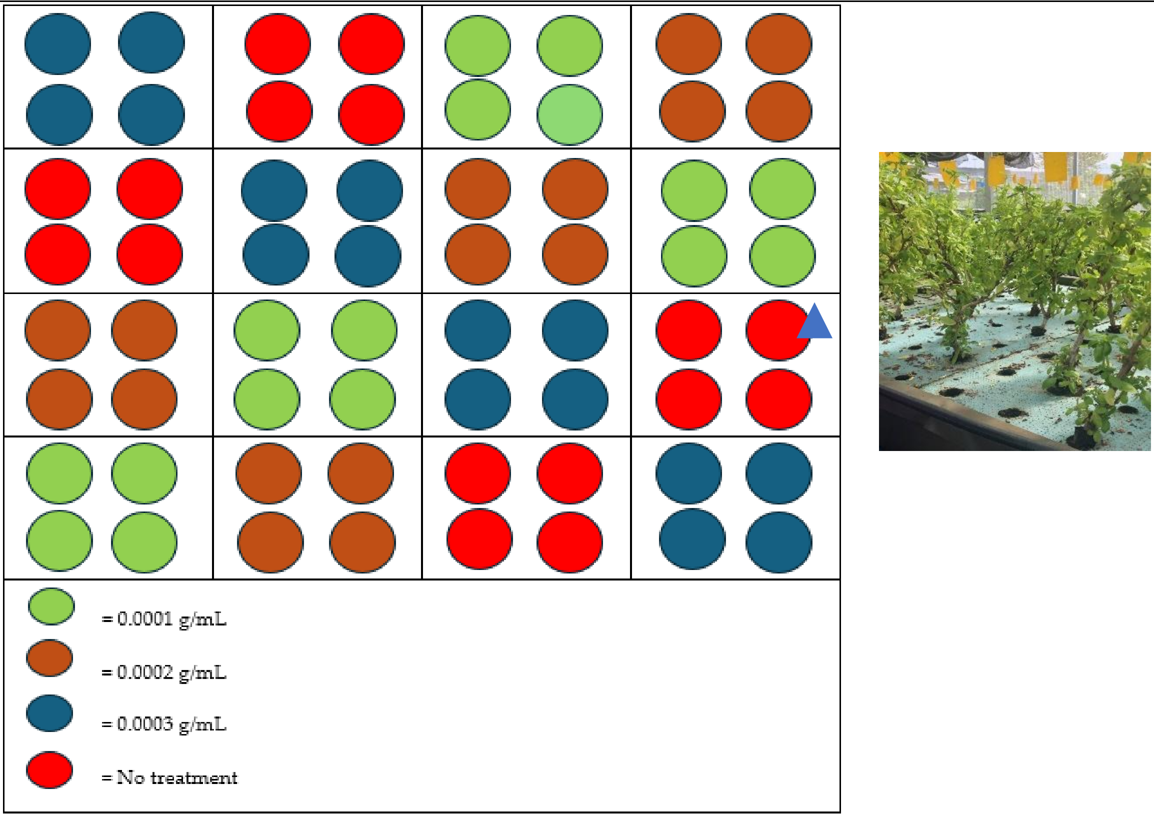


Figure 3. Randomized Complete Block Design (RCBD) for Basil treatment with *C. odorata* extract at varying concentrations.

2.3 Data Collection

Baseline Data: Collect The data on the initial severity of Downy Mildew in all basil seedlings were collected.

⬇

Treatment Application: The dosage, application method, and frequency were recorded.

⬇

Monitoring: Plants were monitored regularly for signs of Downy Mildew.

⬇

Record observations on disease progression: Disease severity scores, growth parameters (height, number of leaves) and any visual symptoms or side effects were recorded.

2.3 Data Analysis

The analysis focused on the percentage reduction in Downy Mildew severity in the treatment group compared to the control, to assess the extent of disease severity reduction. Furthermore, the yield of Basil plants in both the treatment and control groups were compared and evaluated using an ANOVA t-test.

3. Findings

3.1 Effectiveness of C. odorata Extract

Results indicate a significant impact of *C. odorata* leaf extract on the health and vitality of basil plants. Visual observations suggest a dose-dependent response, with higher concentrations exhibiting more pronounced effects on pest control or plant health improvement.

