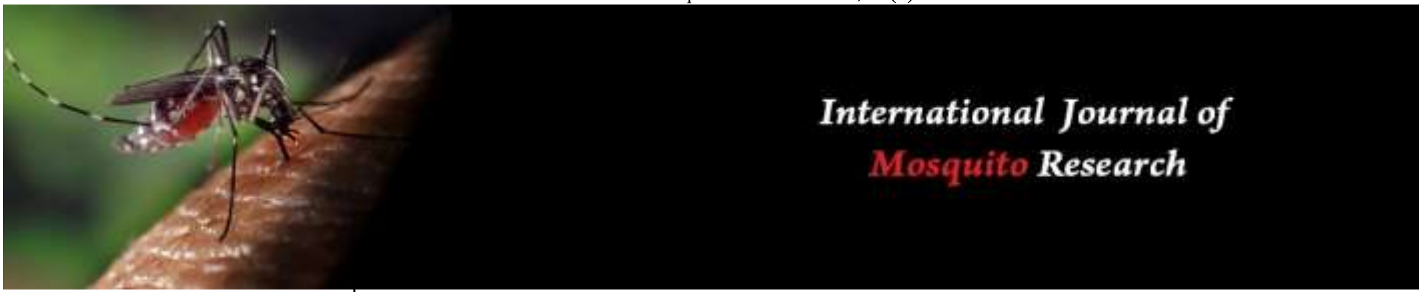

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Dengue vector (*Aedes aegypti*) control in south Chennai using ovitraps through community participation

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Abstract
Dengue fever, caused by the Dengue virus (DENV), is a mosquito-borne disease that poses a significant public health threat in many parts of the world. The primary vector for dengue transmission in Tamil Nadu is the *Aedes aegypti* mosquito, which exhibits anthropophilic behavior and prefers breeding in stagnant water in residential areas. This research paper focuses on evaluating the effectiveness of using ovitraps, modified with locally available materials, for *Aedes aegypti* control in Chennai through community participation. Five sampling locations within Chennai were selected for the surveillance study (K.K. Nagar, Nesapakkam, J.B.A.S College, Triplicane and Royapettah). Ovitraps of 5 different colors, such as black, blue, red, orange, and white were used. The egg counts varied across different locations, time periods and different coloured ovitraps. Nesapakkam area exhibited the highest egg counts, suggesting the presence of factors such as poor sanitation and drainage that promote mosquito breeding. The results of the study showed that the highest number of *Aedes aegypti* eggs was collected during the months of February-March, indicating increased mosquito breeding activity during the dry season. The study also found that black and blue ovitraps yielded the highest number of eggs, while red, orange, and white ovitraps had lower counts. These findings highlight the potential effectiveness of color-coded ovitraps in capturing mosquito eggs and suggest the importance of seasonal monitoring and targeted vector control efforts. To protect the public from dengue/DHF, large-scale dengue prevention can be implemented by combining this system with other routine prevention measures. This will enable individuals to integrate and learn more about the effective control of dengue vectors.

Keywords: Dengue, mosquito, ovitrap, colours, months, community

Introduction

Dengue fever is a rapidly spreading mosquito-borne disease caused by Dengue virus (DENV). With four distinct serotypes (DENV -1, DENV -2, DENV -3 and DENV -4) DENV poses a significant threat to public health in many parts of the world, particularly in tropical and subtropical regions. In India, dengue cases have been on the rise, with the southern state of Tamil Nadu experiencing a substantial proportion of these cases.

The primary vector for dengue transmission in Tamil Nadu is the *Aedes aegypti* (Linnaeus) mosquito, which breeds in stagnant water and exhibits anthropophilic behavior being closely associated with human territories, especially residential areas where human hosts are easily accessible.(Azura *et al*., 2021; Delatte *et al*., 2010) [3, 9]. Studies have shown that *Aedes aegypti* displays endophilic behavior, seeking refuge indoors, and exhibits an endophagic feeding pattern, indicating a preference for feeding inside houses (Hii *et al*., 2009) [13].

