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 mosquito. 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]. 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].

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.
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D. METHODOLOGY AND PROCESS FLOW
Sourcing of mosquito nets, orange, lime peels and ethanol
↓
Grating of peels into smaller pieces
↓
Mixing of ethanol with orange, lime peels
↓
Mixture is kept undisturbed for 24 h
↓
Collecting the residue using filter paper
↓
Applying on fabric by padding method
↓
Testing of the samples

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.

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 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)

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| 9.    | Carbohydrates  | NO          | YES       |
| 10.   | Cardiac glycosides | NO | YES |
| 11.   | Reducing agents| NO          | YES       |
| 12.   | Amino acids    | YES         | NO        |
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:

\[
\text{Mosquito Repellency} \% = \frac{(u - t)}{u} \times 100
\]

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.

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
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5 inoculum streak

| Antibacterial test | Sample A | Sample B |
|--------------------|----------|----------|
| Escherichia coli   | 29.3     | 27.0     |
| Staphylococcus aureus | 30.4      | 29.2     |

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.

\[
\text{Mosquito Repellency (\%) = } \frac{(a + b)}{a} \times 100
\]

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

Fig.7. Excito chamber box

Sample A

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)
The samples exhibit 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. | SAMPLES | WAS H | WASH 4 | WASH 6 | WASH 8 |
|--------|---------|-------|--------|--------|--------|
| 1      | A       | 41    | 30.1   | 24.2   | 15     |
| 2      | B       | 42.6  | 38     | 26     | 17     |

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

Excito chamber test

Fig. 11. Durability test for the finished fabric

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

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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