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The Effectiveness of Rice Straw and Cogongrass Straw Soaked Water Attractants on the Number of *Aedes spp*. Mosquitoes

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Aedes spp. mosquitoes are the main vectors of Dengue Hemorrhagic Fever (DHF), which remains a public health problem in Indonesia. Chemical insecticide-based mosquito control has the potential to cause environmental pollution and vector resistance, so safer and more environmentally friendly control alternatives are needed. This study aimed to analyze the effectiveness of rice straw and cogongrass straw-soaked water attractants in attracting Aedes spp. mosquitoes. Method this study used a pure experimental design with a post-test only control group design. The study was conducted at Muhammadiyah Ahmad Dahlan University, Palembang. Traps were placed purposively with a total of 27 observation units consisting of three treatment groups, namely control (water without attractant), rice straw-soaked water attractant, and cogongrass straw-soaked water attractant, each with nine replications. Traps were set for 5–7 days. Data were analyzed using the Shapiro–Wilk normality test, homogeneity test, One Way ANOVA, and the Least Significant Difference (LSD) test with a significance level of 0.05. The results showed the total number of mosquitoes trapped in the control group was 16, in the rice straw attractant group was 31, and in the cogongrass straw attractant group was 32. The average number of mosquitoes in the control group was 2.00 ± 0.67, in the rice straw group was 3.00 ± 1.13, and in the cogongrass straw group was 4.00 ± 1.13. The results of the One- Way ANOVAanalysis showed a significant difference between the treatment groups (p = 0.01). Further LSD tests showed that both attractant groups were significantly different from the control, but there was no significant difference between the rice straw and cogongrass straw attractants. These findings indicate soaked water from rice straw and cogongrass straw was effective in increasing the number of trapped mosquitoes compared to the controlas a natural attractant to catch Aedes spp. mosquitoes and has the potential to be an alternative vector control that is cheap, easy to apply, and environmentally friendly.

Keywords: *Aedes spp*., Natural attractants, Rice straw, Cogongrass straw, Mosquito traps

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) remains a serious public health problem in Indonesia, with fluctuating but consistently high case rates. All ages are susceptible to dengue fever. This disease's devastating impact often causes outbreaks and can be fatal, especially in children (Ministry of Health, 2024), (Irawati & Putri, 2021). Based on data from the Indonesian Ministry of Health's Early Warning and Response System (SKDR), the number of dengue fever cases in Indonesia reached 131,393 cases with 544 deaths by the end of October 2025, making Indonesia a significant contributor to global dengue fever cases.(Alivianti, A., Purnama., 2021), Dengue fever cases were reported almost evenly across all provinces, with a number of endemic areas experiencing a high disease burden throughout the year (Chandra, 2019; Herawati & Hakim, 2022). Aedes spp. mosquitoes are found in public places and residential areas, except in locations at altitudes of more than 1,000 meters above sea level (Ridha et al., 2019). The Aedes spp. mosquito, the primary vector, transmits not only the dengue virus but also chikungunya and yellow fever. Its distribution spans nearly all tropical regions, so the risk of transmission continues to increase. This situation demonstrates that vector control efforts still require stronger, more effective, and sustainable strategies to suppress mosquito populations and prevent disease transmission in the community (Muhammad Baghowi, 2022; Rahayu et al., 2019; Taslisia & Rusjdi, 2018).

Based on the vector control standards set by the Ministry of Health of the Republic of Indonesia, the national target for the Larvae Free Rate (ABJ) is a minimum of 95 percent as an indicator of the success of eradicating mosquito nests in efforts to prevent Dengue Fever (Ministry of Health Regulation No. 50 of 2017). Until 2025, various regional reports indicate that ABJ achievement in Indonesia still varies, and not all regions have achieved the national target. Several regions reported ABJ below 95 percent, for example, Jember Regency recorded an ABJ of 92 percent in 2024, and several other regions showed similar values or below the standard threshold. In line with this, local governments have set a target of increasing ABJ coverage to ≥95 percent by 2025 as part of their local dengue control strategy (Ghoniatussilmi & Sukendra, 2022; Habib et al., 2025; Qibtiyah et al., 2022).