Chennai, the capital city of Tamil Nadu, is one of the most densely populated metropolitan areas in India and is at high risk for dengue fever due to its tropical climate, making it a major public health concern in the region. The city has witnessed numerous dengue outbreaks in recent years, exacerbated by heavy monsoon rains that create favorable breeding conditions for *Aedes* mosquitoes.

The prevalence and transmission of dengue fever depends on various factors, such as climate, human population density, habitat availability, and vector control measures. Meteorological factors, including temperature, rainfall, and relative humidity, can influence dengue transmission by affecting vector growth (Ramasamy and Surendran, 2012; Mohiddin *et al*., 2015; Ahmad *et al*., 2018) [21, 17, 1].

A temperature range of 25 °C to 30 °C has been identified as optimal for the transmission of dengue fever, as it accelerates viral replication, enhances *Aedes* mosquito oviposition rate, larvae development and survival, and increases the frequency of female mosquito blood feeding (Morin *et al*., 2013; Delatte *et al*., 2009) [18, 10].

Rainfall also plays a significant role in the dengue transmission providing suitable breeding sites for the *Aedes* mosquito, leading to an increase in its density and ultimately dengue incidence (Sharmin *et al*., 2015; Barrera *et al*., 2011) [26, 4]. However, heavy rainfall can both reduce mosquito numbers initially by washing out eggs, pupae, and larvae, while also creating potential breeding sites with remaining water in the long run (Chen and Hsieh, 2012; Morin *et al*., 2013) [6, 18].

Effective control of *Aedes aegypti* populations is crucial to prevent dengue transmission, and various control strategies have been developed and implemented worldwide. Vector surveillance plays a critical role in preventing and controlling dengue transmission as it helps to determine vector distribution, identifies areas of high vector densities and periods of increased mosquito population. (Dom *et al*., 2013, Azura *et al*., 2021) [11, 3].

For decades, the preferred method of entomological surveillance for dengue control has been the larval survey, which establishes indices to monitor vector-infested areas (Nathan *et al*., 2006) [19]. However, larval surveys are time-consuming, labor-intensive, and carried out in an unsystematic way, limiting their effectiveness.

As an alternative, oviposition traps or "ovitraps" have been developed as a reliable, rapid, non-invasive, and cost-effective method for detecting areas where female *Aedes aegypti* mosquitoes deposit their eggs (Jakob and Bevier, 1969) [15]. Ovitraps designed to attract and trap female mosquitoes, have been widely studied and proven effective for vector surveillance, providing systematic and continuous monitoring of high, medium, and low-risk areas for *Aedes*-borne diseases. Ovitrap surveillance system was also found to be effective in detecting *Aedes* mosquito even when the population was low and provides information of breeding habitat behaviour. (Wright *et al*., 2022) [27]. Several countries, including Mexico and Brazil, have implemented ovitrap surveillance systems as a public health policy, with precise guidelines and standardization of their systems. These systems offer valuable data for vector and disease control, as well as scientific investigations. (Wright *et al*., 2022) [27].

In South Chennai, a densely populated urban area in Tamil Nadu, dengue poses a significant public health concern, necessitating effective mosquito control measures. This study aims to evaluate the effectiveness of using ovitraps for *Aedes aegypti* control in South Chennai through community participation. By engaging communities in mosquito control efforts, this intervention has the potential to be sustainable and effective in reducing mosquito populations and preventing dengue transmission.

The findings of this study hold important implications for local authorities in devising dengue control strategies through vector management, particularly in urban areas of Tamil Nadu and other regions with similar epidemiological characteristics, even in the absence of reported dengue cases in the localities. By harnessing community involvement, this intervention can contribute to sustainable and effective dengue prevention and control.

Materials and Methods

Location for surveillance

In the present study, 5 sampling locations within the Chennai district of Tamilnadu, India were selected. Kalaignar Karunanidhi Nagar (K.K Nagar), Nesapakkam, Justice Basheer Ahmed Sayeed College for Women (J.B.A.S college - Teynampet), Triplicane and Royapettah were chosen.

