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Analysis of Insect Repellent Behavior of Eucalyptus Oil and Cedar Wood Oil towards *Lepisma saccharina*

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Abstract: Silverfish (*Lepisma saccharina)* is a household insect found at damp places, Silverfish has enzymes in its gut that digest cellulose. Silverfish choose bookcases, closets and places where books, clothing, starch or dry foods are available. Silver fish eat any kind of starch, including the glue in book bindings; paper; and natural fabrics like linen, cotton and wool. Natural insect repellents are best alternative to use while considering the chemical compounds involved with commercial products. Essential oils can be used as natural insecticides for silverfish. Eucalyptus and cedar wood oils are the type of essential oil having medicinal, aromatic, antibacterial, antimicrobial and insect repellent properties. They are the natural source of fragrance and insect repellent finish. Present invention set a new approach to repel insects like silverfish (*Lepisma saccharina)* by using these two essential oils on fabric through microencapsulation finish. A comparison was made between developed finish from eucalyptus oil and cedar wood oil to demonstrate the best insect repellent behavior.

Keywords: Textile, Microencapsulation, Insect repellent, Essential oils, Complex conservation.

I. INTRODUCTION

Essential oils are known for their rich medicinal values and aromatic effects they are concentrated compounds and have long lasting effect onto the substrate. Many essential oils have antiseptic and anti-fungal properties that help successfully to kill mildew and its accompanying odour. It's an ecofriendly approach to use natural essential oils instead of chemical insecticides,

Eucalyptus is a diverse genus of flowering trees and shrubs belong to myrtle family of Australia, It has more than 700 species all around the world [1]. Among the various timber and other products, essential oil found in its foliage is the most important one and finds extensive use in food, perfumery and medical industry. In addition, the oil possesses a wide spectrum of biological activity including anti-microbial, fungicidal, insecticidal/insect repellent, herbicidal. An essential oil extracted from eucalyptus leaves contains compounds that are powerful natural disinfectants. *Eucalyptus globulus* is the principal source of eucalyptus oil worldwide.

Cedar is the common name for cedar wood, used for several different trees that grow in different parts of the world. *Cedrus* or cedar is a genus of coniferous trees in the plant family Pinaceae. *Cedrus deodara* is also known as deodar cedar, Himalayan cedar, or devdar. It is a species of cedar native to the western Himalayas in eastern Afghanistan, northern Pakistan and India (Jammu and Kashmir, Himachal Pradesh, Sikkim, Darjeeling and Uttarakhand states), In India Jageshwar Temple of lord Shiva is surrounded by Cedar trees. Oil extracted from Cedar wood also known as cedar wood oil. It is produced from the foliage, and sometimes the wood, roots, and stumps. It has many uses in medicine, art, industry and perfumery, besides these it can also be suggested as pesticide.

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Eucalyptus oil and cedar wood oils, due to their volatile nature are difficult to preserve for long time, therefore through microencapsulation of these two essential oil gives a long lasting effects on to the substrates. It can provide aroma to many novelty applications, particularly for garments and upholstery. Through textiles it has also allowed exposure at home and in the work place for the beneficial effects. The technology allows a textile manufacturer to add a fragrance that can work as insect repellent. In the present study a house hold insect Silverfish (*Lepisma saccharina)* which is found at damp places, has enzymes in its gut that digest cellulose is targeted to check the repellent behavior of two essential oils. This tiny insect chooses bookcases, closets and places where books, clothing, starch or dry foods are available. Silver fish eat any kind of starch, including the glue in book bindings; paper; and natural fabrics like linen, cotton and wool. Natural insect repellents are best alternative to use while considering the chemical compounds involved with commercial products. Essential oils can be used as natural insecticides for silverfish. Therefore present study was design to fulfill following objectives-

Objectives of the Study

1. To develop microcapsules of eucalyptus oil and cedar wood oil by using complex coacervation technique.
2. To incorporate microencapsulated insect repellent finish on fabric.
3. To analyze insect repellent behavior of fabric encapsulated with eucalyptus oil and cedar wood oil.

