Mosquito Repellent Finish of Cotton Fabric by Extracting Castor Oil

Granch Berhe Tseghai

ABSTRACT- Malaria is ranked as the leading infectious disease in Ethiopia. Control of mosquitoes is something of utmost importance in the present day with rising number of mosquito borne illnesses. Thus, specialty products like mosquito repellent used to combat mosquitoes are required. Chemical mosquito repellents has a remarkable safety profile , but they are toxicity against the skin & nervous system like rashes, swelling, eye irritation, and worse problems, though unusual including brain swelling in children, anaphylactic shock, and low blood pressure. Hence it better to move natural mosquito repellents over chemical mosquito repellents. Now day's textiles are playing a great roll beyond the usual clothing application. Mosquito repellent textiles is 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. In this study textile sample was treated with binder and castor oil. Different property has been study for effective on mosquito repellency property.

Index Terms – Mosquito repellents, castor seed oil, cotton, natural mosquito repellent, diseases.

1. INTRODUCTION

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 [1]. [7] 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 defense of plants against insects/mosquitoes. Plants may be alternative source for mosquito repellent agents since they constitute a rich source of bioactive chemicals [2].[9] 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 posses [3].[10] 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 mosquito borne illnesses.

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Mosquitoes need to be exterminated using the right tools and with a little bit of effort. These blood thirsty beasts don't care about boundaries and they can bite you if your neighborhoods are allowing its breeding. So the mosquito control measures can be successful only if public mosquito programs are designed. First and foremost thing is to destroy the breeding areas of these mosquitoes.

The mosquitoes are horrific they're highly aggressive, you can be bitten hundreds of times without protection, its torture, impossible to bear. Deforestation and industrialized farming are also two of the factors causing an alarming increase in the range mosquitoes.[4] The World Health Organization says global warming is also expanding the range of mosquitoes that carry malaria, yellow fever, and dengue fever, putting millions more humans at risk. Malaria mosquitoes are appearing in upland areas where they've never been seen before. A child dies of malaria every 12 seconds.[1] Mostly in the Third World, In the history of the world, more people have died from diseases transmitted by mosquitoes than from all the fighting in all the wars, says appropriate technology company Jade Mountain."The world's most dangerous animal is the mosquito," according to a BBC World Service health program: malaria now infects approximately 110 million people annually, causing 2-3 million deaths, and with increasing drug resistance, the problem is worsening, while attempts to control the mosquitoes with pesticides have proved ineffective. Escaping from mosquito is nowadays a great necessitate in the world as they are posing much irritation and even throwing many to death. They are the carriers of many

harmful diseases like West Nile Virus disease; Malaria, Dengue Fever, Chikungunya, Lyme disease etc. Dengue Fever and Dengue Hemorrhagic Fever are the most common mosquito-borne viral diseases that affect a wide range of people in the world. It is caused due to the bite of an infected Aedes Mosquito. It is a threatening disease as there is no proper vaccine or treatment yet found. These diseases are caused only due to our carelessness. Actually we our self is getting in to the danger. The only way to get away from these diseases is by taking proper protection as soon as possible. There are number of things you should take care to avoid being bitten by mosquitoes. Wear long-sleeved shirts and long pants tucked into socks while you are working outdoors. While indoors, stay in air-conditioned or screened areas or use bed nets. Avoid mosquito breeding by clearing stagnant water from drains. Another important method to break out from mosquitoes is by the usage of Repellent.[2, 3]

Reducing the risk of malaria providing mosquito repellent finish to cotton fabrics is very important to achieve the health strategy of the country to save the society implementing this project in small scale level with less investment cost and with less skill and knowledge. Until now malaria is an unsolved problem for Ethiopia and other countries for that matter DDT is the most chemical used in Ethiopia. Treated bed nets are also used. Some lotions are also available. But all the above synthetic chemicals have side effects. So it is necessary to replace them with natural products which can be prepared locally [5]

1.1. Definition of mosquito repellent

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).[7, 11]

1.2. Mosquito repellent chemicals

Mosquito repellents primarily are categorized into two groups: repellent insecticides and contact insecticides (cause death of the insects). Mosquito repellents are also divided into two groups, namely chemical repellants and natural repellants.[7] Peoples initially applied mosquito repellents on their skin directly as lotion and was effective only for few hours, besides most of them can be harmful, since they are coming in direct contact with body.

