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Microencapsulated with Acalypha indica Essence with mosquito repellent finishing on Knits

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ABSTRACT:

Objective: This study was conducted to design the textile structured dress of knitted materials with mosquito repellent behavior using microencapsulated Acalypha indica extract on a fabric.

Methods: Acalypha indica essence is extracted from plant which is having high potential medical properties and it is one of the perennial grasses, can be used to produce the very low cost and affordable medical products. The extract is taken by hydro distillation process, which was used as core and gum acacia was used as wall material. 20% W/V gum acacia was allowed to swell with hot water and stirred well with temperature of 70 ºC. Further to this mixture 20 ml of Acalypha indica was mixed and stirred around 600rpm for 30 min. Subsequent with this process 30% V/V sodium sulphate was added then the stirrer speed was reduced 80 rpm and then 5ml of 17% formaldehyde was added along with this mixture. Finally the microcapsules were obtained. Then this Acalypha indica extract capsule mixture was coated on the Knitted and woven fabrics through Pad- dry-cure method and these materials can be used as Bed Spreads and Bed Sheets.

Results: Mosquito repellent study was carried out through Excito Chamber method and assessed in the terms of Mosquito repellence percentage. The maximum mosquito repellency percentage was obtained around 90% wash durability, abrasion resistance.

Conclusion: It was proved that Acalypha indica capsule which is microencapsulated into textiles of the Knitted wear provide good resistance against mosquito bites and also concluded that this process is one of ecofriendly process. This coated fabrics a can be used as dresses, Bed Spreads and Bed Sheets.

Key word: Mosquito repellent in textile, Acalypha indica, Cotton, Knitted Fabrics, Bed Spreads and Bed Sheets, microencapsulation Technique, Pad- dry-cure method.

1. Introduction:

Mosquitoes are the important vectors of diseases through transmitting pathogens. They are one of the primary causes for spreading diseases to the human being [1]. The genus Andes mosquitoes are the main causes for urban yellow fever in worldwide. Around 120 million people in the world have been infected due to mosquito bites and 4 million people are DENGUE. Another study, of the prevalence of dengue, estimates that 3.9 billion people, in 128 countries, are at risk of infection with dengue viruses Dengue fever is a mosquito-borne tropical disease caused by the dengue virus.[26] Symptoms typically begin three to fourteen days after infection.[27] This may include a high fever, headache, vomiting, muscle and joint pains, and a characteristic skin rash. Recovery generally takes two to seven days.[28] In a small proportion of cases, the disease develops into the life-threatening dengue hemorrhagic fever, resulting in bleeding, low levels of blood platelets and blood plasma leakage, or into dengue shock syndrome, where dangerously low blood pressure occurs.

Acalypha indica (English: Indian Acalypha, Indian Mercury, Indian Copperleaf, Indian Nettle, Three-seeded Mercury) is an herbaceous annual that has catkin-like inflorescences with cup-shaped involucres surrounding the minute flowers. It is mainly known for its root being attractive to domestic cats, and for its various medicinal uses. It occurs throughout the Tropics.

2. Materials& Methods

2.1 Materials

Acalypha indica extract was used a coating agent for mosquito repellant and purchased from M/S Naga natural products, Tirupur, Tamil Nadu. Plan knitted single jersey cotton fabric of 240 GSM was scoured and bleached well with alkali and peroxide respectively. Gelatin and gum Arabic was used as shell formation compound, which was sourced from GVR enterprises, Madurai 100% low twisted cotton yarn is knitted through plain and rib knitted structures [12]. Both the fabrics were scoured and bleached

with sodium hydroxide and hydrogen peroxide respectively subsequently dyeing was carried out using hot brand reactive dye.

2.2 Preparation of microcapsules:

Mosquito repellent treatment was approached through microencapsulation technic over cotton knitted fabric. Acalypha indica extracted from Cymbopogoncitratus by hydro distillation process [13].It was used as core material gum acacia was used as wall material. 10% W/V gum acacia was allowed to swell with hot water. To this mixture, 50 ml of hot water was added and stirred well with temperature of 70 ºC. Further to this mixture 20 ml of vetiver root extract was mixed and stirrer speed was maintained around 600rpm for 30 min. Followed by this process 20% V/V sodium sulphate was added then the stirrer speed was reduced 80 rpm and then 5ml of 17% formaldehyde was added along with this mixture. The microcapsules were obtained by decantation and washed with isopropyl alcohol followed by drying at the temperature of 45ºC for 12hrs.

