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# PROCESS AND DEVELOPMENT OF ANTI-MOSQUITO FABRICS BY USING PYRETHRUM EXTRACTION FROM CHRYSANTHEMUM PLANT

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**ABSTRACT** In today's era of modernization of the textile industry, we are going through advancements of technology in every field of this industry. The world where this would lead us would be astonishingly hi-tech and materialistic. To ensure our security and safety from the future hazards, we need to equally development the technology for our protection. A Mosquito repellent textile is one such textile product. It protects the human beings from the bite of mosquitoes and thereby promising safety from the diseases like malaria and Nile fever. To impart this character a finish of the mosquito repelling agent is given to the textile material. Thorough research and development has facilitated the applicability of certain chemicals on the textile products, which sustain this character for a reasonable period. Insect repellent textiles are also a part of protective textiles which help in protection from the species that are prone to cause damage in some or the other manner. These textile products find their application over a wide range. A lot has been achieved and much more is yet to be covered, as there is no end to it. These types of textiles ensure the protection of human beings from the mosquitoes and the mosquito borne disease includes malaria, filariasis and dengue fever. This study focused on the penetration of mosquito repellent finish in textile applications as well as nature based alternatives to commercial chemical mosquito repellents in the market. Suitable technologies and materials to achieve mosquito repellency are discussed and pointed out their applications and further scope of research and development.

**KEYWORDS :** Mosquito Repellent Finish, Mosquito Repellent Textile, Chemical Repellents

## 1. INTRODUCTION

Mosquitoes transmit diseases worldwide to more than 700 million persons annually and account for 1 in 5 childhood deaths in Africa.Mosquitoes will kill 1 in 17 persons currently alive on the planet through diseases such as malaria, dengue, and mosquito-borne encephalitis. Mosquitoes traditionally have been a concern of the developing world, yet the arrival of West Nile virus in North America has renewed public attention and concern toward these insects. Indeed, the cost of medical care for mosquito-borne illness is rapidly rising in the United States. Many organizations for adolescents participate in summer-camp experiences, immersing themselves in the North American outdoors. Chief among these organizations is the Boy Scouts of America. In 2001, over 2 million youth members of the Boy Scouts of America participated in summer camp, placing themselves at increased risk for zoonotic diseases. With the rising concern over mosquito-borne arbovirus encephalitis, such as La Crosse or West Nile virus, avoidance of mosquitoes is the best protection against disease. There are mainly three varieties of mosquitoes which spread most of the dreadful diseases among the humans. They are ***Anopheles, Culex***, and ***Aedes.*** The mosquitoes which have the potential of spreading diseases among the humans are generally termed as ***vectors***. Furthermore it is difficult to apply this finish on fabrics as their longevity is too short and hence will not be able to satisfy the requirement. In this work an attempt has been made to provide mosquito repellent fabrics without any adverse effects to the users.

## 2. MATERIALS AND METHODS

### 2.1 SELECTION OF FABRICS

For the purpose of developing mosquito repellent fabrics initially two fabrics were sourced. The first being cotton and the other sample being nylon. The logic behind choosing specifically these two fabrics is that cotton is widely used as bed-spreads and nylon as mosquito nets and also in camping and trekking gears.

In order to develop the repellent fabric, the fabric should be dipped in the chemical which is extracted from the chrysanthemum flower. The method of extraction is as follows:

### 2.2 SELECTION OF MOSQUITO SPICIES

The test mosquito species chosen for the study is *Aedesaegyptia* which is a primary vector for spreading the dreadful disease namely *Dengue.* The other species which was chosen for testing is *Arvigillus* which is a non-vector and is commonly referred to as nuisance mosquitoes. It is a strong variety and difficult to deal with.

