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Potential of Geranium From Pelargonium Graveolens As Natural Mosquito Repellent Agent In Fabric Softener

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***Abstract*— Mosquito repellent-incorporated fabric softener was produced using geranium oil from Pelargonium Graveolens plant as a potential natural source of repellent agent to provide efficacy against mosquitoes. This paper provides the method of making the mosquito repellent-incorporated fabric softener having the geranium oil added during the preparation. 100% cotton fabric was laundered and treated using the fabric softener. The treated samples were tested using the Bioassay Repellence Assessment, WHO Cone Test using Aedes Aegypti mosquito species to ascertain the repellence potential of the fabric softener against mosquitoes. Some physical attributes of the treated fabric, i.e. the fabric weight, fabric stiffness and crease recovery angle, were determined to ensure the main functions of the fabric softener are retained. The Bioassay WHO cone test result showed that the fabric softener incorporated with the geranium oil from the Pelargonium Graveolens plant has the potential to drive away mosquitoes from the treated fabric with better fabric hand properties.**

***Keywords*— Mosquito repellent, fabric softener, Pelargonium Graveolens.**

I. Introduction

Clothing functions to cover and protect the wearer's body. Some textile treatments add additional functional properties such as mosquito repellent, softening finishes and others. An effort to treat the fabric with mosquito repellent helps to prevent and control the spreading of the mosquito borne disease such as dengue fever. Dengue fever has re-emerged and being endemic in more than 110 countries as reported by the World Health Organization (WHO). It is transmitted from female Aedes Aegypti mosquitoes in a domestic environment. Recently, in Malaysia cumulative dengue cases were reported throughout the country from January 2015 to 25th April 2015 with 38517 cases, compared to 28814 during the same period in 2014, increase about 33.7 % (9703 cases) with 126 death cases reported [1]. Mosquitoes are attracted to people by skin odors and carbon dioxide from human breathing activity [2-4]. The female mosquitoes need blood protein found in blood to produce their eggs[5, 6]. Mosquito repellent can be specified as a substance applied to skin, clothing or other surfaces which inhibit insect from landing or climbing on the applied surfaces [7]. The used of repellents make a person unpleasant of feeding and therefore ward off the mosquito.

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At present, there are a number of highly effective repellents that can be applied onto clothing such as DEET and Permethrin. However, there are concerns among public associated to DEET and Permethrin chemical contain and toxicity and its risk to human [8-10]. Natural repellent substances from plants such as geranium oil from Pelargonium Graveolens is a better alternative since they are perceived as safer and trusted means of mosquito repellent agent [11, 12]. The geranium oil incorporated fabric softener falls under the repellent insecticides category, where the mechanism of the repellent, by mean of sense of smell, has the effect of keeping insects away from the treated fabric surface without them touching the surface.

Geranium oil from Pelargonium Graveolens plant contains multifarious components, including two active components claimed of having potential mosquito repellent activity which is geraniol and citronella. The geranium essential oil produces a strong, sweet rose-lemon aroma believed to come from the geraniol compound of the Pelargonium Graveolens plant [13, 14]

The use of less scented conditioner as the softening agent in fabric softener which contain quaternary ammonium salts be certain of to soften the garments and reduce the static cling to fabric within the scope of conditioning agent in hair conditioner [15] for example, deposition of the conditioning agent on the fabric fibers or hair fibers reduce the sliding friction between fibers, resulted softness in fabrics and as soft as silky feel in hair.

In the present study, a home-made fabric softener liquid with added natural mosquito repellent was developed, where the geranium essential oil from Pelarganium Graveolens plant, believed to repel mosquito, is added during the preparation of the softener. The essential oils from Pelarganium Graveolens are an active ingredient for bio-repellents against mosquito. The softener was applied onto a cotton fabrics during the last rinse of laundering cycle. The mosquito repellency test, together with some fabric property test i.e. fabric weight, stiffness and crease recovery, were conducted to determine the effectiveness of the essential oils from the geranium compound as a mosquito repellent.

II. Method

A. *Materials, Preparation and Washing procedure*

Materials

Geranium essential oil (supplied by the Best Formula Industries, Segambut, Malaysia) was used as the main active

ingredient. The fabric used in the study was 100% desized and bleached cotton fabric. Less scented hair conditioner and acetic acid were used as part of the ingredients for the homemade fabric softener.

