

# Development of Mosquito Repellent Finish on Handloom Home Furnishing Fabrics using On-Loom Integrated Finishing Device



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## Abstract

Home Furnishing varieties – Bed Sheets, Spreads, Table Covers and Curtains produced on Handlooms are very famous utilised in local as well as export markets. If these fabrics are converted into protective textiles by applying mosquito repellent finish it will drive away mosquitoes and other blood sucking insects and safeguard humans from diseases like malaria, dengue etc. In this study microencapsulated mosquito repellent finish is applied on home furnishing fabrics on handloom during the weaving process using on-loom integrated finishing device. The effectiveness of finish applied by this method on different home furnishing fabrics at different conditions along with its durability and change in physical properties have been studied.

## Introduction

Handloom Home Furnishing Fabrics are used in Living Room as Tablecloth, Sofa Covers in Bedrooms as Bed Sheet / Bedspreads and as Door & Window Curtains in all rooms of the house. Mosquitoes are the most harmful vectors that impact human life by spreading diseases like dengue, malaria and chickenguniyaetc [1]. Mosquito Repellent finished fabrics behaves as Protective Textiles by protecting the human beings from the bites of mosquitoes and other insects by driving them away by Olfactory (transpiration) mode and Tactile (direct contact) mode. There are Chemical as well as herbal repellents are available in market [2,3]. For this study microencapsulated 'Permethrin' based commercially available chemical has been used. The optimum conditions required for application of finish by the 'On-loom integrated finishing device' on handloom has been studied by varying chemical concentration and other parameters [4,5]. The efficiency of finish applied durability of the finish and changes in physical properties of finished fabric has also been studied.

## Materials and Methods

### On-loom integrated Finishing Device

The handloom attached with 'on-loom integrated finishing device' which consists of a Finish Applicator and Curing Chamber has been used for the study. The Finish Applicator attachment has a tank with dripper and an Applicator. The tank contains finished liquor which slowly drips into the Applicator which applies the finish over the fabric, while the fabric rests on the specially designed Front Rest. The number of strokes of the applicator increases the wet pickup percentage. By trial & error method, 70% wet pick up has been achieved by making two strokes on the fabric.

### Preparation of mosquito repellent finish liquor

Commercially available Permethrin based microencapsulated Mosquito Repellent agent Repello-MSQ Chemical with & without Saralink ULF – resin with low temperature curing cross linking agent used for this study.

Permethrin is an insecticide in the pyrethroid family that can be inhaled, ingested, or absorbed through skin. Depending on the formulation, permethrin is a non-toxic to moderately toxic pesticide. Pyrethroids are synthetic chemicals that act like natural extracts from the chrysanthemum flower. Permethrin is used in a number of ways to control insects. Products containing permethrin are used in public health mosquito control programs. Permethrin is the commonly used insect repellent which is safer than other other chemicals used in the industry.

The Mosquito Repellent Finish Liquor in the concentration

of 80 g/l, 100 g/l and 120 g/l has been used. Saralink ULF with concentration of 30 g/l, 35 g/l and 40 g/l has been used for the study. The liquor is added with Acetic Acid to maintain a pH value of 6.

### Selection of fabric sample

Handloom Home furnishing Fabrics with the standard specifications has been considered for the study. Loom is set up with the required specifications (Table 1) and the weaves have been changed to Plain, Rib and Twill for each sample as per the availability of commercial home furnishings fabrics in the market.

**Table 1:** Specification of Home Furnishing Fabrics.

S.No.	Home Furnishing Fabric details	Weave details	Warp Count	Weft Count	Ends / Inch	Picks /Inch	Nominal Fabric Weight (g/m <sup>2</sup> )
1	Table Cloth / Covers	Plain	2/20 <sup>s</sup>	2/20 <sup>s</sup>	44	32	190
2	Bed Sheets/Spreads	Twill	2/20 <sup>s</sup>	2/20 <sup>s</sup>	44	36	200
3	Curtains	Rib	2/20 <sup>s</sup>	2/20 <sup>s</sup>	44	42	220

The Home Furnishing Fabrics are woven on Handloom attached with 'On-loom Integrated Finishing Device. One set of fabric samples applied only with Mosquito Repellent Finish of three different concentrations and cured at three different temperatures. The other set of sample fabrics applied with Mosquito Repellent Finish along with resin as cross-linking agent, which is recommended by the industry to increase the durability of the MR finish.

