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Eco Friendly Mosquito Repellent Finish on Fabric by Using Natural Herbs

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Abstract: In textile, Finishing is one of the significant processes which augment the performance of the fabric and functional properties as well. Health is always thought to be an indispensable requirement for human beings to live without any stress and it aids in giving the best output of any work. Mosquito repellent textiles are one of the revolutionary ways to advance the textile field by providing the much-needed features of driving away mosquitoes, especially in the tropical areas a mosquito repellent textile protects the human beings from the bite of mosquitoes and ensures safety from the diseases like malaria and dengue fever. In This project is an exiguous endeavor in developing an eco-friendly mosquito repellent finished fabric using the herbal extract from Neem and Tulsi. The extracted chemicals are finished on to the fabric by pad-dry-cure process & exhaust process and are evaluated using a mosquito repellency activity test. The sequestering agent, wetting agent, cross linking agent is used for finishing mosquito repellent fabric. The different concentrations are used of Neem leaf and Tulsi leaf. In finishing treatment, the temperature is about 80^0C, and the time is 30 minutes, and the total liquor is 150 ml. After heating the samples are removed and padding is carried out and the pressure of padding mangle is 3 bar. After drying and curing is carried out and finally samples are ready with mosquito repellent finish. Then the repellency behavior of fabrics was checked after washing.
Keywords: Neem Leaf, Tulsi leaf, Cotton Fabric.

1. Introduction

Mosquito repellent is a substance or finishing process applied to skin, cloths, and other surfaces which repels away mosquitoes. Only female mosquitoes have the mouth parts necessary for sucking blood. So they are responsible for the diseases like malaria, Dengue, Yellow fever, Chikungunia etc Because of global warming the distribution of mosquitoes has expanded from topical region to northern latitudes, and that leads to a spread in sources of viral infection from mosquitoes. By using this anyone can keep themselves far away from mosquitoes. Plants like Neem and Tulsi contained great herbal characteristics. They are cheap and not processed and can be used as raw materials for required applications. Natural repellents have been identified by researchers to control Mosquitoes.

Many insects affect human health. Insect bites generally have a harmful effect- irritation and illness. The less severe effect is the simple irritation, swelling and pain that sometimes come from bites of certain insects such as mosquitoes, bees, some spiders and also flies. There is only a small amount of vaccine are available to treat these types of diseases. There are many ways to repel insects like spray, smoke and chemical coils. This is a danger to humans due to the high use of chemicals. Therefore, it is necessary to develop a natural repellent that can be used.

Protective textiles are a challenge to the human race. It is the textile industry that has to make many changes to meet the need. Insect repellent helps to repel insects in tropical areas. Citronella oil is an essential oil obtained from the leaves and stems of different species of cymbopogan nardus. Deforestation and industrialized farming are also two of the factors causing an alarming increase in the range of mosquitoes.

2. Project Objectives

- The main objectives of this project are to make the mosquitoes more familiar to the common people by the extensive use of mosquito repellent fabric industrially.
- To find out the eco-friendly mosquito repellents and their action.
- To analyze the performance of mosquito repellent finish among different types of fabric.

3. Literature Review

Mosquitoes are one of the most harmful vectors which transmit parasites and pathogens impacting human life to a very great extent by spreading deadly diseases like malaria, dengue, filariasis and Chikungunia. Approximately 2700 species of mosquito are found all over the world; the three most significant of these are the Aides, Anopheles, and Culex According to the World Health Organization (WHO), more than 1 million people dies every year due to mosquito bites and the majority are due to malaria.

