

Effect of Repellency on Mosquito Nets using Citrus Peel Extract



C. Prakash, S. Kubera Sampath Kumarand, P C Shobana Sree

Abstract: Mosquitoes are considered as one of the most dangerous creatures on the planet as they cause various diseases like dengue, malaria, chikungunya and so on. We can protect ourselves from mosquito bites by using mosquito repellent agents like spray, lotions and mosquito nets. The use of mosquito nets does not cause any harmful effects on the human body. The objective of this project is to improve the repellency of mosquito nets by applying the extracts of the citrus peels namely CITRUS SINENSIS (sweet orange) and CITRUS AURANTIFOLIA (lime) by padding method on the cotton mosquito nets. The samples have been tested by standard methods of testing such as Cage Test (WHO-1996), Modified Excito Chamber Test, Anti-bacterial Test (AATCC-147) and Durability Test (AATCC-135). The treated mosquito nets ensures good repellency against the mosquitoes along with Anti-bacterial property.

Keywords: Mosquito repellent, cage test, modified excito chamber test, anti-bacterial test and durability test.

I. INTRODUCTION

Mosquito-borne diseases or mosquito-borne illnesses are diseases caused by bacteria, viruses or parasites transmitted by mosquitoes. They can transmit disease without being affected themselves. Diseases transmitted by mosquitoes include: malaria, dengue, west Nile virus, chikungunya, yellow fever, filariasis, tularemia, dirofilariasis, Japanese encephalitis, Saint Louis encephalitis, Eastern equine encephalitis, Venezuelan equine encephalitis, La Crosse encephalitis and Zika fever. Aedes Aegypti is the mosquito that causes dengue fever. When a mosquito bites, it also injects saliva and anti-coagulants into the blood which may also contain disease-causing viruses or other parasites.

This cycle can be interrupted by killing the mosquitoes, isolating infected people from all mosquitoes while they are infectious or vaccinating the exposed population. We can also make our own mosquito repellent to keep mosquitoes away [1]. The mosquito repellent agents like spray, lotions and mosquito nets. There are other methods also like using mosquito coils, mosquito swatter and so on. The use of mosquito nets does not cause any harmful effects on the human body. The mosquito nets are available in various materials like nylon, polyester, cotton and blends of polyester and nylon and so on [2].

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The cotton mosquito nets are non-toxic whereas polyester and nylon are toxic. The objective of this project is to improve the repellency of mosquito nets by applying the extracts of the citrus peels namely Citrus sinensis (Sweet orange) and Citrus aurantifolia (Lime) [3]. It has been scientifically proved that the citrus peel have the tendency to repel mosquitoes [4]. The extract from these two fruits is collected by using 100% ethanol and it is applied on to the cotton mosquito nets by padding method. Padding method offers continuous process of the fabric in concerned liquor such as dyeing or finishing.

The samples have been tested by standard methods of testing such as Cage test [5]–[7], Antimicrobial test (AATCC-147) and Durability test (AATCC-135). The cage is designed in such a way so that to observe the mosquito landing on the untreated and treated fabric in the cage. The advantage of cage test is that it provides the real situation of the probing and biting of the mosquito or it can directly provide the observation of the mosquitoes behavior towards the treated materials [8]. Specially designed excite repellency test chambers were used to evaluate the efficiency of repellency activity [7]. The durability test has been done to check the ability of the fabric to withstand wear, pressure or any other damage. Thus the treated mosquito net ensures good repellency against the mosquitoes along with anti-bacterial property.

II. MATERIALS AND METHODOLOGY

A. Fabric details

Material-cotton, colour-white, EPI-42, PPI-31, GSM-124 Ethanol-100%, orange & lime peels - fresh, wattman filter paper (grade 1)

