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## RESEARCH ARTICLE

### IMPACT OF MOSQUITO REPELLENT FINISHING ON COTTON/POLYESTER BLENDED FABRIC USING EXTRACT OF SENNA AURICULATA FLOWERS

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#### ABSTRACT

Malaria is a destructive disease distressing human being caused mostly by mosquitoes. In general this disease can be avoided by preventing mosquito bites by mosquito net and chemical repellents. Chemical repellents which are applied in cloth are allergic to human and create irritations on skin and breathing troubles. In order to avoid problems of chemical repellents a research attempt has been made to treat cotton bed spreads with the extract of naturally available Senna Auriculata flowers which has mosquito repellency which helps in protecting human from mosquito bites and it is environmental friendly too. The effects of the extract of naturally available Senna Auriculata flowers on Cotton/Polyester blended bedspread for the repellency towards the mosquitoes were evaluated by Cage Test. The result show that the natural extract from Senna Auriculata flowers gives excellent mosquito repellency on cotton/polyester blended bedspreads.

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#### INTRODUCTION

Cotton fibre is natural short staple fibre consisting of cellulose molecules used to produce bedspreads. Mosquito-borne diseases or mosquito-borne illnesses are diseases caused by bacteria, viruses or parasites transmitted by mosquitoes. They can transmit disease without being affected themselves. Insect-borne diseases are a worldwide health problem, especially in tropical and subtropical climates. Mosquitoes transmit many diseases, including yellow fever, dengue hemorrhagic fever, malaria, several forms of encephalitis, and filariasis (Jong Kwang Yoon, 2015). There are chemical mosquito repellents existing to kill and mosquito and to protect human body from mosquito bites but the chemical mosquito repellents are causing unpleasant effects on human and environment by bad aroma, rashes on skin, eye burning, inhaling, headaches, coughs, sore throats, nausea, dizziness, asthma and respiratory irritation. Medicinal plants are the gift of nature to cure limitless number of diseases among human beings (Marta Ferreira Maia, 2011). The abundance of plants on the earth surface has led to an increasing interest in the investigation of different extracts obtained from the traditional medicinal plants as potential sources of new Mosquito Repellent agents (Marwa M. M. Khodary). Most plants contain compounds that they use in preventing attack from phytophagous insects.

These chemicals fall in to numerous categories, together with repellents, feeding deterrents, toxins, and growth regulators (Apoorva Gupta, 2017 and Banupriya, 2013). Natural smelling repellents are preferred because plants are perceived as a safe and trusted means of mosquito bite prevention<sup>1</sup>. To conquer the harms of chemical mosquito repellent agents, the natural extract of Senna auriculata was the alternative as it is copiously available in nature with medicinal values and it is not harmful to human and environment. In this research, subjective assessment of mosquito repellent finish applied Cotton/Polyester Blended Bedspread fabrics are analyzed. The results of the mosquito repellency by natural extract of Senna auriculata are based on the cage test for evaluating the effectiveness of finish.

#### Mosquito repellent

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) (Patel EK and Rizzardo, 2012). 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

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natural repellants. Peoples initially applied mosquito repellents on their skin directly as lotion and were effective only for few hours, besides most of them can be harmful, since they are coming in direct contact with body (Granch Berhe Tseghai, 2016).

**Mechanism of mosquito repellent:** Mosquitoes usually use the warm and humid convection rising from the human body as a mode for contacting humans by sensing an increase in atmospheric carbon-dioxide concentrations. In Olfactory mode which is also called as transpiration repellency, humidity-sensing holes of mosquitoes which helps the mosquitoes in locating the living organisms are blocked hence they cannot locate humans. While the tactile mode is based on the action of repellent substances on the mosquito's nervous system which causes them to enter in a confused state and resist their behaviour at sub-lethal/mortal/toxic doses, before knockdown due to their contact with fabric surface. The tactile mode action is also called as direct-contact repellency which drives the insects away from the surface before they can suck blood (Lalit Jajpura, 2015).

**Mosquito repellency from natural sources:** Extracts from roots, stem, leaves, flowers, fruits and seeds of diverse species of plants have been assessed for mosquito repellent properties. Several natural products like rosemary oil, clove oil, eucalyptus oil etc have been identified for giving mosquito repellence. Essential oils are complex mixtures of volatile organic compounds present in the plants. Monoterpenes, sesquiterpenes, and phenols are the main groups of compounds produced as secondary metabolites in the plant system (Raja, 2015 and Isman, 1999).

**Senna auriculata as mosquito repellent:** Senna auriculata is a legume tree in the subfamily Caesalpinioideae. It is commonly known by its local names matura tea tree, ranawara or avaram. The powdered seed of senna auriculata is also applied to the eye, in case of chronic purulent conjunctivitis (Dr. Vustelamuri Padmavathi). This plant is said to contain a cardiac glucoside (sennapicrin) and sap, leaves and bark yield anthraquinones, while the latter contains tannins (Saritha.P). The plant has been shown to have antibacterial activity in the laboratory. Senna auriculata has property of Enhanced Acaricidal Activity and it can be used as antimicrobial finishing and for mosquito repellency.

