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RESEARCH ARTICLE

Optimizing ovitrap design: the role of ovistrip texture, colour, and water in modulating oviposition behavior of *Aedes* vector mosquitoes

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ABSTRACT

Ovitrap surveillance of *Aedes* vectors in Sri Lanka needs improvement to effectively monitor vector abundance in dengue high-risk areas and detect emerging infestation zones. A study was conducted in two dengue high-risk areas, Narahenpita and Battaramulla in the Western Province, to assess the influence of ovistrip texture, color, and water type on *Aedes* oviposition, while adhering to WHO guidelines. The relationship of OI and the mean number of eggs per trap with ovitrap designs were determined by General Linear Model (GLM), which revealed a significant difference in the OI between the two study sites (P=0.005), while the mean number of eggs per ovitrap did not differ significantly (P=0.134). Water type had no significant influence on OI and mean number of eggs per ovitraps. A significant effect of ovistrip type (F=6.73, P<0.001) was found on OI and mean egg per trap (F=9.85, P<0.001), where filter paper exhibited the largest coefficient in magnitude (-0.1698), indicating a strong negative correlation with OI and mean eggs per trap (-2.445) while white fabric showed a strong positive co-efficient magnitude with OI (0.1108) and mean egg per trap (1.605). According to Spearman's rank correlation, the rainfall did not have a statistically significant effect on the number of eggs collected or the OI. The study suggested that fabric ovistrips colored white combined with rainwater or tap water, make ovitraps highly effective for *Aedes* vector surveillance, while the currently used filter paper ovistrip having a negative effect on the egg number laid.

Keywords: *Aedes* vector; ovitrap surveillance; ovistrip texture; ovistrip color.

INTRODUCTION

Aedes aegypti and *Aedes albopictus* are vectors of dengue fever in Sri Lanka and are most abundant in urban and semiurban areas island wide. Use of ovitraps has been proven to be an inexpensive and effective in vector surveillance for monitoring dengue vectors (Focks, 2004) and currently ovitraps are utilized in dengue vector surveillance in Sri Lanka (NDCU, 2016). Preference to oviposit in artificial containers among *Aedes aegypti* has been used to design ovitraps for vector surveillance (Day, 2016). The concept underlying mosquito oviposition is that during a gravid female's flight in search of a location to lay eggs, it relies on visual and olfactory cues to identify a potential site. Once gravid females land on chosen sites, tactile cues such as temperature, texture, and moisture content are factors that they evaluate before egg laying (Day, 2016).

An ovitrap, is a plastic container with a black hue. It serves as a reservoir for water, which holds substrate upon which female *Aedes* mosquitoes deposit their eggs (Day, 2016). Oviposition substrates used so far have been relatively rough, can be any of the following, namely a wooden paddle, fine sandpaper, blotting paper and velour paper (Chanampa *et al.*, 2018). Typically, ovitraps are utilized for the purpose of collecting eggs and for indirectly estimating the female *Aedes* population in a given area (Dibo *et al.*, 2008). Ovitrap Index (OI) and Egg Density Index (EDI) show the extent of distribution of mosquito vectors and the intensity of the vector prevalence, respectively (Santos *et al.*, 2003).

Furthermore, the quantity of eggs present in an ovitrap is considered as a primary factor influencing the level of nuisance or increased likelihood of disease transmission (Manica *et al.*, 2017) and is frequently utilized in the formulation of mosquito control strategies. However, ovitrap surveys are not without limitations. When other artificial or natural breeding sites are plentiful in a given geographic area, the reliability of survey results as indicators of the gravid mosquito population may be undermined (Wijegunawardana *et al.*, 2019; Sasmita *et al.*, 2021).

Exploring an effective ovitrap is essential to determine risk of vector prevalence, in dengue high risk areas and to detect new infestations, especially when dengue cases are recorded in geographical areas where larval breeding is not observed. Several laboratory and field studies have been carried out on suitable container type (Gunathilaka *et al.*, 2018; Prasad *et al.*, 2023) for ovipositon, and oviposition container colour (Sazali *et al.*, 2020);

however, studies on the preference of ovitrap substrate for oviposition among *Aedes aegypti* and *Aedes albopictus* mosquitoes are rare in Sri Lanka.

Currently ovitrap surveillance uses ovitraps with either filter paper or red color fabric as substrates for *Aedes* egg deposition. Such substrates are commonly referred to as ovistrips. Specifically, no studies have examined the impact of the ovistrip texture / colour and type of water used in ovitraps on oviposition of the *Aedes* species. Therefore, the study intends to optimize the ovitrap design with respect to ovistrip texture/ colour/ rainwater/ tap water and determine the most effective ovitrap design after carrying out a dengue vector surveillance in two dengue high risk areas in the western province of Sri Lanka.

MATERIAL AND METHODS

Study sites

Field studies were conducted in two study sites categorized as priority high-risk areas (Epidemiology Unit, 2024) namely Narahenpita, Division 4 Medical Officer of Health (MOH) in Colombo municipal council (6.8908° & 79.8773°), an urban area, and Battaramulla MOH (6.8926° & 79.9281°), a suburban area, that recorded respectively an average of 1200 and 935 dengue cases annually (Epidemiology Unit, 2024), three years prior to the study.

Narahenpita with approximately 13,364 population per km^2, is highly urbanized and contains more than 70 government and private institutions, 8 hospitals, private residences and housing complexes but does not have much open space with vegetation. Comparatively, Battaramulla, with an approximate population density of 4224 people per km^2, is less urbanized, containing private residences and 260 government institutions and more open space with dense vegetation (Figure 1).