### Application of finish with different parameters

Three different process parameters have been considered during application of finish on the fabric as shown in the L Table 2. Finish applied in 3 different concentrations, dried and cured at 3 different temperatures as shown in table. The duration of curing is maintained to be 3 minutes synchronising with other processes.

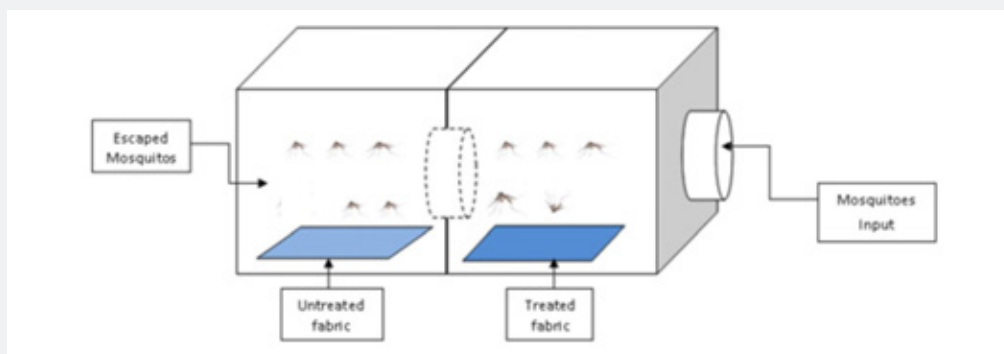
**Table 2:** Mosquito Repellency %on different Finish Parameters.

Fabric Details applied with Finish	% Repellency																		
	80 g/l 3 min. Curing time									100 g / l 3 min. Curing time									120 g / l 3 min. Curing time
	140°C			150°C			160°C			140°C			150°C			160°C			
	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	W / o resin	With resin	
Table Cloth / Covers	80	80	90	90	90	90	80	80	100	100	100	100	90	90	100	100	100	100	
Bed Sheets / Spreads	80	80	90	90	90	90	80	80	90	90	90	90	90	90	100	100	100	100	
Curtains	80	80	90	90	90	90	80	80	90	90	90	90	90	90	90	90	100	100	

### Mosquito repellency test using exito repellency chamber test method

Mosquito Repellency is normally assessed through three different tests- Cage test, Cone Test and Excito Chamber test method. The Excito Chamber is based on WHO/CTD/WHO PES/

IC/96 standard test. This method does not involve human subjects to lure the mosquitoes but effectively determines the behavior of mosquitoes towards treated fabric. Approximately one metre of fabric is tested against 10 mosquitoes of Culex species which are released in Excito Chamber Figure 1.



**Figure 1:** Excito Repellency Chamber.

Excito Repellency Chamber consists of a box / chamber divided into two parts as shown in figure. One half of this chamber is covered with treated fabric, while the other half is covered with untreated fabric. Both the halves of chamber are separated by a partition as shown in figure. 10 mosquitoes are let inside the Input hole of first half of chamber. The tendency of mosquitoes is to get away from the place due to the smell of the chemical treated fabric. While doing so some mosquitoes tend to die and fall on the treated fabric and some mosquitoes tend to escape through the hole to the other partition.

Repellency of fabric is tested by observing number of mosquitoes died or moving away from treated fabric chamber to untreated one. The observation is recorded after 10- and 30-minutes exposure. The test was conducted in daylight and repeated 4 times. The percentage of mosquito repellency was calculated using the following formula

$$\text{Mosquito Repellency \%} = \frac{(\text{NES} + \text{NDE})}{(\text{NEX})} \times 100$$

where, NES - Number of mosquitoes escaped; NDE - Number of mosquitoes dead.

NEX - Number of mosquitoes Exposed.