1.2.1. DDT (Dichlorodiphenyltrichloroethane)

First synthesized in 1874 by a chemist named Zeidler. It affects the nervous system by interfering with normal nerve impulses. 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.[2] Therefore due to this developed countries do not use DDT. DDT can still legally be manufactured in the U.S., but it only be to be sold to, or used by, foreign countries. This chemical is applied on roof and wall of the house as well as in water pond.[6]

1.2.2. DEET (N,N-diethyl-m-toluamide)

DEET is commonly used insect repellent for several types of biting and sucking insects, including mosquitoes. It can be applied on human skin as a lotion or on clothes. Normally this pesticide does not kill the insects but repels from treated area. Because DEET is used directly on human skin, scientists have thoroughly studied its toxicity. Over its long use history, relatively few confirmed incidents have been reported when DEET is used properly. When it is applied on human skin as a lotion it can penetrate through the human skin. Once in the body, it is eliminated in the urine. But still for those who have allergic for this repellent it is advisable not to use it.[4, 5]

1.3. Mosquito repellent plants

Medicinal plants have been used in almost all cultures and communities for thousands of years. Castor (Ricinus communis), Pyrethrum (chrysanthemum cinerariaefolium), Patchouli, Cymbopogon (lemon grass) are plants that can be used as mosquito repellent. Of this castor is plenty available in Ethiopia. [3, 8]

1.3.1. Castor

The castor oil plant (Ricinus communis) is a species of flowering plant in the spurge family, Euphorbiaceous. It belongs to a monotypic genus, Ricinus, and subtribe, Ricininae.

The evolution of castor and its relation to other species are currently being studied using modern genetic tools.[12] It reproduces with a mixed pollination system which favor selfing by geitonogamy but at the same time can be an out-

crosser by anemophily or entomophily. [11] Its seed is the castor bean, which, despite its name, is not a true bean. Castor is indigenous to the southeastern Mediterranean Basin, Eastern Africa, and India, but is widespread throughout tropical regions (and widely grown elsewhere as an ornamental plant).[12] Castor seed is the source of castor oil, which has a wide variety of uses. The seeds contain between 40% and 60% oil that is rich in triglycerides, mainly ricinolein. The seed also contains ricin, a water soluble toxin, which is also present in lower concentrations throughout the plant.[11]

1.4. Mosquito Repellent Finish on Textile

MCT-β-CD and pyrethrums are environmentally save complexing agents which are used to encapsulate fragrances compounds. A fascinating property of the cyclodextrins is their ability to incorporate other organic compounds into their cavity, both in the solid state and in solution. The application of cyclodextrins to the textile industries has become more interesting, (dye stabilization, printing, long lasting perfumed cloths). The cotton fabric is separately functionalized with R-β-CD then treated with insect repellent agent (permethrin). Therefore using cyclodextrin, it is possible to develop and characterize cotton fabrics having long lasting insect repellent properties.[4] N-N diethyl benz amide mosquito repellent finish was applied on cotton fabrics using by simple padding method. A cotton fabric is scoured and bleached prior to the application of finish. Then the fabric is treated with soap at 600c for 30 minutes to remove the dirt on the untreated fabric with water. The soap solution is added into water in the proportion of 3 to 1. Then the material is given hot wash and cold wash with MLR 1 to 20. The pretreated sample is treated with N-N Diethyl Benz amide at different concentration at room temperature for 30 minutes with water [4].

2. MATERIAL AND METHODS

2.1. **Material and Equipments :** Castor seeds, soap, cotton fabric, full setup of distillation apparatus, weighing balance, padding mangle, launder-o-meter, cage, glass beaker and dryer were used.

