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Effectiveness of a modified double-trap mosquito device with rice straw infusion attractant in increasing ovitrap and gravidtrap indices

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Abstract

The modified double-trap mosquito device combines ovitrap and gravidtrap functions in a single container to capture mosquito eggs and gravid adults, with application for *Aedes aegypti* surveillance in dengue-endemic households. This study assessed whether adding a 0.83% rice straw infusion attractant improved the ovitrap index (OI), gravidtrap index (GI), and trap catches compared with a control device. An experiment was conducted in 100 houses in Kampung Sindangsuka, Gunung Gede Village, Kawalu District, Tasikmalaya City, from 14 to 27 April 2024. Each house received one modified device and one control device, yielding 100 per group. Traps were placed in humid, low-light indoor locations and monitored for two weeks. Mosquito eggs and adults were counted, although specimens were not identified to species level. OI and GI were calculated as percentages of positive traps, while egg and adult counts were compared using the Mann–Whitney U test after normality assessment. The modified device achieved higher OI and GI values than the control, with an OI of 62% versus 12% and a GI of 52% versus 23%. It collected 8,002 eggs, averaging 80.02 eggs per device and representing 91% of all eggs, and 94 adult mosquitoes, averaging 0.94 per device and representing 72% of all adults. The control collected 746 eggs and 36 adults. Differences in egg and adult catches were significant ($p < 0.001$). These findings indicate that 0.83% rice straw infusion enhances trap attractiveness and detection capacity, supporting its use as a low-cost tool for *Aedes* surveillance and community-based dengue vector control.

Keywords

Aedes spp., Attractant dengue vector surveillance, Modified double-trap mosquito device, Rice straw infusion

1. Introduction

Dengue hemorrhagic fever (DHF) is an acute mosquito-borne viral disease transmitted mainly by female *Aedes aegypti* and *Aedes albopictus* mosquitoes. Dengue remains a major public health problem in tropical and subtropical countries because transmission is strongly influenced by vector density, human mobility, urbanization, environmental sanitation, and climate conditions (Paz-Bailey et al., 2024; Setryawan, 2020). In Indonesia, dengue is still endemic. National data reported 143,266 cases and 1,237 deaths in 2022, while 31,380 cases and 246 deaths were recorded up to the 19th week of 2023 (Kemenkes, 2023a). West Java also recorded a high dengue burden, with 36,608 cases reported from January to June 2022 (Dinkes Jabar, 2024). In Tasikmalaya City, the Dengue Hemorrhagic Fever Information System recorded 246 cases from January to March 2024, with Kawalu District contributing the highest number of cases.

The Indonesian Ministry of Health recommends 3M Plus as the main community-based dengue prevention strategy, including draining water containers, covering water reservoirs, and recycling or managing used items that can become mosquito breeding sites (Kemenkes, 2023b). Additional measures include changing water in flower vases, using mosquito repellent, maintaining larva-eating fish, and applying ovitraps, larvitraps, gravidtraps, or other mosquito traps (Kurniawati et al., 2020). These strategies require practical surveillance tools that can detect vector presence at the household level and support timely vector-control action.

Ovitraps are simple devices for detecting mosquito egg-laying activity and estimating vector density, especially in areas where conventional larval surveys may be less sensitive (Liu et al., 2022; Nurpadila, 2022). The ovitrap index (OI) describes the percentage of ovitraps that are positive for mosquito eggs. Gravidtraps, in contrast, are designed to attract and capture gravid adult mosquitoes seeking oviposition sites; the gravidtrap index (GI) describes the percentage of traps positive for adult mosquitoes (FEHD, 2024; Ong et al., 2020). OI and GI can therefore provide complementary information on egg-laying activity and adult mosquito density.

Attractants are important components of mosquito traps because female mosquitoes use chemical and physical cues to locate hosts and oviposition sites (Coutinho-Abreu et al., 2022). Organic infusions such as rice straw infusion may release volatile compounds, including carbon dioxide, ammonia, lactic acid, octanol, and other fermentation products that stimulate mosquito olfactory responses (Hasanah et al., 2017; Rahayu et al., 2019). Previous studies have reported that rice straw infusion can increase the attractiveness of ovitrap-based devices and that temephos can reduce larval emergence in lethal ovitrap systems (Ridha et al., 2020).