### 2.3 METHOD OF PRODUCING POWDERED EXTRACT

Initially the flower is soaked in water for about 24 hrs and the soaked flower is dried in shade. Drying should be done only in shade as exposure to sun light will have detrimental effects on the amount of pyrethrum present in the flower. The dried flowers are then ground to fine powders using pestle & mortar. The powder is then sieved to remove larger particles and other macro materials so that a very fine powder results.

### 2.4 EXTRACTION OF PYRETHRUM

The finely powdered flowers of chrysanthemum contain the active ingredient namely the pyrethrum which has to be extracted. There are several solvents available for this purpose but some of them are volatile in nature and some are not suitable for its application in textiles as they are banned. The simple and the most effective method of extracting pyrethrum both in terms of cost and process, is by using water. The powdered extract along with water is taken and the extraction is carried out at two different temperatures 60°C and 90°C.

About 5g of the powdered extract along with 100 ml of water is taken. Two such baths are used. In one bath the temperature is maintained at 60°C and in the other bath 90°C is maintained. The process is carried out for two hours beyond which there is very little improvement in the concentration of the final extract solution. Out of the two baths the bath maintained at 90°C showed poor quality of the final extract solution than that of the bath maintained at 60°C. This can be understood from the fact that rising the temperature beyond 70°C has a detrimental effect on the powdered extract.

Finally the extraction is carried out at 60°C for about two hours. At the end of the process the final extract solution (is allowed to stand for at least two hours) is filtered off to remove the residues and the supernatant i.e., the final clear solution is used for the finishing purposes.

### 2.5 FINISHING OF FABRICS

Methods by which the finish can be applied on to the fabrics. They are

**1. Exhaust method**

In the first method the fabric is simply impregnated in the extract solution followed by drying and then finally cured. In the second method the fabric is treated with the solution for about an hour at 50°C-60°C and then it is squeezed and dried.

The methods were found to be effective to a large extent in particular the exhaustive method was highly successful for both nylon and cotton and less complicated than the padding technique. Nylon was finished only by exhaustive method as it was too difficult to maintain the parameters for padding technique. Since we used a mesh cloth for this purpose it was not able to withstand the stresses and strains in the padding technique.

The following recipes were used for the purpose of finishing:

## 2.6 EXHAUST METHOD

**Recipe 1:**

| | | |
|---|---|---|
| Pyrethrum extract | - | 100% |
| M: L | - | 1:30 |
| Time | - | 1 hr |
| Temperature | - | 50°C |

**Recipe 2:**

| | | |
|---|---|---|
| Pyrethrum extract | - | 50% |
| M: L | - | 1:30 |
| Time | - | 1 hr |
| Temperature | - | 50°C |

**Recipe 3:**

| | | |
|---|---|---|
| Pyrethrum extract | - | 25% |
| M: L | - | 1:30 |
| Time | - | 1 hr |
| Temperature | - | 50°C |

**Recipe 4:**

| | | |
|---|---|---|
| Pyrethrum extract | - | 10% |
| M: L | - | 1:30 |
| Time | - | 1 hr |
| Temperature | - | 50°C |

**Recipe 5:**

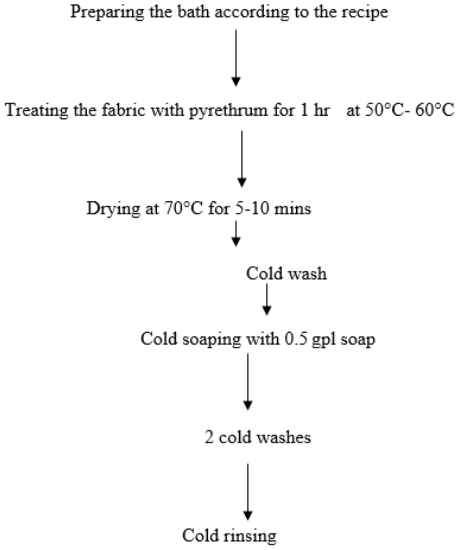
| | | |
|---|---|---|
| Pyrethrum extract | - | 5% |
| M: L | - | 1:30 |
| Time | - | 1 hr |
| Temperature | - | 50°C |