Ovitrap surveillance and analysis

Ovitrap surveillance was conducted at five (05) randomly selected premises representing houses, temples and government institutes in Narahenpita and Battaramulla, monthly, from November 2023 to April 2024. To determine the effect of ovistrip texture/colour and water type on the oviposition preference of *Aedes* adults, sets of ovitrap designs were prepared. Each set had 10 black plastic ovitraps with ovistrip (20 cm × 8 cm) of different textures namely, filter paper, germination paper and different coloured fabric, namely white, brown and red (Table 1). Half of the ovitraps were filled with tap water and the other half with rainwater up to 2/3 of the inner height of the ovitrap. Ovistrips were held along the inner lining of the ovitraps. Two such ovitrap sets were placed indoors and outdoors at each sampling

Table 1. Ovitrap designs placed indoors and outdoors in each sampling premise in the Narahenpita and Battarmulla study sites

Ovitrap number	Texture of the ovistrip	Color of ovistrips	Source of water designated for ovitrap
1	Fabric	Red	Rainwater
2	Fabric	White	Rainwater
3	Fabric	Brown	Rainwater
4	Filter paper	White	Rainwater
5	Germination paper	White	Rainwater
6	Fabric	Red	Tap water
7	Fabric	White	Tap water
8	Fabric	Brown	Tap water
9	Filter paper	White	Tap water
10	Germination paper	White	Tap water

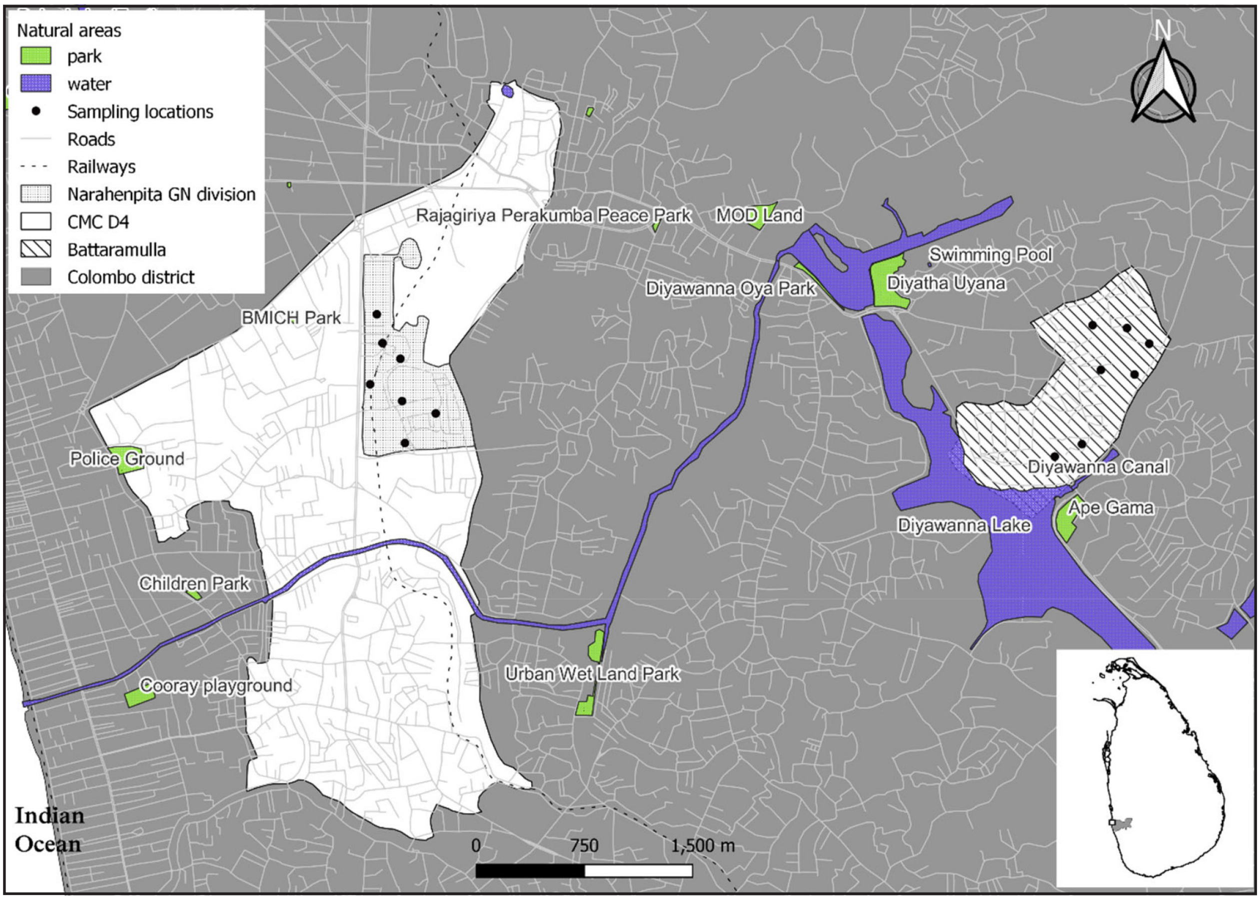

Figure 1. Map of the sampling area, indicating the sampling locations in both Narahenpita (D4 MOH) and Battaramulla MOH areas.

premise (NDCU, 2016). Outdoor ovitraps were placed in areas that were either partially or totally shaded to avoid direct sunlight and heavy rain that may cause water spillage.

After six days, ovistrips from ovitraps were collected from the field, the number of eggs of *Aedes* species on each ovistrip were counted, using a Stereomicroscope (4.5X). Larvae hatching out from eggs sampled from both study sites were reared separately in the insectary under 25±2 °C, temperature and 65±5% RH humidity up to the adult stage, identified using keys (Rueda, 2004) and counts of numbers emerged adults maintained monthly in both study sites.

Data analysis

Preference for *Aedes* oviposition in an ovitrap design was determined based on the Ovitrap index (OI) as described in the following equation:

$$\text{Ovitrap Index (OI)} = \frac{\text{Number of positive ovitraps}}{\text{Number of ovitrap installed}} \times 100$$

Preferences for types of ovistrip texture, colour and water for oviposition, were calculated considering the number of positive ovistrips from respective ovitrap designs of both study sites (n=200) using the above equation (Wan-Norafikah *et al*., 2013; Weeraratne *et al*., 2013).