B. Chemicals used

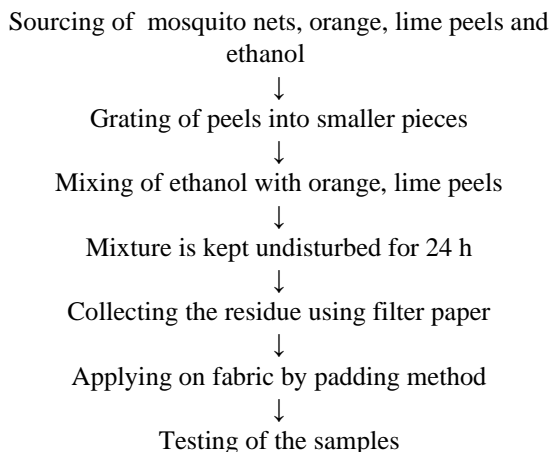
ORANGE PEELS	LIME PEELS
For 100 grams of peels, 200ml of ethanol was taken.	For 25 grams of peels, 50ml of ethanol was taken.
The ratio is 1:2	The ratio is 1:2
Concentration – 50%	Concentration – 50%

C. Instruments used:

Padding mangle and curing chamber. A form of mangle for the impregnation of textiles in an open width in which the textile is passed through one or more nips and a curing chamber is an oven or enclosure designed to cure epoids or other materials at an elevated temperature.



D. METHODOLOGY AND PROCESS FLOW



E. Procedure: Padding method

The collected residue is applied to the fabric sample using padding mangle of 13.5 inches width and the samples were cut in the length of 1m and width 11.5 inches.



(a)



(b)

Fig.1. (a), (b) Extract application on fabric

The samples were made wet and immersed in the extract and was kept for half an hour. Then the padding process was done at 60% expression and dried using curing chamber.

IV.RESULTS AND DISCUSSION

A. PHYTOCHEMICAL ANALYSIS

Table 1. Phytochemical analysis

S.NO.	PHYTOCHEMICALS	ORANGE PEEL	LIME PEEL
1.	Alkaloids	YES	YES
2.	Flavonoids	YES	YES

3.	Saponins	YES	YES
4.	Phenolics	YES	NO
5.	Tannins	YES	YES
6.	Terpenoids	YES	NO
7.	Steroids	NO	YES
8.	Phenols	NO	YES
9.	Carbohydrates	NO	YES
10.	Cardiac glycosides	NO	YES
11.	Reducing agents	NO	YES
12.	Amino acids	YES	NO

B. Cage test

The cage test (WHO-1996) might assess the viability of repelling substance against mosquitoes for lotions, cream including impregnated material done fast and effective approach. It is designed to observe the mosquito landing on the untreated and treated fabric in the cage.

C. Cage fabrication

Materials Required: 1. Acrylic sheet (30cm per side, thickness-2mm), 2. CYNO 777F (Anabond Gum and 3) Grey fabric (2 meter)



(a)



(b)

Fig. 2. (a), (b) Fabricated cage

The cage is made by cutting the acrylic sheet into five sides of 30cm (length x width) in each side.

The sides are joined by using Anabond gum and it is made into cube shape leaving the front side open. Now the cage is covered by grey fabric in order to cover the front side which is left open so that the mosquitoes won't escape. A hole is made in centre of the grey fabric to insert the hand for testing. The mosquitoes were bred in the laboratory according to (Mangesh D. Teli & Pravin P. Chavan 2016). The testing is done for 3 minutes and the number of mosquitoes landing on the treated, and untreated sample have been noted down at regular intervals. The formula used to calculate the mosquito repellency are as follows:

$$\text{Mosquito Repellency (\%)} = \frac{(u - t)}{u} * 100$$

Where,

u = No. of mosquitoes on untreated sample,

t = No. of mosquitoes on treated sample.



Fig. 3. Mosquito repellency test

Table 2. Cage test

S.NO.	FABRIC SAMPLE	REPELLENCY %
1	A	71
2	B	74.2

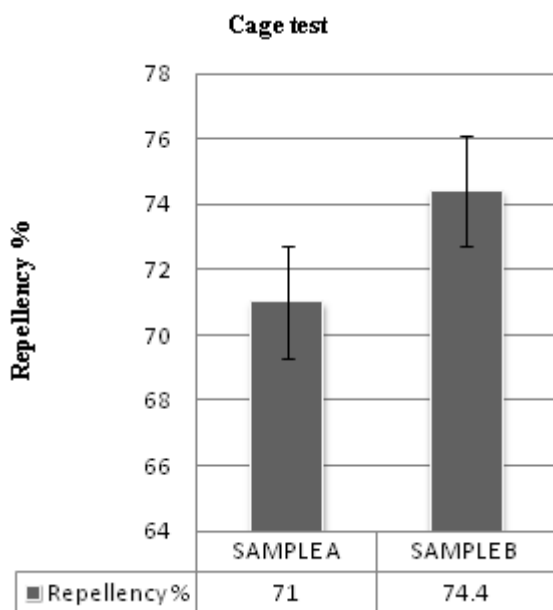


Fig. 4. Cage test

According to the Novelty Journals by Frank Adusei-Mensah, Ivy Eyiah Inkum, Caleb Mawuli Agbale, Adua Eric, it was observed that Citrus aurantifolia have the highest d-limonene content while Citrus sinensis has the least d-limonene content and so sample B (C.aurantifolia) has better repellency than sample A (C.sinensis)