**Recipe 6:**

| | | |
|---|---|---|
| Pyrethrum extract | - | 1% |
| M: L | - | 1:30 |
| Time | - | 1 hr |
| Temperature | - | 50°C |

## 2.8 PROCESSFLOW CHART FOR FINISHING

**Exhaust method:**




## 2.9 TEST METHODS

### 2.9.1 CONE BIO CONE TEST

In this test method the given sample is fixed at the base of the hollow cone. The cone is made out of pure plastic and has a base diameter of 11.4cms and a height of 5.7cms. The nose part of the cone is provided with a small hole through which the mosquito species are sent in by means of a suction tube. After the mosquitoes have entered the cone the nose part is sealed by placing a bunch of cotton. Care should be taken to provide adequate air circulation for the mosquitoes. Otherwise it may die due to suffocation and the final results might not be conclusive. The test is carried out by taking two such cones one is called control specimen and the other one is called test specimen. In the control specimen untreated fabric is fixed to the bottom of the cone and in the test specimen the treated fabric is fixed to the bottom of the cone. Both the specimens are then fixed to the wall with the base facing the wall. The behavior of the mosquitoes inside the cone is observed for a certain time period and reported

### 2.9.2 SUSCEPTIBILITY TEST

In this test method the given sample is placed inside the cylindrical compartment. The upper and the lower part of the cylinder are sealed with the help of a plastic lid. The lid is provided with mesh clothing in the centre to provide necessary air circulation. In this test also two susceptibility test tubes are taken. One tube acts as the control (untreated fabric) and the other acts as the test.(treated fabric). The bottom lid has a sliding door with a small hole. The mosquitoes are collected by means of a suction device and are introduced in to the control as well as the test specimen. After the mosquitoes are exposed to the treated and untreated fabrics their behavior over a time period is studied and reported.

### 2.9.3 BARAD CAGE:

In this test method the given sample is cut according to the dimensions of the cage. In this method also, a control and a test specimen is taken for testing. Inside the cage, five fabrics are placed one on each side, the remaining one side of the cage is left free. A small provision is made at one side of the cage through which the mosquitoes are introduced. It's a usual practice that this side of the cage is kept free from the test or control specimen. The mosquitoes are left inside the cage and they are observed for their behavior for a given time period.

## 3. RESULTS AND DISCUSSION

In this project a detailed analysis on the efficiency of pyrethrum treated fabrics has been made. All the fabrics were tested by three different test methods namely susceptibility test, cone bio cone test and Barad cage test.

For each test ten Aedesaegyptia mosquitoes were taken and studied for their normal behavior, abnormal behavior and death at room temperature for a time period of about 1 hour. The results are tabulated in Tables 5.1.and 5.2.and their corresponding Figures are from Fig 5.1. To Fig 5.4.

### 3.1 COTTON FABRICS

From the Table 5.1., it is clear that at higher concentrations the number of mosquitoes died is more. The Table 5.1.also shows that apart from the concentration of pyrethrum the space availability inside the testing equipment and the time of exposure of the treated fabric inside the testing equipment are also the important factors influencing mortality. Barad cage is more spacious compared to susceptibility tube and cone. Hence the number of mosquitoes died in susceptibility tube and cage are more and these two tests are more efficient compared to Barad cage.

In the plot of concentration of pyrethrum against mortality rate decreases. So it is evident that at higher concentrations the mortality rate decreases.

From the above Table I clearly shows that the Mosquito repellent tests on cotton fabrics treated with pyrethrum of different concentrations under different test methods.

According to WHO standards all the tests should be carried out for a time period of at least 24 hours. When all the pyrethrum treated cotton fabrics are exposed for 24 hours 100% mortality is observed in all the test methods

Even though it is stated that higher concentrations of pyrethrum leads to higher mortality rate , the ANOVA results( appendix-) shows that there is no much significant difference in mortality rate due to concentration.