Vector abundance per ovistrip texture / colour and water were calculated considering the number of eggs on respective ovistrip from ovitrap designs of both study sites (n=200) using the below equation (Weeraratne *et al*., 2013).

$$\text{Mean number of eggs per ovitrap} = \frac{\text{Total number of eggs}}{\text{Total number of ovitraps installed}} \times 100$$

Statistical analyses were carried out using MINITAB 21 software package. All data were tested for the normality by Anderson-Darling test. The percentage data (i.e. Ovitrap index (OI)) were transformed to Arcsine (Warton & Hui, 2011) and the count data (i.e. Number of eggs) were transformed to Log X+1. To identify the overall effect of ovitsrip colour, texture and water source on OI (Arcsine-transformed: Arcsine OI) and mean number of egg count, General Linear Model (GLM) was used. The interactive effects of the independent variables on the same dependent variables were also considered. To determine the effect of ovistrip type the germination paper was used as reference since recent research shows that germination papers are effective in collecting *Aedes* eggs over other ovitrap substrates and more countries are using germination papers in ovitraps as a standard (Parker, 2020; Momen *et al*., 2025). Statistical significance was determined at an alpha level of 0.05.

The medians of the percentage data and count data and factors (study site indoor or outdoor placement,) were compared with the Kruskal-Wallis test (for the effect of one factor). Spearman Correlation analyses were performed to determine the strength of the relationship between rainfall and the mean OI and the mean number of eggs per trap.

RESULTS

Oviposition across the ten types of ovitrap designs

Overall, oviposition by *Aedes* spp., assessed across both study sites and represented as the mean OI (Figure 2a) and mean number of eggs per design (Figure 2b), varied among the ten different ovitrap designs. Overall, filter paper gave the lowest OI and mean number of eggs per trap for the two water types (rain and tap water). White fabric produced the highest mean number of eggs per trap for both rain and tap water. Although white fabric had the highest OI in both rain and tap water, brown fabric too provided similar results for OI for tap water as the white fabric.

This variability indicates that *Aedes* mosquitoes exhibit selectivity in oviposition site choice, highlighting the need to investigate specific features of the ovitrap designs that may influence their preferences. The GLM analysis using overall OI from both study sites revealed a significant effect of ovistrip type (F=6.73,

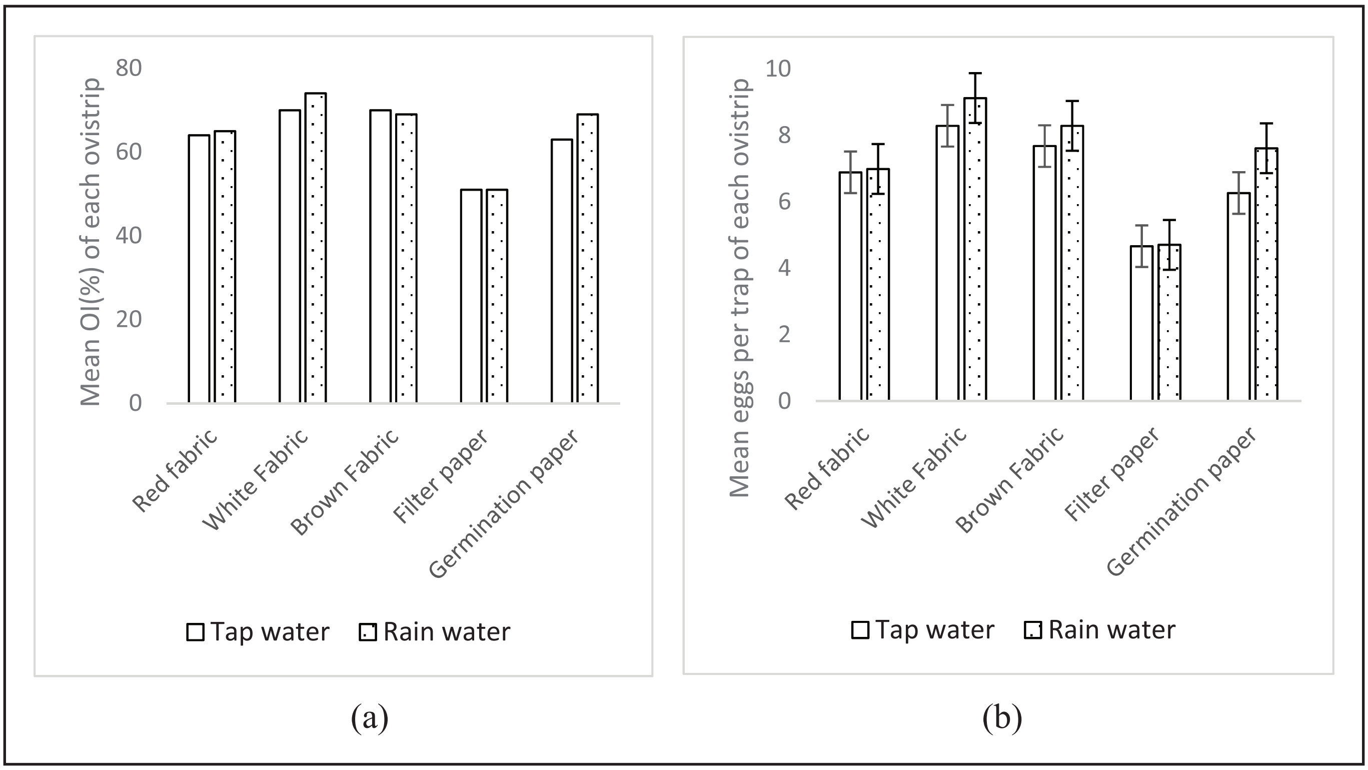

Figure 2. (a) shows the mean ovitrap index (OI%) of each ovistrip with tap water and rainwater, while (b) presents the mean number of eggs per ovitrap of each ovistrip with tap water and rainwater.

P<0.001) on OI (Table 2). However, the study site, water source or the interactions of the variables were not significantly influencing OI (P>0.05) Similarly, GLM analysis indicated a significant effect of ovistrip type on mean egg counts per trap (F=9.85, P<0.001) (Table 2). As observed with OI, the study site, water source or the interactions of the variables were not significantly influencing the mean egg count per ovitraps (P>0.05).