Vectors are one link in the chain of disease transmission. Arthropods transmit infectious agents either mechanically, biologically, or through a host. Arthropodborne (*vectorborne*) disease is the transmission of disease to humans caused by insects (Miranti, A. Kurnia., 2023), (Lesmana et al., 2021). Vector control, which relies on the use of chemical insecticides through thermal fogging, is a key area of concern in dengue control initiatives. Organophosphates (malathion, fenitrothion) and synthetic pyrethroids (permethrin, deltamethrin, and lambdacyhalothrin) are among the chemical insecticides used. Control of Aedes spp. mosquitoes has traditionally relied heavily on chemical methods such as fogging and larvicides (Handiny, Febry., 2020).

While this method can provide quick results, repeated use raises serious issues such as environmental pollution, threats to human health, and the emergence of mosquito resistance to chemicals. Fogging doesn't even eradicate larvae, thus failing to address the root cause. Chemical larvicides also have the potential to leave residues and impact water quality. This situation highlights the need for vector control innovations that are safer, easier to implement, and less disruptive to environmental balance (Hairani et al., 2020). In addition to the challenges of insecticide resistance and the risk of environmental pollution from the use of chemical methods, Aedes spp. control also faces challenges related to the effectiveness of fogging and larvicides, which only work at certain stages of the mosquito life cycle. This situation demands alternative approaches that are more environmentally friendly, affordable, and still effective in reducing mosquito populations. One strategy that is gaining increasing attention is the use of natural attractants as part of a trapping system to attract adult mosquitoes (Ambarita. L. P., 2019; Darmawati, 2021).

Attractants work by utilizing volatile compounds produced by the fermentation of organic materials such as rice straw or cogongrass, which produce aromas similar to the natural habitats where Aedes spp. lay their eggs. This approach has several important advantages. First, attractants pose no toxicity risk, making them safe for use in household environments. Second, straw-based attractants are readily available, inexpensive, and can be prepared by the public without the need for special technology or instruments. Third, attractants attract adult female mosquitoes, which act as the primary vectors, thereby reducing the risk of transmission by reducing the population of mosquitoes actively seeking blood and laying eggs (Marin et al., 2020; Nurjana & Kurniawan, 2017). Strengthening the use of attractants aligns with modern vector control efforts, which emphasize biological and mechanical control, rather than relying solely on chemicals. Attractants can also be part of a mosquito population monitoring system, facilitating early detection of the risk of increased dengue fever cases in an area.

One emerging alternative approach is the use of natural attractants from organic materials such as straw soaked water. The straw fermentation process produces volatile compounds such as ammonia, CO_2, lactic acid, and fatty acids that can attract female mosquitoes to approach or lay eggs. Mosquitoes recognize these compounds through their antennae, which contain olfactory receptor neurons (ORNs). These specialized neurons in the nose detect odor molecules (odorants), converting chemical signals into electrical impulses that are then sent to the brain to be interpreted as odors. Each ORN typically expresses one type of odor receptor (OR) and can respond to a variety of odors (Reddy et al., 2018). Water soaked in rice straw has been shown to contain a high level of organic compounds, making it an effective attractant. Meanwhile, cogongrass straw contains high levels of lignocellulose, which, when decomposed, produces glucose, which is fermented into CO_2 and a distinctive odor. Both materials are readily available, inexpensive, and environmentally friendly, making them suitable alternatives for community-based mosquito control (Busra, 2019).

A novel aspect in recent years, research on the use of natural attractants as a vector control strategy has become a new focus in environmental health research. Attractants work through the release of volatile compounds from fermented organic materials that can attract adult mosquitoes, especially females seeking egg-laying sites. A systematic literature review of 24 studies between 2020 and 2025 showed that fermented straw soaked water is one of the most effective natural attractants in attracting Aedes spp. mosquitoes, especially females ready to lay eggs, due to organic compounds such as ammonia and volatile acids produced during the fermentation process. Furthermore, another study also found that sugar solutions formulated as Attractive Toxic Sugar Baits (ATSB) can both attract and have a toxic effect on mosquitoes, thereby increasing the effectiveness of vector control. However, substantial limitations remain in the current literature. Most studies evaluating natural attractants focus on a single material or technique, with methodological variations that make direct comparisons between studies difficult. Few studies have compared two different types of natural attractants within the same experimental design, especially in the real-world conditions of residential or community areas.