Preparation and washing procedure

The primary ingredients of homemade fabric softener comprising of 28% of hair conditioner as conditioning agent, 28% of acetic acid as grease neutralizer and soap residues and 44% pure geranium essential oil as mosquitoes repellent agent as well as fragrance.

Cotton fabrics were placed in the top loading domestic washing machine (Haier HWM70-9288) with standard detergent and ballast fabric to make a total air-dry material load of 2 kg. The fabrics were laundered following the ISO 6330 [16] standard to simulate the normal home laundering process.

The softener was added during the last rinse cycle of the washing process. The washing was done using normal washing cycles with normal cycle water level conditions, with the water temperature of 37 ± 3˚C. The fabric samples were dried using the line dry method at relaxed standard atmosphere (22 ˚C, 65 % RH) for at least 24 hours before the test.

The fabrics that were not been treated with fabric softener were laundered following the same procedure, except that no fabric softener was added during the last rinse cycles.

B. *Softener and Fabric Evaluation*

Softener was tested for physical properties i.e. the smell sensory test, and the product stability, according to ASTM method with slight modification. The treated and untreated fabrics were tested for the physical properties i.e. the fabric weight (MS ISO 3801-2003), fabric stiffness (ASTM 1388-96/202), and fabric crease recover angle (AATC 66-2003).

C. *Mosquito Repellency Assessment*

Bioassay Mosquito Repellency Assesment

Mosquito collection

Adult female mosquitoes of the Aedes Aegypti species (non-blood fed 2-5 days) were obtained from the Institute Medical Research (IMR). The Aedes mosquito species were chosen as they are the carrying agent of dengue virus. They were collected a day before the test and were carried in a special mosquito box. The mosquitoes are left overnight at room temperature and fed with 10% sucrose solution.

Sample preparation

Twenty samples of cotton fabric were used which are ten for untreated fabric as control samples and another ten for treated samples. The samples were cut from the fabric each measuring 20 x 20 cm, having four thicknesses of fabric, overlocked and bartacked together on all corners. The samples were used for the three-minute exposure bioassay test.

Three-minute bioassay (WHO Cone Test)

The fabric treated were evaluated using the WHO Cone Test following the standard procedure described in the World Health Organization (WHO) 1998: Test Procedures for Insecticide Resistance Monitoring in Malaria Vectors, Bioefficacy and Persistance of Insecticdes on Treated Surfaces [17]. The three-minute exposure test was carried out under the temperature of 27˚C in the Textile Chemistry Laboratory, UiTM Shah Alam. The standard WHO plastic cone was placed on top of the treated surface of the sample and secured using a masking tape. Five female mosquitoes were blown into the cone using aspirator and mosquitoes were exposed to the treated surface. The mosquito behavior was monitored for three minutes. The number of mosquitoes resting on the treated samples were counted within three-minute exposure. At the end of exposition, the mosquitoes were transferred to the plastic cones for further observation. The plastic cup kept in an insecticide-free air and supplied with 10% sucrose solution. The number of immobilized, knocked down test mosquitoes was determined one hour after the exposition and the mortality rate was determined after 24 hours. The two controls and two treated replicates were tested in 5 repetitions each totaling 100 test mosquitoes for all treated and untreated tests. The control replicates important for comparison purpose.

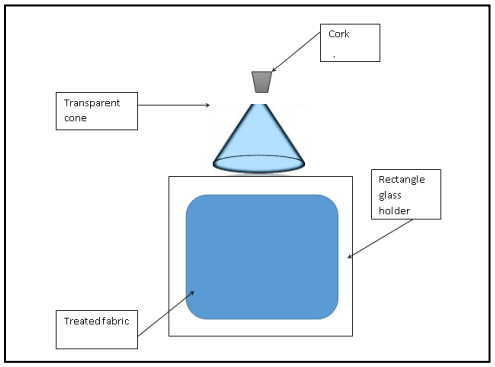

Figure 1: Illustration of the fabricated WHO Cone Test

III. Result and Discussion

A. *Softener and Textile Analysis*

A 350 ml fabric softener added with Geranium essential was produced. The physical appearance in the form liquid with pale yellow to off white colour emulsion due to the combination of the primary ingredients of the softener. There is no separation phase formed because it is emulsified well together. The scent of the fabric softener added Geranium oil employed a similar scent by original Geranium essential oil which is rose lemon scented. This is determined by the sensory smell test by the three evaluators with only a slight difference in term of intensity. The use of hair conditioner and acetic acid does not overpower the scent of the Geranium essential oil because the scent of the oil is the

most important component to provide the mosquito repellent effect to the fabric softener.

