WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Impact Analysis of Eucalyptus Leaves and Barks Juice as Mosquito Repellent Applied on Single Jersey Knitted Fabric

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DOI: 10.55248/gengpi.4.623.47193

ABSTRACT:

Natural repellents utilized for human protection are growing needs of mankind. The application of repellents on the fabric as multifunctional textiles are the current interest of many researchers. The traditional DEET (N, N-diethyl-m-toluamide) has an adverse effect on nature and consumers. However, plant-based extracted repellents such as Eucalyptus leaves have been used in many ways as mosquito repellents applied on fabric by padding, or exhaustion methods because it has no harmful effects on the body and the environment. This paper analyses the effectiveness of plant-based repellents Eucalyptus (Leaves & Bark) extracts as repellents and successfully applied on single jersey knitted fabrics by exhaustion methods. A cage test was illustrated on treated samples wearing the clothes on the subject's hand. The results have shown that a moderate percentage of repellent in fabric and mosquitos stopped biting in 15 minutes. Mosquito biting manners have been studied and it observed that fabric repellence % increases the decrease of mosquito biting amount. Chemical fixation has not been done with treated samples and dried at room temperature. In this research, SEM (Scanning Electronic Microscope) and IR spectroscopy (Infrared spectroscopy) were not utilized for surface morphology study as well as the generation of mildew after repellent applications.

Keywords: Eucalyptus leaves, bark repellent, Natural repellent, Mosquito repellent fabric, Single Jersey Knitted fabric.

1. Introduction:

Mosquito-repellent fabrics are one of the excellent outcomes in advancement in the textile field by providing multifeatured and multifunctional cloth. This feature can be repelling away mosquitoes, especially in idyllic countryside areas. The textile accommodated mosquito repellent is the best approach to prevent the mosquito in nets, apparel, and dresses. Furthermore, there are several published and unpublished data from who has been demonstrated that vector-borne diseases have been spread out each year and 17 % of that infected by insects (*PESTICIDES PESTICIDES PESTICIDES PESTICIDES PESTICIDES AND THEIR APPLICA AND THEIR APPLICA AND THEIR APPLICA AND THEIR APPLICA AND THEIR APPLICATION TION TION TION TION Department of Control of Neglected Tropical Diseases WHO Pesticide Evaluation Scheme (WHOPES)*, 2006) . Frequently using synthetic chemicals as pest controls also are a major threat to the human being. Different kinds of fibers and fabrics are used now for mosquito repellent application. An efficient melt extruded and drawn bicomponent filament-based utilization as functional fabric whose durability remained unchanging after 33 weeks and 20 cold washes (Sibanda et al., 2018) . The foot-in-case system is exhibited in this literature. The fabrics treated with natural plant extracts possess good mosquito-repellent properties, and both the methods of direct application and microencapsulation are effective (*T4E-Shivankar-Fahne 1*, n.d.). The available mosquito repellents were reported in various articles like Eucalyptus globulus, Hemidesmus Indicus, and Santalum Album applied with solvent, which has good odour properties. Andrographis Paniculata, flowers, and leaves can be used. Rosemary repellent and has fragrance, dyed fabric with Pomegranate peel, by distillation processed lemon grass oil. Sun-dried, grinded-Mint leaves are better than a coil or fume repellent. The most used synthetic mosquito repellence is DEET (N, N-Diethyl-meta-toluamide), Picaridin (2-(2-hydroxyethyl)-1-piperidine carboxylic acid 1-methyl propyl ester), N, N-diethyl phenylacetamide (DEPA) (Raja et al., 2015). Mosquitoes can attract the human being for Carbon dioxide and lactic acid present in the blood. The repellence depends on N, N-di ethyl phenyl acetamide (DEPA) not only repellent for the mosquito also used for cockroach destruction in different countries (Prakash et al., 1990). An Ecofriendly modified silver nanoparticles with Moringa Oleifera fabric composite utilized as multifunctional fabric as antibacterial, antifungal, and mosquito repellent (El-Sayed et al., 2020) .This paper demonstrated the modification of 100% cotton, 50% Cotton, and 50 % polyester, viscose, and linen by a hybrid solution containing Moringa- Silver nanoparticles (AgNPs). The research has found that Osage Orange and Maclura pomifera has repellence property to repel roaches and other insects (Peterson et al., 2002). The incorporation of repellent in textiles is the

alternative approach but the main challenge is washing fastness for prolonged usage. The different percentages of citronella oil for mosquito repellent finishing have been successfully applied on the cotton fabric (Specos et al., 2010) .