Based on the description above, the purpose of this study was to analyze the differences in effectiveness of rice straw and cogongrass straw soaking water in attracting trapped Aedes spp. mosquitoes, and to assess the potential of both as alternative natural attractants in controlling dengue vectors that are cheap, safe, and applicable in the field.

METHOD

This study uses a true experimental design with a post-test only control group design.This design was chosen to directly evaluate the effect of using rice straw and cogongrass straw soaking water attractants on the number of Aedes spp. mosquitoes trapped.Three treatment groups were used, each consisting of a control group (P0), a rice straw attractant (P1), and cogongrass straw attractant (P2). Each group was repeated nine times to meet the test strength requirements based on the Feeder formula (r ≥ 9). Measurements were only taken after treatment was administered, thus avoiding potential bias due to initial measurements and learning effects or adaptation of mosquitoes to the traps. External variables were controlled systematically. All traps were placed in locations with relatively uniform environmental characteristics, including light intensity, humidity, temperature, and distance between traps. Traps were placed in areas not exposed to direct sunlight and with similar potential mosquito populations. Furthermore, all traps used the same type, size, color, and material, so differences in results could be directly attributed to the type of attractant used, rather than factors external to the treatment.

Randomization was performed at the treatment determination stage for the trapping units, not the mosquito population, given that the study subjects were wild mosquito populations in an open environment. Each trapping unit was coded and randomly assigned to a treatment type to minimize assignment bias. This approach is commonly used in field-based vector control studies, where randomization of individual biological subjects is not feasible, but randomization of treatment units remains methodologically feasible. In this study. In this study. The term used is "attractant," not "feed formula." Attractant is defined as a solution resulting from soaking organic materials (rice straw and cogongrass) that undergoes a natural fermentation process and produces volatile compounds, such as ammonia and organic acids, which function to attract Aedes spp. mosquitoes to the trap. This term is in accordance with scientific terminology commonly used in vector control and mosquito behavior research, and refers to the concepts of oviposition attractants and olfactory attractants that have been reported in various recent studies.

The population in this study was Aedes spp. mosquitoes that occur naturally in the study area. This study did not conduct laboratory rearing of mosquitoes, so the species, age, and physiological status of the mosquitoes could not be individually controlled. This condition is a common characteristic of field experimental studies on vector control in real-world conditions. To maintain the accuracy of the experimental design, the experimental unit was not an individual mosquito, but rather a mosquito trap unit. Each trap was treated as a single observation unit receiving a specific type of treatment, so that the naturally occurring biological variability of mosquitoes was treated as part of the same environmental conditions across all treatment groups.

Attractant Making Procedure in this study made from organic materials in the form of rice straw and Imperata cylindrica straw, which are fermented naturally using a soaking method referring to and modified from several previous studies which reported that straw-based organic materials are able to produce volatile compounds that attract Aedes spp. mosquitoes through a natural anaerobic fermentation process, such as ammonia, lactic acid, and other organic acids (Saputra et al., 2022). A total of 125 grams of dry straw (rice straw or cogongrass) was cleaned of coarse dirt, then placed in a closed plastic container and soaked in 15 liters of clean water. The proportion of ingredients and water volume is based on previous research that showed that a straw to water ratio in the range of 1:100 - 1:150 is able to produce optimal fermentation odor intensity to attract mosquitoes without causing excessive decomposition that can reduce the attractiveness of the attractant. Volume adjustments were made to ensure the homogeneity of the solution and the adequacy of attractant in all trap units. The soaking solution was then fermented for 7 days under natural conditions. This fermentation time was chosen because several studies report that the optimal fermentation phase of organic attractants for Aedes spp. mosquitoes occurs on days 5 to 10, when volatile compound production reaches a stable maximum level (Subekhi, 2025), to maintain consistency of results, each treatment group used the same fermentation batch, so that variations between trap units were not influenced by differences in the fermentation process between batches.

