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Mosquito Repellent Finishing of Cotton Using Pepper Tree (*Schinus molle*) Seed Oil Extract

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Abstract

Mosquito repellent materials are a standout amongst the most developing approaches to propel the textile field by giving the required attributes of protection against mosquitoes, particularly in tropical territories. These kinds of materials make sure the protection of individuals from the mosquitoes and the mosquito-borne diseases like intestinal sickness, filariasis and dengue fever. In this investigation *Schinus molle* (Pepper Tree) seed oil was utilized as mosquito repellent completion. The investigation concentrated on the entrance of mosquito repellent completion in textile applications just as nature-based options in contrast to commercial synthetic mosquito anti-agents in the market. Appropriate techniques and materials to accomplish mosquito repellency are talked about and brought up. Cotton sample was treated within the sight of acrylic copolymer cover for better obsession. *Schinus molle* Seed Oil demonstrated very inspiring repellency to mosquitoes without causing much impact on the mass properties of the texture like quality, solidifies and bowing length. Be that as it may, the absorption was altogether diminished.

Keywords: Cotton; *Schinus molle* seed oil; Mosquito repellent; Mosquito borne diseases

Introduction

Mosquitoes are insects of the leading public health concern because many species are vectors of diseases. Because of warming the distribution of mosquitoes has prolonged from tropical regions to northern latitudes that has unfolded the sources of infection from mosquitoes. San Martin J. L indicated that as per the statement of World Health Organization (WHO) every year 2.5 billion people at risk from dengue fever with a 50 million estimated infections in worldwide [1]. Saraf N.M and Alat D.V mentioned that the developing textiles are high tech interdisciplinary products and it becomes an integral part of everyone's demands on life [2]. Kumaravel S and Kantha L.C.B reported that clothing plays important part in livelihood and considered as the second basic need for human life [3]. Mosquito transmit is an additional health disease Dingo, Malaria, Viral fever. In addition mosquito bites can cause severe skin irritation through an allergic reaction to the mosquito saliva, it cause red bump and itching. In today fast changing global competition textile fields give more conscious of environment eco-friendly aspects of textile production. Chemical repellent activities alternate source for eco-friendly express. One of the foremost effective tools for dipteran repellent finishing and also the meditative plants like *Tulasi, Lemongrass, Keelaneli, Neem, Eucalyptus,* Bernard D.R explained that turmeric are used of the production of mosquito repellent finish [4]. Hence the ecological point of view mosquito repellent fabric with natural source treated like herbal oil *Cymbopogancitros* application of herbal subtracts have repellent activity. Mosquitoes are the most therapeutically huge vector and they transmit parasites and pathogens, which keep on overwhelmingly affecting individuals. Likewise, they are the fundamental driver of spreading fatal ailments like jungle fever, dengue, filariasis, and chikungunya. Among the expanding number of arthropod-borne ailments, just a couple are preventable by antibodies. There is no successful immunization against jungle fever. Dengue, the best way to maintain a strategic distance from it stays to dodge mosquito chomps. The utilization of the anti-agents, for example, salves loops and vendors are restricted in their because of different reasons. This has required the improvement of mosquito repellent textures. A textile texture with the mosquito repellent is one of the progressive ways and the truly necessary component of heading out the mosquitoes. It shields the people from the chomp of mosquitoes and in this way encouraging security from the mosquito-borne ailments. Cotton is the normal vegetable fiber of extraordinary financial significance as a crude material for fabric. Natural cotton will be cotton that is developed utilizing strategies and materials that lowly affect the earth. Restorative plants are the endowment of nature to fix a boundless number of sicknesses among individuals. The plenitude of plants on the earth surface has prompted an expanding enthusiasm for the examination of various concentrates acquired from the conventional therapeutic plants as potential wellsprings of new mosquito repellent specialists [5].

Materials and Methods

Mosquito Repellents can be classified based on source, action and other techniques.