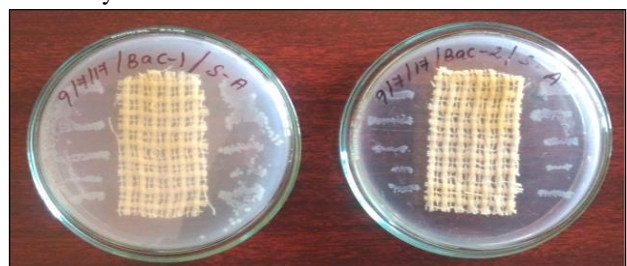
D. ANTI-BACTERIAL TEST

ANTI-BACTERIAL TEST (AATCC-147)

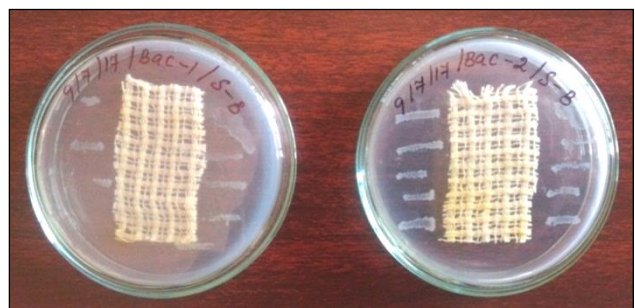
Evaluating the antibacterial activity of finished fabrics by AATCC standards.

Parallel Streak Method (AATCC Test Method 147-1988).

The objective is to detect bacteriostatic activity on samples A & B. The method is useful for obtaining a rough estimate of activity in that the growth of the inoculum organism decreases from one end of each streak to the other and from one streak to the next resulting increasing degrees of sensitivity.



(a)



(b)

Fig.5. (a) Antibacterial activity of Sample A, (b) Antibacterial activity of Sample B

*Bac-1: Escherichia coli, Bac-2: Staphylococcus aureus

Table 3. Antibacterial activity-Parallel Streak Method

Samples	Zone of Inhibition (mm)	
	Escherichia coli	Staphylococcus aureus
A	29.8	30.4
B	27.0	29.2

*Values in the table are the calculated as mean value from

5 inoculum streak

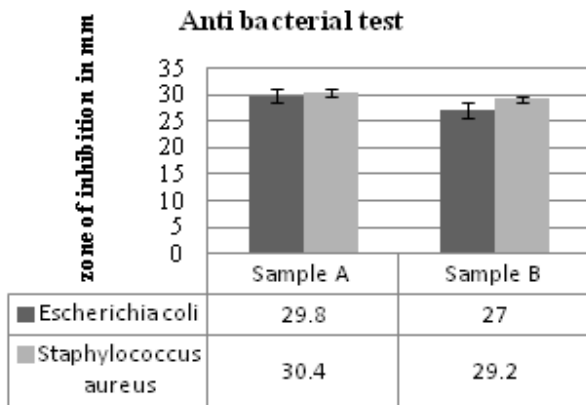


Fig.6. Antibacterial test

Both the samples A and B showed good antibacterial activity against the test bacteria (*Escherichia coli* and *Staphylococcus aureus*). The antibacterial activity exhibited by the test fabrics indicated that it shall be used for any home textile and medical textile applications. According to an research article by B. Pattanayak and N. K. Dhal both Citrus sinensis and Citrus aurantifolia has good antibacterial property.

E. EXCITO CHAMBER TEST

Mosquito Repellency Procedure (Modified Excito Chamber Method)

Specially designed excito repellency test chambers were used to evaluate the efficiency of repellency activity as previously described by Chareonviriyaphap et al. [7]. The percentage of Mosquito repellency was calculated by the following formula.