II. MATERIALS AND METHODS

Formation of Microcapsules

Gum acacia (arabic) as wall material was combined with both oils to be used as core material i.e., eucalyptus and cedar wood oil separately. Gelatin was the common ingredient in all the processes of complex coacervation technique. Formation of microcapsules with complex coacervation technique was carried out on magnetic stirrer [2,3]. The whole process was conducted using standard recipe given by Agarwal. Modification in recipe was done according to the quantity needed for application.

Confirmation of Microcapsule Formation in the Solution

Formation of microcapsules in the solutions made with the technique was ensured by using digi vision microscope. Before applying the solution on the fabric, presence of capsules in the solution was noticed. Then the solution containing microcapsules was applied on the fabric specimens.

Application of Developed Finish on Substrate

Fabric was dipped into the prepared precipitated solution with water on the basis of material liquor ratio (MLR) i.e., 1: 30 for 10 minutes. Finish was applied on fabrics with the help of padding mangle. Each fabric sample was passed through the padding mangle rollers with the standard pressure of 80%. After application of finish each fabric was given heat treatment at 80^{o}C in an oven for 5 minutes [4].

Scanning Electron Microscopy (SEM) of Finished Fabric

Both fabric finished with microcapsules using eucalyptous oil and cedarwood oil was analyzed for the presence of microcapsules on its surface by using Scanning Electron Microscopy (SEM JSM- 6610LV apparatus). Firstly fabric sample finished with microcapsules was completely dried in an oven for 5 minutes before SEM analysis. Microencapsulated fabric was cut into small piece (size 0.5 cm^2) and placed on the carbon strip which was stuck at the stock. Then, gold was spitted on fabric sample by gold coat JFC 1600 machine, to protect the finished fabric sample from heat during test. Then this small piece of fabric (size 0.5 cm^2) was placed under the Scanning Electron Microscope to analyze the presence of capsules in the fabric. Microscope was attached to the computer in which the software of SEM

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was installed. Microscopic image of specimen can be seen in computer screen to analyze presence, shape and size of microcapsules.

III. RESULTS AND DISCUSSION

In the present study microcapsules were produced by using one of the phase separation methods of microencapsulation i.e., complex coacervation technique. Gum acacia as wall material and essential oil (cedar wood oil and Eucalyptus oil) as core material were used for the formation of microcapsules. Ratio of wall and core material was kept as 1:1.

Confirmation of Microcapsules in the Prepared Solution

Prepared solution (microencapsulated) was tested under Digi vision microscope to confirm the formation of microcapsules because it was essential to check whether or not microcapsules were formed in the solution. It was found that a great no. of microcapsules with appropriate size were formulated by using complex coacervation technique (Fig. 1). Microcapsules prepared from complex coacervation technique were less round to spherical in shape. Microcapsules prepared from eucalyptus oil were clearer in shape as compared to microcapsules of cedarwood oil.

Agnihotri et al. stated that selection of appropriate coating material decides the physical and chemical properties of the resultant microcapsules/microspheres. While selecting a wall material the product requirements i.e., stabilization, reduced volatility, release characteristics, environmental conditions etc. should be taken into consideration. Wall material should be capable of forming a film that is cohesive with the core material. It should be chemically compatible, non-reactive with the core material and provide the desired coating properties such as strength, flexibility, impermeability, optical properties and stability. Therefore gum acacia was used as wall material due to its following properties i.e., can form viscous solution at relatively low concentration; possess general colloidal properties and a fine film can be formed, which includes the binding of particles into solid masses.

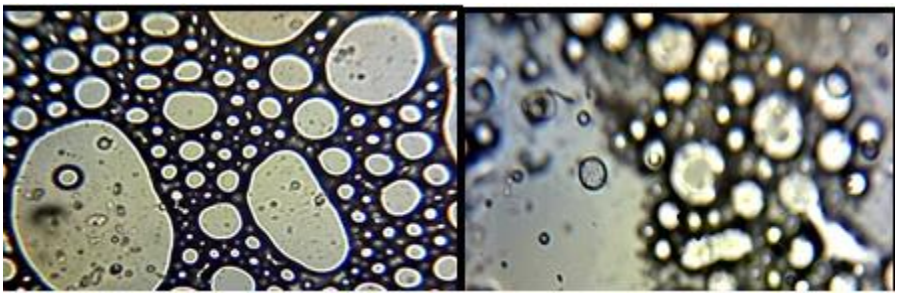

Fig. 1. Microcapsules of gum acacia + eucalyptus oil, microcapsules of gum acacia + cedarwood oil.