Classifications of mosquito repellents based on source

Chemical repellents: DEET (Di-Ethyl Meta Toluamide) containing item found moderately few instances of poisonous quality of dermatitis, hypersensitive responses, and neurologic and cardiovascular toxicities like seizures after the utilization, ingestion and high-focus use on kids and grown-ups of DEET. Some other unfavourable wellbeing impacts like encephalopathy, tremor, slurred discourse, conduct changes, trance state, and even demise have likewise been accounted for [6]. Due to their impediments and downsides, the plan and interest for home grown items in the market have achieved a pinnacle of fame. Home grown

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material structures a gigantic spot as a standout amongst the most critical and helpful needs in an eco-accommodating way. Picaridin is a kind of substance repellent that affects the earth and people like eye aggravation, unfavourably susceptible &toxic to amphibian life. Allethrin likewise engineered substance repellent has low poisonous quality towards humans& feathered creatures however high harmfulness level towards amphibian life. Malathion an engineered synthetic anti-agents affects human and creatures. Furthermore, is profoundly harmful to honey bees and other helpful creepy crawlies, some fish and other amphibian life.

Natural repellents: There are different normal mosquito anti-agents, as; Castor oil, Cedar oil, Peppermint oil and Geranium oil. Among all the previously mentioned characteristic anti-agents, Chrysanthemum was observed to be the best anti-agents.

Classification of Mosquito Repellent Based Action

Repellent insectside: These substances that are fundamentally used to repulse creepy crawlies and bugs instead of causing passing. A few mosquito anti-agents are accessible in the present market, of which an expected 110 million individuals securely use DEET worldwide every year.

Contact insectsid; are the substances that contain Neuro-poisons for nuisances and bugs. They make the creepy crawlies and irritations oblivious when they interact with them.

Mechanism of repellent action

The activity of repellent specialists for bloodsucking mosquitoes can be extensively separated into two sorts, following up on the olfactory or material detects. The olfactory mode is called transpiration repellency, fending off mosquitoes without them contacting the outside of the completed texture. This works by obstructing the bugs' dampness detecting openings, which implies they can't find people. The material mode is called direct-contact repellency, and this drives creepy crawlies off the prepared surface before they can suck blood, even after they have contacted the outside of the texture [7]. It is trusted that these anti-agents substances chip away at the creepy crawlies' fringe sensory system when contact is made, making them enter a confounded state and repressing their conduct at sub-deadly dosages, before knockdown and deadly activity.

Application of mosquito repellent textiles

Utilization of mosquito repellent can be utilized in hostile to mosquito pieces of clothing, bed sheets, wide work netting coats, head nets, bands& anklets, bed nets, bed drapes, window blinds and restroom draperies.

Essential oil: Essential oils are common items that plants produce for their very own necessities other than sustenance (for example assurance or fascination). When all is said in done, they are mind boggling blends of natural exacerbates that give trademark smell and flavour to the plants. They are principally made up by monoterpenes and sesquiterpenes whose fundamental metabolic pathway is through mevalonate prompting sesquiterpenes and from methyl-erythritol prompting monoterpenes. They are situated in various pieces of the plant.

There are diverse techniques for fundamental oil extraction. A standout amongst the most widely recognized is steam refining, since it considers the detachment of somewhat unpredictable, water-immiscible substances by methods for low-temperature refining, being of specific use when the parts bubble at high temperature (higher than 100°C) and are defenceless to decay underneath this temperature. Despite the fact that this strategy displays a few points of interest, it is important to endure as a primary concern that it isn't simply basic steam hauling business. The arrival of the parts present in the stomas is brought about by cell-divider crack because of the higher weight and the oil content extension of the cell created by warmth. The steam stream gets in through the stomas, breaks them and in the long run hauls the basic oil. More or less, steam-refining comprises of steam because of a straight ebb and flow of steam water, which warms the blend just as it diminishes the bubbling temperature in light of the higher steam strain characteristic in water to those of unpredictable segments in basic oils. The steam originating from the distillatory gets cold in a condenser and, at long last, the in miscible blend gets isolated in a clarifier or Florentine jar. This technique is more advantageous than natural dissolvable extraction or straight refining as water steam has a lower cost contrasted with natural solvents. Likewise, it maintains a strategic distance from oil warming or the utilization of advanced gear. Regardless, the extraction strategy depends, among different variables, on the sort of material to be handled and the area of the parts inside the vegetable structure as indicated by the species and natural family.

