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Optimization of Drying Temperature for Bintaro Fruit Seeds (*Cerbera manghas*) as a Bioinsecticide for *Aedes aegypti* Using a Tray Dryer

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ABSTRACT

As a tropical country, Indonesia has various plants that can be utilized for human needs. One such plant is Bintaro (*Cerbera manghas*). Bintaro contains secondary metabolites that can be used as a bioinsecticide. These secondary metabolite compounds can degrade if dried at high temperatures. This study focused on optimizing the drying temperature of Bintaro fruit seeds (*Cerbera manghas*) using a tray dryer to produce bioinsecticide. The research employed a Completely Randomized Design (CRD) with four different drying temperature treatments: 40°C, 50°C, 60°C, and 70°C. The ethanol extracts from Bintaro seeds produced at each temperature treatment were tested for their effectiveness as a bio-insecticide against *Aedes aegypti* mosquitoes. The results indicated that the optimal drying temperature for Bintaro seeds, which provided the best bioinsecticide effectiveness, was 50°C.

Keywords: Drying, Temperature, Tray dryer, Bintaro seeds, Bioinsecticide.

INTRODUCTION

Drying of raw materials is typically carried out before storage by active ingredient extraction industries to prevent spoilage of fresh materials during storage. Conventionally, sun drying requires a long time due to uneven sunlight intensity throughout the day and the low hygienic quality of the product. The drying temperature is a crucial factor affecting the quality of medicinal plants because it can lead to changes in bioactive compounds and volatile substances in plants, particularly those from wild sources (Damawidjaya Biksono 2022).

Currently, mechanical drying methods using Tray Dryers are an alternative due to their ease of use and controllable temperatures, although they are relatively more expensive. The principle of this equipment is that the material to be dried is placed on trays that are directly in contact with the drying medium. A blower circulates hot air generated from a heating source throughout the drying chamber. Tray dryers effectively dry solid materials, powder grains, or not-too-large granules (Asiah et al. 2023).

Indonesia, a tropical country, has various plants that can be utilized for human needs. Many studies have been conducted to explore the insecticidal activity of natural sources, one of which is Bintaro (*Cerbera manghas*). *Cerbera manghas*, with its small stems, belongs to the Apocynaceae family and is native to Southeast Asia, Australia, and several Polynesian islands. In Indonesian urban and rural areas, this tree is often used as an ornamental plant along roadsides and public parks. Its chemical constituents include steroids, saponins, triterpenoids, and alkaloids. The alkaloid cerberin from *C. manghas* seeds is known to be toxic and can inhibit calcium ion channels in cardiac muscles, potentially leading to death (Aziz et al. 2024).

The fruit produced by this plant is the size of a softball, similar to a green mango, and is called othalanga, changing from bright red to ripe (Maharana 2021). The seeds of *Cerbera manghas* are toxic and contain steroid alkaloids (cerberine, nitritolin, and theven), terpenoids, and saponins, which can cause heart attacks and sudden death (Musdja and Djajanegara 2019).

Essential phytochemicals found include steroids, tannins, terpenoids, flavonoids, phenols, saponins, cardiac glycosides, lignans, and iridoids present in various parts of the plant, such as leaves, stems, and roots (Maharana 2021). Bintaro is also believed to have antifungal and antimicrobial properties due to its steroid, tannin, and terpenoid content (Chu et al. 2015). Additionally, phenolic acids in the plant have antioxidant capabilities (Piazzon et al. 2012).

Bintaro (*Cerbera manghas*) is one of Indonesia's botanical riches as a source of bioinsecticide and is also known by synonyms like *C. lactaria Ham* and *C. odollam Gaertn*. This perennial plant has traditionally had its latex used as a poison for hunting arrows, its fruit used to poison fish, rats, pigs, and as a mosquito repellent (Rohimatun 2011).

The seeds have the highest toxicity among all parts of the bintaro plant. Phytochemical analyses have shown the presence of toxic metabolites such as coumarins, phenolics, triterpenoids, steroids, and glycosides/alkaloids with repellent and antifeedant properties (Alfiandri 2017).