2.3 Coating process over knitted fabric:

The Acalypha indica capsule mixture was coated on the fabric through pad dry cure method.As reported by Golji the finishing of this agent through binder compound such as polyurethane ,acrylic to fix the micro capsule over the surface of the fabric ,which enable the last longing effect[13]. A finishing bath was prepared with prepared microsules, 15 % V/V of acrylic crosslinking agent and remaining quantity of softener (Perisoft Nano, Bayer).The cotton knitted and woven fabric was immersed in this solution pneumatic padding mangle, squeezed and then dried at 80-85ºC in an oven.

3. Characterization

3.1 Mosquito repellency testing:

The mosquito repellent activity was tested through Excito Chamber method (Roberts, D, et al ,1997).with Anopheles variety of mosquito's Specially designed two-excitorepellency test chambers were used to evaluate the efficiency of repellency 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 mosquito escape zone consists of an outward projecting funnel with the dimension of 14 cm long in its top and bottom exit funnel, leaving 1.5 cm wide (a horizontal slit) through which mosquitos can escape from the chamber. The back size of the metal door is hinged metal door, which tightly closed. The back side consists of mosquito exposure zone having is a hinged metal door, which is also contains an inner removable panel. This panel fits inside the back of the exposure chamber, in addition to this 4 small flanges were available along with this chamber to serve the imprison the mosquitos. The plexiglass helps to observe the mosquito's population inside the chamber.

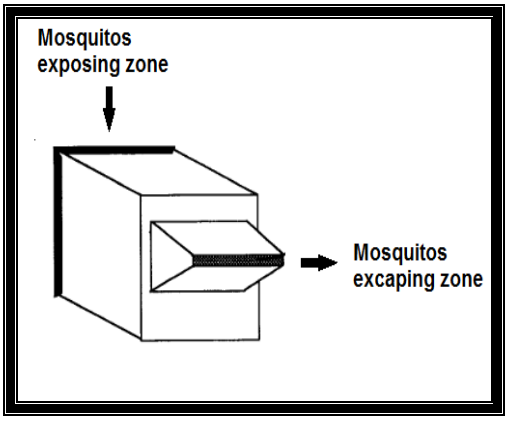

Fig. 1.Excito chamber used for Mosquito repellence testing [14].

This test consists of 4 group of 25 mosquitoes were introduced in to this chamber for one minute. Before conducting the experiments Mosquitoes were deprived of all nutrition and water for a minimum of 4 hours before exposure. Laboratory tests were performed during daylight hours only. Before initiating the testing procedure the exit funnels were sealed and mosquitos were permitted exposure in to the chamber without test specimen, which ensures the mosquitoes to adjust the test chamber condition and funnel was opened then the mosquito repellent treated fabric was kept in to the chamber and one by one all the group of 25 mosquitos were exposed in the chamber for one minute. Number of escaping mosquitos from the chamber was recorded manually at 1 min intervals of 5 min of observation. A survival analysis approach was used to estimate the rates of mosquitoes escaping from chambers. In the excito-repellency test, there are only 2 possible outcomes for a specimen: it will either escape or not escape from the exposure chamber (Mosquitos escaped are treated as death).

3.2 Wash durability analysis

As per the AATCC-124-2009 the samples were washed in a front loading washing machine in a 5% neutral soap solution for 20 minutes and dried. This process was repeated 10 washes, 20 washes and 30 washes for the microencapsulated samples. Mosquito repellency test was carried out for all the samples, which ensured the wash durability of the coated samples of knitted fabrics.

3.3 Abrasion resistance

Abrasion resistance was tested using Martindale abrasion tester. This tester gives a controlled amount of abrasion between fabric surfaces at comparatively low pressure environment. A circular specimen of fabric was abraded with simple harmonic motion. The resistance of abrasion was estimated by finding the loss in mass of the specimen.

3.4 Bursting strength

It is the measure of pressure required to rupture a fabric. The selected busting strength tester working under the hydraulic bursting .According to IS0-13938-1 standard, the testing was executed. The sample tested will be clamped over the testing diaphragm and clamped with ring. The amount pressure exerted on the sample for busting through diaphragm was measured.