Schinus molle

Schinus molle (Figure 1) is an evergreen tree with sobbing foliage, 3-15 m in stature; trunk short; crown with equivalent spread; bark dull dark colored, profoundly fissured, chipping; sticky latex shapes if the bark is harmed. Its leaves are impair-pinnate, with a winged rachis and 20-40 hand-outs, flyers straight lanceolate, edges whole or dentate, 2-5 cm × 4-8 mm [8]. Blossoms in hanging panicles can develop to 30 cm long; petals around 2 mm long; hanging groups of little, light yellow roses form into packs of pink berries; the more female blooms a tree has the more berries will build up; a few trees have for the most part male blossoms and have no 'peppers.

Schinus species are portrayed by impactful smell fundamental oils packed particularly in organic products which are utilized to treat respiratory scatters, mycosis, and obtrusive candida contaminations. These properties are credited to the nearness of large amounts of monoterpenes in these species. Basic oil from the products of *S. terebinthifolius* was distinguished and explored for its cell reinforcement and anticancer exercises [9]. These creators detailed a

Figure 1: *Schinus molle* collected from Kombolcha Institute of Technology.

stamped cancer prevention agent and cytotoxic exercises in vitro on human bosom carcinoma. These discoveries recommend that the basic oil from *S. terebinthifolius* may be a promising wellspring of dynamic mixes for creative treatments or potentially preventive procedures against malignant growth. Two triterpenoids segregated from *S. terebinthifolius* berries were described as dynamic site-coordinated explicit focused inhibitors of phospholipase A2, which demonstrates a conceivable calming action [10].

Essential oils are mind-boggling blends, established by terpenoids hydrocarbons, oxygenated terpenes and sesquiterpenes [9]. They start from the plant auxiliary digestion and are in charge of their trademark fragrance. The different uses of basic oils represent the extraordinary enthusiasm for their investigation. Such applications might be found in the corrective business, as elements of scents, ornamental restorative, fine aromas, and seasoning, in the sustenance business, as smells and flavours, in the pharmaceutical business, as dynamic segments of prescriptions and as antibacterial/antimicrobials, and in fragrance based treatment.

At present, there are numerous examinations in which they are utilized as middle people in fine science responses, among different applications. The most widely recognized strategies utilized for the modern extraction of these oils are steam refining, extraction with solvents and articulation, Their determination will rely upon the attributes of the material from which the oil will be extricated, since they can be available in various pieces of the plant, similar to the roots, the stem, the leaves, the leafy foods/the seeds. When the oils are acquired, the basic commitment of the natural science to the business lives in their portrayal, as their concoction synthesis may fluctuate even inside one plant-animal category. These varieties may be because of the nearness of various chemo-types, as indicated by the plant adjustment to the encompassing condition, just as its condition of improvement. We need to consider the way that it is the organization of the fundamental oils what gives their inherent properties and monetary esteem. They can be found in the root, for example, that of. The Vetiver grass (*Vetiver zizanioides*), in stems like that of peteribi wood (*Cordialtracheotomy*) And incense, in leaves like in eucalyptus trees (*Eucalyptus citriodora*), citronella (*Cymbopogon nardus*), chinchilla (*Targets minuta*) and lemongrass (*Cymbopogon citratus*), in blossoms like lavenders (*Lavandula officinalis*), in natural product like lemon, orange (*Citrus spp.)* and even in seeds as on account of anise (*Pimpinella anisum*), coriander (*Coriandrum sativum*) and pepper (*Piper Nigrum*), among others [11]. They can function as interior envoys, similar to guard substances or plant volatiles went for characteristic foes yet in addition pull in pollinating creepy crawlies to their host [12].

The essential oil present in *Schinus molle* (Table 1) with major components identified are 20.6% α-phellandrene, 10.8% β-Phellandrene, 8.7% α-pinene, 5.1% β-pinene, 6.9 % β- myrcene, 5% β-element, 6.5% copane, 5.8% germacrene, 6.3% γ-cadinene and α-5.4% humulene. Be that as it may, the organization of these oils varies in their primary parts contrasted with information detailed from different sources (Figure 2) [13,14].