Furthermore, the repellent nature was evaluated by the exposition of a human hand and arm covered with treated textiles to Aedes aegypti mosquitos. A conventional pad dry method was used, and the final product was efficient at 90 percent after three weeks or so. The extract of Vitex Negundo leaves can withstand 76 % efficiency and is sustained until 15 cycles of washing (Ramasamy et al., 2013). This extraction and application process described as effective, economical, and ecofriendly. This extraction and application process is described as effective, economical, and eco-friendly. A mosquito-repellent woven fabric made of Tulsi, Neem and Mint leaves has been reported as mosquito-repellent finishes by doing chamber tests A mosquito repellent woven fabric made of Tulsi, Neem and Mint leaves has reported as mosquito repellent finishes by doing chamber test (Tseghai, 2016).

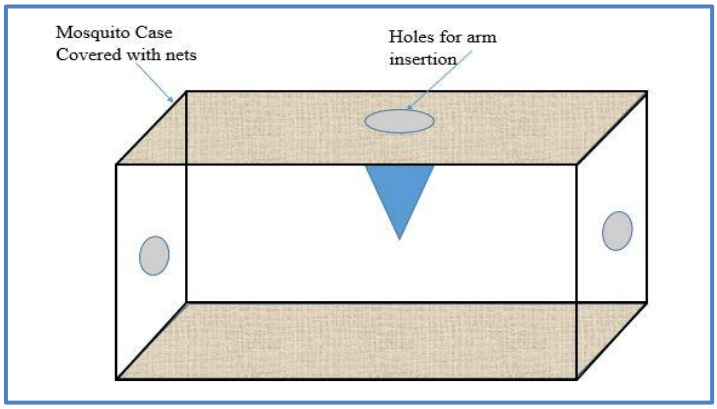


Fig. 1 Case test process

The chitosan-based commercial binder composite mosquito repellent knitted fabric was developed and reported as having high tensile strength, with great air permeability, and the fabric was proposed for furniture fabrics, garments, and military purposes("Use of Chitosan in Mosquito Repellent Finishing for Cotton Textiles," 2014). The three methods that can be utilized to impart the mosquito repellent agents and the assessing mosquito repellent Case test, Cone test, and Excito chamber test was proposed (Anuar & Yusof, 2016). This research has done a cage test to assess the mosquito bites and the efficiency of mosquito repellent fabric. The recently reported article (Endris & Govindan, 2022) showed that the Eucalyptus Globulus leaves have an insect-repellent rate of around 90% and good durability.

Medical textiles such as gauges, bandages, and wound caring products can be made of herbal ingredients as antibacterial, antifungal, and insecticidal active textiles (Specos et al., 2010). The manmade " DEET (N,N-diethyl-3-methyl-benzamide, Picaridin (US) and Icaridin (EU)(2-(2-hydroxyethyl)-1-piperidine-carboxylic acid1-methylpropyl-ester), 3-[N-butyl-N-acetyl]-amino-propionic acid ethyl ester, Oil of lemon eucalyptus(p-menthane-3, 8-diol), Citronella(3, 7-dimethyloct-6-en-1-al) and Natural plant oil obtained from Cymbopogon spp. grasses, Permethrin(3-phenoxy benzyl (1RS)-cis, trans-3-(2, 2-dichloro vinyl)-2, 2-dimethyl-cyclo-pro-pane-carboxylate) Pyrethroid derived from dried, crushed flowers of Chrysanthemum spp.",(Diaz, 2016) were investigated and shown the oil of lemon eucalyptus excellent repelled against the anopheles' mosquitos. The study about toxicology regulated by the USA has demonstrated that the solutions containing 10 % might be safe but after 30% unsafe and recommended to use proper instructions, especially for kids (Sudakin & Osimitz, 2010). To protect human beings as well as the environment plant-based chemicals are preferable to use as repellent textiles. The leaves have naturally high amounts of compounds like limonene, Z-citral, E-citral, beta-citronellal, and 1,8-cineole (E. globulus)(Maciel et al., 2010). Those chemicals are effective against the egg, larval, and adult phases of mosquitos. This research paper is conducted on E. Globulus Eucalyptus leaves and barks and applied on single jersey knitted fabric. Then mosquito repellence solution has applied to the fabric and a biting manner study was done by every 15 minutes in terms of protection. Other mechanical and Odor properties have not been tested in this work.