Microbial contamination control was carried out in a controlled, non-sterile manner, as this fermentation produces volatile compounds from natural microbial activity. The containers used were cleaned before use, the water used was clean, and no external microbial inoculants were added. This approach aligns with previous studies of natural attractants, which have shown that spontaneous fermentation is more representative of real environmental conditions and produces a volatile compound profile that is ecologically relevant to Aedes spp. mosquitoes.(Saputra et al., 2022). Fermentation is carried out at ambient temperature (±27–30°C) without special temperature control. The selection of environmental temperature is based on the consideration that this research. This is a field experiment aimed at producing an attractant that is applicable and easily replicated by the community. This temperature is also within the optimal temperature range for fermentative microbial activity and is suitable for the tropical environment where Aedes spp. mosquitoes thrive (WHO, 2022). During the fermentation process, the container is kept in a shaded area and out of direct sunlight to prevent extreme temperature increases that could inhibit the fermentation process. The tools used included scissors, a cutter, black plastic sheets, adhesive tape, and 1.5-L plastic bottles, how it works is 1) prepare 3 plastic bottles with a size of 1.5 liters, 2) cut the middle of the bottle, on the back of the bottle cap resembles a funnel and join it with the bottom of the bottle, 3) each bottle is filled with 500 ml of rice straw and cogongrass straw attractant, 4) the bottle is covered with black plastic until it covers the plastic bottle so that it is not visible on the side, 5) the trap is placed in dark and damp places that are a breeding source for Aedes sp mosquitoes for 5-7 days, 6) Count and observe the number of mosquitoes trapped.

RESULTS AND DISCUSSION

Description of the results of observations of the percentage of Aedes mosquitoes caught, the table below shows the following results :

Table 1.
Results of observations of the percentage of the number of Aedes sp mosquitoes caught

Treatment Group	Number of Observations (n)	Repetition									Total Mosquitoes (tails)	Mean ± SD (tails)
		1	2	3	4	5	6	7	8	9		
Control (P0)	9	2	1	2	2	1	2	2	1	3	16	1.78 ± 0.67
Rice Straw Attractant (P1)	9	2	3	4	5	2	3	4	5	3	31	3.44 ± 1.13
Cogongrass straw Attraction (P2	9	4	5	3	2	4	3	2	5	5	32	3.56 ± 1.13

As shown in Table 1, the number of Aedes spp. mosquitoes trapped varied between treatment groups during the nine observations. In the control group (P0), a total of 16 mosquitoes were caught, with an average of 1.78 ± 0.67 per observation. The number of mosquitoes caught in this group was relatively lower and showed little variation between repetitions. In the treatment group using rice straw-soaked water attractant (P1), the total number of mosquitoes trapped increased to 31, with an average of 3.44 ± 1.13. The number of mosquitoes caught in this group showed variation between observations, with a minimum value of 2 and a maximum of 5. The treatment group using cogongrass straw soaked water attractant (P2) showed the highest number of mosquitoes caught, namely 32, with an average of 3.56 ± 1.13. The pattern of mosquito numbers in this group was relatively similar to that of group P1, with a range of observed values between 2 and 5.

Table 2.
Results of Analysis of Differences in Mosquito Numbers with One-Way ANOVA

	N	Mean	Standard Deviation	95% CI	df	F	Sig	Information
Between Group	9	1.78	0.667	1.27- 2.29	2			
Within Group	9	3.44	1.130	2.58 - 4.31	24	8,931	0.001	Significant
Total	9	3.67	1.225	2.73 - 4.61	26			