Pepper tree seeds are used for medical purpose to prevent inflammation and growth of health promote as well as to astringent, antibacterial, digestive stimulant, antiviral, and wound healer. The main uses of *Schinus molle* seed oil in medicine as abroad spectrum antimicrobial and antiseptic against bacteria viral and fungus infection. To stop bleeding and heal wounds internally and externally. For mycoplasma infection can use the plant.

The plant is used for bleeding disorder (reduce disorder), Anti-depressant, Anti-septic digestive Stimulant and Menstrual stimulant. Peoples use *Schinus molle* locally and its ground brown or green powder originated from dried leaves, ripe seed of the plant with lemon juice and boiling it at high temperature for other medical application and *Schinus molle* is traditionally used in Ethiopia to repel house flies.

In the other way, our globe in general Africa in particular is suffering by malaria diseases which are one of the mosquito borne diseases like in addition to filariasis and dengue fever which are also very fatal. The mosquito repellent available in market are synthetic chemicals which very toxic and are applied at home in spray technique and as lotions. The chemicals used today like DEET, Allethrin, Permethrin (Synthetic analogue of pyrethrum), and Malathion cause environment hazard. Synthetic chemicals complete can attack agricultural area,

S. No.	Compounds	Composition (%)
1	α- Pinene	8.7
2	trans-Piperitol	3.5
3	α-Phellandrene	20.6
4	β-Pinene	5.1
5	β –Phellandrene	10.8
6	β –Myrcene	6.9
7	β-Elemene	5.1
8	Copan	6.5
9	Isolidene	1.7
10	Germacrene	5.8
11	α- Cubebene	1.4
12	Aristolene	1.8
13	δ-Cadinene	6.3
14	α-Humulene	5.4
15	α-Gurjunene	1.3
16	β-Caryophyllene	1.4

Table 1: Some Common Essential Oils in *Schinus molle*.

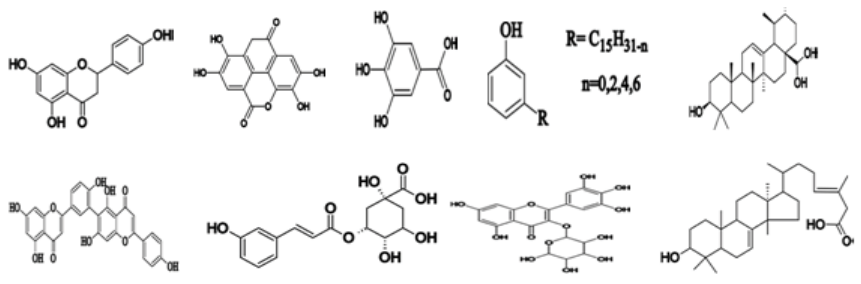

Figure 2: Some common chemical compound in *Schinus molle* Seed.

human health and also animals in addition to this those chemicals can cause many disease that are series problem for human health. Besides, spraying the chemicals at home only helps to far away from mosquito only when we are at home meaning that escaping from mosquito while walking and working outside impossible. In developing countries using of chemicals daily is not affordable in terms of cost. Applying Pepper Tree (*Schinus molle*) Seed Oil which is natural oil on apparel like cotton fabric is a perfect solution for the aforementioned problems associated with synthetic chemical repellents and their application as spray at home and lotion.

Laboratory Testing

Sample of the *Schinus molle* seed was collected at Wollo University, Kombolcha Institute of Technology. The fabrics used for the experiment was half bleached plain woven cotton fabric with count of 34 NM, of 140 GSM. The chemicals used were acetone solvent for oil extraction and binder to fix the oil on fabric.

Soxhlet apparatus to extract oil, padding mangle to pad the fabric sample, cage box to collect mosquito & check the repellency of the oil & crusher machine for crushing the seed of the *Schinus molle* were used.