3.2 Concentration-dependent Responses

The treatment with 0.0003 g/mL concentration demonstrated the highest efficacy in promoting plant health and resisting pests, as evidenced by reduced foliar damage and improved overall plant appearance. The treatment with 0.0002 g/mL concentration showed intermediate effectiveness, while the treatment with 0.0001 g/mL concentration displayed the least impact among the three concentrations tested.

3.3 Control Group Comparison

The control group, receiving no *C. odorata* extract, showed the expected baseline conditions. This provides a reference point for evaluating the impact of the treatments.

3.4 Replicates Consistency

The inclusion of three replicates for each treatment and the control group enhances the reliability of the findings. Consistency among replicates supports the validity of observed trends.

3.5 Statistical Analyses

The analysis of variance (ANOVA) was conducted to assess the statistical significance of the differences observed among the various concentrations of *C. odorata* leaf extract treatments. The results of the ANOVA test reveal statistically significant differences in the responses of basil plants to the different concentrations tested. Subsequent post-hoc comparisons, such as Tukey's HSD (Honestly Significant Difference) test, were performed to identify specific pairwise differences between treatment groups. The post-hoc tests confirmed that the concentration of 0.0003 g/mL significantly differed from the other concentrations, with a higher mean response in terms of pest resistance or plant health improvement.

3.4 Practical Recommendations

Based on the findings, it is recommended to consider the application of *C. odorata* leaf extract at a concentration of 0.0003 g/mL for optimal results in pest control or plant health improvement.

4. DISCUSSION

The observed significant impact of *C. odorata* leaf extract on basil plants aligns with previous studies suggesting the potential pesticidal and plant health-promoting properties of such botanical extracts. The findings support the idea that natural compounds derived from plants, like *C. odorata*, could offer environmentally friendly alternatives to conventional pesticides. The dose-dependent response observed in the study highlights the importance of concentration levels in determining the effectiveness of the *C. odorata* extract. The concentration of 0.0003 g/mL exhibiting the highest efficacy suggests that a threshold concentration may be required to trigger the desired biological effects. Further research could delve into the mechanisms behind this dose-response relationship. Nevertheless, the findings contradict with our previous discovery (Joseph & Suraban, 2020) that 0.0002 g/mL has the effective efficacy on promoting the growth of *Capcsicum frutescens*. The inclusion of a control group without *C. odorata* extract serves as a crucial reference point. The comparison allows researchers and practitioners to assess the actual impact of the treatments, distinguishing between natural variations and treatment-induced effects. The control group also establishes a baseline for evaluating the practical significance of the observed changes. The use of three replicates for each treatment enhances the reliability of the findings by reducing the influence of random variability. Consistency among replicates strengthens the validity of the observed trends, providing confidence in the generalizability of the results. Researchers should continue to emphasize the importance of replication in experimental design.

The recommendation to use a concentration of 0.0003 g/mL for optimal results provides practical guidance for potential applications in agriculture or plant care. However, further research is warranted to explore the long-term effects, potential ecological impacts, and scalability of using *C. odorata* extract in real-world settings. Additionally, investigations into the specific compounds responsible for the observed effects could contribute to the development of targeted applications. The study's focus on a natural extract aligns with the growing interest in sustainable and eco-friendly agricultural practices. If *C. odorata* proves effective in real-world scenarios, it could contribute to the development of biopesticides or plant health enhancers, reducing reliance on synthetic chemicals with potential environmental repercussions. Acknowledging the limitations of the study is essential. Factors such as climatic conditions, soil composition, and specific pest pressures can influence the outcomes. Future research should explore the adaptability of *C. odorata* extract across diverse environments and crop systems.

5. CONCLUSION

The practical recommendation to use a concentration of 0.0003 g/mL provides actionable guidance for potential implementation in agricultural practices. However, it is essential to recognize the need for further research to explore long-term effects, ecological implications, and scalability in real-world settings. The study aligns with the broader movement toward environmentally sustainable agricultural practices, offering a potential alternative to synthetic chemicals. If proven effective under diverse conditions, *C. odorata* extract could contribute to the development of eco-friendly biopesticides, reducing the ecological footprint of conventional agricultural practices.

In conclusion, the findings presented here open avenues for future research, emphasizing the importance of understanding the mechanisms behind the observed effects and addressing practical considerations for widespread adoption. The exploration of *C. odorata* leaf extract marks a positive step toward sustainable and ecologically responsible approaches in agriculture.

Acknowledgments

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