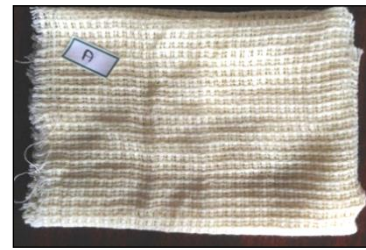
$$\text{Mosquito Repellency (\%)} = \frac{(a + b)}{a} * 100$$

- a- No. of specimens escaped
- b- No of specimens dead



Fig.7. Excito chamber box

Sample A



(a)



(b)

Fig 8. (a) Sample A Finished fabric, (b) Mosquito repellency test for finished fabric

Sample B



(a)



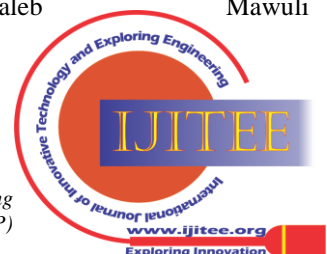
(b)

Fig.9. (a), Sample B – Finished fabric, (b) Mosquito repellency test for finished fabric

Table 4. Mosquito repellency behavior of the fabric

S.No.	Fabric sample	Mosquito Repellent: Excito Chamber test method
1.	A	80.0%
2.	B	83.3%

According to the Novelty Journals by Frank Adusei-Mensah, Ivy Eyiah Inkum, Caleb Mawuli Agbale,



Adua Eric, it was observed that Citrus aurantifolia have the highest d-limonene content while Citrus sinensis has the least d-limonene content and so sample B (C.aurantifolia) has better repellency than sample A (C.sinensis)

Excito chamber test

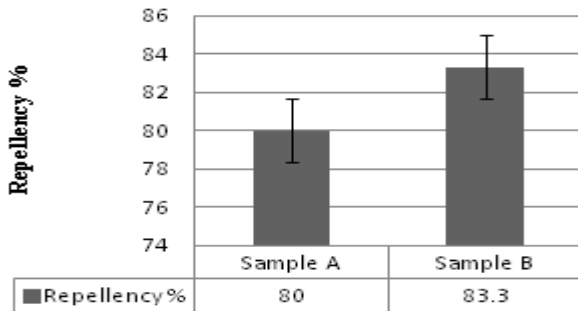


Fig.10. Excito chamber test behavior of the sample for Mosquito repellency

F. DURABILITY TEST

DURABILITY TEST (AATCC-135): “The durability test is done to determine the ability of the fabric to withstand wear, pressure or any other damage”.



Fig.11. Durability test for the finished fabric

The samples exhibits less durability because binder was not used. The sample B (Citrus aurantifolia) shows better durability when compared with sample A (Citrus sinensis).

Table 5. Durability test

S. No..	SAMPLS	WASH 2	WASH 4	WASH 6	WASH 8
1	A	41	30.1	24.2	15
2	B	42.6	38	26	17

Durability test

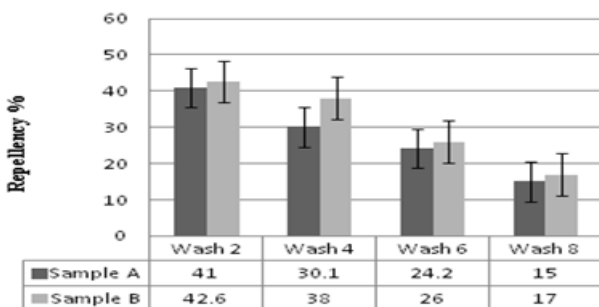


Fig. 12. Durability test of different washing cycle samples

V. CONCLUSION

The treated cotton mosquito nets with citrus peel extracts shows:

- ❖ The samples show good repellency against mosquitoes.
 - ❖ Both samples A and B show good anti-bacterial activity against the test bacteria (Escherichia coli and Staphylococcus aureus). The anti-bacterial activity exhibited by the test fabrics indicated that it shall be used for any home textile and medical textile applications.
 - ❖ Finished cotton exhibits significant repellent properties for the samples A and B which deserve further investigation for possible use as mosquito repellent home textile materials and equivalent.
 - ❖ Finished cotton nets exhibits good repellency after certain washes.
- “The treated mosquito nets ensures good repellency against the mosquitoes along with anti-bacterial property”.

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