The Effectiveness of *Carica Papaya* Linn. LEAF Extract with the Contact Poison Method for Controlling Subterranean Termites *Coptotermes sp.* (Isoptera: Rhinotermitidae)

Zulyusri Zulyusri[1(✉)], Rosi Fitri Ramadhani[1], and Desyanti Desyanti[2]

[1] Department of Biology, Faculty of Mathematics and Netural Sciences, Universitas Negeri Padang, Padang, Indonesia
zulyusri0808@gmail.com

[2] Faculty of Forestry, University of Muhammadyah Sumatera Barat, Padang, Indonesia

Abstract. The study to find out the effectiveness of *Carica papaya* leaf extract using contact poison on the termite *Coptotermes* sp., one of the most harmful types of termite, mortality was conducted. This research using an experimental research with Completely Randomized Design (CRD) in seven extract treatments and 3 replications. Analysis of variance (ANOVA) and followed by Duncan test at 5% significance level is using to count mortality data and the loss of feed. The lethal concentration (LC) and lethal time (LT) were analyzed by Probit analysis. The results showed that through contact poison methods, the leaf extract of *C. papaya* Linn. is effectively applied to control termites and it functions most effective at a concentration of 1%. The lethal concentration (LC_{50}) leaf extract of *C. papaya* Linn. is 0.157% and lethal time (LT_{50}) is 3.976 days.

Keywords: *Coptotermes sp.* · *Contact poison methode* · *C. papaya Linn.* · *Leave extract*

1 Introduction

Termites are very important part in recycling plant nutrients through the process of disintegration and decomposition of organic material from wood and plant litter [1], but termites are often as potential pest because they damage buildings and other cellulose materials including live plants such as oil palm, rubber and industrial forest plantations. Such as pine, eucalyptus and others [2]. Termites are one of the wood-eating insects of the order Isoptera which are very dangerous for buildings that contain wood elements and wood derivatives (particle board, fiberboard, etc.) [3]. Each year losses due to termite attacks in Indonesia are recorded at around Rp. 224 billion to Rp. 238 billion [4]. C. curvignathus attack can cause more than 50% damage (heavy attack) resulting in death of oil palm plants [5].

One of the most harmful termites to humans is the termites belonging to the Rhinotermitidae class of the Coptotermes genus, namely *Coptotermes sp.*. These termites generally live on the ground and also in wood related to the soil. In addition, the termites

M. Fadilah et al. (Eds.): IcoBioSE 2021, ABSR 32, pp. 147–154, 2023.
https://doi.org/10.2991/978-94-6463-166-1_22

Coptotermes sp. can also live on wood that is not in contact with the ground, as long as the wood is always splashed with water [6]. *Coptotermes sp.* is a type of termite that makes an important contribution to wood damage by making burrows in wood and making it a place to live as well as a source of nutrition for termite colonies so that the wood becomes porous and destroyed [7]. *Coptotermes sp.* also damage wood and roots of rubber, oil palm, walnuts, flamboyants, and so on [8] Thus, controlling Coptotermes populations is very necessary.

Many attempts have been made to control termites both using chemicals and natural materials (biopesticides). Most of the termites control uses chemicals that are very toxic and not environmentally friendly (non-biodegradable) such as boric acid, CCB (Copper-Chrome-Boron), CCA (Copper-Chrome-Arsenic), and CCF (Copper-Chrome-Flour) [9]. The control of Coptotermes termites has also been widely carried out using natural pesticides (Biopesticides) that utilize the availability of flora in nature such as kirinyuh leaves (Eupathorium odoratum) [10], citronella extract insecticide [11], extracts of antiaris (Antiaris toxicaria) and Ki pahit (*Picrasima javanica*) caused the death of 100% of test animals at a concentration of 5% [12]. Extracts of Bintaro (*Carbera odollam Gaertn*) and Amethyst (*Brugmansia candida Pers*) [13] to control Coptotermes.