Table 1. Fabric properties of the treated and untreated samples

Fabrics	Weight (g/m^2)	Stiffness Bending Length (cms)		Crease Recovery Angle (˚)	
		Warp	*Weft*	*Warp*	*Weft*
Untreated	109	2.88	1.61	53.1	52.5
Treated	110	2.25	1.48	69.6	74.7

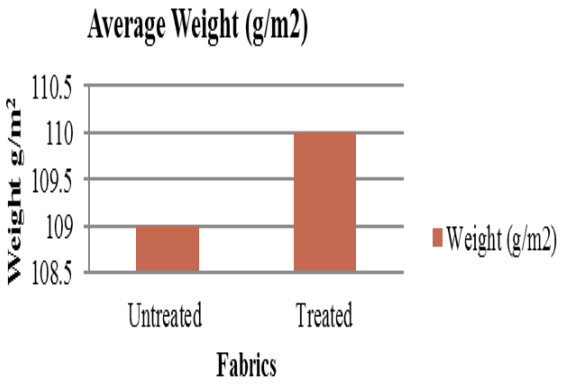

Figure 1. Graph Of Fabric Weight

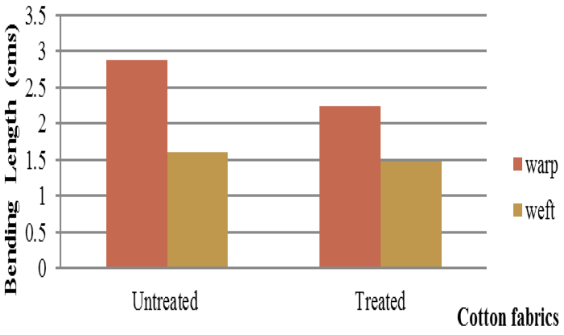

Figure 2 .Graph Of Fabric Stiffness Bending Length

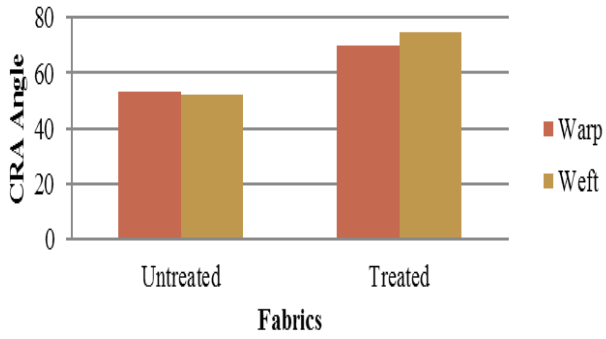

Figure 3. Graph Of Fabric Crease Recovery Angle [18]

Table 1 shows the fabric weight, stiffness of fabric, crease recovery angle of the treated and untreated fabric. The treated fabric resulted in gaining more weight, which is by 0.01 g. This is because the treated fabric absorbed the softener liquid into the fiber at the last rinse cycle. In terms of stiffness properties, the treated fabric produced the lower value of bending length in both warp and weft direction which indicates that fabric has good drapability, less stiff and softer. The presence of the hair conditioner acts as a conditioning agent to soften the fabric. The treated fabric also exhibited higher crease recovery angle [18] value in both warp and weft directions. It shows that the deposition of conditioning agent in the fiber reduces the sliding friction between fibers, thus improves the ability of the treated fabric to recover from creasing.

B. *Mosquitoes observation and Analysis*

WHO Cone bioassay test and mosquito behavior observation.

In all trials, the mosquitoes were observed to behave differently when exposed to the untreated and treated fabric surface during the three minute exposure in the cone. Figure 4 shows that the mosquitoes were resting leisurely on the untreated fabric surface during the exposure. This happened due to no scent produced by the fabric. On the other hand, the movement of mosquitoes exposed to the treated fabric surface was noticed to be more aggressive during the exposure, as shown in figure 5. Some mosquitoes tend to look for ways to escape from the exposed environment by going to the edges of the cone while some are resting around the cotton wool. This situation occurred due to the scented effect of the geranium oil produced by the fabric treated with the softener. The action of repellent on sense of smell is called transpiration repelling, and this has the effect of keeping insects away without them touching the surface treated with repellent agent.

Mosquito Repellency Analysis

The assessment to measure the effectiveness of the geranium oil added in the fabric softener were conducted by looking at the number of immobilized mosquitoes after a certain period of exposure to the treated and untreated fabric. The results of mosquito repellency were presented in table 2.