A chemical finish on fabric is applied to add certain property on the fabric. Lustrous finish, Anti-bacterial finish, firm shade variation on denims is commonly used chemical finish nowadays. The aim of mosquito repellant finish on fabric is mainly to drive away the mosquito. In this study we have aimed to find the best mosquito repellant to be applied on fabric. As well as comparison between different processes to imparting mosquito repellant and making the whole process economical and environment friendly. This study also aims to make mosquito repellant finish on fabric more familiar and increase the real time use in different products. The main part of our methodology is to test different types of sample with different factors. There are three test methods commonly used for laboratory testing. Certified by various international standardization organizations. The three tests are cage test, cone test and excito test. Even the efficiency of mosquito repellents after washing will also be determined significantly. We have firstly focused on the repellant to be used for this study. We have used DEET as inorganic compound and Andrographis *paniculata* plant extraction as mosquito repellant. We have selected these repellants because it is easy to be found and economic as well as. DEET is being used for so long as mosquito repellents and used directly on skin by military forces across the world.

A mosquito repellent is a substance applied to skin, clothing, or other surfaces which discourages insects (and arthropods in general) from landing or climbing on that surface. Mosquito repellents are also divided into two groups, namely chemical repellants, and natural repellants. People initially applied mosquito repellents on their skin directly as lotion and were effective only for few hours, besides most of them can be harmful since they are coming in direct contact with body. Initially it was used by the military in World War II for public health purposes. People excessively exposed to DDT while working with the chemical or accidental exposure report a prickling sensation of the mouth, nausea, dizziness, confusion, headache etc. Therefore, due to this developed countries do not use DDT. DDT (Dichlorodiphenyltrichloroethane) can still legally be manufactured in the U.S., but it only be to be sold to, or used by, foreign countries. The castor oil plant (Ricans communes) is a species of flowering plant in the spurge family, Euphorbiaceous.

Currently, different new Mosquito control devices have been developed which have the capability to control Mosquitoes and other biting arthropods. These products claim that they can dramatically decrease or even eradicate the number of Mosquitoes and other biting arthropods present by effectively trapping or repelling them from residential properties. In the experiment cotton fabric (woven and knit) was used as textile substrates. Both fabric samples were collected from NITER wet processing lab. For the dyeing and pretreatment process IR Dyeing Machine was used. To complete the finishing process Padding Mangle was used for woven fabric and IR Dyeing Machine was used for knitting fabric. The curing machine was used for curing and drying purposes. At first the medicinal plants were identified and collected from natural sources both living areas and forest areas. For this experiment Neem, Tulsi & Mint-leaf were chosen. The method initiates with the selection of the medicinal plants which were screened and therefore those were washed by distilled water for several times. According to the weight of the fabric, the same number of leaves of Neem, Tulsi & mint were taken. Around 5gm leaves per 100ml methanol was taken in a glass container.

A variety of mosquito repellent products in the form of lotions, cream, coils, spray, liquidators are available in markets. But this type of synthetic chemical contained products cause health hazards to human kinds. So, to overcome these problems, mosquito repellent fabrics are used for unlimited safety purposes. Application of mosquito repellent finish on textile fabrics makes the surface characteristics such that it will repel

the mosquitoes away. A mixture of Tulasi oil and Neem oil (Azadirachta Indica) are to be used as mosquito repellent finish on textile. Tulasi and Neem oil were taken because of their insect (mosquito) repellent properties in addition, It has many beneficial medicinal properties including analgesic, anti-inflammatory, antidepressant, antipyretic, antiseptic, antibacterial, antifungal, astringent, carminative, diuretic, insecticidal, sedative, and anti-cancer properties. And Neem oil also has many medicinal properties for skin, mouth, bones, etc in this method; the extract is directly applied on the fabric using pad-dry-cure method. In this method the extracts are enclosed in microcapsules.

4. Definition of Mosquito Repellent

Mosquitoes are a serious threat to public health transmitting several dangerous diseases for over two million people in the tropics. There has been a large increase in the insecticide resistance of this vector and has become a global problem. Insecticides residues in the environment, as a result of chemical insecticide usage, have turned the researcher's attention towards natural products.In the past years; the plant kingdom has been of great interest as a potential source of insecticidal products. Many species in the plant kingdom synthesize a variety of secondary metabolites which play a vital role in defence of plants against insects/mosquitoes. Plants may be alternative source for mosquito repellent agents since they constitute a rich source of bioactive chemicals] Plant products can be used, either as an insecticide for killing larvae or adult mosquitoes or as repellents for protection against mosquito bites, depending on the type of activity they possess Products of secondary plant metabolisms may be responsible for the chemical communication between plants and insects. Control of mosquitoes is something of utmost importance in the present day with rising number of mosquitos borne illnesses. A mosquito repellent is a substance applied to skin, clothing, or other surfaces which discourages insects (and arthropods in general) from landing or climbing on that surface. There is also mosquito repellent products available based on sound production, particularly ultrasound (inaudibly high frequency sounds).