Another potential plant for termite control is papaya (*Carica papaya Linn*). *C. papaya Linn.* leaf extract can act as an insecticide, fungicide and rodenticide [14], because *C. papaya Linn.* leaves contain alkaloid compounds carpaine, caricaksantin, violaksantin, papain, saponins, flavonoids, and tannins [15], as well as various enzymes such as papain, karpain, pseudocarpain, nicotine, kontinin, myosmin, and carposid glycosides [16]. *C. papaya Linn.* leaf extract caused acute toxicity to drywood termites, Cryptotermes [17].

The application of natural pesticides in controlling termites can be done in various ways, depend on their behaviour especially trophalaxis, namely the nature of gathering and licking each other, kissing, rubbing their bodies and exchanging food. The exchange of food is through the proctodeal (through the anus) and stomadeal (through the mouth) [18]. Aplication through stomach poison methode most effectively at a concentration of 1.5% [19] For this reason, it is necessary to study whether *C. papaya Linn.* leaf extract is also effective when given as a contact poison.

2 Materials and Methods

This research is an experimental study using a completely randomized design (CRD) in 6 treatments of papaya leaf extract (0%, 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%) and 3 replications. Analysis of variance (ANOVA) and followed by Duncan test at 5% significance level is using to count mortality termites and the loss of feed. The Lethal concentration (LC) and Lethal Time (LT) were analyzed by Probit analysis.

The termites used consisted of the worker caste and the soldier caste of *Coptotermes sp.* taken from their habitat and then kept in a maintenance box. The leaves of *C. papaya Linn.* used are old leaves (dark green). *C. papaya Linn.* leaf extract was made in the chemical research laboratory of Faculty of Math and science Padang State University. The *C. papaya Linn.* leaves to be extracted were first finely chopped and then dried in the sun covered with black cloth so that the secondary metabolite compounds were not damaged by exposure to sunlight. Dried *C. papaya Linn.* leaves were put into bottles

and given 90% methanol until all were submerged, left for 3x24 hours. This powder bath was filtered with filter paper to obtain a solution of C. papaya Linn. leaf extract. *C. papaya Linn.* leaf extract solution which still contains methanol is separated from the extract through a distillation process using a rotary vacuum evaporator so that *C. papaya Linn.* leaf extract is obtained and stored in bottles. The pure *C. papaya Linn.* leaf extract obtained was then diluted using distilled water according to the required extract concentration.

A total of 20 termites consisting of 18 workers caste and 2 soldier caste were sprayed with *C. papaya Linn.* leaf extract according to the treatment to wet the entire body of the termites. The termites that have been sprayed are then put into the provided paralon pipe. After that put a paper disc that has been weighed into the paralon pipe as termites food. The paralon pipe was stored in a dark place at room temperature with a humidity of ± 95% for 7 days of observation [20]. Observation of termite mortality was carried out at intervals of 1 day.

3 Results and Discussion

3.1 Mortality of *Coptotermes sp.* termites

Based on the analysis of variance carried out on various application of *C. papaya Linn.* leaf extract, the average results of termite mortality with the contact poison method were obtained as shown in Table 1.

From Table 1 it can be seen that the mortality of termites in the control was significantly different from the treatment given various concentrations of *C. papaya Linn.* leaf extract. The treatment with *C. papaya Linn.* leaf extract concentration 4% was significantly different from the 3% treatment, while the 2.5%, 3.5%, 2%, 1% and 1.5%

Table 1. Average Mortality of Termites with *C. papaya Linn.* leaf extract using Contact Poison Treatment

Leaf Extract Concentration (%)	Mortality Average (%)
0	15 a
1	78.33 bc
1.5	80 bc
2	75 bc
2.5	73.33 bc
3	95 c
3.5	73.33 bc
4	53.33 b

Note: Numbers that followed by the same lowercase indicate that there is no significant different on 5% significant level

