ATLANTIS PRESS

Advances in Health Sciences Research, volume 22

4th International Symposium on Health Research (ISHR 2019)

The Effect of Materials and Colors of Artificial Water Container Toward Mosquito (*Aedes Aegypti)* Egg Index

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ABSTRACT

Aedes aegypti is the main vector of Dengue Haemorrhagic Infection in Indonesia and it is predominantly breeding in clear water within household artificial containers. Thus, it is necessary to implement environmental management that is tends to be simple, low-cost and effective to create disadvantageous condition for *Aedes Aegypti* mosquito's breeding sites. The objective of this study is to investigate the effect of water container colour made of concrete and plastic material to the amount of Aedes Aegypti egg density. Two types of artificial water container made of cement and plastic material with 2.5 litres capacity, are painted in red, blue, green, black and white as controls. These containers were placed into two test cages according to material's type. The samples of 60 female *Aedes aegypti* mosquitoes (F1) were inserted into test cages and guinea pig's blood was provided, waited for duration of 4 x 24 hours to allow mosquitoes to lay eggs and the number of eggs in each container were calculated and proceeded with statistical analysis. Container that is made of blue concrete is the most placed eggs that contain 264 eggs (27.91%) whereas green plastic container is the least placed eggs that contain 103 eggs (11.09%). There is no significant difference of eggs index based on container's material types (p = 0.126) but there is a significant difference of egg index based on container's colour (p = 0.015). The container's colour that tends to be most preferred by *Aedes Aegypti* mosquitoes to lay their eggs is blue, this finding could support environmental management of *Aedes Aegypti* habitat by avoiding to use blue as water container's colour.

Keywords: *container material, container color, mosquito egg index*

1. INTRODUCTION

The number of Dengue Hemorrhagic Fever (DHF) cases increased from 2.2 million cases in 2010 to 3.2 million cases in 2015. Even though the global burden regarding the cases were unable to be clearly evaluated, however the initiation to recording DHF has been peaked off recently. Nowadays, DHF are endemic cases found in around a hundred countres worldwide, including Africa, USA, East Mediterania, South East Asia dan West Pacific. In particular, the number of cases in USA, Southeast Asia and West Pacific reaching more than 1.2 million cases in 2008 and more than 3.2 million in 2015 [1].

In Indonesia, the risk of population getting DHF due to infection of dengue virus with *Aedes aegypti* (*Ae. aegypti*) as its vector is quite high and widely distributed, including within household, as well as within public places, except at the location with altitude more than 1000 meter aboved sea level [2].

The breeding sites of *Ae. Aegypti* is usualy located around and inside the house such as within crocks (46%), drum (29%) and bathtub (23%). From these breeding sites, bathtub is the main site with highest larvae index due to its large water volume compared to crocks and drum [3]. In line with a research conducted by Ridha, Rahayu [4] that crocks, drum and bathtub are the types of container that are most potentially containing *Ae. Aegypti* egg.

On the other hand, the color of container is become one of the attractive factor for female mosquitoes (*Ae. aegypti*) to lay their eggs [5]. A research conducted in in East Baturaja Elementary Schools shows that there is a correlation between color and mosquitoes larvae index (P = 0.017), the number of *Ae. aegypti* larvae is higher within dark colored container [5]. Whereas, Bartlett-Healy, Unlu [6] reported that the existence of 306 container with black and grey colored located around, within and in the border of New Jersey, USA were correlated with the existence of *Ae. albopictus* dan *Ae. Japonicas* larvae.

Consequently, one of the succeded methods in DHF vector control that existed in some countries is conveyed through environmental management by source reduction in terms of controlling mosquitoes breeding sites. For instance, vectrol control in Cuba dan Panama in the beginning of 20th century were quite succeed using environmental management based control, and this control approach still implemented whenever and wherever DHF cases existed [7]. While, in Singapore, DHF cases has been successfully controlled since 15 years ago by the implementation of entomology surveillance and source reduction [8].

Dark colored and rough surface water container is preferred by *Ae. aegypti* mosquitoes for laying their eggs compared to light colored and smooth surface containers.Therefore, a research regarding the tendency of preferred location, water containers color and material is needed to be conducted, in order to analyse ovoposition of *Ae. aegypti* mosquitoes. So, that DHF vector control through environmental management and by using water containers that are tend to be avoid by mosquitoes for laying their eggs could be applied in the community.