A part of K.K Nagar and Royapettah, where the present study was conducted, is a slum area where unwanted materials such as tires, and plastic buckets were found discarded in the street and in front of the houses. Open sewage system which is a breeding site for mosquitoes is common in both K.K Nagar and Nesapakkam. J.B.A.S College - Teynampet is a place with a high number of trees which give rise to a huge population of mosquitoes. Due to the scarcity of water in Triplicane, residents collect and store water in large containers for household use which when left open provide a suitable building site for mosquitoes.

Ovitrap designing

Ovitraps used in the present study were modified using materials available locally. It includes a large plastic bucket that was filled with a layer of hay. The inner side of the bucket was lined with another layer of locally purchased; seed germinating paper or filter paper covering hay. Paper and water were refilled periodically as was necessary.

Ovitrap setting

In each chosen location, Modified ovitraps of different colours viz., Black, Blue, Red, Orange and white were placed. A total of 75 ovitraps were used in this study with 15 ovitraps placed in each selected localities during three seasons: October- November (2022), December-January (2022) and February – March (2023).

Egg collection and identification

At regular intervals, filter paper with eggs and larvae was collected and preserved for identification. Eggs and any larvae found in ovitrap were counted and identified to species based upon the keys provided by Kalpage and Brust (1968) [28] using a dissection microscope at 10^X magnification. *Aedes* adult identification was made using the adult dichotomous keys of Darsie and Morris (2000) [29]. Eggs and Adults were also identified by Vector Control Research Centre (VCRC) in Puducherry and Malarial Research Centre (MRC) in Chennai.

Results

The results of this study provide insights into the mosquito population dynamics and egg collection data from different locations in Chennai, Tamil Nadu. The analysis focused on three time periods: October-November, December-January, and February-March.The modified ovitraps placed at each site yielded significantly greater number of *Aedes aegypti* eggs as the surface area available for egg laying was greatly increased by lining the inner surface of the bucket with filter paper. Eggs captured in ovitrap were collected, enumerated and identified.

Information on the number of eggs collected from different locations during specific months is provided in Table-1 and depicted in Fig 1. Across all locations, the highest egg counts were observed during February-March. For example, in K.K. Nagar, the egg count increased from 735 during October-November to 829 during December-January and further increased to 874 during February-March. Similar patterns were observed in Nesapakkam, J.B.A.S College, Triplicane, and Royapettah, with higher egg counts during February-March compared to the other time periods.

Table-2 and Figure-2 provides information about the number of eggs collected from ovitraps of various colors in different locations. The highest number of eggs was observed in the black ovitraps, with K.K. Nagar having 532 eggs, Nesapakkam with 251 eggs, J.B.A.S College with 462 eggs, Triplicane with 331 eggs, and Royapettah with 490 eggs. The blue ovitraps also yielded significant egg counts, with K.K. Nagar having 195 eggs, Nesapakkam with 215 eggs, J.B.A.S College with 224 eggs, Triplicane with 210 eggs, and Royapettah with 300 eggs. The red, orange, and white ovitraps had relatively lower egg counts.

These results provide valuable information on mosquito breeding activity and egg counts in the selected locations of Chennai. The variations in egg counts by ovitrap color and location demonstrate the potential effectiveness of different color-coded ovitraps in capturing mosquito eggs. Additionally, the trends observed in egg counts over time highlight the importance of seasonal monitoring and targeted vector control efforts. This data can assist in monitoring and implementing appropriate control measures to prevent dengue transmission. Further analysis and interpretation of the data would require considering factors such as seasonality, weather conditions, and trends over time.