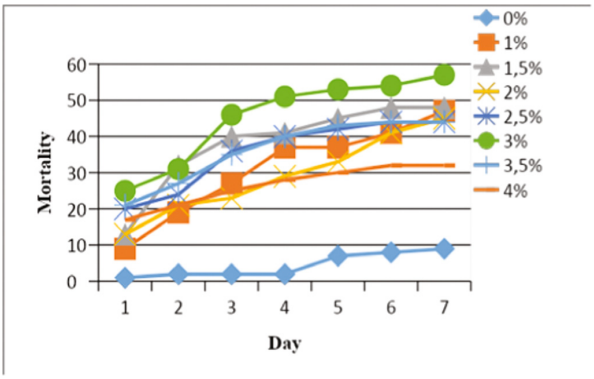

Fig. 1. Termite Mortality Graph with various *C. papaya Linn.* leaf extract using Contact Poison Method.

treatments were not significantly different from 4% and 3%. From Table 1 it can be concluded that the most recommended *C. papaya Linn.* leaf extract with the contact poison application method is at a concentration of 1%. Application of C. papaya Linn. leaf extract at a concentration of 1% is more recommended because with a lower concentration of extract the mortality caused is not significantly different from that caused by a higher concentration the toxicity of *C. papaya Linn.*

In the treatment of this contact poison at the highest concentration, the resulting mortality decreased. This may be due to the high concentration of extract, the resulting liquid will be more viscous so that it may be difficult for the extract to pass through the cuticle of termites. The contact poison method, *C. papaya Linn.* leaf extract enters the body of termites through the cuticle on the termite body which has pores and holes for the epidermis and sensilla glands [11].

Table 1 also shows that the control was significantly different with various treatments of *C. papaya Linn.* leaf extract concentration. The difference between the mortality of control termites and the mortality of termites treated with extract proved the effectiveness of *C. papaya Linn.* leaf extract as a termite control. This means that even in small concentrations, this *C. papaya Linn.* leaf extract is already effective for controlling termites. [13] found that LC50 *C. papaya Linn.* leaf extract on dry wood termites (*Cryptotermes sp.*) 0.09gr/ml.

The average daily termite mortality can be seen in Fig. 1. From the graph it can be seen that the mortality of termites treated with papaya leaf extract was higher than that of control termites. According to [8], a high concentration of extract will cause insects to exhibit resisting behavior. With this contact poison method, the extract enters the termite's body through the cuticle on the termite body which has pores and exit holes for the epidermis and sensilla glands [11]. Perhaps the resisting behavior is indicated by the inability to pass the extract into the termite's body.

3.2 Percentage of Lost Bait

The percentage of bait weight loss after 7 days *C. papaya Linn.* leaf extract application can be seen in Table 2.

Table 2. Average Percentage Loss of Feed Weight after Application of *C. papaya Linn.* Leaf Extract

Leaf Extract Concentration (%)	Percentage of bait weight loss (%)
0	3.47 a
1	0.44 b
1.5	0.45 b
2	0.61 b
2.5	0.56 b
3	0.33 b
3.5	0.32 b
4	0.76 b

Note: Numbers that followed by the same lowercase indicate that there is no significant different on 5% significant level

In the control treatment, termite mortality was very low, but the bait weight loss was high. This is understandable because the termites that were not treated with *C. papaya Linn.* leaf extract were able to eat normally. The high weight loss of bait in the control was also thought to be due to the low mortality of the control termites. This is supported by the results of research by [21], that termite consumption increases with the increase in the number of termites. [22] also revealed that the higher the termite mortality rate, the lower the bait loss and conversely the lower the termite mortality rate, the higher the bait loss.

3.3 Lethal Concentration (LC50) Leaf Extract of C. papaya Linn. against *Coptotermes sp.*

Lethal Concentration (LC50) is the concentration required for termite mortality to reach 50%. LC50 of C. papaya Linn. leaf extract against *Coptotermes sp.* Can be seen in Table 3.