Since there is no significant difference in mortality rate due to concentration and 100% mortality is observed in all the tests samples when exposed for 24 hours, cotton fabrics with 5% and 10% pyrethrum concentrations can be chosed. 10% concentration is also stronger in all the cases.

So considering all the above mentioned factors and economical limitations into account it is suggested to chose cotton fabric with 5% pyrethrum concentration as an optimum concentration. In some cases cotton fabrics with concentrations less than 5% is also effective in their repellent action.

| CONC OF PYRETHRUM | 1% | | | 5% | | | 10% | | | 25% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TESTS | SUSCEPTIBILIY | CONE-BIO-CONE | BARAD CAGE | SUSCEPTIBILITY | CONE-BIO-CONE | BARAD CAGE | SUSCEPTIBILITY | CONE-BIO-CONE | BARAD CAGE | SUSCEPTIBILITY | CONE-BIO-CONE | BARAD CAGE |
| NO OF MOSQUITOES | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| MOSQUITOES WITH NORMAL BEHAVIOUR | 3 | 4 | 5 | 3 | 3 | 5 | 2 | 2 | 3 | 1 | 2 | 2 |
| MOSQUITOES WITH ABNORMAL BEHAVIOUR | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 6 | 5 | 5 | 6 |
| MOSQUITOES DIED | 1 | 1 | 0 | 2 | 2 | 0 | 3 | 2 | 1 | 4 | 3 | 2 |

**3.2. NYLON FABRICS:**

From the Table II., it is clear that at higher concentrations the no of mosquitoes died is more. The Table II also shows that apart from the concentration of pyrethrum the space availability inside the testing equipment and the time of exposure of the treated fabric inside the testing equipment are also the important factors influencing mortality.

Barad cage is more spacious compared to susceptibility tube and cone. Hence the no of mosquitoes died in susceptibility tube and cage are more and these two tests are more efficient compared to Barad cage.

In Fig 5.4.the plot of concentration of pyrethrum against mortality rate decreases. So it is evident that at higher concentrations the mortality rate decreases.

| **CONC OF PYRETHRUM** | 5% | | | 10% | | | 25% | | |
|---|---|---|---|---|---|---|---|---|---|
| **TESTS** | SUSCEPTIBILY | CONE-BIO-CONE | BARAD CAGE | SUSCEPTIBILITY | CONE-BIO-CONE | BARAD CAGE | SUSCEPTIBILITY | CONE-BIO-CONE | BARAD CAGE |
| **NO OF MOSQUITOES** | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| **MOSQUITOES WITH NORMAL BEHAVIOUR** | 3 | 3 | 4 | 2 | 2 | 3 | 1 | 2 | 3 |
| **MOSQUITOES WITH ABNORMAL BEHAVIOUR** | 5 | 6 | 6 | 5 | 6 | 6 | 5 | 5 | 5 |
| **MOSQUITOES DIED** | 2 | 1 | 0 | 3 | 2 | 1 | 4 | 3 | 2 |

From the above Table II clearly shows the Mosquito repellent tests on nylon fabrics treated with pyrethrum of different concentrations under different test methods.

**CONE BIO CONE TEST:**

| | MORTALITY RATE | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5% | | | | | 10% | | | | | 25% | | | | |
| COTTON | 0 | 1 | 0 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 4 | 2 |
| NYLON | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |

Since Fcal<Ftabthere is no significant difference between pyrethrum treated cotton and nylon fabrics and there is no significant difference in mortality due to different concentrations of pyrethrum.