Experiments

Preparation: The seed of the *Schinus molle* was crushed into powder by using grinding machine or crusher machine then by weigh the sample powder (28 gm.) ready for extraction (Figure 3).

Extraction: The crushed *Schinus molle* powder was filled into Soxhlet thimble 250 ml of acetone was added to 25 gram of crushed seed at room temperature for one hour and half to get the required oil.

Application on cotton: The extracted oil was applied on cotton in conditions.

- ***Sample 1:*** 4 ml oil & 10 ml binder with 1 dip & 1 nip at room temperature for 10 seconds
- ***Sample 2:*** 4 ml &10 ml binder with 2 dip & 2 nip at 55°C temperature for 30 second
- ***Sample 3:*** 4 ml & 10 ml binder with 3 dip & 3 nip at 70°C temperature for 60 seconds
- ***Sample 4:*** 4 ml oil only with 1 dip & 1 nip at room temperature for 10 seconds
- ***Sample 5:*** 4 ml oil only with 2 nip & 2 dip at 55°C temperature for 30 seconds
- ***Sample 6:*** 4 ml oil only with 3 nip & 3 dip at 70°C temperature for 60 seconds

In all the samples the oil and binder were mixed with water and a single drop of emulsifier to make 100 ml and then steered with water.

Mosquito repellency test

Cage preparation: The repellency test was performed using in-situ prepared mosquito cage and collecting 8 mosquitoes. 30 cm X 40 cm homemade mosquito cage was fabricated. The four contrary sides and the top cover up were made from transparent glass material and the bottom parts were from wood. In the cage light source was installed to attract the mosquitoes (Figure 4).

Mosquito collection: 8 mosquitoes were collected from bathroom around Kombolcha Institute of Technology student dormitory. A bottle was used to catch the mosquitoes.

Repellency test: the gathered mosquitoes were put into the pre-assembled confine while the mosquitoes are embedded into the enclosure they will in general sit on the mass of the pen however not on the ground. At that point, the testing technique was finished by setting the treated examples on the mass of the confine and the number of mosquitoes touched base on the treated examples was checked and recorded inside 25 minutes (Figure 5).

Method of testing: The treated examples were appended to the mass of the confine. One example was tried at once. At that point, the mosquitoes were embedded into the enclosure. The number of mosquitoes touched base on the treated examples were gathered and recorded for 30 min for each example. Since the mosquitoes settle on a spot where they sit first (when it is agreeable for them) they may not excoriate to different spots. So the confine had been shacked every 1 minute to exasperate the mosquitoes. As of now, they endeavour to sit again and checking and recording the number of mosquitoes had been.

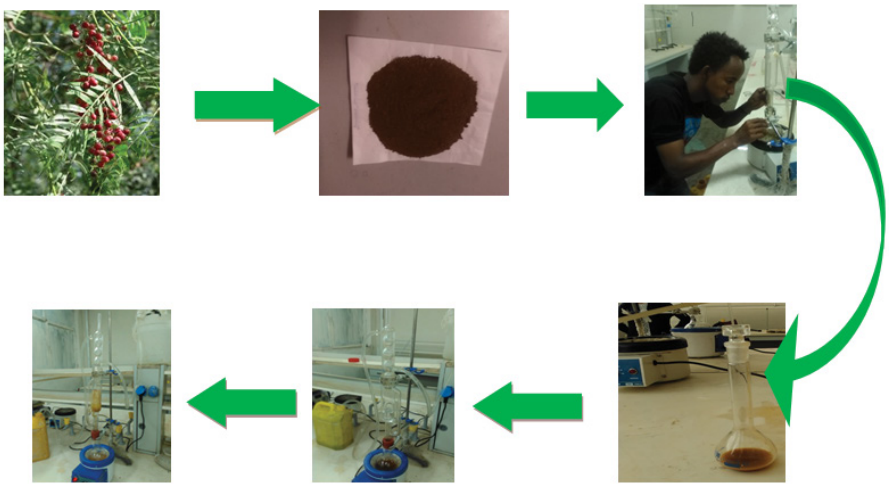

Figure 3: Procedure of oil extraction from *Schinus molle* Seed.

