JPPIPA 10(9) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Potential of Pangi Leaf Extract For Papaya Mealybug Control (Paracoccus marginatus)

Juliet Merry Eva Mamahit[1*], Vivi B. Montong[1], Sandra E. Pakasi[2]

[1] Department of Plant Protection, Faculty of Agriculture, Sam Ratulangi University, Manado, Indonesia
[2] Department of Agroecotechnology, Faculty of Agriculture, Sam Ratulangi University, Manado, Indonesia

Received: July 19, 2024
Revised: August 28, 2024
Accepted: September 27, 2024
Published: September 30, 2024

Corresponding Author:
Juliet Merry Eva Mamahit
evamamahit@unsrat.ac.id

DOI: 10.29303/jppipa.v10i9.9149

Abstract: The use of smer plant extracts is one alternative in environmentally friendly pest control. This research generally aims to obtain a technology for controlling Paracoccus marginatus mealybug pests that is environmentally friendly and easily applied by farmers. This study aims to determine the formulation of vegetable insecticide extract of pangi leaves to control papaya mealybug P. marginatus. This research was conducted at the Laboratory of Plant Pests and Diseases, Faculty of Agriculture, Sam Ratulangi University Manado. This research method used consisted of five treatments of pangi leaf extract dosage, namely: 5%, 10%, 20%, 40% and control. Each treatment was tested on pest nymphs. P. marginatus. And each treatment was repeated 5 times. The results of the study showed that 40% pangi leaf extract had the highest percentage of daily mortality at 24% and 48%. The higher the concentration of pangi leaf extract formulation, the higher the killing power on mealybug P. marginatus.

Keywords: Mealybug; Paracoccus marginatus; Papaya; Plant-based insecticide

Introduction

The mealybug Paracoccus marginatus belongs to the order Hemiptera, family Pseudococcidae which are small, invasive, piercing insects sucking fluids, polyphagous and soft-bodied (Prakash et al., 2024). The papaya mealybug, P. marginatus, is an invasive pest species that originated in Mexico and Central America and has been found worldwide (Zhao et al., 2024). It can now be found in more than 50 countries and regions, seriously threatening the safety of the agricultural and forestry industries. Hariri et al (2016) reported the host plants of this pest are soya, cassava and maize. Papaya mealybug infestation has been recorded on more than 200 host plants in 25 plant families. Host plants of mealybugs include: hibiscus, mulberry, avocado, guava, citrus, cotton, tomato, eggplant, bell pepper, chickpea, pea, sweet potato, potato, mango, cherry, pineapple, jatropha, chilli, chickpea, okra, pomegranate and papaya (Amarasekare et al, 2008; (Prakash et al., 2024).

Mealybugs have piercing sucking mouthparts by thrusting their mouthparts into plant tissue and sucking. Females are wingless and move short distances by crawling or being carried by the wind. The female imago is yellow in colour and covered with a white waxy powder. Imago is approximately 2.2 mm long and 1.4 mm wide (D. R. Miller & Miller, 2002). The male imago is pink in colour, but appears yellow in the first and second in stars. The male is approximately 1.0 mm long, has an elongated oval body shape and the widest part of the thorax measures ± 0.3 mm. The male has 10-lobed antennae, lateral pore groups, a highly sclerotised thorax and head and wings (William & Willink, 1992; D. William, 2004).

This pest spreads rapidly and has been reported to attack papaya and other crops worldwide (Muniappan et al. 2006; Zhao et al. 2024), including in many places

How to Cite:
Mamahit, J. M. E., Montong, V. B., & Pakasi, S. E. (2024). Potential of Pangi Leaf Extract For Papaya Mealybug Control (Paracoccus marginatus). *Jurnal Penelitian Pendidikan IPA*, *10*(9), 6690–6694. https://doi.org/10.29303/jppipa.v10i9.9149

throughout Indonesia (Sartiami et al., 2009; Mamahit et al., 2010; Maharani et al., 2016; Rauf & Sartiami 2022). The papaya mealybug Paracoccus marginatus is not only a national problem in Indonesia but is now an international problem as it is spreading rapidly throughout the world especially in tropical and subtropical climates. This pest threatens papaya plants and other types of plants because this pest is polyphagous or eats many types of agricultural plants as well as horticultural and ornamental plants. In addition, this pest is very dangerous because it has a high egg-laying capacity. In severe infestations, black-coloured sooty mould growth is formed, reducing the photosynthetic efficiency of the plant and yield losses of almost 100% (Prakash et al., 2024).