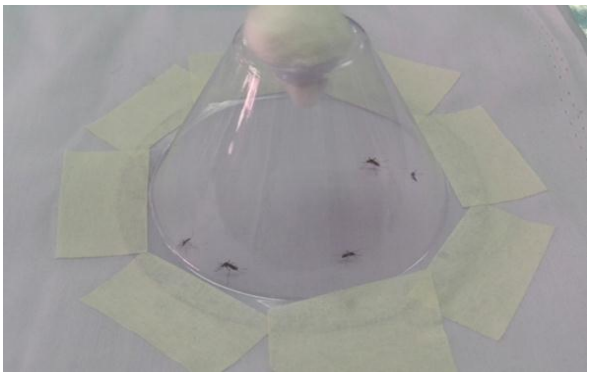

Figure 4. Mosquito behavior on untreated fabric

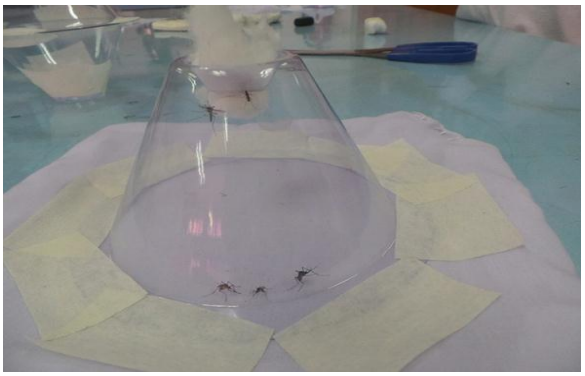

Figure 5. Mosquito behavior on treated fabric

Table 2. Knock-down analysis of the WHO Cone test on cotton fabric using geranium added softener.

Fabric details		**No of exposed mosquitoes (10x each)**	**No of knocked down after 3 minutes**	**No of dead after 24 hours**	**Average % Mortality**	***Corrected % mortality @ % Mosquito repellency**
Untreated	**Control 1**	5	0	0	0 %	
	Control 2	5	0	1	4%	
Treated	**Replicate 1**	5	0	4	16 %	16 %
	Replicate 2	5	0	2	8 %	8%
					Total	**24 %**

$$\text{*Corrected \% mortality} = \frac{\text{Mortality in test replicates - \% Mortality in control}}{\text{100 – \% Control mortality}} \times 100$$

Exposure time: 3 minutes (5 female per cone x 20 cups = 100 mosquitoes) using non-blood fed 2-5 days female mosquitoes

Replicate 1 resulted in 16% mortality of the mosquitoes recorded after 24 hours, and replicate 2 resulted in 8% mortality rate. Therefore the total percentage mosquito repellency after 24 hours was 24%. Based on WHO Geneva, the percentage of replicates sample mortalities between 20% to 90% indicated that have potential to repel mosquitoes. In the present study, the mortalities recorded from treated replicate samples showed 24% mosquito repellent, thus the cotton fabric treated with Geranium essential oil added to fabric softener has a potential as a mosquito repellent agent.

IV. Conclusion

This study was conducted to determine the potential of *geranium* oil from *Pelargonium Graveolens* plant as a mosquito repellent agent when added to home-made fabric softener and applied onto cotton fabric during normal laundering. The home-made fabric softener with added *geranium* oil from *Pelargonium Graveolens* plant was produced using the home-made fabric softener formulation. Both the stiffness and the CRA test results showed an improved properties of the fabric after being treated using the geranium added fabric softener. This shows that the addition of geranium oil did not alter the main purpose of the fabric softener, which is to improve hand feels of the fabric. The treated fabric also showed a slight increase in weight, which may improve the drape behavior together with the improved stiffness property. The scent produced by the fabric softener added geranium oil is comparable with the scent produce by the original *geranium* essential oil. It was proven by the positive result of the odor test conducted. The effectiveness of geranium added fabric softener as a natural mosquito repellent was assessed by mean of the Bio-assay Repellency Assessment WHO Cone Test. Both the three-minutes exposure and the knock-down analysis tests conducted using the Aedes Agypty mosquitoes showed that the fabric softener with added *geranium* oil from *Pelargonium Graveolens* plant has the potential to repel mosquitoes away from the treated fabrics. The use of plant based mosquito repellent agent in the softener can reduce the chemical ingredients that are commonly used in mosquito repellent agent available in the market.

This may provide an alternative repellent agent that is less toxic and lower risk to human health and the environment .

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