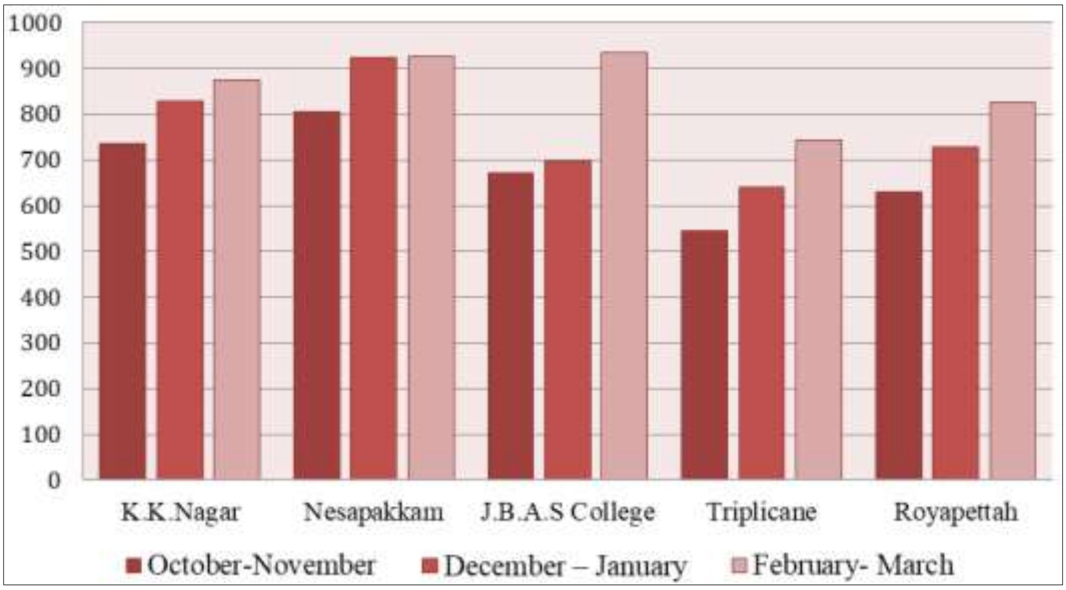

Fig 1: *Aedes aegypti* egg counts from ovitraps in five different location in Chennai during three time periods (October-November, December-January, February-March

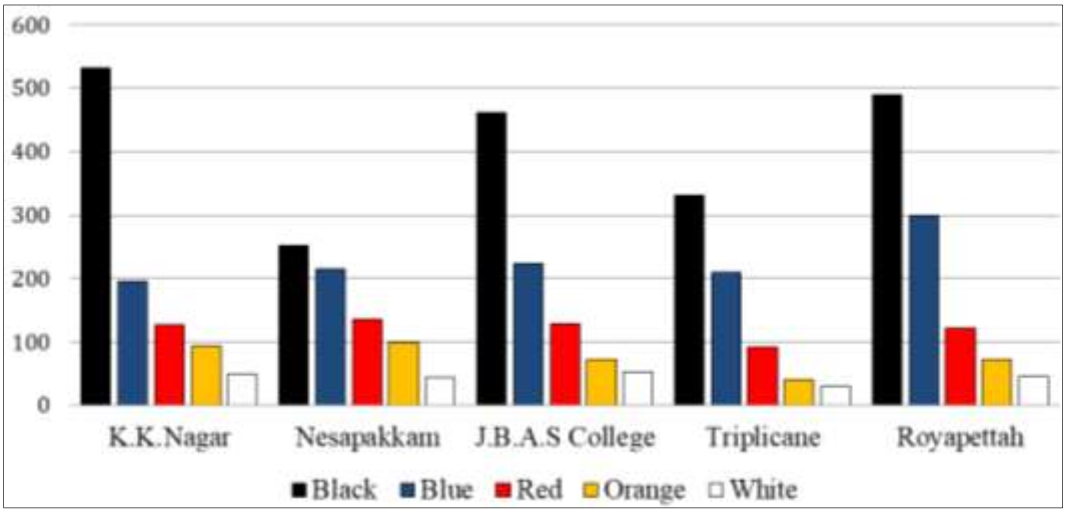

Fig 2: Comparison of *Aedes aegypti* mosquito attraction to five different coloured ovitraps (Black, Blue, Red, Orange, White)

Table 1: *Aedes aegypti* egg counts from Ovitraps in Five Different Locations in Chennai during Three Time Periods (Oct-Nov, Dec-Jan and Feb-Mar)

Periods	K.K. Nagar	Nesapakkam	J.B.A.S College	Triplicane	Royapettah
October-November	735	806	672	544	629
December-January	829	925	696	640	729
February-March	874	926	934	743	825