The results of research by Mamahit (2013) showed that mealybugs can attack papaya plants from the vegetative to generative phase, namely on the leaves, stems, stalks to papaya fruit. Papaya mealybugs attack papaya plants by sucking plants by thrusting their stylets into the epidermis of leaves, fruit and stems. While stabbing their stylets, these mealybugs infect a toxic compound into the leaves which results in chlorosis, dwarfing, mis-shapen leaves, young leaves and fruit dropping, the formation of a lot of honeydew and further attack of the plant eventually the plant dies (Tanwar et. al. 2010).

The spread of mealybugs can be caused by wind, carried by seeds, carried by people, or carried by other insects and birds. The presence of mealybugs that are quite high and polyphagous has the potential to spread greatly. Research results from Mamahit and Sembel (2011) found that the mealybug P. marginatus is not only spread in Manado and surrounding areas, but has spread in almost all regions in North Sulawesi including Minahasa, North Minahasa, to South Minahasa and Southeast Minahasa. Furthermore, research by Mamahit (2013) found that this pest can reduce yields, because mealybugs suck plant fluids from leaves to fruit, and the attack rate can reach 80%. The damage caused by this pest will cause chlorosis, yellow colour, wrinkling, curling and wilting of the leaves. The heaviest attack is on the fruit, making the fruit become small and fall off.

To control these pests, farmers still focus on the use of chemical pesticides. To control insects, synthetic chemicals are continuously used, and their toxicity endangers the health of agricultural operators, animals, and consumers (Hikal et al., 2017). One of the techniques to control the mealybug pest P. marginatus is the use of natural enemies, including parasitoids such as Acerophagus papayae (Meyerdirk et al., 2004; Miller et al., 2024), but the disadvantage is that the propagation of natural enemies requires special handling in maintenance and application in the field. For this reason, nowadays, the negative effects on human health due to the dangers of chemical insecticides have led to a resurgence of interest in botanical insecticides due to their minimal cost and no ecological side effects. The use of plant-based insecticides or insecticides that are derived from plants is growing. Plants basically contain many chemicals that are the production of secondary metabolites and are used by plants as a means of defence from pest attacks. More than 2,400 plant species belonging to 235 families are reported to contain pesticide ingredients. Therefore, if it can process these plants as pesticide materials, it will help the farming community to use environmentally friendly controls by utilising local resources in the vicinity (Kardinan, 2002). Plant parts that can be used as botanical insecticides are flowers, leaves, roots and stems which are crushed and then directly used as insecticides (Prijono, 2006).

Pangi (Pangium edule Reinw.) is another name for the Picung or kluwek plant that grows in many regions in Indonesia. Pangi plants are widely spread in North Sulawesi, but the utilisation of pangi is still lacking due to lack of information. For pest control, pangi can be utilised because it has toxic properties including alkaloids, tannins, phenols and terpenoids (Sulistianingsih et al., 2014; Kaitana et al., 2023). The results of research by Wiryadiputra et al (2014) on the application of pangi plant extract on the mortality of coffee fruit borers. For this reason, environmentally friendly pest control efforts, namely pest control by utilising plants that have insect toxic properties such as: pangi (Pangium edule) leaf extract need to be developed. The results of the extra-use test of this plant are expected to be used as a bio-insecticide that is able to control mealybugs naturally so that it can reduce farmers' dependence on the use of pesticides. The purpose of this study was to determine the potential use of vegetable insecticides, namely pangi leaf extract for controlling papaya mealybug P. marginatus and to obtain an effective formulation of pangi leaf extract for controlling P. marginatus mealybug.

This research generally aims to apply the technology of controlling the mealybug pest P. marginatus that is environmentally friendly and easy for farmers to make and apply, by utilising the potential of available natural resources, so that the use of chemicals for pest control of papaya plants can be minimised. This research is useful for reducing the use of chemical/pesticide control by utilising biological control derived from plants.

Method

This research was conducted in the laboratory to test the effectiveness of pangi (Pangium edule) leaf extract as an insecticide to control papaya mealybug

(Paracoccus marginatus). This research was conducted in the laboratory of Pests and Plant Diseases, Faculty of Agriculture, Unsrat. Materials and tools used were: pangi leaves, papaya mealybug test insects (Paracoccus marginatus), papaya leaves, distilled water, gauze, blender, measuring cup, label paper, mealybug rearing container, sieve, knife, scissors, scales, hand sprayer, loupe, microscope.