Effect of ovistrip texture, colour OI and mean number of eggs per trap

During the study, a variation in *Aedes* oviposition was observed among three different textures of ovistrips, fabric, filter paper, and the germination paper. Similarly on different fabric ovistrips that were coloured red, white, and brown. Filter paper recorded the lowest mean OI, 52.5% and fabric recorded the highest mean OI 72.9% (Figure 3a). Further, different coloured fabric ovistrips, revealed mean OI for the white, brown, and red fabrics as 72.9%, 70.0% and 65.0% respectively (Figure 3b). GLM analysis (using germination paper as reference) Table 3, confirmed this finding. Ovistrip types, filter paper and the white fabric had a significant effect on the OI. Filter paper had the largest coefficient in magnitude of -0.1698, suggesting a strong negative association with OI. The white fabric had a co-efficient of 0.1108, suggesting a positive association.

Table 2. Results of the general linear model (GLM) statistical analysis

Factor	Dependent variable			
	Ovitrap Index (OI)		Mean no, of eggs per trap	
	F	P	F	P
Study site	8.06	0.005	2.26	0.134
Water Source	0.25	0.615	2.80	0.096
Type of ovistrip	6.73	<0.001#	9.85	<0.001#
Study site*Water Source	0.06	0.814	0.00	0.979
Study site*Ovistrip Type	0.21	0.933	0.29	0.885
Water Source*Ovistrip Type	0.22	0.928	0.24	0.915
Study site*Water Source*Ovistrip Type	0.14	0.969	0.21	0.933

# denotes significance at 0.05

*Adopted model explained 14.58% of the variance in OI (R^2=0.1458, adjusted R^2=0.0720) and 17.73% of the variance in mean egg count (R^2=0.1773, adjusted R^2=0.1062).

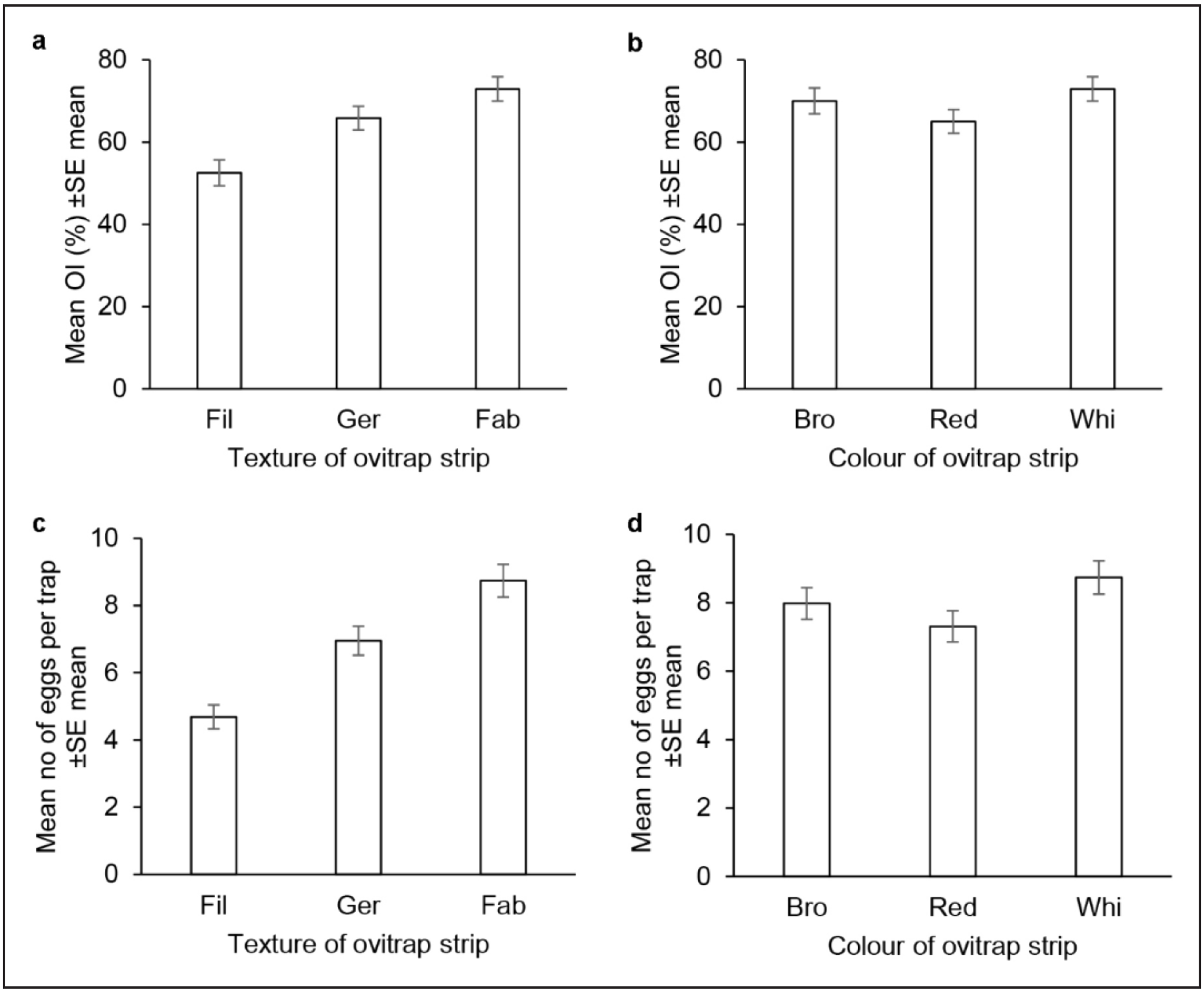

Figure 3. Mean ovitrap index (OI%) of ovistrip with different (a) textures (b) colours, and mean number of eggs per trap on ovitrap strip of different (c) textures and (d) colours of the study sites Fil- filter paper, Ger- germination paper, Fab- fabric, Bro- brown, Whi- white.

Table 3. Coefficients of the significant factors of GLM statistical analysis on OI *(VIF-Variant Inflation Factor)*

Ovistrip Type	Coef	SE Coef	T-Value	P-Value	VIF
Red fabric	-0.0093	0.0376	-0.25	0.806	1.6
White fabric	0.1108	0.0376	2.94	0.004	1.6
Brown fabric	0.0797	0.0376	2.12	0.035	1.6
Filter paper	-0.1698	0.0376	-4.51	<0.001#	1.6
Germination paper	0.0114	0.0376	-0.3	0.762	–

VIF-Variant Inflation Factor, # denotes significance at $p < 0.05$.