The potential of bintaro seed extract as a bio insecticide has been studied for its effectiveness against the subterranean termite *Coptotermes gestroi* (Tarmadi et al. 2013). The effectiveness of bintaro seed extract against *Aedes aegypti* mosquitoes as a bioinsecticide shows that higher concentrations of the extracted result in faster mosquito mortality (Aziz et al. 2021).

Research and experiments conducted to kill mosquito larvae naturally have found that crude extracts from bintaro, both from leaves and seeds, have a significant impact. Higher concentrations of the extract lead to quicker larvae killing and inhibit their development into pupae (Tarmadi et al. 2013; Wulandari and Ahyanti 2018). Another pathogen vector, *Culex quinquefasciatus*, which is responsible for the spread of arboviruses, has shown high larvicidal activity when treated with bintaro seed extracts using ethyl acetate and n-hexane, indicating that bintaro extract can be used for larval control (Permana et al. 2024).

The optimal drying temperature for bintaro seeds using a tray dryer is essential for maintaining bioactive components to standardize the raw material used as a bio-insecticide. The parameters measured include the drying temperature and the effectiveness of bintaro seed extracts as a bioinsecticide.

Bioactive compounds in natural materials are sensitive to heat; higher drying temperatures can damage or degrade active compounds. Excessive drying at high temperatures can reduce quality due to damage to the components from heat (Stephen et al. 2020).

High moisture content can affect the material's texture, density, and porosity. Changes in shape and size impact physical properties and ultimately affect texture and transport properties during drying (Rizvi 2014; Yan, Sousa-Gallagher, and Oliveira 2008).

RESEARCH METHODOLOGY

The research is experimental, using a Completely Randomized Design. There are four temperature treatments for drying bintaro seeds with a tray dryer at temperatures of 40°C, 50°C, 60°C, and 70°C. The biological activity is assessed based on the effectiveness of the bioinsecticide extract.

Statistical Analysis

Experimental data were analyzed using one-way analysis of variance (ANOVA), and differences between treatment means were determined using Duncan's multiple range test with SPSS for Windows Version 17. AP value less than 0.05 was considered statistically significant.

Initial Treatment of Bintaro Seeds

Mature bintaro fruits, which are red, were collected, sorted, and split open, and the flat, white seeds were extracted. The seeds were then chopped and dried in a tray dryer for 12 hours at four different temperature treatments (40°C, 50°C, 60°C, and 70°C). The dried seeds from each treatment were ground using a blender to obtain a coarse powder that passed through a 20-mesh sieve.

Preparation of Bintaro Seed Extract

The dried powder from each treatment weighed 750 grams and was then macerated with ethanol for 3 days. The resulting extract was filtered through Whatman No. 42 filter paper and concentrated using a rotary vacuum evaporator at 45°C and 50 rpm.

Preparation of Bintaro Seed Extract for Bioinsecticide Effectiveness Testing

Each ethanol extract of bintaro seeds from the four treatments was diluted with absolute ethanol to achieve a 5% concentration.

Testing Animal Breeding

Larvae of *Aedes aegypti* mosquitoes collected from residential areas were placed into a mosquito-rearing cage and kept at room temperature until they matured into mosquitoes aged 3-5 days.

Bioactivity of Bintaro Seed Extract on *Aedes aegypti* Mosquitoes

Four CDC bottles were coated with 1 ml of 5% ethanol extract of bintaro seeds, and one CDC bottle was coated with 1 ml of ethanol solvent as a control (5 bottles of the coating were used for each test sample). 10 to 25 mosquitoes were placed into each bottle and exposed for 15 minutes. The percentage of mosquitoes that died in each bottle after 15 minutes of exposure was used to determine the effectiveness of the bintaro seed ethanol extract as a bioinsecticide.

$$\text{Mortalitas (\%)} = \frac{Jumlah\ Nyamuk\ mati}{Jumlah\ Total\ Nyamuk} x100$$

RESULT AND DISCUSSION

The drying of bintaro seeds was carried out using a tray dryer method. Drying treatments were conducted at four temperature levels: 40°C, 50°C, 60°C, and 70°C, with a drying time of approximately 12 hours until the seeds were dry, indicated by a color change from white to brownish-black and a crispy texture (easily crushed) when squeezed, with a moisture content of around 3-5%. During the drying process, the material in the tray dryer was regularly turned, and the position of the trays was adjusted to ensure uniform heat distribution, resulting in a uniform drying level and reduced drying time.