Table 2: Comparison of *Aedes aegypti* Mosquito Egg Collection in Five Different Coloured Ovitraps (Black, Blue, Red, Orange and White)

Ovitrap colour	K.K. Nagar	Nesapakkam	J.B.A.S College	Triplicane	Royapettah
Black	532	251	462	331	490
Blue	195	215	224	210	300
Red	127	136	128	91	121
Orange	94	99	72	41	72
White	50	44	53	30	46

Discussion

The results obtained from this study shed light on several important aspects related to the prevalence and distribution of *Aedes aegypti* mosquitoes, which are the primary vectors responsible for dengue transmission in the Chennai district of Tamil Nadu, India.

In the present study, the ovitraps placed in the Nesapakkam area yielded the highest number of mosquito eggs, while the Triplicane area had the lowest count. Chien and Yu (2014) [7] established that the impact of rainfall on dengue fever is influenced by various factors, including the frequency, duration, intensity, and magnitude of rainfall, as well as human-related factors such as cleanliness and household storage practices, and the management of drainage systems.

Direct observations at the Nesapakkam site revealed a noticeable neglect of cleanliness both within households and in the surrounding areas. Several unused open plastic containers, flower vases, tyres and old buckets were left outside which are susceptible to accumulation of rainwater, providing favorable breeding sites for *Aedes* mosquitoes. Additionaly Nesapakkam, similar to many other parts of Chennai, faces challenges in terms of its drainage system and storm water management. The area relies on a network of storm water drains and channels to handle rainwater runoff during the monsoon season. However, due to rapid urbanization and inadequate infrastructure development, some areas suffer from insufficient drainage systems. This can result in waterlogging and flooding during heavy rainfall. These factors may have contributed to the yield of high number of *Aedes* eggs in the Nesapakkam site.

Similarly, Triplicane also encounters similar issues with its drainage system. However there is an existing network of storm water drains and channels designed to redirect rainwater away from residential areas where ovitraps were placed for the study. This may attribute to the low count of egges collected in the Triplicane area.

The findings of the present study indicate that in all the 5 study areas, the months of February-March exhibited higher mosquito breeding activity while during October-November it was comparitivly less. This observation can be attributed to environmental and climatic conditions during those specific months. In Chennai, the dry season typically occurs from February to March, characterized by minimal rainfall, lower humidity levels and relatively dry weather conditions compared to the rest of the year, which create favorable conditions for mosquito breeding. On the other hand the monsoon is between October-November.

Dry season supports sustained egg production and adult mosquito survival, thus contributing to the persistence of low dengue fever transmission. Throughout the dry season, mosquito abundance levels showed minimal variations and were predominantly supported by breeding sites found in domestic water containers, which remained relatively unchanged. In contrast, during rainy season, the number of mosquito breeding sites in containers that accumulated rainwater increase over time, leading to a slower stabilization of the adult mosquito population (Betanzos-Reyes *et al*., 2018) [5].

The findings emphasize the importance of implementing intensified vector control measures and raising public health awareness campaigns during the dry season to effectively mitigate the risk of dengue outbreaks. By targeting mosquito breeding sites, particularly domestic water containers, and enhancing preventive measures during this period, the transmission of dengue fever can be significantly reduced. These efforts should be accompanied by continuous monitoring and surveillance to promptly detect and respond to any signs of increased mosquito activity or dengue cases, ensuring a proactive and effective approach to disease control.

In order to effectively prevent the transmission of diseases carried by mosquitoes, a thorough understanding of their oviposition behavior is crucial. Therefore, a comprehensive research study was conducted to investigate the influence of color on mosquito oviposition behavior. The color of ovitraps plays a significant role in attracting *Aedes* adult mosquitoes for egg-laying purposes. Previous research by Chua *et al*. (2004) [8] has shown that *Aedes* mosquitoes rely on visual signals to identify suitable areas for oviposition, with a preference for dark containers.