## MATERIALS AND METHODS

**Selection of Fabric:** The cotton/polyester blended fabric was selected and checked for the constituencies were checked by microscopic test, burring test and solubility test. The specification of the selected fabric is tabulated as follows

**Table 1. Fabric Particulars**

| Particulars     | Specification          |
|-----------------|------------------------|
| Fabric          | Polyester/Cotton Blend |
| Ends/Inch       | 72                     |
| Picks/Inch      | 72                     |
| Warp Yarn Count | 60 Ne                  |
| Weft Yarn Count | 60 Ne                  |
| Fabric Weight   | 160 GSM                |

**Preparation of Fabric:** The selected fabric was desized, scoured for removing the starch, oils, waxes, and mineral matters in order to improve the moisture absorbency. The

process parameters for desizing and scouring process are tabulated as follows. Then the fabric is bleached with hydrogen peroxide for removing stains in polyester yarn and to remove natural colouring matters from cotton yarn.

**Table 2. Process Parameters for Desizing and Scouring**

| Process Parameters for desizing and Scouring |              |                  |   |
|--|--------------|------------------|---|
| Desizing Process                             |              | Scouring Process |   |
| Hydrochloric Acid                            | 1% by weight | by               | Sodim Hydroxide 3% by weight                |
| Wetting Agent (Turkey Red Oil)               | 1% by weight | by               | Sodium Carbonate 1% by weight               |
| M: L   | 1:20         |                  | Sodium Silicate 1% by weight                |
| Temperature                                  | 45°C         |                  | Wetting Agent (Turkey Red Oil) 1% by weight |
|  |              | M: L             | 1:20  |
|  |              | Temperature      | Boiling                                     |

**Table 3. Process Parameters for Bleaching**

| Process Parameters for Bleaching |                |
|----------------------------------|----------------|
| Hydrogen Peroxide                | 1% by weight   |
| Sodium Hydroxide                 | 1% by weight   |
| Sodium Carbonate                 | 1% by weight   |
| Sodium Silicate                  | 1% by weight   |
| Wetting Agent (Turkey Red Oil)   | 1.5% by weight |
| M: L                             | 1:20           |
| Temperature                      | 95°C           |

### Preparation Senna auriculata flower extract

**Collection of flowers:** Matured plants Senna auriculata is harvested and flower was collected from the field and dried in shadow until the moisture is removed from the flowers use air drying method. Then the flower was crushed to make it in powder form.

**Extraction:** The powdered flowers were subjected to cold extraction method using methanol and acetone. Then the material was taken out from the extractor and it was mixed well. Then it was filtered using filter paper.

**Pretreatment of fabric:** The cotton polyester blended fabric free from impurities was selected and subjected for pretreatment with 1% soap oil at 65°C temperature for 45 minutes. Then pre treated fabric is rinsed in cold and hot water and it was oven dried.

**Preparation of Senna auriculata flower Extract for treatment:** Senna auriculata flower Extract was pasted with small amount of cold water and made as a paste and the required amount of hot water was added to make 1% Solution.

**Application of Senna auriculata flower Extract:** The bath is setup with required amount of water and Senna auriculata flower Extract solution at room temperature. The well prepared cotton polyester blended fabric material is introduced into the bath, then the temperature is raised to 80°C in 30 minutes and the process was continued for 30 minutes. For the entire duration of process the material and liquor ratio and concentration were maintained constantly. Then fabric was taken out and washed with cold and hot water. Then the material was dried using hot air oven.

**Testing and Analysis:** The laboratory test samples were cut according to the specification from relative portion of all the treated samples for the laboratory tests. The fabric was examined for subjected for cage test to determine the repellency from mosquitoes for the treated samples.

**Table 4. Process Parameters of Treatment**

| Particulars                     | Sample 1         | Sample 2          | Sample 3          |
|---------------------------------|------------------|-------------------|-------------------|
| Senna auriculata flower Extract | 5% of 1% Extract | 10% of 1% Extract | 15% of 1% Extract |
| Temperature                     | 80°C             | 80°C              | 80°C              |
| Time Duration                   | 1 Hour           | 1 Hour            | 1 Hour            |
| pH                              | 7.5              | 7.5               | 7.5               |
| Material : Liquor Ratio         | 1:10             | 1:10              | 1:10              |

**Table 5. Mosquito Repellency before and after washing the fabrics**

| Mosquito Repellency | Mosquito Repellency |                  |                  |                  |
|---------------------|---------------------|------------------|------------------|------------------|
|                     | Untreated Sample    | Treated Sample 1 | Treated Sample 2 | Treated Sample 3 |
| Before washing      | 20%                 | 74%              | 78%              | 88%              |
| After 5 washes      | -                   | 68%              | 72%              | 81%              |
| After 10 washes     | -                   | 55%              | 64%              | 69%              |
| After 15 washes     | -                   | 49%              | 58%              | 62%              |
| After 20 washes     | -                   | 40%              | 49%              | 50%              |