Testing of treated fabrics after washing: The mosquito repellent treated fabric was washed with water soap (with a recipe of 300 ml of water & 3 gm of soap with a cold wash for 15 minutes. Washing and drying the fabric, it was tested for mosquito repellent test at a night to check whether the finish was durable enough or not for each sample (6 samples) through several trials for successive days.

Absorbency test: Sample was taken from the treated and untreated fabric then drop of water was placed on the surface of the treated and untreated fabric, after that time is recorded until the water drop spreads completely. Then time taken for absorbency of the 2 sample was compared.

Shrinkage test: This test was performed by plotting 25 cm × 25 cm square shape on the texture before treatment. At that point this square shape was estimated again after treatment is given. The distinction in the region was determined and the shrinkage was communicated in rate. The mosquito repellent completion was connected on every one of the examples by cushioning technique. At that point the recently plotted box measurement was estimated once more. At last, the shrinkage was determined by the distinction in territory in rate.

Tensile strength test: Since the texture quality analyzer was not practical the test was done on yarn structure with the accompanying system. 10 warp and weft yarns each were taken out from the treated texture. Additionally, 10 warp and weft yarns each were taken out from the untreated texture tests. Every one of the yarns was tried for rigidity utilizing SHIRLEY yarn quality analyzer.

Figure 4: A manual cage box designed at home.

Results and Discussion

A series of experiments with the various variables were carried out to find out the answers of our objectives with Pepper Tree. Many factors were seen which affect the repellency of the mosquito before washing and after washing, durability of the coated fabric, shrinkage of the fabric, and absorbency of the fabric. Each of the factors and their effects are discussed below. In order to extract the oil a series of steps are carried out from the powder to the finale point this processes are carried out by the *Soxlet Apparatus Method* then lastly we have get pure oil from the *Shcinus molle* seed see in Figure 3.

The mosquito repellency test before washing showed that *Schinus molle* oil with binder has better mosquito repellency effect. Increasing the number of nips and dips also improved the repellency effect. The effect has been also represented graphically for better understanding of the impact (Table 2 and Figure 6).

The result showed the treatment needs improvement in washing resistance as its repellency diminished as the quantity of wash increments (Table 3).

It is natural that a textile can get stained during usage and washing is required to ride of the dirt. During washing, the mosquito repellency should not deteriorate. Therefore the final finding of this work can be winded up by explaining the effect of *Schinus molle* Oil extract on mosquito repellency after washing in graph see in Figure 6.

The graph shows that the effect of washing significantly affects the effectiveness of the *Schinus molle* Oil repellency to mosquito as the number of washing cycles increase (Figure 7).

According to the absorbency test result, the absorbency is decreased. This may be due the extract applied on it is oil which is hydrophobic in nature (Table 4).

The result showed a slight shrinkage was observed after treatment. But the percentage shrinkage is very small land insignificant change (Table 5).

The stiffness test result showed that the treated sample is a little bit softer unlike the synthetic chemicals for the same purpose (Table 6).

The tensile strength test result showed that the treated fabric is slightly reduced. This may be due to thermal degradation during treatment (Table 7).

Conclusion

Applying Pepper Tree (*Schinus molle*) Seed Oil which is natural oil on apparel like cotton fabric is a perfect solution for the problems associated with synthetic chemical repellents and their application as spray at home and lotion. Pepper Tree oil extract was applied on the fabric by padding technique gave great repellency to mosquitoes.

Figure 5: Presence of mosquito on fabric surface after three washes.

Sample	Extracted oil (ml)	Binder (ml)	Nip	Dip	No. of Mosquitoes Present
Sample-1	4	10	1	1	1
Sample-2	4	10	2	2	0
Sample-3	4	10	3	3	0
Sample-4	4	0	1	1	2
Sample-5	4	0	2	2	2
Sample-6	4	0	3	3	1

Table 2: Mosquito Repellency Result before Washing.