Preparation of Plant Extract of pangi (Pangium edule) leaves

The vegetable insecticide material used is a typical plant of North Sulawesi Province, namely pangi leaves. The making of pangi leaf extract is done by cleaning the leaves with water, then cutting the pangi leaves into small sizes. Then weighed as much as 1000 grams, then blended by adding 1000 ml of water so that the pangi leaves are crushed, then squeezed so that a green extract is obtained.

Preparation of test insect nymphs

The test insect, P. marginatus, was collected from papaya growing centres in Dimembe village, North Minahasa district. Infested fruits were brought to the laboratory to be reared under laboratory conditions. Subsequently, mealybug nymphs that were sufficiently populated were tested according to the treatment.

Testing of pangi leaf extract

Pangi leaves were cut into small pieces and then water was added and blended until smooth and then the extract was filtered. The results of the extraction were used as test material on P. marginatus ticks. The treatment consisted of pangi leaf extract with five levels of extract dosage, namely: 5%, 10%, 20% and 40% and 0% (control). A total of 10 mealybugs were put in a container containing papaya leaves that had been sprayed with plant extracts according to the dose of vegetable insecticide extracts from plants. Each treatment was repeated 5 times. The observation parameters in this study were: Daily mortality, total mortality and symptoms of death.

Result and Discussion

The results of laboratory studies using pangi leaf extract with several concentrations as treatments showed that the plants tested caused death in papaya mealybug P. marginatus. In this study, laboratory conditions were made stable and homogeneous, so that the percentage of flea mortality at 24 hours to 120 hours of observation was due to the treatment of pangi leaf extract, not death due to the influence of environmental factors. The highest mortality could be achieved in the treatment of 40% concentration of bitter melon leaf extract, which reached 22% mortality at 24 hours and 32% at 48 hours after treatment. The daily percentage of mortality at 24 hours and 48 hours treated with pangi leaf extract is presented in Table 1. From the results of the study, it was explained that mortality increased in relation to the increasing concentration of the test plant extract. In the control treatment (P0) until the 48-hour observation there was no death of mealybugs.

This study shows that pangi leaves are potential enough to be used as a vegetable pesticide to control papaya mealybugs. In the P4 treatment (40%) daily mortality both 24 hours and 48 hours was higher than the other treatments. The results of this study indicate the potential of pangi leaves to control papaya mealybugs. The potential of pangi leaves as a bioinsecticide is in line with some previous studies. The results of research by Sulistianingsih et al (2014) showed that pangi leaves with concentrations of 10 ppm, 20 ppm and 30 ppm have toxicity to control Pomacea caniculata. In addition, pangi leaves can be used as a vegetable pesticide to control coffee fruit borers (Hypothenemus hampei) (Wiryadiputra et al., 2014).

Table 1. Observation results of 24-hour and 48-hour daily mortality against Paracoccus marginatus mealybugs with pangi leaf extract treatment.

Plant-based insecticide treatment	Daily mortality 24 hours (%)	Daily mortality 48 hours (%)
P0 (0%)	0	0
P1 (5%)	4	14
P2 (10%)	6	24
P3 (20%)	18	28
P4 (40%)	22	32

The results showed that the higher the extract of pangi leaves given showed higher insect mortality (Figure 1). This shows the ability of pangi leaf toxicity to control mealybug pests increases as the concentration of active ingredients given increases. Insecticides enter the insect's body in various ways, including as contact poisons that can enter the body through the skin or body wall of the insect, stomach or mouth poisons, enter through the insect's digestive system and finally by fumigant, which is a poison that enters through insect respiration. The potential for pest control by giving pangi leaf extract is due to the content of active ingredients from pangi leaves which consist of: alkaloids (2.69 ppm), tannins (16.0 ppm), flavonoids (1.23 ppm) and cyanide (122.76 ppm) (Sulistianingsih et al., 2014).

The use of pangi leaf extract on mealybug insects, will affect the movement of mealybugs by showing symptoms of mealybugs at first less active in moving, slower movement, then the fleas look still, but the limbs when touched are still moving, and eventually die. The food given to the test insects is pangi leaf extract which

contains compounds that can inhibit movement and feeding activities and eventually die. According to Hikal et al (2017), botanical insecticides affect various insects in different ways depending on the physiological characteristics of the insect species as well as the type of plant source of the botanical insecticide. The components of various botanical insecticides can be classified into six groups namely; repellent, antifeedant, toxic, growth inhibitor, chemosterilant and attractant compounds.