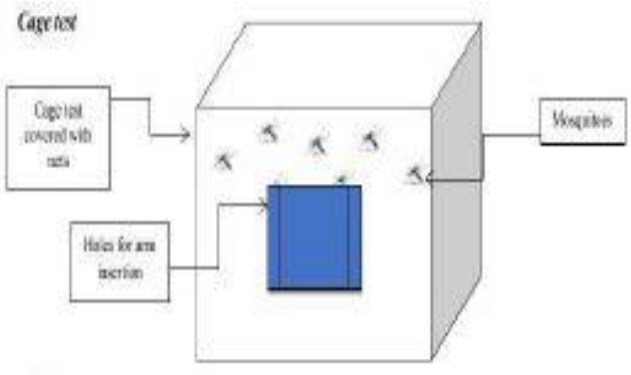


Fig- Mosquito repellent cage

Mosquito repellant plants:

Neem leaf

Usually, Neem is not used in large quantity, because of this products smell. Neem trees contain many compounds, the Saline compound is one of them and has significant effect to be insect repellent, especially against mosquito, and many compounds were extracted from Neem seeds and leaf, and were used as natural insecticides, insect repellent that affected on some kinds of insects

Tulsi leaf

Tulsi distinct clove like aroma arising from its high eugenol content serves to lint the householder to the divine while also repelling mosquito's flies and other harmful insects. Tulsi is another popular herb to protect you against nasty mosquito bites.

5. Extraction process (Neem and Tulsi Leaf)

First took Neem and Tulsi leaves. Then wash them first with clean water. And then put them in hot water. Heated them for 20 minutes. After removing the heat Neem and Tulsi leaf extracted water used as a finishing agent. The heated leaves were ground in a grinder. Later that paste was also used as a finishing agent. According to calculation Neem leaf extracted and Tulsi leaf extracted liquid was used as finishing agent.

Extraction process of Neem leaf:




Neem leaf clean with water grinding of leaf Neem paste

Extraction process of Tulsi leaf:



Tulsi leaf grinding of leaf Tulsi paste

6. Experimental Work

Material and method

Material: In this project we have used 100% cotton fabric and the following materials as a finishing agent.

Fabric Specification:

1. Fabric Type: 100% woven and Knitted Fabric
2. Weave: Plain weave
3. EPI / PPI: 85 / 55
4. GSM: 220

Finishing agent:

1. Neem leaf
2. Tulsi leaf

Chemicals Used:

1. Sequestering Agent
2. Wetting Agent-
3. Cross Linking Agent - Butane tetra carboxylic acid (BTCA)

Finishing Method:

1. Pad-Dry-Cure method
2. Exhaustion method

Pretreatment: Before the fabric was treated it had been washed with 5g/l soap at 60^0C for 30 min. to remove the dirt on the untreated fabric with water.

Procedure of finishing:

1. Take woven and knitted Fabric.
2. Cut the sample of accurate weight of 5 gm.
3. According to calculations take the weight of all chemicals and auxiliaries.
4. Formula- GPL*weight of fabric*MLR ratio/1000.
5. Three samples are cut and prepared for finishing treatment.
6. According to weight of fabric and material liquor ratio set the total liquor.
7. Take 100 ml 0f water and according to calculations of all auxiliary chemicals subtracted from 100 ml of water.
8. Same procedure is carried out for the knitted fabric.
9. Three pots of woven and knitted samples are to be prepared and finally it is heated on heated plate at temperature of 80^0C.
10. After 20 Minute the samples are heated after 20 minutes remove the samples pot from the heated plate.
11. After heating the samples are carried out padding for even penetration of finishing chemicals on the surface of fabric.
12. 3 bar pressure is set for padding of fabric.
13. All samples are carried out padding and after padding the samples are dry by using the hot air woven having temperatures of 60^0C for 10 minutes.
14. After drying the curing is carried out at 120^0C for 5 minutes.
15. Finally, the finished sample can be obtained and in this way the finishing process is carried out.