Several modified traps, including gravid Aedes traps and autocidal gravid ovitraps, have been tested for Aedes surveillance and control, but their performance may vary by design, attractant, local ecology, cost, and operational feasibility (Machange et al., 2024). Therefore, locally adapted devices using inexpensive materials remain relevant for community-based dengue surveillance. This study evaluated a modified double-trap mosquito device that combines ovitrap and gravidtrap functions in one device, using 0.83% rice straw infusion as an attractant and temephos as a larvicide. The objective was to determine OI, GI, index categories, trapped egg and adult mosquito counts, and significant differences between the modified test device and the control device.

Table 1. OI and GI criteria (FEHD, 2024)

Level	OI and GI	Criteria
1	OI and GI < 5%	Very low
2	5% <= OI and GI < 20%	Low
3	20% <= OI and GI < 40%	Moderate
4	OI and GI >= 40%	High

2. Materials and Methods

2.1 Study Design, Place, and Time

This study used an experimental field design to compare a modified double-trap mosquito device with a control device. The study was conducted in Kampung Sindangsuka, Gunung Gede Village, Kawalu District, Tasikmalaya City, from 14 to 27 April 2024. The devices were installed in respondent houses located in RT 01, RT 02, and RT 03, RW 009.

2.2 Population, Sample, and Sampling Technique

The population consisted of all modified double-trap mosquito devices installed during the study period. A total of 200 devices were used, comprising 100 modified test devices and 100 control devices. One test device and one control device were placed in each of 100 houses. The samples were mosquito eggs and adult mosquitoes trapped in the installed devices. Houses were selected using purposive sampling based on the willingness of household members to allow device installation and the availability of a safe indoor location that was humid and less exposed to direct light. Devices that were lost, damaged, spilled, or disturbed during observation were to be excluded from analysis.

2.3 Device Design, Formulation, and Variable Definitions

The modified double-trap mosquito device was made from a black plastic container with a lid hole of approximately 6 cm in diameter. The device was designed to combine two functions: filter paper for egg attachment as the ovitrap component, and adhesive glue for trapping adult mosquitoes as the gravidtrap component. The device components are summarized in Table 2 and illustrated in Figure 1.

Table 2. Components of control and modified test devices

Component	Control device	Modified test device
Container	Black plastic container with lid hole	Black plastic container with lid hole
Well water	700 mL	700 mL
Temephos/abate	0.07 g of 1% temephos granules	0.07 g of 1% temephos granules
Rice straw infusion attractant	Not added	6 g dried rice straw in a tea bag, equal to 0.83% (w/v) in 700 mL water
Filter paper	Installed as egg-laying medium	Installed as egg-laying medium
Mosquito adhesive glue	Installed as adult mosquito trap	Installed as adult mosquito trap

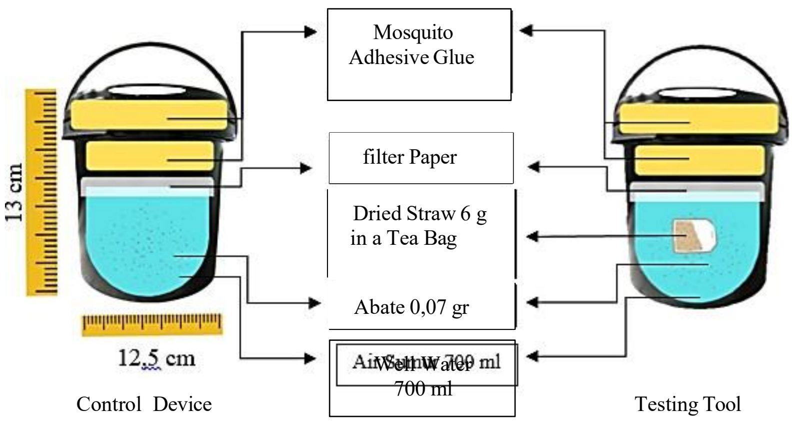

Figure 1. Design of the modified double-trap mosquito device and control device.