The observations are recorded after 10 minutes and 30 minutes of exposure, repeated 4 times.

### Results and Discussions

The test results conducted by modified WH/CTD/WHO PES/IC/96 standard test show the % repellency using Exito Repellency

Chamber. It is seen that at 80 g/l concentration the repellency %age has been in the range of 80 to 90% only. When application of finish done at 100 g/l, 100% repellency obtained at 150°C for Table Cover cloth with plain weave. A further increase in concentration and curing temperature was found to be redundant in this case. For the Bed Sheet fabric with twill weave, it is seen that 100% repellency is obtained at 120 g/l at temperature of 150°C. Further increase in temperature found to be redundant. In the case of Curtain fabric with rib weave, it is seen that 100% repellency occurred at 120 g/l at temperature of 160 °C. This is accountable due to higher GSM of Rib fabric in comparison to other fabrics. There has been no change in repellency %age, has been found when finish is applied with resin. Thus, the optimum conditions for the three different fabrics are shown in the given Table 3.

### Durability Study

According to AATCC 135 the durability of the finish applied fabric is studied for after 1<sup>st</sup>, 2<sup>nd</sup>, 5<sup>th</sup> and 10<sup>th</sup> washes. The results are shown in Table 4.

The durability of Mosquito Repellent Finished Fabric is Good i.e, showed 100 % repellency after 1st, 2nd, 5th and 10th washes except in the Table Cloth & Rib Curtain varieties where after 10th wash the repellency is reduced nominally to 90%. In the case of Fabric treated with resin, the durability found to be better that even after 15th wash all the fabric varieties retained 100% repellency. Thus, it is observed that the application of resin increases durability of the finish.

**Table 3:** Optimum Finish Process Parameters for Mosquito Repellency %.

S.No.	Fabric Details	Weave	MR finish liquor	Resin	Temperature	Time
1	Table Cloth / Covers	Plain	100 g/l	30 g/l	150°C	3 minutes
2	Bed Sheets/Spreads	Twill	120 g/l	35 g/l	150°C	3 minutes
3	Curtains	Rib	120 g/l	40 g/l	160°C	3 minutes

**Table 4:** Washing Durability Test of Optimum Finished Fabrics.

S.No.	Fabric Details (Weave)	Repellency %											
		Without Washing		After 1st Wash		After 2nd Wash		After 5th Wash		After 10th Wash		After 15th Wash	
		With out Resin	With Resin	With out Resin	With Resin	With out Resin	With Resin	With out Resin	With Resin	With out Resin	With Resin	With out Resin	With Resin
1	Table Cloth / Covers (Plain)	100	100	100	100	100	100	100	100	100	100	100	100
2	BedSheets /Spreads (Twill)	100	100	100	100	100	100	100	100	100	100	90	100
3	Curtains (Rib)	100	100	100	100	100	100	100	100	90	100	90	100

### Physical Characteristics of Fabric Treated with Mosquito Repellent Finish

#### Analysis of Tensile Strength

**Table 5:** Tensile strength of fabric treated with MR finish with and without resin Test Method IS:1969-1985.

Fabric Details	Tensile Strength in N					
	(% Reduction ↓)					
	Unfinished Fabric		Without Resin		With Resin	
	Warp	Weft	Warp	Weft	Warp	Weft
Table Cloth (Plain weave)	372	242	364 (2.1↓)	238 (1.6↓)	340 (8.6 ↓)	222 (8.26↓)
Bedsheet/Spreads (Twill weave)	384	368	374 (2.6↓)	357(2.98↓)	350 (8.8↓)	334 (9.23↓)
Curtains (Rib weave)	408	398	392 (3.9↓)	395(4.02↓)	366(10.2↓)	358(10.05↓)

The Strength of Unfinished plain tablecloth shows 372 N in warp and 242 N in weft direction. The strength of unfinished twill bedsheet shows 384 N in warp and 304 in weft direction. The strength of unfinished Rib curtain shows 408 N in warp and 398 N in weft direction. The reduction in strength after MR finish (without resin) is within the range of 2-4% which is nominal and within admissible limits it (Table 5). The reduction in strength

after MR finish with resin has been within the range of 8 -10%. The reduction in strength of resin treated fabric upto 10% is commercially acceptable. Hence, it is also considered to be within admissible limits. The cause behind the tensile strength loss after resin treatment is due to stiffness/brittleness in resin treated fabric, thus, less force is required to break the sample here.