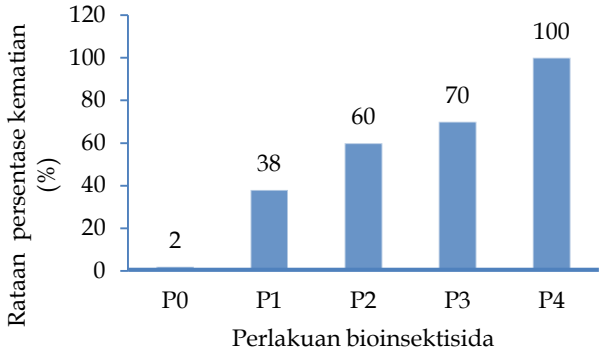

Figure 1. Average total mortality of P. marginatus in five treatments of pangi leaf extract on the fourth day after application

Symptoms of death are: the body of the flea which is initially pink in colour, when experiencing death will be blackish brown in colour. The change in insect colour is the insect's response to the presence of pangi plant extract which contains secondary metabolite compounds. Pangi leaf extract contains alkaloids, flavonoids, tannins, saponins, phenolic compounds, and cyanide compounds, with alkaloids being the most abundant (Kaitana et al., 2023). Saponins can affect the taste in mealybugs, which gives a bitter effect, so it can reduce the appetite of the bugs which eventually leads to death. In addition, saponins can damage the waxy layer that protects the outer insect body, so that insects will lose a lot of body fluids and cause death (Minarni et al., 2013). Saponins and flaphonoids contained in the extract are also stomach poisons capable of suppressing the development of these ticks (Kardinan, 2002). Plants containing alkaloid and phenolic extracts affect the average percentage of insect mortality (Al-Abdalli et al., 2024).

Test insects in the control treatment can carry out eating and moving activities. In contrast to the test plant extract treatment, it turned out to experience obstacles in movement and eventually experienced death. This is the same as the results of research by Wiryadiputra et al (2014) showing that the greater the concentration of plant extracts, the greater the number of cocoa stem borers killed. Likewise, the results of research by Rizal et al (2023) stated that the higher the concentration of citronella oil, clove oil and neem extract, the mortality of papaya mealybugs increased.

Conclusion

The results showed that pangi leaf extract has the potential to control mealybug pests on papaya plants. The application of pangi leaf extract at a dose of 40% had the highest percentage of daily mortality of 24% and 48%. The higher the concentration of pangi leaf extract formulation, the higher the killing power on mealybugs P. marginatus.

Acknowledgments
We would like to thank all parties involved in the completion of this research.

Author Contributions
MHM: Developing ideas, analyzing, writing, reviewing, responding to reviewers' comments; JF, ET: analyzing data, overseeing data collection, reviewing scripts, and writing.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Al-Abdalli, A. F. T., Alebady, E. Q. M., & Hamdoon, A. M. (2024). Efficiency of Alkaloid and Phenolic Extracts of Seeds and Leaves Sesbania Plant on Adults Red Flour Beetle Tribolium castaneum Herbst (Coleoptera : Tenebrionidae). *IOP Conference Series: Earth and Environmental Science*, *1371*(3). https://doi.org/10.1088/1755-1315/1371/3/032013

Hariri, A. M., Saraswati, K. D., Suskandini Ratih Dirmawati, & Fitriana, Y. (2016). Jurnal Agrotek Tropika Jurnal Agrotek Tropika. *Jurnal Agrotek Tropika*, *12*(2), 259–269. https://doi.org/http://dx.doi.org/10.23960/jat.v12i2.8936

Hikal, W. M., Baeshen, R. S., & Said-Al Ahl, H. A. H. (2017). Botanical insecticide as simple extractives for pest control. *Cogent Biology*, *3*(1), 1404274. https://doi.org/10.1080/23312025.2017.1404274

Kaitana, Y., Kurnia, N., Tulung, M., Tuda, J. S. B., Mamahit, J. M. E., & Tallei, T. E. (2023). The potentials of pangi leaf extract for Aedes spp. mosquito control. *Journal of Advanced Biotechnology and Experimental Therapeutics*, *6*(1), 133–139. https://doi.org/10.5455/jabet.2023.d112

Kardinan, A. (2002). *Pestisida Nabati: Ramuan dan*

Aplikasi. Penebar Swadaya.