Table 3 shows that *C. papaya Linn.* leaf extract at a concentration of 0.157% was able to kill Coptotermes sp. termites as much as 50%. This shows that *C. papaya Linn.* leaf

Table 3. Lethal Concentration (LC50) of C. papaya Linn. leaf extract against *Coptotermes sp.* Using Contact Poison Method

Probability	Concentration 95% Fiducial		
	Concentration	lower	upper
0.50	0.157	-	-

Note: (-) less homogeneous data

Table 4. Lethal Time (LT50) of C. papaya Linn. leaf extract against *Coptotermes sp.* Using Contact Poison Method.

Probability	Time 95% Fiducial		
	Time	lower	upper
0.50	3.976	3.094	7.038

extract is very effective as an anti-termite material for Coptotermes sp. [17] found that LC50 *C. papaya Linn.* leaf extract on dry wood termites (*Cryptotermes sp.*) 0.09gr/ml.

3.4 Lethal Time (LT50) dan Lethal Concentration (LC50) *C. papaya* Linn. Leaf Extract Against *Coptotermes* sp.

The effectiveness of *C. papaya Linn.* leaf extract is also proven by the low Lethal Time (LT50) values. Lethal Time (LT50) is the time required for the mortality of the test termite population to reach 50%. (LT50) contact poison *C. papaya Linn.* leaf extract can be seen in Table 4.

Table 4 shows that the time required for C. papaya Linn. leaf extract to kill 50% of *Coptotermes sp.* is 3.976 days. This result shows that C. papaya Linn. leaf extract is effective as an insecticide against termites.

4 Conclusion

Based on the result of study, it can be concluded that *C. papaya Linn.* leaf extract has been effective as contact poison at a concentration of 1%. The higher the concentration of *C. papaya Linn.* leaf extract, the higer its effectiveness in killing *Coptotermes sp.* At a concentration 0.15% *C. papaya Linn.* leaf extract was able to kill 50% *Coptotermes sp.* within 3.976 days.

References

1. A. Safitri, M. Martini, S. Yunawati, Keanekaragaman jenis rayap tanah dan dampak serangan pada bangunan rumah di perumahan kawasan mijen kota Semarang. Jurnal Kesehatan Masyarakat Vol. 4 (1), 2016, pp. 100-105.
2. G.E. Wulandari, Uji toksisitas untuk pengendalian *coptotermes curvignathus* holmgren (Isoptera: Rhinotermitidae) di Laboratorium Fakultas Pertanian Universitas Sumatera Utara, 2009.
3. M. Radhitya, Z. Zulfahmi, Pemanfaatan limbah kulit udang sebagai bahan anti rayap (biotermisida) pada bangunan berbahan kayu, 2010, https://Eprint.undip.ac.id/13810/1/SKRIPSI.
4. K.W. Prasetyo, S. Yusuf. Mencegah dan Membasmi Rayap secara Ramah Lingkungan dan Kimiawi. Bogor: Agro Media Pustaka, 2004.
5. Kementrian Pertanian Dirjen Perkebunan, Pengelolaan rayap *Coptotermes cuvignathus* pada perkebunan kelapa sawit. Ditjenbunpertanian.go.id. 2021.
6. G. Susanta, Kiat praktis mencegah dan membasmi rayap, Jakarta: Griya Kreasi. 2007.