In the present study, conducted across five different study areas, the highest number of *Aedes* mosquito eggs was observed in black ovitraps, followed by blue coloured ovitraps. In contrast, red, orange and white ovitraps yielded significantly less mosquito eggs. These findings are consistent with the research conducted by Moazzeni *et al*. (2023) [16] and Panigrahi *et al*. (2014) [20]. Based on these findings, it can be confirmed that black and blue are the most preferred colors for mosquito oviposition across various species.

This information can be utilized to enhance the effectiveness of ovitraps by incorporating black or blue as the background color. Additionally, the colors that exhibit repellent properties can be explored as a cost-effective and environmentally friendly approach for behavioral control, such as painting artificial mosquito oviposition sites. By implementing these strategies, it is possible to stimulate mosquito oviposition in targeted areas while simultaneously deterring them from laying eggs in undesired locations. This knowledge can contribute to the development of innovative and practical methods for mosquito control and disease prevention, ultimately reducing the risk of mosquito-borne diseases in affected regions.

The ovitraps used in this research were constructed from large plastic buckets, making them cost-effective and easily prepared. The bucket was filled with a layer of hay and seed germinating paper or filter paper covering hay which was periodically sprinkled with enough water to maintain moisture. Moreover Panigrahi *et al.* (2014) [20] suggested that *Aedes* mosquitoes exhibit a preference for laying eggs in larger containers that are less prone to drying, thereby increasing the survival rate of mosquito larvae. To enhance the sensitivity of ovitraps as surveillance tools for detecting the presence of *Aedes* mosquitoes, attractants can be employed (Focks, 2003). One such attractant commonly used is hay infusion which was used in the present study. Another study by Ahmad-Azri *et al*. (2019) [2] suggested NPK fertilizer as an attractant for *Aedes* mosquitoes. It is worth noting that the effectiveness of attractants used in ovitraps depends on the duration of storage (Isoe *et al*., 1995) [14]. These findings offer valuable insights for vector surveillance teams in selecting the most effective ovitrap for dengue vector surveillance and control efforts.

Thus, in this study the utilization of ovitraps as a surveillance tool has demonstrated its effectiveness allowing for continuous monitoring and collection of mosquito eggs. The data obtained from these ovitraps can play a crucial role in informing vector control strategies by identifying high-risk areas and evaluating the efficacy of control measures.

Despite the significant egg collection capability of the modified ovitraps, it is important to acknowledge the limitations of this study. If left unattended for more than seven days, these ovitraps can become breeding containers for *Aedes* mosquitoes (Santos *et al*., 2003) [25]. Therefore, it is imperative to monitor these ovitraps within a seven-day period or less to prevent unintended mosquito breeding. Besides the data presented here represents a specific time period and set of locations within the Chennai district. Generalizing the findings to other regions should be done cautiously, considering the variability in environmental conditions, mosquito behavior, and human factors. Further research is warranted to validate these findings in different settings and explore additional factors influencing mosquito breeding and dengue transmission.

Conclusion

Overall the findings contribute to our understanding of the local dynamics of *Aedes* mosquito populations and their breeding patterns in urban areas of Tamil Nadu. The results indicate significant variations in mosquito breeding activity and egg counts both within locations based on the color of the ovitraps and across time periods. Highest egg counts were observed in Nesapakkam area, suggesting the presence of factors such as poor sanitation and drainage that promote mosquito breeding. The black ovitraps showed the highest attractiveness to female *Aedes aegypti* mosquitoes, followed by the blue ovitraps. Moreover, the months of February-March exhibited the highest mosquito breeding activity, as evidenced by the increased egg counts.

These findings highlight the importance of considering local environmental factors, such as sanitation, drainage, and seasonal variations, in mosquito control efforts. The study emphasizes the importance of targeted vector control measures during the dry season to mitigate the risk of dengue outbreaks. The effectiveness of ovitraps and the choice of color can significantly impact their ability to capture mosquito eggs. By identifying high-risk areas and implementing targeted interventions, it is possible to effectively reduce mosquito populations and mitigate the risk of mosquito-borne diseases like dengue. By engaging communities in mosquito control efforts, this intervention offers a sustainable and effective approach to dengue prevention and control.

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