

Original Article

DEVELOPMENT OF ECO FRIENDLY MOSQUITO REPELLENT FABRIC FINISHED WITH
ANDROGRAPHIS PANICULATA PLANT EXTRACTS

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ABSTRACT

Mosquito repellent textiles are one of the revolutionary ways to promote the textile field by providing the much-demanded features of driving away mosquitoes, particularly in the tropical regions. It protects the human beings from the sting of mosquitoes and thereby promising safety from the mosquito-carried diseases. This work is a small effort in developing an Eco friendly mosquito repellent finished fabric using the herbal extract of the *Andrographis paniculata* plant. The selections are finished onto the fabric by direct application and microencapsulation method and evaluated using a Mosquito Repellency Behavioural test. As the textile fabrics are subjected to washing, the wash durability of the finished fabrics was evaluated at three intervals - 10, 20 and 30 washes. After finishing, the finished fabrics showed 96% of repellent activity for direct application method and 94% activity for microencapsulation method. The microencapsulation method showed good mosquito repellent activity upto 30 washes whereas the direct application method showed was only up to 10 washes. This study helps in the development of a mosquito repellent fabric which protects the human beings from the mosquito bites and thereby promising safety from the mosquito borne diseases.

Keywords: Mosquito repellent, Herbal finish, *Andrographis paniculata*, Microencapsulation, wash durability.

INTRODUCTION

Mosquitoes are most medically significant vector and they transmit parasites and pathogens, which continue to have an overwhelming impact on the human beings. Also, they, are the main cause of spreading the deadly diseases like malaria, dengue, filariasis and chikungunya [1, 2]. Among the increasing number of arthropod-borne diseases, only a few are preventable by vaccines. There is no effective vaccine against malaria. Dengue, the only way to avoid it remains avoiding mosquito bites [3].

The use of the repellents such as lotions coils and liquidators are limited in their due to various reasons. This has necessitated the development of mosquito repellent fabrics. A textile fabric with the mosquito repellent is one of the revolutionary ways and the much needed feature of driving away the mosquitoes. It protects the humans from the bite of mosquitoes and thereby promising safety from the mosquito borne diseases [4]. The use of medicinal plants as a source of relief from illness can be traced back to over five million years in the early civilization of china, India and North East, which is as old as mankind. It has been estimated that in developed countries such as US, plant based drugs contribute about 25% of the total drugs, while in fast developing countries such as India and China, the contribution is about 80%. Thus the economic importance of medicinal plants is much more to developing countries than the rest of the world [5].

Plant products have been used traditionally by human communities in many parts of the world against the vectors and species of insects. The phytochemicals derived from plant sources can act as larvicides, insect growth regulators, repellents and have deterrent activities [6]. The present investigation focuses on developing an Eco friendly natural mosquito repellent fabric treated using the plant extracts of *Andrographis paniculata*. *Andrographis paniculata* is an herb that is available in plenty and it is an erect herb with quadrangular (young) stem, with leaves and white flowers. Andrographolide is one of the active constituents isolated from the plant. It is a bitter tonic and febrifuge. A decoction of the plant is a blood-purifier. It is used as a cure for torpid liver, and jaundice. It also has high repellent activity against mosquitoes, insects and snakes. The study also deals with the effect on treated fabrics against mosquitoes and to enhance the laundering durability of the finished fabrics.

MATERIALS AND METHODS

Preparation of Fabric

100% Cotton rib fabric was knitted, scoured, bleached and dyed. The dyed fabric was Biopolished using cellulase enzymes from *Trichoderma reesei*. Biopolishing of cotton fabrics, using cellulases is aimed to remove cellulosic impurities, individual and loose fiber ends that protrude from fabric surfaces to provide an enhanced appearance and handle of the fabric [7]. It also helps in the enhancement of the finishing process.

Preparation of Plant Extracts

Andrographis paniculata plant is collected from the Coimbatore district. The whole plant is used as such for extraction as all the components of the plant acts as an insect powder. The collected plants were washed with tap water followed by distilled water and shade dried. The dried leaves were ground into a fine powder. For extraction, each 3 grams of dry powder was taken and mixed into 50ml of 80% Methanol. The container was closed and kept overnight. After overnight incubation, the extract was filtered through filter paper and evaporated at room temperature to concentrate the extract. This methanol extract is used for the application on fabrics.

Preparation of Microcapsules

Microencapsulation is a rapidly expanding technology and finds greater applicability in textiles in recent years. Uniqueness of microencapsulation is the smallest of coated particles and it provides a means of packaging, separating and storing materials on a microscopic scale for later release under controlled conditions [8,9]. Micro capsules containing herbal extracts were prepared employing 3% of Sodium alginate. An equal proportion of sodium alginate and extracts were prepared separately and were sprayed into calcium chloride solution by means of a sprayer. The formed droplets were retained in calcium chloride for 15 minutes to harden the capsules. The microcapsules were obtained by decantation and repeated washing with isopropyl alcohol followed by drying at 45°C for 12hrs. The microcapsules were then used for finishing on the Bamboo/Cotton fabrics by the exhaustion method using 8% citric acid as a binder.