Wash Durability Testing: -The antimicrobial activity of the finished samples was evaluated after being subjected to several wash cycles. The finished fabrics were washed using standard detergent (3% owf) at 40°C in an automatic washing machine using the method ISO 6330-1984E.The antimicrobial activity of the finished samples were washed in the Rota dyer Laboratory apparatus according to 150 105-C06 A25 standard. The size of the sample was 100 x 40 mm, the wash bath contained ECE phosphate reference detergent B, the volume of the bath was 150 ml, the temperature of the bath was 40°C and time of washing 45 minutes. Ten

stainless steel globules were added into each bath to perform washing. Which corresponds to five domestic washings? After washing, the samples were rinsed twice in deionized water and air dried at room temperature.

Fig: Washing Fastness (Rota dyer)

Recipe for finishing of textile

Recipe:
Weight of fabric: 5 gram
Temperature: 80^0c
MLR ratio: 1:30
Time: 30 min.

1) Neem treated fabric: (For woven fabric)

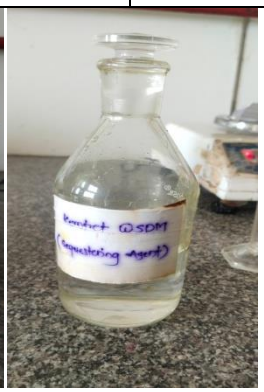
Chemicals	Sample 1	Sample 2	Sample 3
Neem	2%	4%	6%
Sequestering agent	1%	2%	3%
Cross linking agent	2%	3%	4%

Recipe: 2) Neem treated fabric: (For knitted fabric)

Chemicals	Sample 1	Sample 2	Sample 3
Neem	2%	4%	6%
Sequestering agent	0.5%	1%	1.5%
Cross linking agent	1%	2%	3%

Citronella oil pot (Lemongrass)

Cross linking agent **(**BTCA)



Sequestering agent (Kemtret WSDM)

Recipe: 3) Tulasi leaf treated fabric (For woven fabric)

Chemicals	Sample 1	Sample 2	Sample 3
Neem leaf	10%	20%	30%
Sequestering agent	2%	3%	4%
Cross linking agent	5%	10%	15%

Recipe: 4) Tulsi leaf treated fabric (For knitted fabric)

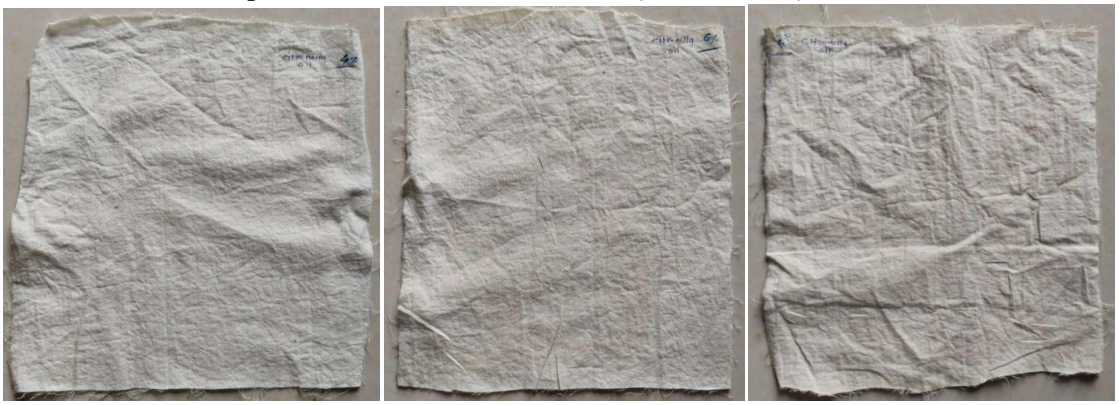
Chemicals	Sample 1	Sample 2	Sample 3
Tulsi leaf	10%	20%	30%
Sequestering agent	1%	2%	3%
Cross linking agent	3%	6%	9%