Table. 2 summarizes the results of the One- Way ANOVA analysis show that the value F of 8.931 with degrees of freedom df = 2 and 24, and a significance value (p = 0.00) n means that there is a difference in the number of mosquitoes trapped between treatment groups is statistically significant. The average number of mosquitoes in the control group was 2 with a standard deviation of 0.667 and a 95 percent confidence interval of 1.27 to 2.29. In the rice straw attractant group, the average catch increased to 3 with a standard deviation of 1.130 and a confidence interval of 2.58 to 4.31. Meanwhile, the cogongrass straw attractant group showed an average of 4 with a standard deviation of 1.130 and a confidence interval of 2.69 to 4.42

Table 3.
Results of LSD Advanced Test Analysis Based on the Average Number of Mosquitoes Trapped in Pada Straw and Cogongrass Straw Attractants

Comparison	Mean Difference	LSD This finding supports previous evidence that	Results
P1 : P0	1.44	1.23	Significant
P2 : P0	1.67	1.23	Significant
P2 : P1	0.23	1.23	Not significant

Based on the results of the Least Significant Difference (LSD) test conducted after the ANOVA analysis, there were significant differences between the treatment groups. The LSD test results showed that there was a significant difference between the rice straw attractant group (P1) and the control group (P0), with an average difference of 1.44 which was greater than the LSD value of 1.23. The comparison between the cogongrass straw attractant group (P2) and the control (P0) also showed a significant difference with an average difference of 1.67. However, the comparison between the rice straw group (P1) and cogongrass straw (P2) showed an average difference of 0.23, which was below the LSD value, so there was no significant difference between the two attractants. This indicates that both types of attractants were equally effective in increasing the number of trapped mosquitoes compared to the control, although the effectiveness between the two did not differ significantly. The results of the study showed that the use of water attractants soaked in rice straw and cogongrass straw increased the number of trapped Aedes spp. mosquitoes compared to the control group. This finding aligns with previous studies that reported that soaking plant materials produces volatile compounds from fermentation that act as mosquito attractants, particularly female mosquitoes seeking egg-laying sites (Aji Rustam, 2020; Alivianti, A., Purnama., 2021; Hairani et al., 2020). The presence of these volatile compounds has been proven to influence the olfactory response of Aedes spp. mosquitoes to oviposition media (Fadilah, R., & Suryani, 2021).

The lack of significant differences between rice straw and cogongrass straw attractants indicates that the type of straw is not the primary determining factor, but rather the fermentation process of the organic material itself. This is consistent with research Wulandari (2019) and Ambarita. LP (2019) which reported relatively similar effectiveness between several types of straw soaks in attracting mosquitoes, as long as the media characteristics and soaking duration were not significantly different. Thus, the results of this study strengthen the evidence that straw-based attractants work through a common mechanism, rather than through unique compounds unique to a particular plant species. The relatively small numerical difference in the number of mosquitoes trapped between P1 and P2 also needs to be interpreted proportionally. Several previous field studies have shown that in natural mosquito population conditions, small differences between treatments often do not reach statistical significance due to environmental variability and local mosquito population dynamics (Busra, 2019; Ghoniatussilmi & Sukendra, 2022).

When linked to the mosquito population in the study environment, these results indicate that chemical stimuli from fermented organic matter play an important role in the behavior of searching for perching and egg-laying sites in Aedes spp. This finding is consistent with the biological characteristics of Aedes spp., which are known to be responsive to the odor of volatile compounds such as ammonia, lactic acid, and CO_2, which are generally produced during the decomposition process of organic matter. Previous studies have shown that Aedes aegypti mosquitoes are attracted to laying eggs differently depending on the type of water source, especially in well water and river water (p value = 0.016; $p < 0.05$). The number of mosquito eggs found in containers containing rainwater, river water, and well water varied, indicating that Aedes aegypti mosquitoes are attracted to various locations to lay their eggs.(Busra, 2019). Other research also states that the average number of Aedes spp. larvae caught in straw-water larval traps is 22.3 larvae/larvae trap, while outside the house, the number is 30 larvae/larvae trap (Ate et al., 2025).