4. Results and discussion

4.1 Mosquito repellency

The percentage was assessed through percentage of insects dead due to mosquito repellent treated fabric was calculated using the equation (1).The analysis was conducted in three different samples such as controlled sample Acalypha indica encapsulated fabric before wash, Acalypha indica encapsulated fabric after 10 wash , Acalypha indica encapsulated fabric after 20 wash, Acalypha indica encapsulated fabric after 30 wash. The consolidated report of mosquito repellent activity was shown in table no. 1

Table .1 Mosquito repellent activities of various stages of Acalypha indica encapsulated cotton knitted fabric

Fabric	Samples	Specimens Exposed(Nos)	Specimens in the cage(Nos)	Specimens Escaped(Nos)	Specimens dead(Nos)	Mosquito repellency percentage
1	Controlled sample	25	25	0	0	0
2		25	25	0	0	0
3		25	25	0	0	0
4		25	25	0	0	0
5		25	25	0	0	0
1	Vetiver root extract encapsulate	25	2	9	14	92
2		25	1	5	19	96
3		25	4	6	15	84
4		25	3	9	13	88
5		25	3	10	12	88
1	Vetiver root extract encapsulate - 10 wash	25	4	9	12	84
2		25	7	10	8	72
3		25	8	11	6	68
4		25	8	10	7	68
5		25	9	10	6	64
1	Vetiver root extract encapsulate - 20 wash	25	10	5	10	60
2		25	9	10	6	64
3		25	10	7	8	60
4		25	8	5	12	68
5		25	9	6	10	64
1	Vetiver root extract encapsulate - 30 wash	25	11	4	10	56
2		25	8	5	12	68
3		25	9	10	6	64
4		25	8	7	10	68
5		25	9	10	6	64

From the analysis, it is clear that the controlled samples showed no repellent activity against mosquitoes. Whereas mosquito repellent encapsulated sample (prior to washing) generated higher level of mosquito repellent activity as compare with other samples. The anova study was carried out to measure the statistical significant between these samples. It is understood that Their difference between other sample is statistically significant (F=26.148,p=0.00). Samples such as Acalypha indica encapsulated fabric after 10 wash, Acalypha indica encapsulated fabric after 20 wash Acalypha indica encapsulated fabric after 30 wash are shown slightly poor performance as compare with unwashed samples due to its loss of activity during washing. In post Hoc analysis it is understood that the difference between these three samples are statistically insignificant (P values between these samples are 0.126, 0.188,0.995)

4.4 Comparative analysis of abrasion resistance of the mosquito repellent coated samples

The following table 2 shows the abrasion resistance of various mosquito repellent coated samples

Table 2. Abrasion resistance of mosquito repellent finished samples

Fabric sample	Weight before abrasion	Weight after abrasion	Weight loss (%)
Untreated sample	5.15	5.06	1.75
Acalypha indica encapsulated	5.10	5.00	1.96
Acalypha indica encapsulate -10 wash	5.18	5.10	1.54
Acalypha indica encapsulate - 20 wash	5.16	5.06	1.94
Acalypha indica encapsulate - 30 wash	5.13	5.02	2.14

From the table it is observed that lemongrass coated sample after 30 wash showed least performance than other samples but from the statistical point of view it is evident that the difference between the samples were insignificant (Since P<0.005).

4.5 Bursting strength analysis

The following table 3 shows the bursting strength ofvarious mosquito repellent coated samples

Table 3. Bursting strength of the mosquito repellent finished samples

Fabric sample	Bursting strength (kg/sq.cm)
Untreated sample	6.24±0.11
Acalypha indica encapsulated	5.65±.09
Acalypha indica encapsulate after 10 wash	5.90±0.05
Acalypha indica encapsulate after 20 wash	5.65±0.08
Acalypha indica encapsulate after 30 wash	5.20±0.04

From the table it is observed that controlled sample showed highest bursting strength performance than other samples. It is interpreted that the surface coating covers the air passage over the surface of the fabric and extensibility of the fiber/yarn is also get affected due to the outer coating of Acalypha indica,which reduces the bursting strength of the coated fabric .

5. Conclusion

Through this research work Acalypha indica encapsulated cotton textile has got good mosquito repellent activity of 90% mosquito repellency activity.This microencapsulation technique provides better wash durability for the treated fabric even after 30 wash cycle, that is even after 30 wash the reduction in Mosquito repellency percentage was only 28.5%. Other physical properties such as abrasion resistance due to washing will not statistically significant at 95% confidence limit. But slight property changes in busting strength due to microencapsulation on the textile structure. In over all aspect natural form of extraction of microencapsulated coating is very safe and eco-friendly.This same treatment can also be applied to the oven Fabrics and it can be used as Bed Spreads and Bed Sheets.

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