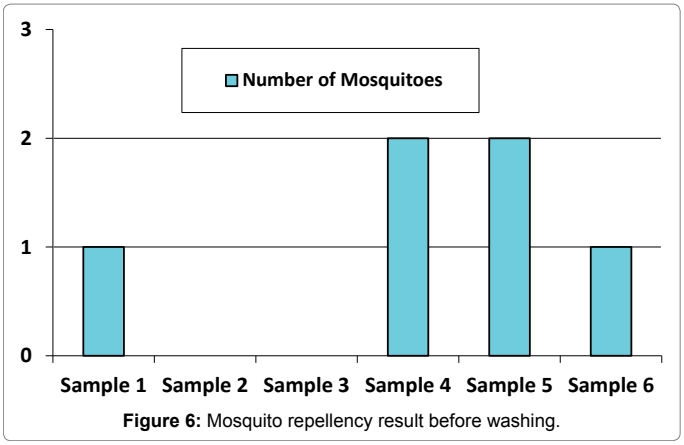

Figure 6: Mosquito repellency result before washing.

S.No.	Number of Washes	No. of Mosquito Present on Fabric	Remark
1	1	0	Good
2	2	0	Good
3	3	2	Slightly Poor
4	4	3	Poor
5	4	3	Poor

Table 3: Mosquito Repellency Result after Washing.

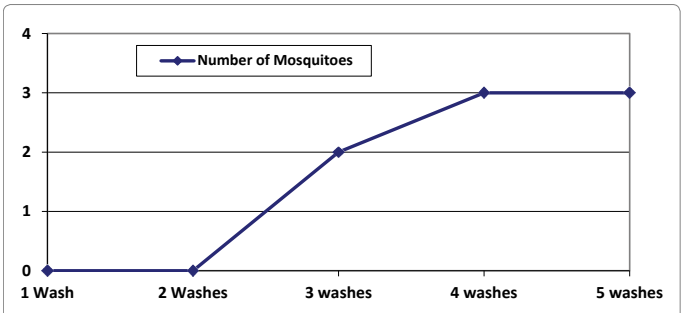

Figure 7: Mosquito repellency result after washing.

The normal completing specialists are eco-accommodating bio-degradable, non-lethal, and non-aggravation to the skin. It demonstrates great mosquito repellent property when connected on the cotton substrate. The treated fabric has slightly decreased in washing fastness. The strength of the treated fabric was more fragile than the untreated one which demonstrates slight corruption because of treatment, while, the completion results nearly with in consequential change in shrinkage. When all is said in done, *Schinus molle* (Pepper Tree) seed oil treated texture has been found with high mosquito repellent property.

S.No.	Drop Absorbency (Seconds)	
	Untreated fabric	***Treated fabric***
	29	41
1	29	40
2	28	42
3	30	40
4	31	39
Average	**29.4**	**40.4**

Table 4: Absorbance test result.

S.No.	Original area (cm^2)	Area after Treatment (cm^2)	Shrinkage (%)
1	25 X 25=625	24.89x24.99=622.001	0.482
2	25 X 25 =625	24.92x24.95=621.754	0.522
3	25 X 25=625	24.9x25=622.5	0.401
4	25 X 25=625	24.9x24.9=620.01	0.804
5	25X25=625	25x24.87=621.75	0.522
Average			**0.5462**

Table 5: Shrinkage test result.

S.No.	Bending Length in cm			
	Before Treatment		**After Treatment**	
	warp	***Weft***	***Warp***	***Weft***
1	3.30	2.90	3.00	2.80
2	3.15	3.05	2.95	2.95
3	3.40	2.60	2.75	2.50
4	3.25	2.90	2.85	2.85
5	3.35	3.10	2.60	3.00
Average	**3.29**	**2.91**	**2.83**	**2.82**

Table 6: Fabric Stiffness Test result.

	Sample No.		S1	S2	S3	S4	S5	Average
Breaking Force in N	Before Treatment	Warp	1.75	2.04	2.02	1.97	2.08	1.972
		Weft	2.01	1.77	1.98	1.86	1.95	1.914
	After Treatment	Warp	1.73	2.01	1.91	1.99	1.75	1.878
		Weft	1.88	1.55	1.94	1.85	1.91	1.826

Table 7: Tensile Strength Test result.

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