Table 4. Coefficients of the significant factors of GLM statistical analysis on mean egg per ovitrap

Ovistrip Type	Coef	SE Coef	T-Value	P-Value	VIF
Red fabric	0.176	0.435	0.40	0.687	1.60
White fabric	1.605	0.435	3.69	<0.001#	1.60
Brown fabric	0.847	0.435	1.94	0.053	1.60
Filter paper	-2.445	0.435	-5.62	<0.001#	1.60
Germination paper	-0.183	0.435	-0.42	0.676	–

VIF-Variant Inflation Factor, # denotes significance at $p < 0.05$.

In addition, the mean number of eggs per trap with white fabric ovistrips recorded the highest mean eggs per trap {8.7(±0.5)} while filter paper {4.8(±0.5)}, had the lowest mean eggs per trap (Figure 3c). The overall mean number of eggs per trap for the white, brown, and red fabrics were 8.7 (±0.5), 7.9 (±0.5), and 7.3 (±0.5), respectively (Figure 3d). Filter paper and the white fabric ovistrips had a significant effect on the mean egg count where filter paper had the largest coefficient in magnitude, which was -2.445, suggesting a strong negative association with the mean egg count. The white fabric had a co-efficient of 1.605, suggesting a positive association (GLM; Table 4).

Variations in *Aedes* vector egg laying behaviour between the two study sites

The GLM analysis indicated a significant difference in the mean OI (Narahenpita - 8.06 and Battaramulla - 2.26) between the two study sites (P=0.005; Table 2). Conversely, the mean number of eggs per ovitrap did not differ significantly (P=0.134) between the two sites (Table 2). The monthly variations in OI and the mean number of eggs were similar in both Narahenpita and Battaramulla. The highest OI and mean number of eggs per ovitrap recorded in December and the lowest in February at both locations (Figure 4 and 5).

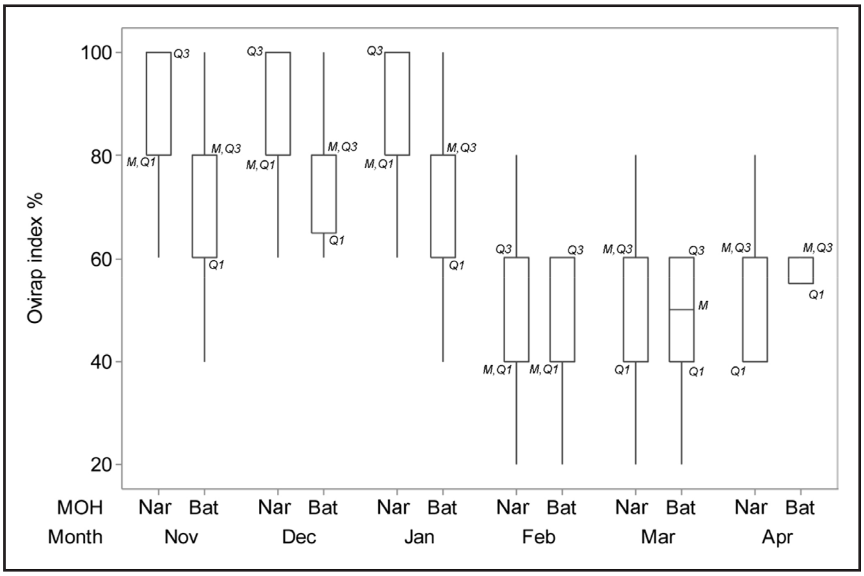

Figure 4. Monthly variation of ovitrap indices (%) in study sites (N=100 monthly) (Nar-Narahenpita, Bat- Battaramulla).

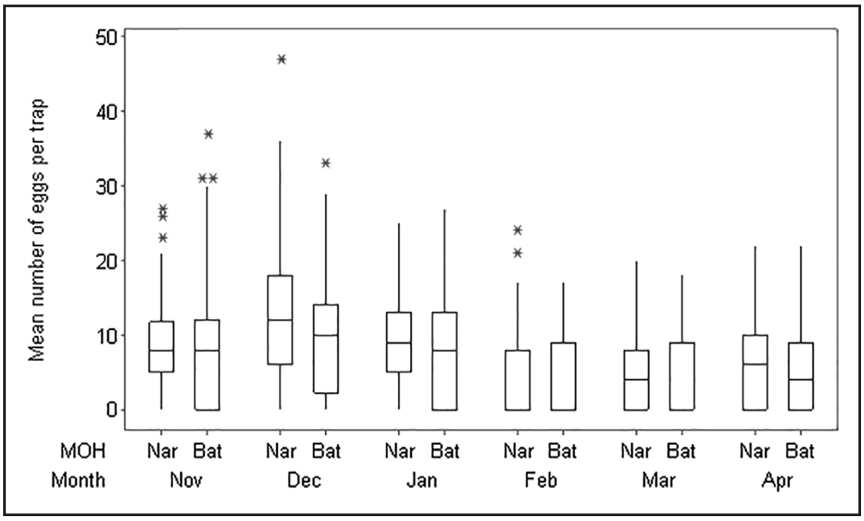

Figure 5. Monthly variation of mean number of eggs per trap in study sites (N=100 per monthly) (Nar-Narahenpita, Bat- Battaramulla).

Table 5. Spearman's Rank Correlation Coefficients and P-values for the relationship between Rainfall and Number of Eggs per Trap and Ovitrap Index on Different ovitrap Materials

Ovitrap strip Material	Response variables			
	Mean eggs per trap		OI	
	Spearman's ρ	P-Value	Spearman's ρ	P-Value
Brown fabric	0.714	0.111	0.696	0.125
Red fabric	0.371	0.468	0.543	0.266
White fabric	0.371	0.468	0.441	0.381
Filter paper	0.657	0.156	0.696	0.125
Germination paper	0.657	0.156	0.638	0.173