Testing procedure:

The treated sample is placed at the bottom side of cage. One sample is treated at a time. Then the mosquitoes are inserted into the cage. The number of mosquitoes arrived on the treated samples were collected and recorded for 10 min per sample. Since the mosquitoes settle in a place where they sit first, they may not flay to another place. So the cage had been shaken every 5 min to disturb the mosquitoes. Now at this time they will try to sit again and count and record the number of mosquitoes had been done.

Fig- Cage preparation method

Citronella oil terated sample with different concentrations: (Woven fabric)



Sample1: 4% Concentration | Sample2: 6% Concentration | Sample3: 8% Concentration

Citronella oil terated sample with different concentrations: (Knitted fabric)

Sample1: 2% Concentration | Sample2: 4% Concentration | Sample3: 6% Concentration

7. Observation Table

Mosquito repellency test before washing:

Sr. No	Finishing Agent	No. of mosquito exposed in cage	No. of mosquito escaped in cage	Mosquito landed on treated fabric	Mosquito repel from sample	Repellency
2	Neem leaf	15	12	5	7	93%
3	Tulsi leaf	15	10	8	2	77.67%



Citronella oil treated Sample | Neem leaf treated Sample | Tulsi leaf treated Sample

Fig- Mosquito repellency test before washing

Mosquito repellency test after washing:

Sr. No	Finishing Agent	No. of mosquito exposed in cage	No. of mosquito escaped in cage	Mosquito landed on treated fabric	Mosquito repel from sample	Repellency
1	Neem leaf	15	12	3	7	80%
2	Tulsi leaf	15	10	6	4	66.67%