2.2. Finish Application of the Fabric

2.2.1. **Pretreatment :** Before the fabric was treated it had been washed with 5g/l soap at 600C for 30 minutes to remove the dirt on the untreated fabric with water

2.2.2. **Application:** Different treatments had been done with different method. These are

- 2% oil and 6% binder with pad-dry method
- 2% oil and 6%binder with pad-batch-dry method
- 2% oil only with pad-dry method
- 2% oil only pad-batch-dry method
- 6% binder only pad – batch – dry

The above motioned amount of oil and binder are mixed by adding a single drop of emulsifier and water to make it 100%. The solution was steered continuously to mix the oil and the water. The fabric was padded by 2 dip and 2 nip technique. The padded fabric was rolled on a clean rod and covered with plastic material and stored for 24 hour. This was done for the samples that are treated with pad- batch-dry method. And for the fabrics treated with pad – dry method the samples were padded and then dried at room temperature.

2.3. Mosquito Repellency Test

2.3.1. **Cage preparation:** The repellency test was done by preparing a cage and collecting 50 mosquito. 40 cm X 40cm cage was prepared. The two opposite sides and the top cover are prepared from transparent plastic material. And the other parts from carton. The plastic covers are perforated for enough air circulation. The mosquitoes were collected from a place where there are available like shower rooms.

2.3.2. **Mosquito collection:** 50 mosquitoes were used for the test. The mosquitoes were collected from toilets around dormitory. A big flask was used to collect the mosquitoes.

2.4. Testing the Treated Fabrics Before and After Washing

The repellency test of the samples was done on the basis of the standard with some minor modifications that thought important during the observations. The observations and modifications are: While the mosquitoes are inserted in to the cage they tend to sit/rest on the wall of the cage…not on the ground. So the testing method was modified by placing the treated samples on the wall of the cage and the number of mosquitoes arrived on the treated samples were counted and recorded with in 30 min.

2.4.1 **Testing procedure:** The treated samples were attached on the wall of the cage. One sample is tested 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 30 min per sample. Since the mosquitoes settle on a place where they sit first (when it is convenient for them) they may not flay to other place. So the cage had been shacked each 3 min to disturb the mosquitoes. Now at this time they will try to sit again and counting and recording the number of mosquitoes had been done.

2.4.2 Testing the treated fabrics after washing :

The treated fabric was washed with the recipe mentioned below in the launder-o-meter. After the fabric washed and dried, it was tested for mosquito repellent test to check whether the finish is durable or not.

TABLE 1
WASHING RECIPE

Amount of water(ml)	Amount of soap (g/l)	Time(min)	Type of wash
200	5	30	Cold wash

After washing the samples were tested with similar procedure used for the untreated fabric.

A. Tensile strength test:

Since the fabric strength tester was not functional the test was done on yarn form with the following procedure. 10 warp and weft yarns each were taken out from the treated fabric. Similarly 10 warp and weft yarns each were taken out from the untreated fabric samples. All the yarns were tested for tensile strength using SHIRLEY yarn strength tester.

B. Shrinkage test:

This taste was done by plotting 10cm X 10cm rectangle on the fabric before treatment. Then this rectangle was measured again after treatment is given. The area difference was calculated and the shrinkage was expressed in percentage. 10 untreated fabric samples were prepared with the dimension 15cm X 15cm. 10 cm X 10cm box was plotted on each sample. The mosquito repellent finish was applied on all the samples by pad-batch-dry method. Then the previously plotted box dimension was measured again. Finally the shrinkage was calculated by area difference in percentage.

C. Fabric stiffness test:

This test measures the bending stiffness of a fabric by allowing a narrow strip of the fabric to bend to a fixed angle under its own weight. Rectangular specimens of dimension 25 mm X 200 mm were cut from sample; three specimens were cut with the length parallel to the warp and three more with length parallel to weft. The specimens were placed on the platform with one end coincident with the front upper edge of the platform. The slide was placed on the specimen so that the zero of the scale is in line with the notch. The slide was pushed forward at a uniform rate, carrying the specimen with it, until by looking in the mirror it is seen that the end edge of the specimen is in line with the two scribed lines at 41.5o to the horizontal. The procedure was repeated with the other side up and again at the other end of the specimen. The same procedure was done for samples in the weft way.