7. T. Kartika, D. Tarmadi, I. Guswenrivo, A.H. Prianto, S. Yusuf, Daya petogenitas cendawan *Cunninghamella* sp. terhadap rayap tanah *Coptotermes* sp.. Laporan Penelitian UPT Balai Litbang Biomaterial, Lembaga Ilmu Pengetahuan Indonesia, 2006.
8. A.E. Prasetyo, S. Susanto, kenali dan kendalikan serangan rayap di areal perkebunan kelapa sawit, lahan gambut dan eks hutan, Warta Pusat PPKS 23 (3), 2018, pp. 91-98.
9. K.W. Prasetyo, Khitosan pengendali rayap ramah lingkungan, Laporan penelitian LIPI Biomaterial. 2009, http://www.biomaterial.lipi.go.id/?p=140.
10. M. Hadi, Pembuatan kertas anti rayap ramah lingkungan dengan memanfaatkan ekstrak daun kirinyuh (*Eupatorium odoratum*), Jurnal Bioma Juni 2008 Vol. 6, No. 2, 2008, pp. 12–18. http://eprints.undip.ac.id/1936/1/Bioma_Juni_08_Hadi.pdf.
11. T.T.W. Hardi, R. Kurniawan, Pengendalian rayap tanah pada tanaman kayu putih dengan ekstrak sereh wangi, Jurnal Fakultas kehutanan Universitas Nusa Bangsa. 2008.
12. I. Prianto, S. Guswenrivo, D.A.H. Tarmadi, T. Kartika & S. Yusuf. Sifat Anti Rayap Ekstrak Antiaris (*Antiaris toxicaria*) dan Ki Pahit (*Picrasima javanica*) terhadap Rayap Tanah (*Coptotermes Curvignathus Holmgren*). *Laporan teknik akhir tahun.* UPT Balai Penelitian dan Pengembangan Biomaterial-LIPI. 2006.
13. D.A.H. Tarmadi, I. Prianto, S. Guswenrivo, Y. Yusuf, T. Kartika, 2006, Pengaruh ekstrak bintaro (*Carbera odollam gaertn*) dan kecubung (*Brugmansia candida pers*) terhadap rayap tanah *Coptotermes* sp. Laporan Teknik Akhir Tahun UPT Balai Penelitian dan Pengembangan Biomaterial-LIPI, 2006.
14. W.R. Setiawati, N. G. Murtiningsih, T. Rubiati. Tumbuhan bahan pestisida nabati dan cara pembuatannya untuk pengendalian organisme pengganggu tumbuhan (OPT), Bandung: Balai Penelitian Tanaman Sayuran, 2008.
15. K. Wijaya, Mengatasi DBD dengan daun papaya, 2011, http://karyawijayabbs.students-blog.undip.ac.id/2011/01/15/62/.
16. N. Bermawie, Mengatasi demam berdarah dengan tanaman obat, Warta Penelitian dan Perkembangan Pertanian Vol 28, No 6, 2006, http://pustaka.litbang.deptan.go.id/publikasi/wr286063.pdf.
17. D. Setiawan, Toksisitas akut ekstrak daun pepaya (*Carica papaya* L.) terhadap rayap kayu kering (*Cryptotermes* sp.) kasta pekerja dewasa, Thesis Universitas Negeri Yogyakarta. 2013.
18. R.C. Tarumingkeng, Biologi dan perilaku rayap. Institute Pertanian Bogor, 2001, http://www.rudyct.com/biologi_dan_perilaku_rayap.htm.
19. Z. Zulyusri, D. Desyanti, R.F. Rosi, Keefektifan ekstrak daun *Carica papaya* Linn. dengan metode racun lambung untuk pengendalian rayap tanah (*Coptotermes* sp.) rhinotermitidae. Jurnal Sainteks Vol. IV (2), 2012, pp. 145–150.
20. T. Kartika, D.A.H. Tarmadi, S. Guswenrivo, I. Prianto & S. Yusuf. Daya Petogenitas Cendawan *Cunninghamella* sp. Terhadap Rayap Tanah *Coptotermes* sp. Laporan Penelitian. UPT Balai Litbang Biomaterial, Lembaga Ilmu Pengetahuan Indonesia, 2006.
21. D. Nandika, R. Rudi, Konsumsi makan dan daya hidup rayap tanah *Coptotermes curvignathus* Holmgren (Isoptera: Rhinotermitidae) pada Pengujian Laboratorium. Prosiding Seminar Hasil-Hasil Penelitian Bidang Ilmu Hayat, 1999.
22. F. Simanjuntak, Z.N. Maimunah, H. Zahara, Pemanfaatan daun sirsak dan berbagai jenis umpan untuk mengendalikan hama rayap di laboratorium, Laporan penelitian Balai Besar Karantina Tumbuhan, 2007.