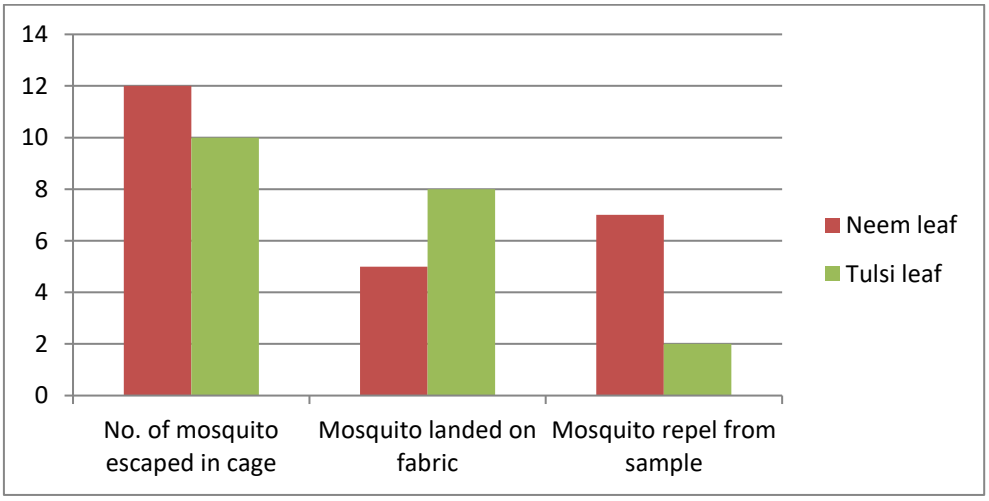
Neem leaf treated Sample

Tulasi leaf treated Sample

Fig- Mosquito repellency test after washing

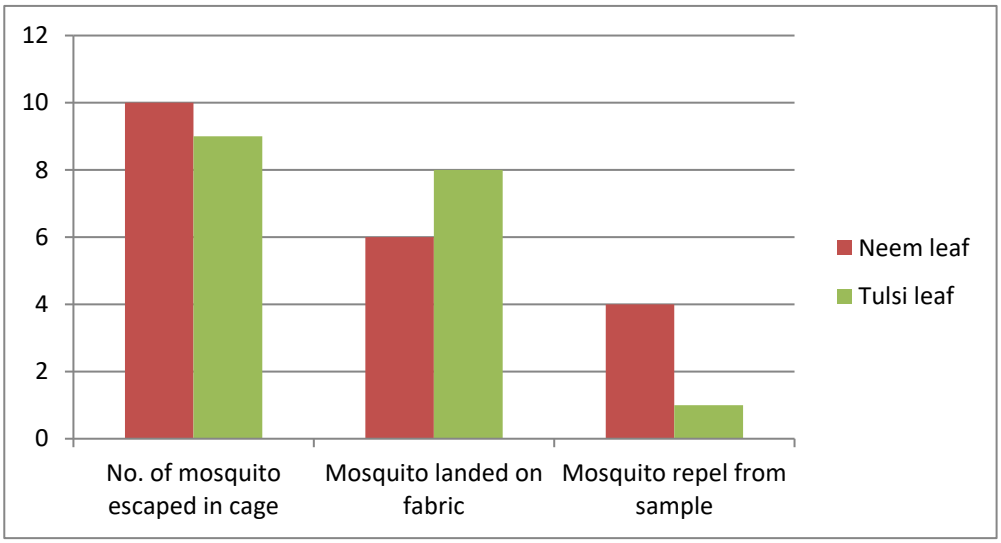
Graphical representation

Mosquito repellency test before washing:



Mosquito repellency test before washing gives better result. In this test the citronella oil gives excellent mosquito repellency effect as compare to Neem and Tulsi leaf treated sample. But Neem leaf treated sample is more effective for mosquito repellency effect than Tulsi but less than citronella oil treated sample. The citronella oil, Neem leaf and Tulsi leaf finishing agent are used in different concentrations to treat samples and sample treated with citronella oil having 8% concentrations shows best mosquito repellency effect. The knitted fabric with citronella oil treated shows best result of repellency than woven fabric. Before washing all finishing agent gives better result but after washing how much they repel the mosquito shows the effect after washing the samples.

Mosquito repellency test after washing:



After washing the effect of mosquito repellency was greatly reduced. But the effect is not completely reduced for a single washing of the sample. Up to three washes the Tulsi leaf treated sample effect of finish is get completely reduced. Neem leaf treated sample up to three washes very less amount of mosquito repellency effect show. But citronella oil shows the best result up to three washes and repels the mosquito also. But when I increased the multiple washes the repellency of mosquito gets reduced. Up to seventh washes citronella oil gives better result for mosquito repellency. So that the citronella oil treated fabric sample gives better mosquito repellency for multiple washes as compared to Neem and Tulsi leaf treated fabric samples.

8. Conclusion

This research aimed to identify effective uses of textile finishes that makes the fabric repellent from mosquitoes as well as other insects. In today's world, the growing number of mosquito -borne diseases necessitates the discovery of new forms of mosquito repellents, in both synthetic and natural forms. In this project with a view to compare the efficiency of mosquito repellency for different finishing agents like citronella oil, Neem leaf and Tulsi leaf. Mosquito repellency behavior test of citronella oil is more efficient to driving away than Neem and Tulsi leaf treated sample. As well as it is eco-friendly and economic. So, the use of mosquito repellants from natural sources like citronella oil will be more efficient. The volume of mosquito repellents to be applied on fabric will increase the more repellency percentages.

The use of mosquito repellant finished fabric treated with citronella oil can be used in clothing and home textile which will help to skip hazardous process for driving away mosquitoes. Neem leaf treated sample shows better washing fastness than Tulsi treated sample. Neem and Tulsi treated sample finish durability stable up to three washes but after three washes the durability of finish get reduced. Neem leaf shows better mosquito repellency for several washes.

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