Figure 1 Bintaro fruit (Cerbera manghas)

The tray dryer is a cabinet-shaped drying device with stacked trays inside. It uses LPG gas as the heat source and is equipped with a blower for heat distribution. It also includes a temperature control valve with a thermocouple to maintain a consistent temperature.

Figure 2. Tray Dryer

The construction of the tray dryer is suitable for drying at low temperatures with the aid of airflow. The product to be dried is placed on thin trays mounted on racks within the drying chamber. Air heating is circulated vertically from a fan located in the circulation area. Fresh air is introduced into the cabinet, while moist air is expelled to control the fan and incoming air. The tray dryer is designed to prevent air from drying too quickly.

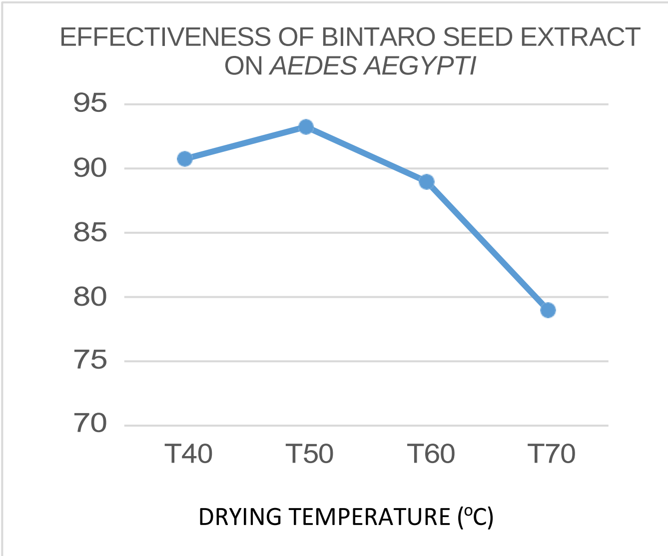
Drying is a commonly used method to maintain the stability of natural materials, reduce moisture content, and lower water activity. Drying helps reduce microbial activity and minimize physical and chemical changes in dried natural materials during storage (Doymaz 2008; Fatouh et al. 2006).

Figure 3. Bintaro Seed Powder at Four Drying Temperatures

The size and thickness of the material stack in each type of dryer significantly affect the drying speed. Drying with an oven is faster than solar energy (Golisz et al. 2022). High moisture content impacts the material's texture, density, and porosity. Changes in shape and size affect physical properties and, ultimately, impact texture and transport properties during drying (Rizvi 2014; Yan, Sousa-Gallagher, and Oliveira 2008).

In this study, four types of dried bintaro seeds produced at four different drying temperatures using a tray dryer were subsequently subjected to maceration and extraction with ethanol, with the solvent separated using a rotary evaporator. The obtained extracts were tested for bioinsecticidal effectiveness against *Aedes aegypti* mosquitoes using the CDC Bottle Bioassay Test to determine the optimal drying temperature that preserves the best condition of bioactive compounds in the bintaro seeds. The results are presented in Graph 1.