Maharani, Y., Rauf, A., Sartiami, D., & Anwar, R. (2016). Biology and life table of papaya mealybug Paracoccus marginatus Williams & Granara de Willink (Hemiptera: Pseudococcidae) on three host plant species. *Journal of Tropical Plant Pests and Diseases*, *16*(1), 1–9. https://doi.org/10.23960/j.hptt.1161-9

Mamahit, J. M. E. (2013). *Serangan Hama Kutu Putih Paracoccus marginatus*.

Mamahit, J. M. E., Manengkey, G. S. J., & Makal, H. V. G. (2010). eugenia_V16_No3_Des_2010.pdf. *Eugenia*, *16*(3), 161–167.

Meyerdirk, D. E., Muniappan, R., Warkentin, R., Bamba, J., & Reddy, G. V. P. (2004). Biological control of the papaya mealybug , Paracoccus marginatus (Hemiptera : Pseudococcidae) in Guam. *Plant Protection Quarterly*, *19*(3), 110–114. https://www.cabidigitallibrary.org/doi/full/10.5555/20043160011

Miller, D. R., & Miller, G. L. (2002). Redescription of Paracoccus marginatus Williams and Granara de Willink (Hemiptera: Coccoidea: Pseudococcidae), including descriptions of the immature stages and adult male. *Proceedings of the Entomological Society of Washington*, *104*(1), 1–23. https://biostor.org/reference/55581

Miller, S. O., Makale, F., Nyasani, J. O., Muvea, A., Kabole, M., Chacha, D., Agboyi, L. K., Asudi, G. O., Rehman, A., Luke, B., & Rwomushana, I. (2024). Prospects of classical biological control of papaya mealybug in Kenya: Performance of its exotic parasitoid, Acerophagus papayae, under laboratory and field conditions. *Crop Protection*, *175*(October), 106476. https://doi.org/10.1016/j.cropro.2023.106476

Minarni, E., Armansyah, T., & Hanafiah, M. (2013). Daya Larvasida Ekstrak Etil Asetat Daun Kemuning (Murraya Paniculata (L) Jack) Terhadap Larva Nyamuk Aedes aegypti. *Jurnal Medika Veterinaria*, *7*(1), 27–29. https://doi.org/10.21157/j.med.vet..v7i1.2915

Prakash, H., Veershetty, C., Shukla, P., Subrahmanyam, G., & Moorthy, S. M. (2024). Stereo-microscopic study of the anatomy of papaya mealybug Paracoccus marginatus (Williams and Granara De Willink). *International Journal of Tropical Insect Science*. https://doi.org/10.1007/s42690-024-01342-1

Prijono, D. (2006). Pedoman praktis pengembangan dan pemanfaatan insektisida botani. *Fakultas Pertanian, Institut Pertanian Bogor*, *January*. https://doi.org/10.13140/RG.2.2.25798.63042

Rizal, M., Lidar, S., & Ibrahim, R. (2023). Efektivitas Insektisida Nabati Dalam Mengendalikan Hama Kutu Putih (Paracoccus Marginatus) Pada Tanaman Pepaya (Carica papaya L.). *Jurnal Pertanian Presisi (Journal of Precision Agriculture)*, *7*(1), 86–93. https://doi.org/10.35760/jpp.2023.v7i1.8086

Sartiami, D., Dadang, Anwar, R., & Harahap, I. S. (2009). Prosiding Semnas PERLINTAN (artikel 2)_. *Seminar Nasional Perlindunagn Tanaman*, 453–462.

Sulistianingsih, M., Jati, A. W. N., & Zahida, F. (2014). *Uji Toksisitas Biji Kluwak (Pangium edule Reinw.) sebagai Moluskisida pada Keong Mas (Pomacea caniculata Lamarrk, 18044 pada Tanaman Padi*. Universitas Atnajaya, Jogjakarta.

William, D. (2004). *Mealybug of Southern Asia.* Southdene SDN BHD.

William, D. ., & Willink, M. C. G. de. (1992). *Mealybug of Central and South America.* CAB International.

Wiryadiputra, S., Rusda, I., Iis Nur Asyiah, D., Perlindungan Tanaman, P., & Penelitian Kopi dan Kakao Indonesia, P. (2014). Pengaruh Ekstrak Tanaman Picung (Pangium edule) Sebagai Pestisida Nabati Terhadap Mortalitas Penggerek Buah Kopi. *Pelita Perkebunan*, *30*(3), 220–228.

Zhao, Q., Li, H., Chen, C., Fan, S., Wei, J., Cai, B., & Zhang, H. (2024). Climate Change Conditions , Using MaxEnt. *Insects*, *15*(98), 1–16. https://doi.org/https://doi.org/10.3390/insects15020098