Objectives:

- To extract Eucalyptus juice from bark and leaves.
- To evaluate impacts of juice as a mosquito repellent.
- To observe mosquito bites in a closed cage.

2. Materials and methods:

2.1 Materials Used

Eucalyptus: Leaves & Barks (Collected)

Levelling Agent: Dispersol VLH, Non-ionic, ICI, India.

In this paper, a knit fabric was collected from the City University laboratory. Fabric specifications have given below: -

Table 1 Grey fabric specification

Specifications Fabric	100 % cotton Knit (Single Jersey)
Count	30/1 Ne
Stitch length	2.75 mm
GSM	160
CPI	48
WPI	56

2.1.1 Equipment's used:

The extracted liquid was kept in a ceramic bowl, and boiled on stainless steel pots, and fabric exhaustion done in a laboratory dyeing bath.

2.2 Methodology:

2.2.1 Process sequence:

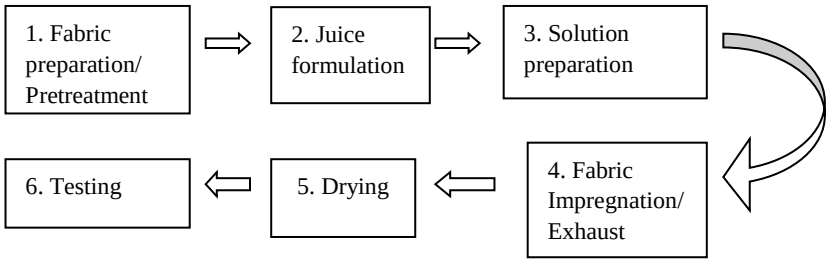


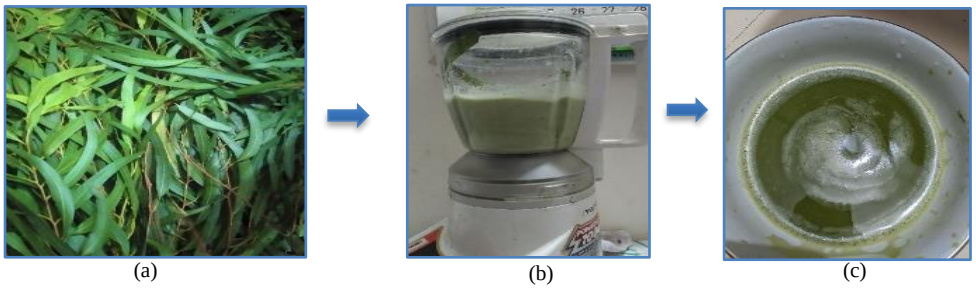
Fig. 2 Solution application process flow chart

2.2.2 Fabric Pretreatment:

The knit cotton fabric was scoured and bleached on a single bath process with Sodium Hydroxide (NaOH), Hydrogen Peroxide (H_2O_2). The recipe contained 4% owf sodium hydroxide (NaOH), 0.5% owf wetting agent, 1 % owf sequestering agent, 1% owf regular detergent, 2% owf hydrogen peroxide (H_2O_2), temperature 80-90^{0}C, P^H = 10-11, M: L ratio 1: 50 for 1.30 hour. (owf.= on the weight of fabric)

2.2.3 Plants and bark juice preparation:

The eucalyptus plant and bark were collected from seemingly matured trees in the forest. Leaves were collected from small branches. Barks were collected by the peeling-off process. Awareness was taken as if the main wood was not come out during the peeling off the barks by knife. Firstly, Eucalyptus leaves were collected. Poured into a blender with a ratio of 5:1, leaves vs. water. Then the thickened extract was filtered and collected in a bowl for further use. Methanol was used and kept the solution in dark places.