The independent variable was the addition of 0.83% rice straw infusion attractant to the modified test device. The dependent variables were the number of positive ovitraps, number of positive gravidtraps, OI, GI, number of mosquito eggs, and number of adult mosquitoes trapped. Controlled operational conditions included the device volume, container color, observation period, indoor placement, use of filter paper, use of adhesive glue, and addition of temephos/abate.

2.4 Data Collection Procedure

The test and control devices were placed inside each respondent's house, preferably in humid, shaded, and low-light areas such as kitchens or locations near bathrooms. The devices were observed once every seven days for two weeks. During each observation, the researchers recorded the presence or absence of mosquito eggs on filter paper and the presence or absence of adult mosquitoes attached to the adhesive glue. Egg counts and adult mosquito counts were also recorded for each device.

2.5 Index calculation

The ovitrap index and gravidtrap index were calculated using the following formulas:

Ovitrap Index (OI)	GI
OI = (Number of ovitrap-positive devices / Number of installed devices) x 100%	GI = (Number of gravidtrap-positive devices / Number of installed devices) x 100%

2.6 Ethical Considerations

This field study did not involve human biological specimens, clinical intervention, or identifiable personal health data. Before device installation, permission was obtained from local community representatives and from household occupants. Participation was voluntary, and household identities were not reported in the manuscript. Devices were placed in locations considered safe and not easily reached by children or pets.

2.6 Statistical Analysis

This field study did not involve human biological specimens, clinical intervention, or identifiable personal health data. Before device installation, permission was obtained from local community representatives and from household occupants. Participation was voluntary, and household identities were not reported in the manuscript. Devices were placed in locations considered safe and not easily reached by children or pets.

3. Results and Discussion

3.1 Trap Positivity and Index Values

The modified test device showed a higher number of positive devices than the control device for both ovitrap and gravidtrap components (Figure 2). Among the 100 modified devices, 62 devices were positive for mosquito eggs and 52 devices were positive for adult mosquitoes. In contrast, among the 100 control devices, only 12 devices were positive for mosquito eggs and 23 devices were positive for adult mosquitoes. These findings indicate that the addition of rice straw infusion increased the probability that mosquitoes would visit the device and either lay eggs or become trapped as adults.

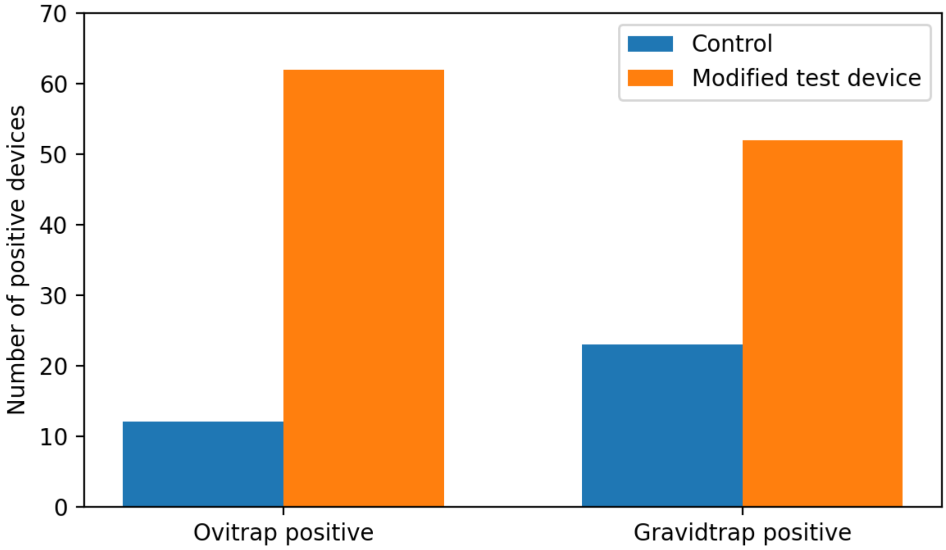

Figure 2. Number of positive ovitraps and gravidtraps in the control and modified test devices.