**Table 6:** Stiffness characteristics of MR finished fabric with and without resin.

Fabric Details	Unfinished Fabric	Stiffness / Bending Length (cm)				
		Without Resin		With Resin		
	Warp	Weft	Warp	Weft	Warp	Weft
Table Cloth (Plain weave)	2.0	1.8	2.1	1.9	2.8	2.6
Bedsheet / Spreads (Twill weave)	1.9	1.8	1.9	1.8	2.6	2.5
Curtains (Rib weave)	2.0	1.8	2.0	1.8	2.8	2.6

From the above Table 6, it is observed that MR finish without resin causes 0.1 cm length difference in bending length in respect of plain cloth, which is insignificant difference and resin treatment has shown significant influence on bending length of fabric sample. Bending length of fabric has increased with resin treatment. Increase in bending length of the fabric is particularly more in the warp direction than in the weft direction. This can be due to the result of fabric density which is more in the warp direction than the weft direction. From the table, it has been observed that, the bending length of different samples has increased after MR finish with resin. It indicates that after MR finish with resin, stiffness of fabric increases. The reason behind the increasing of bending length is that, at the time of curing hydroxyl groups

of cellulose forms covalent bond with the cross-linking agent in high temperature. So that the cross-sectional area of fibre is also increased, and other factors remain same which results in the increase of stiffness of fabric.

### Analysis of Drape co-efficient %age of fabric with & without resin

From the above Table7, it is observed that there is no difference in Drape co-efficient of MR finished fabric without resin whereas MR finished fabrics with resin shows difference in all the three kinds of fabrics in the range of 14 to 16% i.e drape co-efficient increased by 14% in respect of plain tablecloth & twill bed sheet fabrics and increased by 16% in respect of rib curtains.

**Table 7:** Drape Co-efficient (%) of fabric without resin and with resin treatment.

Fabric Details	Unfinished Fabric	Drape Co-efficient (%)	
		Without Resin	With Resin
Table Cloth (Plain weave)	70	70	84
Bedsheet / Spreads (Twill weave)	58	58	72
Curtains (Rib weave)	60	60	76

### Comparative Study with Conventionally Finished Fabric

The Home Furnishing Fabrics of similar specification commercially available in market treated with this finish in conventional way in Processing Mill is compared with the 'On-

loom finished fabric using Integrated Finishing Device'. The result shows Table 8, the MR Repellency is equal to that of Commercial Mill Finished fabrics.

**Table 8:** Comparative Study of On-loom Finished Fabric with Conventional Mill Finished Fabrics.


S.No.	Fabric Details	On-loom Finished sample at (Optimum Conditions) % Mosquito Repellency (MR)	Conventional Mill Finished % Repellency
1	Table Cloth (Plain weave)	100 % (100 g/l / 150°C / 3 min)	100 %
2	Bedsheet / Spreads (Twill weave)	100 % (120 g/l / 150°C / 3 min)	100 %
3	Curtains (Rib weave)	100 % (120 g/l / 160°C / 3 min)	100 %

### Conclusion

The study shows that different Home Furnishing Fabrics applied with MR finish at optimum conditions through 'on-loom integrated finishing device' on handloom during the weaving process gives similar finishing effect i.e, 100% Mosquito Repellency effect as that of Conventional Mill Finished fabrics. The durability of finished fabric is better in the case of finish applied with resin whereas the physical properties like strength, stiffness are adversely affected due to inclusion of resin and crease recovery angle improves to better due to inclusion of resin for the very obvious reason for which resin is applied. It can be concluded that the 'On loom integrated finishing device' attachment on handloom at optimum finishing conditions gives same result in the finished end product as that of conventional mill finished product.

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