(a) (b) (c)

Fig. 2 Extraction of juice from leaves (a) Eucalyptus leaves (b) Blender (c) filtered juice

Secondly, Bark was collected from Eucalyptus leaves by boiling tree bark at 90^0C temperature for 15 minutes. After cooling liquid was collected into a bowl for application. Methanol was used after boiling and mixing, keeping it in a dark place as sunlight did not affect the solution.

(a) (b)

Fig. 3 Extraction of juice from Eucalyptus Bark (a) Tree barks (b) Condensed solution after boiling

2.2.4 Mosquito samples collection:

Female mosquitoes were used for repellent testing. Mosquitoes were arranged tests done by the Bangladesh Council of Scientific & Industrial Research (BCSIR). The mosquitoes were kept at 25^0C and 70% RH. Mosquitoes were fed and maintained on a 10% sucrose solution.

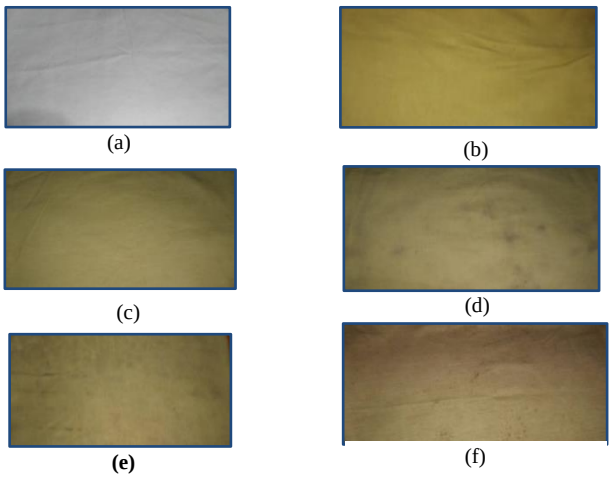
2.2.5 Mosquito repellent preparation:

The knitted fabric samples were impregnated by using 16 % owf extracted chemicals, 2 cc/l citric acid, 10 gm salt (NaCl)& 2cc/l wetting agent, 3 % Levelling Agent (Dispersol VLH, Non-ionic type), P^H 6-7, at temperature 60^0C for 30 min.

2.2.6 Washing:

The treated fabric was washed with normal water and household detergent at 40^0C for 10 min.

2.2.7 Sample library:



(a) (b) (c) (d) **(e)** (f)

Fig. 4 Sample library- (a) Pretreated fabric, (b) Treated fabric before wash, (c) Treated fabric after normal wash, (d) Treated fabric after detergent wash, (e) Bark treated fabric after wash, (f) Treated fabric leaves and barks after wash

2.2.8 Mosquito biting testing:

The test was done in a described case covered with nets. About 10-15 female mosquitoes were collected and placed into a cage measuring 30 cm X 30cm X 30cm (see Fig. 5) each time. Mosquitos were not given any food or solution for 6 hours. The cage was placed in a closed room at 24 to 32^0C temperature and 65-70 % RH. And then volunteers (men) were engaged to find out the biting pressure and the counting of the numbers. As mentioned above sample gallery the repellent fabric wore out of hand and the hand was inserted into the cage through the hole. The repellent fabric was labelled sequentially from 1 to 5 and each repellent was tested four times on each fabric sample. Fabric worn arm subjected to bite from mosquitos in test cage 15 minutes after and 5 minutes gap. If they were not bitten within 5 minutes, then the arm was reinserted for 1 full minute. The was carried out three days in a row during the

dusk time. Mosquito samples were changed every day. A total of 50 mosquito samples were used in three days. The observation times average 6 to 7 hours a day.