Finishing of the fabrics using extracts

Direct Application Method: The prepared methanol extract was directly applied on the Bamboo/Cotton fabric using pad-dry-cure method. The fabric was immersed for 30 minutes in the extract. After 30 minutes, the fabric was removed, squeezed and dried at 80-85 °C in the oven for 5 minutes and cured at 150 °C for 2 minutes.

Microencapsulation Method

The fabric was finished using exhaustion method. The fabric was kept immersed in the microcapsules solution for 30 minutes at 50°C. After finishing, the fabric was removed, squeezed and dried at 80°C for 5 minutes and cured at 120°C for 2 minutes.

Assessment of Mosquito Repellent Property

The mosquito repellent of the *A. paniculata* extracts treated fabrics was tested using a Mosquito Repellency Behavioural test.

Collection of Mosquitoes

Anopheles mosquitoes were identified and collected based on morphological keys during evening hours. Mosquitoes were deprived of all the nutrition and water for a minimum of 4 hours before exposure.

Mosquito Repellency Behavioural test

Specially designed two extra repellency test chambers were employed to measure the efficiency of repellent activity. The wooden outer chamber of excito-repellency testing device measures 34 cm × 32 cm × 32 cm and faces the front panel with the single escape portal. The box is composed of a rear door cover, an inner plexiglass, glass panel with a rubber latex-sealed door, a Plexiglas holding frame, a screened inner chamber, an outer chamber, a front door, and an exit portal slot (Fig 1).

Laboratory tests were performed only during daylight hours and each test was replicated four times. Observations were conducted at one-minute interval of 30 minutes. Later on each trial was filled out, the number of Escaped specimens and those staying in the chamber were recorded individually for each exposure chamber, external holding cage, and paired control chamber. Escaped specimens and those staying in the chamber, for the treated samples, were controlled separately in small holding containers with food and water.

Efficiency of the Mosquito Repellency %

$$= \frac{\text{No of Specimen Escaped} + \text{No of Specimen Dead}}{\text{No of Specimen Exposed}} * 100$$



Fig 1: Excito chamber used for mosquito repellency testing

Wash Durability Analysis

The finished samples are subjected to washing using standard detergent (3%owf) at 40°C in an automatic washing machine up to 30 wash cycles. The washed samples are also evaluated by mosquito repellent behavioural test at the interval of 10, 20 and 30 wash cycles.

RESULTS & DISCUSSION

Assessment of mosquito repellent property

The mosquito repellent property of the *A. paniculata* plant extract treated fabrics was shown in Table 1. The samples treated by the direct application method showed about 96% efficiency, whereas the microencapsulated sample showed 94% efficiency. Andrographolide, the bioactive compound has been reported to have a wide range of biological activities, acts as the mosquito repellent.

Table1: Assessment of mosquito repellent efficiency

Samples	Mosquito Repellency (%)	
	Direct Application method	Microencapsulation method
Untreated Sample	40 +1.58*	40 +1.58*
<i>A. paniculata</i> extract treated sample	96 +1.22*	94 +0.70*

* Values are means + S.D, n = 5, Significant at, p<1.005 (t - test)

Table2: Assessment of Wash durability of the treated samples

No of Wash Cycles	Efficiency of the Mosquito repellency (%)	
	Direct Application	Microencapsulation
10	72 + 0.71*	72 +1.22*
20	48 +1.22*	64 + 1.58*
30	40 +1.58*	52 +1.41*

* Values are means + S.D, n = 5, Significant at, p<1.005 (t - test)

Assessment of Wash durability

The wash durability of the washed samples is shown in Table 2. The samples treated by the direct application method showed good resilience activity until 10 washes as the extracts are only coated on the surface of the fabrics without any bonding on to the fabrics, which are removed during repeated washings.

While the microencapsulated samples showed good resilience activity until 30 washes due to the sustained release of the encapsulated extracts. This shows that the microencapsulated

fabrics have a high retention of the repellent activity when compared with the directly applied samples.

CONCLUSION

Andrographis paniculata plant extracts treated fabrics has found to have good mosquito repellent property, by both direct application method and microencapsulation method. The wash durability of the encapsulated samples showed better efficiency than by directly applied samples and the microencapsulated samples which have a high retention of the

repellent activity. Vector borne diseases are one of the major problems in developing countries. To avoid such sort of disease transmission to humans can be avoided using mosquito repellent fabrics. This form of natural extraction of the mosquito repellent finishes is very safe and ecofriendly and protect the body from mosquitoes. The sample treated with *Andrographis paniculata* extract is effective, economical and ecofriendly.

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