Figure 1. Effectiveness of Bintaro Seed Extract on *Aedes aegypti*



The data presented in the graph indicate that the mortality rate of *Aedes aegypti* mosquitoes increased with the ethanol extract from seeds dried at 40°C up to 50°C and then decreased at 60°C and 70°C. The optimal temperature for drying bintaro seeds using a tray dryer, which provides the best effectiveness, is 50°C. The results of the analysis of variance for the data are summarized in the following table:

Table 1. Effect of Drying Temperature of Bintaro Seeds on Mortality of *Aedes aegypti*

Parameter	Mean Mortality			
	T40	T50	T60	T70
Mortality Sig 0.081	90.75 ± 8.421[a]	93.25± 4.992[a]	89.00 ± 3.742[b]	79.00 ± 10.424[b]

The ANOVA test results at a 5% significance level indicate that ($p > 0.05$), showing no significant difference in the effectiveness of the bioinsecticide from the ethanol extract of bintaro seeds dried at 40°C compared to 50°C and 60°C compared to 70°C.

Drying at excessively high temperatures impacts the degradation of certain bioactive compounds. While higher temperatures can speed up the drying process of agricultural products, especially those with high moisture content, they can also damage the texture and appearance of the material. High-temperature drying leads to case hardening, where the outer part of the material becomes wrinkled and hard, with moisture trapped inside (Rani 2012; Yuliantari, Widarta, and Permana 2017).

CONCLUSION

Ethanol extract of bintaro seeds (*Cerbera manghas*) demonstrated a mortality effect on *Aedes aegypti* in experiments using four different extracts from drying processes. The optimal temperature for drying bintaro seeds, resulting in the best bioinsecticidal effectiveness, is 50°C. Variations in drying temperature using a tray dryer do not significantly impact ($P > 0.05$) the bioinsecticidal effectiveness of the ethanol extract of bintaro seeds against *Aedes aegypti* mosquitoes.

SUGGESTION

For future research, it is recommended that variations in drying temperature be considered to optimise the content of secondary metabolites that are effective as bioinsecticides. In addition, further research is needed to explore the effect of drying at lower temperatures and longer drying duration to maintain the stability of active compounds. Tests under different environmental conditions also need to be conducted to measure the effectiveness of bioinsecticides in various situations. Using further analytical techniques such as chromatography or mass spectrometry can help identify and quantify bioactive components more accurately.

REFERENCES

Alfiandri, Luthfi. 2017. "Identifikasi Senyawa Metabolit Sekunder Bintaro (*Cerbera Manghas* L.), Uji Sitotoksik Dengan Metode BSLT (Brine Shrimp Lethal Test) Dan Uji Aktivitas Antioksidan." [Google Scholar]

Asiah, Nurul, Dessy Agustina Sari, Meilya Suzan Triyastuti, and Mohamad Djaeni. 2023. "Peralatan Pengering Pangan."

Aziz, A., Amin, B., Afandi, D., Efriyeldi, E., Gusfa, F., Khayan, K., Masnun, M., Wardoyo, S., Daswito, R., & Dahlan, A. (2024). Toxic effects of bintaro (cerbera manghas) seed extract on aedes aegypti mosquito. *Journal of Medicinal and Pharmaceutical Chemistry Research*, *6*(2), 174-182. [Crossref] [Publisher]

Aziz, Alkausyari, R Sahknan, Khayan Khayan, and Slamet Wradoyo. 2021. "Comparative Biochemical Effects of Seeds Extract *Cerbera manghas* and Leaves Carica Papaya the Vector of *Aedes aegypti* Mosquitos." *Journal of Entomological Research* 45(3): 453–60. [Crossref], [Publisher]

Chu, Sue-Yin et al. 2015. "Phytochemical Screening of Antifungal Biocompounds from Fruits and Leaves Extract of Cerbera Odollam Gaertn." *Malays Appl Biol* 44(3): 75–79. [Publiher]

Damawidjaya Biksono, S T. 2022. *Teknik Pengeringan Dasar*. Deepublish.