The index values and their categories are presented in Table 3. The categories were interpreted using the FEHD criteria shown in Table 1, in which values below 5% are very low, 5% to less than 20% are low, 20% to less than 40% are moderate, and 40% or higher are high.

Table 3. Ovitrap and gravidtrap indices by device type

Device type	Positive ovitraps (n/100)	OI (%)	Positive gravidtraps (n/100)	GI (%)
Control device	12	12% (Level 2/low)	23	23% (Level 3/moderate)
Modified test device	62	62% (Level 4/high)	52	52% (Level 4/high)

Based on the FEHD criteria, the OI of 62% and GI of 52% in the modified device were categorized as level 4, indicating a high level of mosquito presence in the study area. The control device produced a lower OI (level 2) and GI (level 3), suggesting that the same household environment yielded different detection results when the rice straw attractant was absent. Thus, the modified device was more sensitive for demonstrating mosquito distribution in the respondent area.

3.2 Number of Trapped Eggs and Adult Mosquitoes

The modified test device trapped 8,002 mosquito eggs, representing 91% of all eggs collected in the study, while the control device trapped 746 eggs or 9% of the total. For adult mosquitoes, 94 adults (72%) were trapped in the modified device and 36 adults (28%) were trapped in the control device (Figure 3). This pattern strengthens the interpretation that rice straw infusion acted not only as an oviposition attractant but also as a cue that increased adult mosquito visitation to the device.

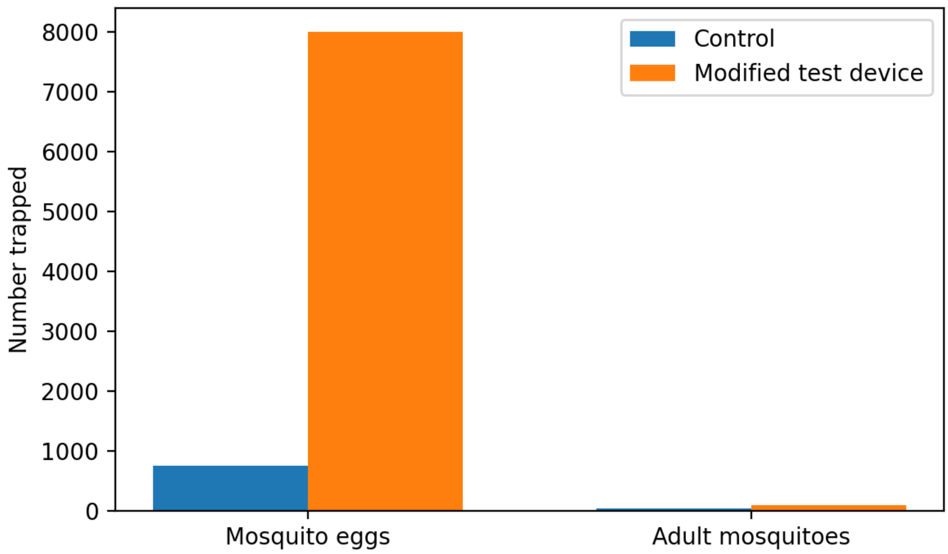

Figure 3. Number of mosquito eggs and adult mosquitoes trapped in the control and modified test devices.

Rice straw infusion may improve trap attractiveness because organic fermentation can release volatile compounds recognized by mosquitoes through olfactory receptors. Carbon dioxide and ammonia are commonly associated with mosquito activation and orientation, while lactic acid, octanol, and other volatile organic compounds may further enhance attraction under certain conditions (Coutinho-Abreu et al., 2022; Rahayu et al., 2019). The 0.83% concentration used in this study appeared operationally acceptable because the infusion remained usable for two weeks and did not produce an excessively strong odor or overly thick liquid. This condition may have maintained the suitability of the device as an oviposition site.