Further, variations between the two study sites with respect to the eggs laid in ovitrap designs placed indoors and outdoors were observed. Indoor OI (Kruskal-Wallis test; H=7.78, df=1, P=0.005) and the mean number of eggs (Kruskal-Wallis test; H=8.21, df=1, P=0.004) were significantly higher in Narahenpita. Outdoor OI (Kruskal-Wallis test; H=8.56, df=1, P=0.003) and the mean number of eggs in ovitraps placed outdoors (Kruskal-Wallis test; H=20.69, df=1, P<0.001) were significantly higher in Battaramulla. Rearing eggs collected from ovitraps to the adult stage revealed that over 88% of emerging mosquitoes per month were *Aedes aegypti* in Narahenpita, while more than 89% were *Aedes albopictus* in Battaramulla*.*

Influence of rainfall on mean OI and mean number of eggs per ovistrip types

According to Spearman's rank correlation rainfall was not having a significant relationship with either the number of eggs collected per trap or the OI on any of the tested ovistrip materials (P>0.05; Table 5). The number of eggs per trap on brown fabric (P=0.714), filter paper (P=0.657), and germination paper (P=0.657) showed a moderately strong positive monotonic correlation with rainfall, suggesting a tendency for higher egg counts with increased rainfall. However, these correlations were not statistically significant. Similarly, a weaker positive monotonic correlation observed for red fabric and white fabric (P=0.371) were also not statistically significant.

The analysis of the OI data mirrored these findings. Brown fabric (P=0.696) and filter paper (P=0.696) exhibited moderately strong positive monotonic correlations with rainfall, and germination paper showed a similar trend (P=0.638). However, none of these correlations were statistically significant. The weaker positive monotonic correlations for red fabric (P=0.543) and white fabric (P=0.441) were also not statistically significant. It is evident from these data that the rainfall does not have a statistically significant effect on the number of eggs collected or the OI for any of the ovstrips used in ovitrap designs.

DISCUSSION

The five ovitrap designs experimented in two dengue high risk areas were successful in identifying many features useful for future dengue vector surveillance in Sri Lanka. Primarily all ovitrap designs in both study sites were positive for *Aedes* eggs, displaying their attractiveness and sensitivity to *Aedes* vector oviposition as described by Codeço *et al*. (2015). The highest OI and mean eggs per trap were recorded in December, and the lowest numbers were recorded in February in all ovistrips. However, the Spearman correlation showed that there was no significant effect of rainfall on the OI and mean eggs per trap, similarly reported by Nirmani *et al*. (2019). However, the current study demonstrated that the ovitraps were effective in indirectly tracking variations in female mosquito abundance, which is similar to the observations made by Gopalakrishnan *et al*. (2012).

GLM analysis revealed a significant effect of the area of study, on the OI, but not on the mean egg count per trap. Specifically, the OI was significantly higher in Narahenpita, the predominant area for *Aedes aegypti*, compared to Battaramulla, where *Aedes albopictus* is the dominant species. This seemingly contradictory finding, where the overall mean egg count remains similar across areas despite a significant difference in OI, can be explained by the differing oviposition behaviors of these two mosquito species.

Aedes aegypti is well-known for its skip-oviposition behavior (Rey & O'Connell, 2014). This involves laying only a portion of its egg batch in a single suitable container before flying off to deposit the remaining eggs in other locations. This strategy increases the chances of larval survival by distributing the offspring across multiple potential breeding sites, mitigating the risk of desiccation or resource competition in any one location. Consequently, in *Aedes aegypti*-dominated Narahenpita, a higher proportion of ovitraps are likely to be positive for eggs (leading to a higher OI) because individual females are visiting and laying small clutches in multiple traps. However, the mean number of eggs per positive trap, and thus the overall mean egg count per trap across all traps (positive and negative), might not be different from Battaramulla.

In contrast, *Aedes albopictus* exhibits less pronounced skip-oviposition (Rey & O'Connell, 2014). While they may lay eggs on more than one site, they tend to deposit larger clutches in each suitable container they find. In *Aedes albopictus*-dominated Battaramulla, a lower proportion of ovitraps might be positive for eggs (resulting in a lower OI) because females are concentrating their egg-laying in fewer, perhaps more preferred, sites. However, when a trap is found to be positive, it may contain a larger number of eggs, potentially leading to a mean egg count per positive trap that is comparable to or even slightly higher than in Narahenpita. When considering the overall mean egg count per trap (including the higher number of negative traps in Battaramulla), this average can remain similar to Narahenpita, where more traps are positive but with fewer eggs per positive trap.

Therefore, the higher OI in the *Aedes aegypti*-predominant Narahenpita reflects the species' tendency for skip oviposition, leading to a wider distribution of smaller egg clutches across more traps. Conversely, the lower OI in the *Aedes albopictus*-predominant Battaramulla suggests a less dispersed oviposition strategy, with fewer traps being utilized but potentially receiving larger egg clutches. Despite these differences in oviposition distribution patterns, the overall mean number of eggs collected per trap can remain relatively consistent across the two areas, highlighting the importance of considering both the OI and the mean egg count per trap to gain a comprehensive understanding of oviposition patterns and vector abundance. This finding underscores the distinct ecological behaviors of these two important arbovirus vectors and has implications for targeted surveillance and control strategies.

Although a marked monthly variation was observed, the mean number of eggs per ovitrap did not vary significantly between the two study sites. One explanation may be, *Aedes*' abundance is directly related to the availability breeding sites with water and not very much dependent on the characteristics of the study sites, for e.g., urban or suburban / higher population/ lower population etc. It is well known that both the vectors *Aedes aegypti* and *Aedes albopictus* in Sri Lanka breed in container habitats either natural or manmade, having even a very small quantity of water (Kusumawathie & Fernando, 2003). However, the equivalent monthly abundance of *Aedes* vectors in the two study sites can be considered favorable for identifying the most effective ovitrap design since in this situation, oviposition will not be influenced by numbers of *Aedes* vectors, but by the nature and constituents of the five different ovitrap designs.

In the current study, on preference of ovitrap designs, white fabric ovistrip, having a different texture, to both the filter paper and the germination paper, outperformed by attracting higher *Aedes* oviposition, and recording a higher OI and a higher mean number of eggs per ovitrap. Similar observations have been reported in a study by Chanampa *et al*. (2018) where fabric & the velour paper ovistrips had significantly higher *Aedes* oviposition. The rough nature which gives rise to higher frictional properties of fabric compared to paper, are preferred substrates for egg laying by *Aedes* species.