**BARAD CAGE:**

| | MORTALITY RATE | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5% | | | | | 10% | | | | | 25% | | | | |
| COTTON | 0 | 1 | 0 | 2 | 1 | 2 | 1 | 2 | 3 | 0 | 1 | 3 | 2 | 2 | 3 |
| NYLON | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |

**CONCLUSION**

In this work various tests are carried out with pyrethrum treated fabric samples against the species such as *aedes, anopheles* and *varigillus* species. The test results were very conclusive as 100% mortality rates were observed with all the species. Also pyrethrum treated fabrics are found to be safe for humans. Good mosquito repellency was observed in both cotton and nylon fabrics treated with pyrethrum.100% mortality rate was observed in all the pyrethrum treated samples when the mosquitoes were exposed for 24 hours. Fabrics with pyrethrum concentration of 5% were found to be optimum. Susceptibility tube and cone bio cone gave better results when compared to Barad cage. For fine nylon mesh cloths exhaust method or batch process is suitable. Both cotton and nylon fabrics treated with pyrethrum, posses good wash fastness properties (finish remains even after 5-10 washes).

**References**


1. Clements AN. The Physiology of Mosquitoes. Oxford: PergamonPr; 1963.
2. Maibach HI, Skinner WA, Strauss WG, Khan AA. Factors that attract and repel mosquitoes in human skin. JAMA. 1966; 196:263-6.
3. Bock GR, Cardew G, eds. Olfaction in Mosquito-Host Interactions. New York: J Wiley; 1996.
4. Gjullin CM. Effect of clothing color on the rate of attack of Aedes mosquitoes. J Econ Entomol. 1947; 40:326-7.
5. Gillies MT. The role of carbon dioxide in host-finding by mosquitoes (Diptera: Culicidae): a review. Bulletin of Entomological Research. 1980; 70:525-32.
6. Davis EE, Sokolove PG. Lactic acid-sensitive receptors on the antennae of the mosquito, Aedesaegypti. J Comp Physiol. 1976; 105:43-54.
7. Khan AA. Mosquito attractants and repellents. In: Shorey HH, McKelvey JJ, eds. Chemical Control of Insect Behavior. New York: J Wiley; 1977:305-25.
8. de Jong R, Knols BG. Selection of biting sites by mosquitoes. In: Bock GR, Cardew G, eds. Olfaction in Mosquito-Host Interactions. New York: J Wiley; 1996:89-108.
9. Kline DL, Schreck CE. Personal protection afforded by controlled-release topical repellents and permethrin-treated clothing against natural populations of Aedestaeniorhynchus. J Am Mosq Control Assoc. 1989; 5:77-80.
10. Schreck CE, Kline DL, Carlson DA.Mosquito attraction to substances from the skin of different humans. J Am Mosq Control Assoc. 1990; 6:406-10.
11. Knols BG, de Jong R, Takken W. Trapping system for testing olfactory responses of the malarial mosquito Anopheles gambiae in a wind tunnel. Med Vet Entomol. 1994; 8:386-8.
12. Geier M, Sass H, Boeckh J. A search for components in human body odour that attract females of Aedesaegypti. In: Bock GR, Cardew G, eds. Olfaction in Mosquito-Host Interactions. New York: J Wiley; 1996:132-48.
13. Foster WA, Hancock RG. Nectar-related olfactory and visual attractants for mosquitoes. J Am Mosq Control Assoc. 1994; 10 (2 Pt 2):288-96.
14. Curtis CF, Lines JD, Ijumba J, Callaghan A, Hill N, Karimzad MA. The relative efficacy of repellents against mosquito vectors of disease. Med Vet Entomol. 1987; 1:109-19.
15. Muirhead-Thomson RC. The distribution of anopheline mosquito bites among different age groups. Br Med J. 1951; 1:1114-7.
16. Gilbert IH, Gouck HK, Smith N. Attractiveness of men and women to Aedesaegypti and relative protection time obtained with DEET. Florida Entomologist. 1966; 49:53-66.
17. Port GR, Boreham PFL. The relationship of host size to feeding by mosquitoes of the Anopheles gambiae Giles complex (Diptera: Culicidae). Bulletin of Entomological Research. 1980; 70:133-44.