3. RESULTS AND DISCUSSION

3.1. Mosquito repellency result of different samples before washing

TABLE 2
MOSQUITO REPELLENCY RESULT BEFORE WASHING

No.	Type of Treatment	Batched or Un-batched	No. of mosquitoes
1	2% oil & 6%binder	Unbatched	4
2	2% oil & 6%binder	Batched	1
3	2% oil	Unbatched	5
4	2% oil	Batched	4
5	6% binder only	Batched	6
6	Untreated fabric	----------	10

From the table above a sample treated with 2% oil & 6%binder and batched showed better repellency to mosquito.

3.2. Mosquito repellency result of different samples after washing

TABLE 3
MOSQUITO REPELLENCY RESULT AFTER WASHING

No.	No. of washes	No of mosquitoes	Remark
1	One time	5	Poor repellency
2	Two times	8	Poor repellency
3	Three times	6	Poor repellency
4	Four times	6	Poor repellency
5	Five times	9	Poor repellency

The result showed us the treatment had poor washing fastness as its repellency decreases proportionally as number of wash increases.

3.3. Shrinkage test result

TABLE 4
SHRINKAGE TEST RESULT

No.	Original area (cm^2)	Area after treatment (cm^2)	Shrinkage (%)
1	10 X 10=100	9.5X 9.9= 94.05	5.95
2	10 X 10=100	9.7 X 9.6=93.12	6.88
3	10 X 10=100	9.5 X 9.7=92.15	7.85
4	10 X 10=100	9.7 X 9.5= 92.15	7.85
5	10 X 10=100	9.6 X 9.5= 91.2	8.8
6	10 X 10=100	9.7 X 10= 97.00	3.0
7	10 X 10=100	9.8 X 9.8= 96.04	3.96
8	10 X 10=100	9.9 X 9.8=97.02	2.98
9	10 X 10=100	9.9 X 9.9=98.01	1.99
10	10 X 10=100	9.9 X 10= 99.00	1.0
Average	100	94.97	5.03

The above result showed a slight shrinkage is observed on the samples after treatment. But this is the most noticeable effect on many other finishes and chemical treatments of cotton.

3.4. Fabric stiffness test result

The stiffness property of the fabric was not also increased much.

TABLE 5
STIFFNESS TEST RESULT

	Bending length (cm)			
No.	Treated		Untreated	
	warp	Weft	Warp	Weft
1	3.20	2.55	3.50	2.70
2	3.20	3.05	3.25	2.75
3	3.20	2.75	3.30	2.80
Average	3.20	2.78	3.35	2.75

3.5. Tensile strength test result

From the result , in treatment, there is improvement in tensile strength after treatment besides the repellency as indicated in table 6 below.

4. CONCLUSION

Sample treated with binder and oil was effective on mosquito repellency property. Thus, treatment should be given by Pad-Batch-Dry (PBD) method. The wash fastness was poor so it is recommended not to wash the treated fabric or retreat it after washing by spraying. The strength of the treated fabric was better than the untreated on therefore the finish doesn't degrade the fabric. The finish results slight shrinkage on the fabric. But this is the most noticeable effect on many other finishes and chemical treatments of cotton. The stiffness property of the fabric was not also increased much. Finally it is concluded that the finish applied on the fabric was effective without washing and it has no remarkable problem on the property of the fabric rather than increasing the strength of the fabric. The future work may potentially link the gap by improving the wash fastness using some chemicals.

TABLE 6
STRENGTH TEST RESULT

	Sample No.		1	2	3	4	5	6	7	8	9	10	Average
Breaking Force (N)	Treated	Warp	1.80	2.21	1.71	2.10	2.08	3.5	2.12	2.31	2.36	2.19	2.24
		Weft	1.88	1.37	2.08	2.24	2.01	2.03	2.22	2.37	1.94	2.43	2.06
	Untreated	Warp	1.73	2.01	1.67	2.26	1.65	1.52	1.88	1.81	2.01	1.82	1.84
		Weft	2.10	1.83	1.99	1.92	1.81	1.79	2.23	2.28	2.06	1.68	1.97

5. ACKNOWLEDGEMENT

The author express his gratitude to the Management, Kombolcha Institute of Technology (KIOT), Wollo University, for their support. He also extends his thankfulness to the staff of Textile Engineering Department, KIOT, Wollo University for their encouragement and support and to all others who assisted in the work.

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