2. METHOD

This research is an experimental study, two material types were concrete and plastic with water volume is 2.5 litres, the containers were painted red, green, black. As a control, one container is painted with white color. Clean and clear 2 litres water is poured inside all containers, at the above inside of the containers, filter sheets were installed as ovitrap. Furthermore, the containers are positioned into two cages based on its materials.
Samples were gathered from 30 ovitrap installations in DHF endemic area in Lamreung Village, Darul Imarah Sub-District. The experiments were conducted in several days until reaching adequate number of female mosquitoes as samples. 60 *Ae. Aegypti* female mosquitoes (F1) were inserted into two cages sized 1 metre square, in each cage, 30 mosquitoes were inserted and guinea pig's blood was provided for 1 to 2 hours to reassure all mosquitoes fully feed, waited for duration of 4 x 24 hours to allow mosquitoes to lay eggs. The number of eggs in each container were calculated for 3 times, between calculations, containers were washed, water was changed and new filter sheets were installed. The research results calculations was conducted between January and March 2017 in Entomology Laboratory, Port health Office Class III Banda Aceh. The number of eggs gathered between concrete and plastic container were relatively no big differences from three frequencies of feeding and different calculations, that this results shows contradictory with the study conducted by Setyaningsih and Agustini that reported the frequency of feeding resulted in significant different number of eggs [9].

3. RESULTS AND DISCUSSION

The results showed the highest eggs index is gathered from blue concrete container, which is 264 eggs (27.91%) and the lowest is 131 eggs (13.85%) that is gathered from green concrete container. Whereas, the results eggs gathered from plastic containers showed that the highest eggs index is gathered from blue plastic container 330 eggs (35,52 %), while the smallest number was in green plastic container, 103 eggs (11.09%).

Table 1. Frequency Distribution of *Ae. aegypti* eggs Number in Concrete and Plastic Container

Colors	Materials			
	Concrete		Plastic	
	N	%	N	%
Control	109	11,52	124	13,35
Red	189	19,98	105	11,30
Blue	264	27,91	330	35,52
Green	131	13,85	103	11,09
Black	253	26,74	267	28,74
TOTAL	946	100,00	929	100,00

Table 2. ANOVA Test Result: The Mean of Plastic Container Colors Influence to the Number of Ae. Aegypti Mosquitoes Eggs Number

Variable	Mean	Standard Deviation	SE	95% CI	p value
Control	41.33	11.590	6.692	12.54-70,13	0,015
Red	35.00	32.512	18.771	(-45.76)-115,76	
Blue	110.00	28.478	16.442	12.54-180,74	
Green	34.00	21.166	12.220	(-18.58)-86,58	
Black	89.00	33.181	19.157	6.57-171,43	
Total	61.87	39.661	10.240	39.90-83,83	

Table 3. ANOVA Test Result: The Mean of Concrete Container Colors Influence to the Number of Ae. Aegypti Mosquitoes Eggs Number

Variable	Mean	Standard deviation	SE	95% CI	p value
Control	36.33	9.292	5.364	13.25-59.41	0,126
Red	63.00	22.000	12.702	8.35-117.65	
Blue	88.00	22.716	13.115	31.57-144.43	
Green	43.67	24.007	13.860	(15.97)-103.30	
Black	84.33	42.548	24.565	(21.36)-190,03	
Total	63.07	30.985	8.000	45.91-80,23	

Anova test described that the mean of *Ae. Aegypti* eggs index in blue plastic container is 110 (SD=28.478, CI=12.54-180.74), and the mean of *Ae. Aegypti* eggs index in green plastic container is 34 (SD=21.16, CI=-18.58-86.58) and P= 0.015 that emphasizing the influence of different colors of plastic containers to the number of *Ae. Aegypti* mosquitoes' eggs.

The result using Anova test showed that the mean of *Ae. Aegypti* eggs in blue concrete containers is 88 (SD=22.716, CI=31.57-144.43), while the mean of *Ae. Aegypti* eggs index in green concrete container is 43.67 (SD=13.860, CI=-15.97-103.30) and P= 0.126, which means that there is no influence of different colors of plastic containers to the number of *Ae. Aegypti* mosquitoes' eggs.

Containers material that is made from concrete shown to be the place with the highest number of *Ae. aegypti* mosquitoes eggs were calculated (946 eggs or 50.45%) while the number of eggs calculated in plastic container are 929 (49.55%). The research by Rosa [10] showed that the types of water containers influence the mosquitoes eggs number, that within concrete container, the eggs density is higher. Consequently, there is a significant reltionaship between types of container materials and the existence of *Ae. Aegypty* eggs [11]. The research by Sungkar [3] reported that smooth surface of containers were also influencing Ae. Aegypti larvae desity, the type of containers that contained higher eggs number were in concrete bathtub (64.4%) compared to plastic bathtub (38%) [12].