Fabric ovistrips, fit more easily onto ovitrap cup surfaces than filter paper and germination paper, and can be reused after washing with hot water, while filter papers and germination papers are not reusable. Hence, fabric ovistrip could be more cost-effective and efficient ovistrip substrate than paper based ovistrips. Moreover, in the current study the colours of the used fabric ovistrips (White, brown and red) also had a significant influence on *Aedes* oviposition, where white and brown significantly attracted the adult females for oviposition ($p<0.05$) while red did not. Previous studies related to preference of ovistrip or the substrate colour are not available, hence this study becomes the first record related to the effect colour of ovitrap substrate on *Aedes* oviposition.

Fabric ovistrip egg densities in terms of mean numbers of eggs per ovistrip were higher compared to paper ovistrips throughout the study. This pattern was observed in both Narahenpita and Battaramulla, where *Aedes aegypti* and *Aedes albopictus* were the predominant species, respectively (Janaki *et al*., 2022). Accordingly, the present study indicates that optimized ovitrap designs with fabric ovistrips are effective for monitoring the abundance of both dengue vector species in Sri Lanka.

Aedes oviposition was not dependent on aqueous medium, rainwater or tap water which kept the ovistrip moistened. Rainwater, free from chlorine and other disinfectants, is found to provide a conducive environment for *Aede*s eggs due to its natural chemical and physical properties (McNaughton *et al*., 2018). In contrast, tap water contains additives like chlorine and fluoride used in water treatment deter *Aedes* mosquitoes and potentially impact on their ability to oviposit on ovitraps (Mamai *et al*., 2021). The absence of a significant difference in oviposition in tap and rainwater may be a result of *Aedes* mosquito species adapting to lay eggs in less conducive water sources is reported in urban areas in Sri Lanka (Surendran *et al*., 2012).

CONCLUSION

The ovitrap designs, which were optimized traditional black ovitraps with ovistrips having varying texture, colour, aqueous medium were sensitive to *Aedes* egg laying both indoor and outdoor premises. Among texture types, fabric ovistrip out- performed the traditional filter paper, currently recommended to be used in ovitraps in monitoring *Aedes* egg laying. Presence of significant differences between OI and mean number of eggs laid on coloured fabrics along with no significance of "source of water", rain vs tap water in ovitraps are significant new findings. An ovistrip made of white fabric lining the black color ovitrap cup with either tap water or rainwater to moisten the fabric, appears to be the most productive ovitrap design for *Aedes* oviposition according to the current study. Its ability to monitor density changes of both species *Aedes aegypti* and *Aedes albopictus* during variations in climatic conditions, reusability and cost effectiveness will further add value to its use in *Aedes* vector surveillance in Sri Lanka. Moreover, the currently used filter paper ovitrap may seriously undermine the mosquito densities according to the current findings.

Statements and declaration
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Author contributions

1. A.P. S. Perera – Developed the research protocol, planning, implementation and data analysis of the research, coordinating field activities and preparation of Publication
2. K.O. Bandaranayaka – Developed the research protocol, data analysis, editing manuscript and overall monitoring of the research
3. M.M.S.M.B. Marasinghe – Sample collection, GIS mapping and statistical analysis of the data
4. S. N. Weerakoon – Statistical analysis of the data
5. H. T. R. Jayasooriya – Planning and developing the research protocol manuscript editing and overall monitoring of the research

REFERENCES

Chanampa, M., Gil, J.F., Aparicio, J.P., Castillo, P., Mangudo, C., Copa, G.N. & Gleiser, R.M. (2018). Field comparison of oviposition substrates used in ovitraps for *Aedes aegypti* surveillance in Salta, Argentina. *Journal of Applied Entomology* **142**: 985-990. https://doi.org/10.1111/jen.12554

Codeço, C.T., Lima, A.W.S., Araújo, S.C., Lima, J.B.P., Maciel-de-Freitas, R., Honório, N.A., Galardo, A.K., Braga, I.A., Coelho, G.E. & Valle, D. (2015). Surveillance of *Aedes aegypti*: comparison of house index with four alternative traps. *PLoS Neglected Tropical Diseases* **9**: e0003475. https://doi.org/10.1371/journal.pntd.0003475

Day, J.F. (2016). Mosquito oviposition behavior and vector control. *Insects* **7**: 65. https://doi.org/10.3390/insects7040065

Dibo, M.R., Chierotti, A.P., Ferrari, M.S., Mendonça, A.L. & Chiaravalloti Neto, F. (2008). Study of the relationship between *Aedes (Stegomyia) aegypti* egg and adult densities, dengue fever and climate in Mirassol, state of Sто Paulo, Brazil. *Memorias do Instituto Oswaldo Cruz* **103**: 554-560. https://doi.org/10.1590/S0074-02762008000600008

Epidemiology unit, Ministry of Health. (2024). Dengue sentinel site Surveillance *(*Densys*)*, Ministry of health Sri Lanka, Colombo, Sri Lanka. http://dengue.epid.gov.lk/list.php#main. Accessed 24 March 2024.

Focks, D.A. (2004). A review of entomological sampling methods and indicators for dengue vectors. Geneva: WHO (WHO/TDR/IDE/Den.03.1.).

Gopalakrishnan, R., Das, M., Baruah, I., Veer, V. & Dutta, P. (2012). Studies on the ovitraps baited with hay and leaf infusions for the surveillance of dengue vector, *Aedes albopictus* in northeastern India. *Tropical Biomedicine* **29**: 598-604.