Fig. 5 Case covered with mosquito net

3. Results and discussion

Table 2 Mosquito repellence test of knitted cotton fabric.

Short Abbreviations	**Test specifications**	**Tests Results (Mosquito Repellence Testing)**
A	Cotton fabric with Eucalyptus leaves extract (before washing).	80% working
B	Cotton fabric using Eucalyptus leaves extract (After washing with normal water)	60% working
C	Cotton fabric using Eucalyptus leaves extract (after washing with detergent mixed water)	50% working
D	Cotton fabric using a mixture of Eucalyptus leaves and barks extract)	60% working
E	Cotton fabric using Eucalyptus barks extract.	Negative (No repellence).

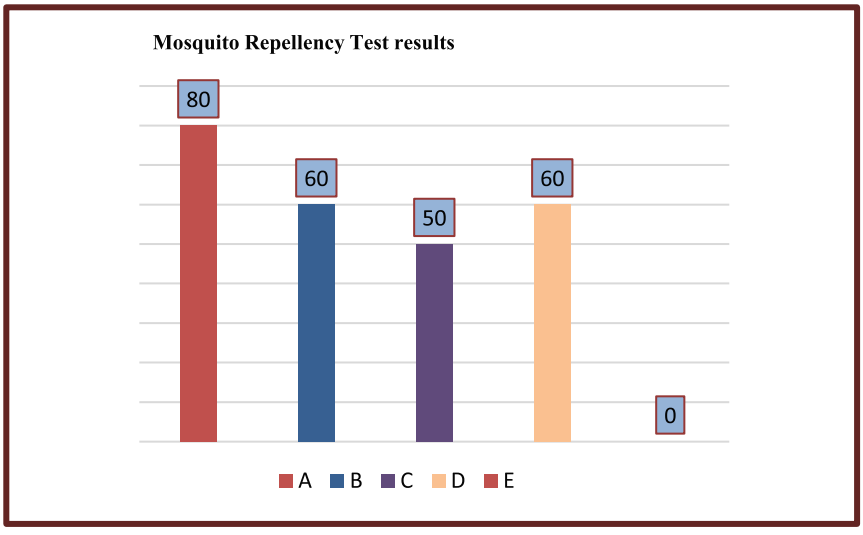


Fig. 1 mosquito repellency percentage

The above diagram has shown the 80% percentage results of mosquito repellent fabric in which treated Cotton fabric was treated with Eucalyptus leaves extract but not washed. The rest of the washed samples were shown at 50-60%. The household detergent reduced the repellence by about 10 % after the 1st wash. Further, a blend with bark and leaves extract was applied to the fabric at around 60% as shown on the right green column. The bark-extracted application samples did not represent any repellence.

Table 3 Mosquito biting results in three days

Specimen	Times durations (Min)	Day 1 Number of bites	Day 2 Number of bites	Day 3 Number of bites
A	**15**	**2**	**No bites**	**No bites**
	15	**1**	**1**	**No bites**
	15	**1**	**1**	**No bites**
	15	**No bites**	**No bites**	**No bites**
B	**15**	**2**	**No bites**	**2**
	15	**1**	**No bites**	**1**
	15	**2**	**No bites**	**1**
	15	**2**	**No bites**	**2**
C	**15**	**No bites**	**2**	**No bites**
	15	**No bites**	**1**	**No bites**
	15	**No bites**	**1**	**No bites**
	15	**2**	**No bites**	**No bites**
D	**15**	**2**	**1**	**No bites**
	15	**1**	**1**	**No bites**
	15	**1**	**1**	**No bites**
	15	**1**	**1**	**No bites**
E	**15**	**4**	**2**	**3**
	15	**2**	**2**	**4**
	15	**4**	**No bites**	**5**
	15	**4**	**No bites**	**3**