The result in this study shows that a large number of mosquitoes egges was found in concrete containers, in contradictory with Pahlepi Study [13] in one of Elementary Schools in Palembang, that the containers existed were mostly made from plastic and ceramic materials, but mosquitoes larvae were mostly found in ceramic container because *Ae.Aegypti* tend to lay their eggs on the junction between ceramic plate and this findings different with Riandi, Hadi [14] research in Cikalang and Cibunigeulis Sub-District in Tasikmalaya, reported that there is no differences in proportion of larvae existences in smooth (plastic/ceramic/glass/metal) or rough (concrete/rubber/soil ceramic) containers.

Similarly, container materials made of metal or plastic showed no significant differences in influencing the existence of *Ae. Aegypti* larvae in Trinidad, West Indian, since the existence of larvae is depend on an interaction biotic and abiotic factors. The content of ammonia in water is also influencing mocrobes population as nutrition source for mosquitoes larvae or it can also be a stressor in development of larvae [15].

A research by Hasyimi and Soekirno [12] focusing on mosquitoes eggs surveillance in Bekasi and Tangerang found that from all containers available, *Ae. Aegypti* were mostly found in plastic based containers, while another research in Palu founds that water reservoir with abundant *Ae. Aegypty* mosquitoes eggs were mostly available in unused neglected tyres (rubber: 32.14%) and in plastic containers (3.89%) [16]. These findings suggest that community are recommended to use plastic container due to its smooth surfaces, ease to clean and the most important things is that it is not an attractive places for Ae. Aegypty mosquitoes' breeding [17].

In this research, the test results P = 0.015 (P < 0.05), which means that there is a significant difference between colors of plastic containers and the number of mosquitos' eggs. On the other hand, the test results indicated that there are no significance differences between colors of concrete containers and the number of mosquitos' eggs with P = 0.126 (P > 0.05).

Budiyanto [18] reported that there is a differences of *Ae.Aegypti* eggs number from five different collors ovitraps, namely red, yellow, blue, black and white. Additionally, the study in East Baturaja, Ogan Komiring

Ulu, reported that there is a relationship berween dark and light-colores container and the existence of *Ae. Aegypti* mosquitoes larva [5].
Hasyimi and Soekirno [12] mentioned that in regards to the colors of containers, black and blue are the container colors liked by *Ae. Aegypti*, with the proportion are 30% for both colors. Dark-colored could facilitate save and calm places for Ae.Aegypti mosquitoes while they are laying their eggs, consequently the egg layed in the dark container is much higher. On the other hand, the density of eggs is lower in light-colored containers. Whereas, in some research that are observing light-colored containers such as light blue, but due to dirty condition, so the containers colors became darker and the usage of black containers attract *Ae. Aegypti* to lay their eggs compared to other container colors [19].
Furthermore, container colors become one of the attractive factors for female *Ae. Aegypti* mosquitoes to lay their eggs. A research by Budiyanto [5] elementary school in East Baturaja showed that the number of eggs is higher in dark-colored container and showed the significant colleration with larvae existences (P = 0.017). A study by Bartlett-Healy, Unlu [6] reported that the existence of 306 container with black and grey colored located around, within and in the border of New Jersey, USA were correlated with the existence of *Ae. albopictus* dan *Ae. Japonicas* larvae.
In regards to the ovitraps colors, the surveillance research of *Ae. Aegypti* mosquitoes in Rajashtan showed that eggs density is highest in red ovitrap (92.7%), followed with black and orange (91.7%) and green (76.3%) and transparent (45.8%) [20].
So, the factors that influence *Ae. Aegypti* mosquitoes behavior in laying their eggs are the colors of containers **[**21**]**. In this research, the main findings are blue container is the places where most eggs found [22], no influence of ovitrap cover colors to the number of Ae. Aegypti trapped [23].

4. CONCLUSION

In conclusion, this study reported that there is a correlation of different types of color for plastic container and the existence of *Ae. Aegypti* mosquitoes egg index (P = 0.015) and there is no significant relationship between types of colors for concrete containers and the number of *Ae. Aegypti* mosquitoes eggs (P = 0.126).
It is recommended that people in community to avoid using blue colors for containers since this color is potential to be one of attractive factors for breeding sites of *Ae. Aegypti* mosquitoes. Also, it is recommended to clean the containers regularly to avoid reproduction and development of mosquitoes. For plastic containers producers, it is recommendend to limit or avoid the production of blue plastic containers due to its color attractiveness as *Ae. Aegypti* mosquitoes breeding sites. Lastly, another recommendation for other reserachers to conduct further research in analyzing mosquitoes breeding sites in other areasn and in different materials and colors.

ACKNOWLEDGMENT

Thank you to Head of Port Health Office Class III Banda Aceh, for allowing the use Entomology Laboratorium for this research. Thank you to Mr. Zulfikar, Mr. Mutasir, Mr. Mahlil and Mr. Alamsyah for helping researcher in ovittrap installations and also for mosquitoes rearing in the research field. This research is self-funded and author does not receive financial assistance from any party.

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