Several previous studies support the tendency that soaking rice straw can increase the attractiveness of traps because the content of fermented chemical compounds that match the sensory preferences of mosquitoes and the attractant of water soaked in rice straw has a significant effect on the oviposition of Aedes aegypti mosquitoes. This is because mosquitoes prefer water soaked in rice straw compared to other water media for laying eggs due to the high ammonia content in the water. The use of rice, rice grass, and rice straw attractants has been shown to have a significant difference in the number of Aedes albopictus mosquito eggs compared to distilled water and used egg water (Ridha et al., 2019). Fermented organic liquids are an effective source of kairomones for various mosquito species. Other studies have even shown that organic-based attractants are able to work not only on Aedes spp. but also on Culex spp. or Anopheles spp., although the level of effectiveness varies. This strengthens the fact that mosquito reactions to chemical stimuli are not specific to one type of material, but rather depend on the combination of chemical components released. Similar studies also state that there is a significant effect between rice straw soaked water on mosquitoes trapped in rice straw soaked water (Aji Rustam, 2020).

However, not all studies agree with these findings (Nurhasanah, & Wulandari, 2019) noted that under some conditions, rice straw provided lower attraction than other attractants, depending on the level of fermentation and the characteristics of the research environment also found that different types of natural attractants did not always produce significant differences, especially when used in open environments with significant competing scents from natural habitats. These discrepancies suggest that attractant attractiveness is strongly influenced by ecological conditions, the microbial composition of the bath, and the characteristics of the air and ambient temperature. These variables can vary across locations, leading to variations in attractant effectiveness.

In the context of this study, Imperata cylindrica straw produced slightly higher catch rates than rice straw. Imperata cylindrica is known to have a higher lignocellulose content, which has the potential to produce different volatile compounds during fermentation. Several studies have identified the presence of compounds such as phenol and methyl acetate in soaked Imperata cylindrica straw, which can provide strong mosquito attraction. However, the difference in catch rates between the two attractants in this study was relatively small, so both can still be considered relatively comparable in effectiveness (Fadilah, R., & Suryani, 2021)This is in line with other studies which state that many organic attractants have an attraction that does not differ significantly when used in semi-field conditions.

This study has several weaknesses that should be considered. First, the mosquitoes captured were from a natural population on campus, so no standardization was performed for age, physiological condition, or daily activity. This could influence variations in catch rates. Second, the study was conducted over a limited time period, even though Aedes spp. populations can fluctuate depending on weather, temperature, and humidity. Third, the organic material fermentation process has the potential to produce inconsistent compounds between batches, so the chemical composition may not be uniform. Furthermore, no laboratory species identification was performed, so only morphological characteristics were used to determine the type of Aedes spp.

Despite its limitations, the study results provide a relevant picture of the potential of natural attractants as an alternative for community-based vector control. Both attractants demonstrated effectiveness and can be utilized in mosquito population reduction activities, particularly in residential areas with a high risk of dengue fever. These findings align with efforts to find affordable, safe, and environmentally friendly control methods recommended in modern vector control strategies.

CONCLUSIONS

This study showed that the average number of Aedes spp. mosquitoes trapped in the control group without attractant was 1.78 ± 0.67, while in the treatment group using rice straw and cogongrass straw attractants, the numbers were 3.44 ± 1.13 and 3.56 ± 1.13, respectively. The results of the One- Way ANOVAanalysis showed a significant difference between the control and treatment groups ($F(2,24) = 8.93$; $p = 0.001$). However, further tests showed that the difference in the average number of mosquitoes trapped between the rice straw and cogongrass straw attractants was not statistically significant. This indicates that both types of attractants showed comparable effectiveness, with a small average difference compared to the variation in data within each group. Thus, the type of straw material is not the main determining factor, but rather the presence of the organic fermentation-based attractant itself.

SUGGESTION

Further research is recommended to evaluate different concentrations and fermentation durations of attractants to determine the most effective formula. Testing in open environments with varying weather conditions is also important to assess the stability of attractant effectiveness. Furthermore, further research could develop other combinations of organic materials that have the potential to produce more potent volatile compounds, as well as use more accurate species identification to determine the response of each Aedes spp. species. This approach is expected to strengthen more applicable and sustainable vector control innovations.

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