The eucalyptus leaves and bark were used as a mosquito repellent. **Table -3** showed the observation of the biting nature of mosquitos. Mosquito biting depends on how hungry they were and the time of day when the experiment was done. The intensity of light or artificial lights may direct the mosquito biting natures such as Ae. Aegypti.(Rund et al., 2020) , , diurnal of a year. The cool season, hot season, and rainy season could also be varied (Yasuno & Tonn, n.d.) . Some mosquitoes do not bite in the daytime rather than choose little dark places like Ades. The frequent biting depends on the availability of mosquitos in a place. The biting test was done in October, in tropical weather. This cage test was done in a low-density environment for counting the mosquito bites easily. Form the table-3 demonstrated the number of bites on day-1, day-2, and day-3. Sample -A has lower numbers than that E because of the high repellence %. But in specimens B, C, and D the biting number is average. Some of them showed no bites some on the third day. Eucalyptus could have a bad odour in the fabric (Radhika, 2019) because the residue of leaves particles on the fabric surface drives away the mosquitos. After all, it can be concluded that specimens A and B have the repellence of mosquito other samples. As there were no mordant chemicals in the bath, the repellence of Sample fabrics B and C exhibited lower repellence % by subsequent normal wash and the detergent wash. Consequently, sample fabric B and C has average actions of mosquito bites.

4. Conclusion

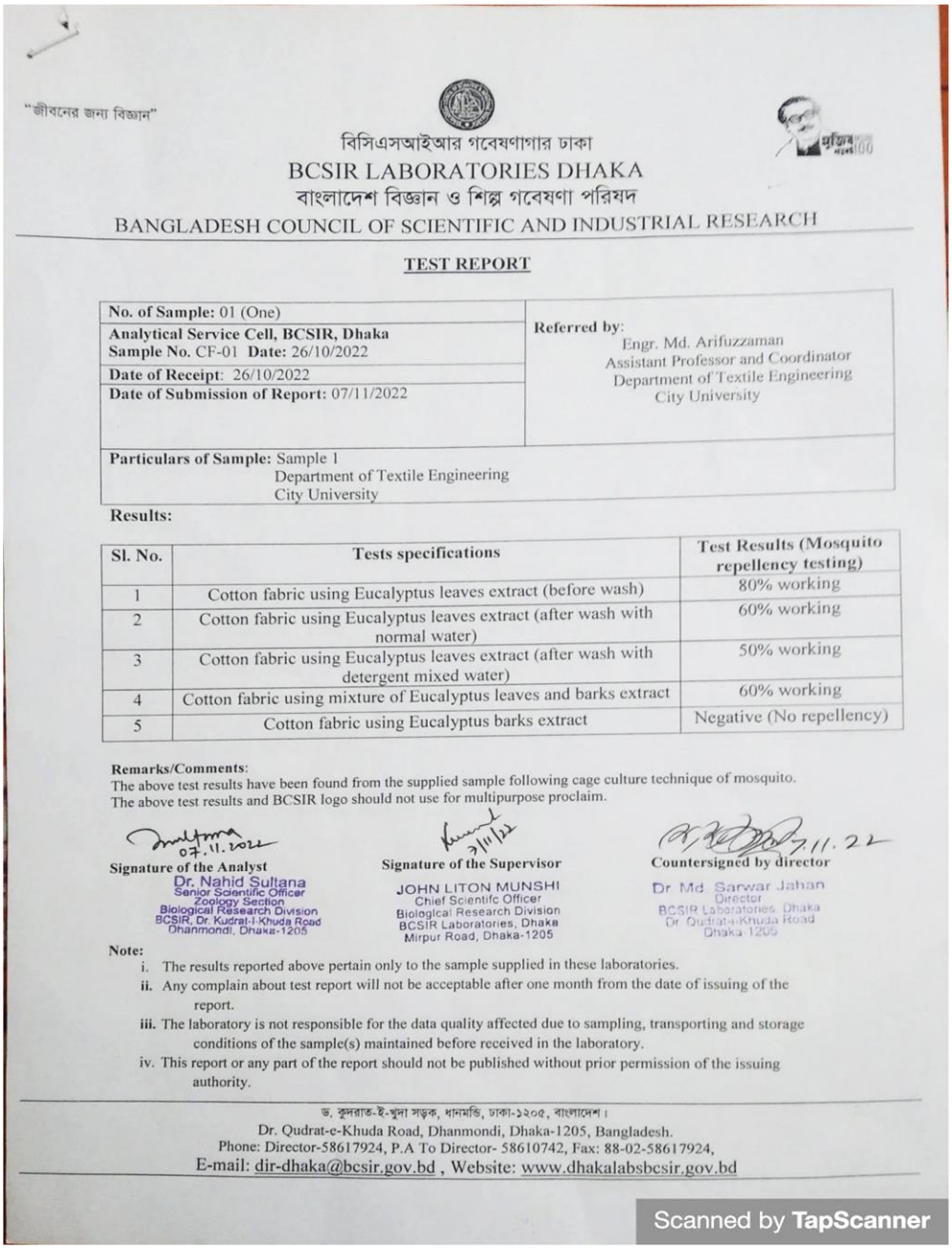
In summary, the impacts of eucalyptus leaves have the potential to repellence of mosquito bites more than the bark extract. Tabulated results have been drawn and evaluated that the fabric has 80 % repellence and might be used as an alternative mosquito repellent. Other specimens have given mixed results. After normal wash and detergent wash reduces the percentages of mosquito repellence also. The Eucalyptus bark reduced mosquito repellence percentage because it has no repellence chemicals. In terms of making future textiles some research needs to be conducted about the time, the number of samples, odour, mildew formation, and physiological performance of the repellent-treated fabric.