Gunathilaka, N., Ranathunge, T., Udayanga, L., Wijegunawardena, A. & Abeyewickreme, W. (2018). Oviposition preferences of dengue vectors; *Aedes aegypti* and *Aedes albopictus* in Sri Lanka under laboratory settings. *Bulletin of Entomological Research* **108**: 442-450. https://doi.org/10.1017/S0007485317000955

Janaki, M.D.S., Aryaprema, V.S., Fernando, N., Handunnetti, S.M., Weerasena, O.V.D.S.J., Pathirana, P.P.S.L. & Tissera, H.A. (2022). Prevalence and resting behaviour of dengue vectors, *Aedes aegypti* and *Aedes albopictus* in dengue high risk urban settings in Colombo, Sri Lanka. *Journal of Asia-Pacific Entomology* **25**: 101961. https://doi.org/10.1016/j.aspen.2022.101961

Kusumawathie, P.H.D. & Fernando, W.P. (2003). Breeding habitats of *Aedes aegypti* Linnaeus and *Ae. albopictus* Skuse in a dengue transmission area in Kandy, Sri Lanka. *Ceylon Journal of Medical Science* **46**: 51-60. https://doi.org/10.4038/cjms.v46i2.4829

Manica, M., Rosà, R., Della Torre, A. & Caputo, B. (2017). From eggs to bites: do ovitrap data provide reliable estimates of *Aedes albopictus* biting females? *PeerJ* **5**: e2998. https://doi.org/10.7717/peerj.2998

Mamai, W., Maiga, H., Bimbilé Somda, N.S., Wallner, T., Masso, O.B., Resch, C., Yamada, H. & Bouyer, J. (2021). Does tap water quality compromise the production of *Aedes* mosquitoes in genetic control projects? *Insects* **12**: 57. https://doi.org/10.3390/insects12010057

McNaughton, D., Miller, E.R. & Tsourtos, G. (2018). The importance of water typologies in lay entomologies of *Aedes aegypti* habitat, breeding and dengue risk: a study from Northern Australia. *Tropical Medicine and Infectious Disease* **3**: 67. https://doi.org/10.3390/tropicalmed3020067

Momen, M., Seheli, K., Hossain, M.A., Ghosh, A. & Hossain, M.F. (2025). Effect of different lining paper materials and infusions on oviposition preference of *Aedes aegypti* (Diptera: Culicidae) gravid mosquitoes. *Scientific Reports* **15**: 16379. http://doi.org/10.1038/s41598-025-01098-9

National Dengue Control Unit, Ministry of Health (NDCU). (2016). Guidelines for *Aedes* Vetor surveillance and control in Sri Lanka. https://www.dengue.health.gov.lk/web/phocadownload/guidlines_for_aedes_vector_surveillance_and_control_in_sri_lanka_new.pdf. Accessed 29 March 2024.

Nirmani, M.D., Perera, K.L.N.S. & Galhena, G.H. (2019). Use of ovitrap surveillance to assess dengue outbreak risks in selected dengue endemic areas in Sri Lanka. *Sri Lankan Journal of Biology* **4**: 32-46. https://doi.org/10.4038/sljb.v4i2.39

Parker, C. (2020). Collection and rearing of container mosquitoes and a 24-h addition to the CDC bottle bioassay. *Journal of Insect Science* **20**: 13. https://doi.org/10.1093/jisesa/ieaa059

Prasad, P., Lata, S., Gupta, S.K., Kumar, P., Saxena, R., Arya, D.K. & Singh, H. (2023). *Aedes aegypti* container preference for oviposition and its possible implications for dengue vector surveillance in Delhi, India. *Epidemiology and Health* **45**: e2023073. https://doi.org/10.4178/epih.e2023073

Rey, J.R. & O'Connell, S.M. (2014). Oviposition by *Aedes aegypti* and *Aedes albopictus*: influence of congeners and of oviposition site characteristics. *Journal of Vector Ecology* **39**: 190-196. https://doi.org/10.1111/j.1948-7134.2014.12086.x

Rueda, L.M. (2004). Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with dengue virus transmission. *Zootaxa* **589**: 1-60. https://doi.org/10.11646/zootaxa.589.1.1

Santos, S.R.A., Melo-Santos, M.A.V., Regis, L. & Albuquerque, C.M.R. (2003). Field evaluation of ovitraps consociated with grass infusion and *Bacillus thuringiensis* var. *israelensis* to determine oviposition rates of *Aedes aegypti*. *Dengue Bulletin* **27**: 156-162.

Sasmita, H.I., Neoh, K.B., Yusmalinar, S., Anggraeni, T., Chang, N.T., Bong, L.J., Putra, R.E., Sebayang, A., Silalahi, C.N., Ahmad, I. *et al*. (2021). Ovitrap surveillance of dengue vector mosquitoes in Bandung city, West Java province, Indonesia. *PLoS Neglected Tropical Diseases* **15**: e0009896. https://doi.org/10.1371/journal.pntd.0009896

Sazali, M., Soesilohadi, R.C., Wijayanti, N. & Wibawa, T. (2020). Surveillance and oviposition behavior of *Aedes aegypti* based on difference container colours at Mataram City. *The 6th International Conference on Biological Science ICBS* **2260**: 020007. https://doi.org/10.1063/5.0015677

Surendran, S.N., Jude, P.J., Thabothiny, V., Raveendran S. & Ramasamy, R. (2012). Pre-imaginal development of *Aedes aegypti* in brackish and fresh water urban domestic wells in Sri Lanka. *Journal of Vector Ecology* **37**: 471-473 https://doi.org/10.1111/j.1948-7134.2012.00254.x

Warton, D.I. & Hui, F.K.C. (2011). The arcsine is asinine: the analysis of proportions in ecology. *Ecology* **92**: 3-10. https://doi.org/10.1890/10-0340.1

Wan-Norafikah, O., Nazni, W.A., Lee, H.L., Zainol-Ariffin, P. & Sofian-Azirun, M. (2013). Susceptibility of *Aedes albopictus* Skuse (Diptera: Culicidae) to permethrin in Kuala Lumpur, Malaysia. *Asian Biomedicine* **7**: 51-62.

Weeraratne, T.C., Perera, M.D.B., Mansoor, M.A.C.M. & Karunaratne, S.H.P.P. (2013). Prevalence and breeding habitats of the dengue vectors *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) in the semi-urban areas of two different climatic zones in Sri Lanka. *International Journal of Tropical Insect Science* **33**: 216-226. https://doi.org/10.1017/S174275841300026X

Wijegunawardana, N.D.A.D., Gunawardene, Y.I.N.S., Chandrasena, T.G.A.N., Dassanayake, R.S., Udayanga, N.W.B.A.L. & Abeyewickreme, W. (2019). Evaluation of the effects of *Aedes* vector indices and climatic factors on dengue incidence in Gampaha District, Sri Lanka. *BioMed Research International* **2019**: 2950216. https://doi.org/10.1155/2019/2950216