**Table 6. Tensile Strength Test Results**

| Samples  | Tensile Strength in Kgs |                |                  |                |
|----------|-------------------------|----------------|------------------|----------------|
|          | Treated Sample          |                | Untreated Sample |                |
|          | Warp Direction          | Weft Direction | Warp Direction   | Weft Direction |
| Sample 1 | 36.8                    | 34.6           | 37.5             | 35.2           |
| Sample 2 | 38.8                    | 34.5           |                  |                |
| Sample 3 | 38.6                    | 33.9           |                  |                |

**Table 7. Stiffness (Bending Length Test) Results**

| Samples  | Bending Length in cm |                |                |                |
|----------|----------------------|----------------|----------------|----------------|
|          | Treated              |                | Untreated      |                |
|          | Warp Direction       | Weft Direction | Warp Direction | Weft Direction |
| Sample 1 | 3.3                  | 2.9            | 3.3            | 2.9            |
| Sample 2 | 3.3                  | 2.9            |                |                |
| Sample 3 | 3.3                  | 2.9            |                |                |

**Table 8. Shrinkage Test Results**

| Samples  | Shrinkage %    |                |                |                |
|----------|----------------|----------------|----------------|----------------|
|          | Treated        |                | Untreated      |                |
|          | Warp Direction | Weft Direction | Warp Direction | Weft Direction |
| Sample 1 | 5.1            | 3              | 4.8            | 3              |
| Sample 2 | 5.0            | 3              |                |                |
| Sample 3 | 5.1            | 3              |                |                |

Then the same tests were conducted by 10 washes using 1% of non ionic soap to check the durability of Senna auriculata flower Extract finish on the fabric. The physical behaviors of treated samples such as tensile strength, fabric shrinkage, stiffness also were tested to check the effect of treatment on the physical properties of fabrics.

**Cage Test:** The cage is prepared with nylon mesh and metal frames of 60cm X 40cm X 40cm dimension with mild intensity light provision. Then the treated samples with Senna auriculata flower extract, untreated samples of polyester/cotton blended samples and 50 mosquitoes were kept inside the cage and the movement of mosquitoes towards the fabric and away the fabric was observed for a one hour. Wash Durability testing (AATCC 124-1996) washing method was followed for conducting the test. The samples were washed with 5% neutral non ionic soap oil for 30 minutes and oven dried. The washed samples were tested for the retention of mosquito repellency for 5, 10, 15 and 20 washes using standard procedures. The mosquito repellency was determined based on AATCC 100 test method.

**Mosquito Repellency before and washing:** Mosquito Repellency Behavior of untreated fabrics and treated fabric are examined under cage before and after the fabrics were subjected to washing.

**Analysis of test results of Mosquito Repellency Behavior before and washing the fabrics:** The results shows that the mosquito repellency of treated fabrics was increasing by treating the fabrics using Senna auriculata flower extract considerably. The repellency was increased by increasing the concentration of Senna auriculata flower Extract. But result shows that the mosquito repellency of fabric is reduced gradually by several times of washes.

**Tensile Strength Test:** Tensile strength of all the treated samples was tested using tensile strength tester using ASTM D5034-95 standards. The results for warp way and weft direction for all the treated and untreated samples are as mentioned in the table.

**Analysis of test results of Tensile Strength Test:** The results show that there are no much significance changes in tensile strength of fabric between treated and untreated fabric samples.

**Stiffness (Bending Length Test):** Stiffness Test (Bending Length) of all the treated samples was tested using stiffness tester based on ASTM D1388 - 08 Standards. The bending lengths of fabric in warp and weft direction for all treated and untreated samples are as mentioned in the table.

**Analysis of test results of Stiffness (Bending Length) Test:** The results show that there are no significance changes in Stiffness (Bending Length) of fabric between treated and untreated fabric samples.

**Shrinkage Test:** Shrinkage Test of all the treated samples was tested using shrinkage tester based on ASTM D7983 – 17 standards. The shrinkage of fabric in warp and weft direction for all treated and untreated samples are as mentioned in the table.

**Analysis of test results of Shrinkage Test:** The results show that there are no significance changes in Shrinkage of fabric between treated and untreated fabric samples.

### Conclusion

Based on the investigation of treating of cotton/polyester blended fabric with Senna auriculata flower extract it may be concluded that mosquito repellency of fabric is increased in high level. So the wearer can be protected from the mosquito bite and can be protected from the disease malaria. As the yield of Senna auriculata cultivation is high naturally and natural resources can be utilized for mosquito repellency finishing on textile materials.

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