Acknowledgment:

First, we would like to thank my almighty for keeping us patient and in good health in our research work. We would like to acknowledge and give our warmest thanks to the Bangladesh Council of Scientific & Industrial Research (BCSIR) who made this test. Their guidance and advice carried out all the stages of the reports. They provided the mosquito samples otherwise the test could be undone. All three authors have equal contributions in this paper.

A. Appendix:

Test report from BCSIR (Bangladesh Council of Scientific and Industrial Research. Cage culture technique is used for mosquito treated samples.



"জীবনের জন্য বিজ্ঞান"

বিসিএসআইআর গবেষণাগার ঢাকা

BCSIR LABORATORIES DHAKA

বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

TEST REPORT

No. of Sample: 01 (One)
Analytical Service Cell, BCSIR, Dhaka
Sample No. CF-01 **Date:** 26/10/2022
Date of Receipt: 26/10/2022
Date of Submission of Report: 07/11/2022

Referred by:
Engr. Md. Arifuzzaman
Assistant Professor and Coordinator
Department of Textile Engineering
City University

Particulars of Sample: Sample 1
Department of Textile Engineering
City University

Results:

Sl. No.	Tests specifications	Test Results (Mosquito repellency testing)
1	Cotton fabric using Eucalyptus leaves extract (before wash)	80% working
2	Cotton fabric using Eucalyptus leaves extract (after wash with normal water)	60% working
3	Cotton fabric using Eucalyptus leaves extract (after wash with detergent mixed water)	50% working
4	Cotton fabric using mixture of Eucalyptus leaves and barks extract	60% working
5	Cotton fabric using Eucalyptus barks extract	Negative (No repellency)

Remarks/Comments:
The above test results have been found from the supplied sample following cage culture technique of mosquito.
The above test results and BCSIR logo should not use for multipurpose proclaim.

07.11.2022
Signature of the Analyst
Dr. Nahid Sultana
Senior Scientific Officer
Zoology Section
Biological Research Division
BCSIR, Dr. Kudrat-I-Khuda Road
Dhanmondi, Dhaka-1205

7/11/22
Signature of the Supervisor
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7.11.22
Countersigned by director
Dr. Md. Sarwar Jahan
Director
BCSIR Laboratories, Dhaka
Dr. Qudrat-i-Khuda Road
Dhaka-1205

Note:
i. The results reported above pertain only to the sample supplied in these laboratories.
ii. Any complain about test report will not be acceptable after one month from the date of issuing of the report.
iii. The laboratory is not responsible for the data quality affected due to sampling, transporting and storage conditions of the sample(s) maintained before received in the laboratory.
iv. This report or any part of the report should not be published without prior permission of the issuing authority.

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