Doymaz, Ibrahim. 2008. "Convective Drying Kinetics of Strawberry." *Chemical Engineering and Processing: Process Intensification* 47(5): 914–19. [Crossref], [Publisher]

Fatouh, M, M N Metwally, A B Helali, and M H Shedid. 2006. "Herbs Drying Using a Heat Pump Dryer." *Energy conversion and management* 47(15–16): 2629–43. [Crossref], [Publisher]

Golisz, Ewa, Izabela Wielewska, Kamil Roman, and Marzena Kacprzak. 2022. "Probabilistic Model of Drying Process of Leek." *Applied Sciences* 12(22): 11761. [Crossref], [Publisher]

Maharana, Pradeep Kumar. 2021. "Ethnobotanical, Phytochemical, and Pharmacological Properties of *Cerbera manghas* L." *Journal of Biosciences* 46(1): 25. [Crossref], [Publisher]

Musdja, Muhammad Yanis, and Ira Djajanegara. 2019. "Antibacterial Activity of Dichloromethane and Ethyl Acetate Extracts of Bintaro Leaf (*Cerbera manghas*, Linn) against Staphylococcus Aureus and Escherichia Coli."

Permana, Tutut Indria et al. 2024. "Mortality Effect of Bintaro (*Cerbera manghas* L.) Seed Extract Against *Aedes aegypti* (Diptera: Culicidae) Mosquitoes." In *BIO Web of Conferences*, EDP Sciences, 1017. [Crossref], [Publisher]

Piazzon, A et al. 2012. "Antioxidant Activity of Phenolic Acids and Their Metabolites: Synthesis and Antioxidant Properties of the Sulfate Derivatives of Ferulic and Caffeic Acids and of the Acyl Glucuronide of Ferulic Acid." *Journal of agricultural and food chemistry* 60(50): 12312–23. [Crossref], [Publisher]

Rani, Ismarani. 2012. "Potensi Senyawa Tannin Dalam Menunjang Produksi Ramah Lingkungan." *CEFARS: Jurnal Agribisnis Dan Pengembangan Wilayah* 3(2): 46–55. [Publisher]

Rizvi, Syed S H. 2014. "Thermodynamic Properties of Foods in Dehydration." In *Engineering Properties of Foods*, CRC Press, 261–348. [Crossref], [Publisher]

Rohimatun, Suriati Sondang. 2011. "Bintaro (*Cerbera manghas*) Sebagai Pestisida Nabati." *Warta Penelitian dan Pengembangan Tanaman Industri* 17(1): 1–4.

Stephen, M Suleman, E A Adelakun, J H Kanus, and Meshack M Gideon. 2020. "Antioxidant Activities of Extracts from Celery Leaves (Apium Graveolens L) Grown in Jos, Nigeria." *International Research Journal of Pure and Applied Chemistry* 21(4): 1–5. [Crossref], [Publisher]

Tarmadi, Didi, Ikhsan Guswenrivo, Deni Zulfiana, and Sulaeman Yusuf. 2013. "Efikasi Asam Oleat Hasil Isolasi Dari Ekstrak Biji Bintaro (*Cerbera Manghas*) Terhadap Rayap Tanah Coptotermes Gestroi Wasmann Dan Rayap Kayu Kering Cryptotermes Cynocephalus Light." *LAPORAN TEKNIK AKHIR TAHUN 2013*: 10.

Wulandari, Khoiriyanti, and Mei Ahyanti. 2018. "Efektivitas

Ekstrak Biji Bintaro (*Cerbera manghas*) Sebagai Larvasida Hayati Pada Larva *Aedes aegypti* Instar III." *Jurnal Kesehatan* 9(2): 218–24. [Crossref]

Yan, Zhengyong, Maria J Sousa-Gallagher, and Fernanda A R Oliveira. 2008. "Shrinkage and Porosity of Banana, Pineapple and Mango Slices during Air-Drying." *Journal of food engineering* 84(3): 430–40. [Crossref], [Publisher]

Yuliantari, Ni Wayan Ayuk, I Wayan Rai Widarta, and IDGM Permana. 2017. "Pengaruh Suhu Dan Waktu Ekstraksi Terhadap Kandungan Flavonoid Dan Aktivitas Antioksidan Daun Sirsak (Annona Muricata L.) Menggunakan Ultrasonik." *Media Ilmiah Teknologi Pangan* 4(1): 35–42. [Publisher]