The addition of temephos/abate in both devices was intended to prevent trapped eggs or larvae from developing into adult mosquitoes. Temephos acts by inhibiting cholinesterase activity in larvae, which disrupts the nervous system and contributes to larval death (Suparyati, 2020). This design is important because a surveillance device should not become a productive breeding container when used in the community. However, because this study did not directly measure larval mortality or egg hatchability under controlled laboratory conditions, the larvicidal effect should be interpreted as a supporting function rather than the primary outcome. Representative trap findings are shown in Figure 4, including mosquito eggs attached to the filter paper and an adult mosquito caught on the adhesive glue.

Figure 4. a) Mosquito eggs on filter paper; b) adult mosquito trapped on adhesive glue.

3.3 Statistical Analysis

Before conducting the comparative test, the distribution of egg and adult mosquito counts was examined for each device group. Table 4 shows that all Kolmogorov-Smirnov p-values were below 0.05, indicating non-normal count distributions. Therefore, the Mann-Whitney U test was used to compare the modified test device and the control device.

Table 4. Kolmogorov-Smirnov normality test results

Number trapped	Modified test device (Sig.)	Control device (Sig.)
Eggs	<0.001	<0.001
Adult mosquitoes	<0.001	<0.001

Table 5. Mann-Whitney U test results for egg and adult mosquito counts

Number trapped	Mann-Whitney U	Wilcoxon W	Asymp. Sig. (2-tailed)
Eggs	2485.500	7535.500	<0.001
Adult mosquitoes	3512.500	8562.500	<0.001

The Mann-Whitney U test showed significant differences between the modified and control devices for both mosquito egg counts and adult mosquito counts ($p < 0.001$). This statistical result supports the descriptive findings that the rice straw infusion attractant substantially increased the performance of the modified double-trap mosquito device.

3.4 Statistical Analysis

The higher OI and GI obtained from the modified device indicate that combining ovitrap and gravidtrap functions in a single low-cost device can improve household-level detection of Aedes activity. Compared with the control device, the modified device may provide broader entomological information because it detects both oviposition activity and adult mosquito presence. This is consistent with the principle that gravid Aedes traps and autocidal gravid ovitraps are useful for surveillance because they exploit the behavior of female mosquitoes seeking oviposition sites (Liu et al., 2022; Machange et al., 2024; Ong et al., 2020).

From a public health perspective, a level 4 OI and GI should not be interpreted merely as device effectiveness, but also as an indication that the study area has a high potential for vector breeding and adult mosquito activity. Therefore, trap-based surveillance should be integrated with environmental management, 3M Plus activities, community education, and routine elimination of breeding sites. The device is best viewed as a supporting tool for early detection and risk communication, not as a single stand-alone solution for dengue control.

The novelty of this study is practical rather than entirely conceptual. Previous studies have used ovitraps, gravidtraps, organic infusions, and lethal ovitrap systems, but this study tested a locally modified double-function device with 0.83% rice straw infusion under household field conditions in a dengue-endemic area of Tasikmalaya. This local adaptation is important because trap acceptability, cost, maintenance, and field performance can differ across ecological and social settings.

This study has several limitations. First, the observation period was limited to two weeks in one village, so seasonal variation could not be evaluated. Second, mosquito species were not confirmed morphologically or molecularly, so the results are reported as mosquito eggs and adult mosquitoes rather than species-specific *Aedes aegypti* or *Aedes albopictus* counts. Third, environmental variables such as temperature, humidity, water-container density, and sanitation conditions were not measured quantitatively. Future studies should include longer monitoring periods, multi-location testing, species identification, environmental covariates, and comparison with standard traps to determine sensitivity, specificity, operational cost, and community acceptability.

4. Conclusions

The modified double-trap mosquito device containing rice straw infusion attractant performed better than the control device in detecting mosquito eggs and gravid adult mosquitoes under household field conditions. The addition of rice straw infusion improved trap attractiveness and increased the detection capacity of the device in this setting. Because the trapped mosquitoes were not identified to species level and the observation period was limited to one village and a short monitoring period, the findings should be interpreted as setting-specific evidence for a low-cost supportive surveillance tool. Further studies should include longer monitoring, wider study locations, environmental measurements, species confirmation, and comparison with standard traps before broader implementation in Aedes surveillance and community-based dengue vector control.

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