Application of Microencapsulated Finish on Fabric Specimens

Two microencapsulated finished fabrics were developed by using complex techniques (Sample sheet 3). Finish was applied evenly on fabric specimens by using padding mangle. It was experienced that fabric finished with microcapsules formed through complex coacervation technique was sticky on padding rollers and become slightly stiff after drying.

Scanning Electron Microscopy (SEM) of Microencapsulated Fabric

After application of microcapsules on fabric the specimens were analyzed under Scanning Electron Microscopy using JSM- 6610LV apparatus to ensure the presence of microcapsules on these test specimens. It was observed that microcapsules were visible on the fabrics. Few images of micro-capsules are shown in Fig. 2.

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Through SEM images each test specimen was also analyzed to check the shape, availability, quantity, size and uniformity of microcapsules. Microcapsules were started to appear at the 400 magnification but it was finally studied till 4000 magnification because the image of microcapsules was very clear at higher magnification as well as few more smaller micro capsules were also visible. Both the combinations of microcapsules (Gum acacia + eucalyptus oil and Gum acacia + cedar wood oil) were applied uniformly on the fabric, each of which were formed by using complex coacervation technique. It was found that the shape of micro capsules was almost same in all samples. Size of the capsules was ranging from 6.59 µm to 46.400 µm. Under the present study it was observed that maximum microcapsules were of small size which is good for their functionality. According to Agnihotri et al. microcapsules were ideally having particle size less than 200 µm. It was also stated by Nelson that micro capsules generally range in size from 1 to 20 µm. In practice, the smaller the capsule the greater is the covering of the product and the longer the fragrance will last, as it takes longer for the capsules to be ruptured by physical pressure. However larger capsules release more fragrance when ruptured.

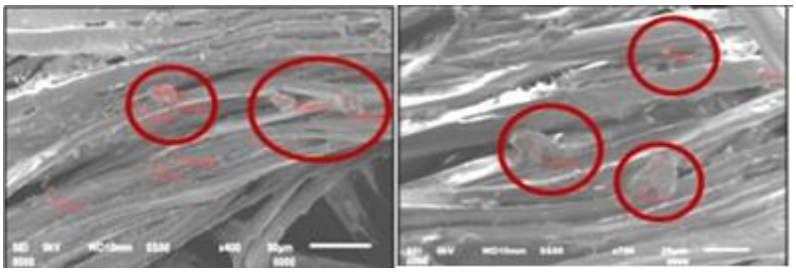

Fig. 2. SEM image of gum acacia + eucalyptus oil, microcapsules of gum acacia + cedarwood oil.

Insect Repellent Behavior of Microencapsulated Fabric

A tool was developed by the researcher to test the insect repellent behavior of microencapsulated fabrics finished with microcapsules of cedarwood oil + gum acacia and Eucalyptus oil+ gum acacia microencapsulated fabrics. A comparison was done between the microencapsulated fabric of cerdarwood oil and eucalyptus oil. Firstly insect repellent behavior of microencapsulated fabric finished with complex coacervation technique by using microcapsules prepared through gum acacia + cedarwood oil was tested. Movement of silverfishes in the insect repellency tester was recorded and it was found that after 2 hours 14 silverfish had moved to the bottle consisting untreated fabric through plastic pipe (connecting both bottles). After 4 hours remaining 13 silverfishes had passed to the bottle consisting untreated sample whereas after 18 hours all silverfishes (30) had moved towards the untreated fabric. It proved that microencapsulated fabric with cedar wood oil has good repellency towards silverfish. Experiment was continued for 7 days and it was found that after 7 days 5 silverfish were died in the insect repellency tester may be due to smell of cedarwood oil [5-7].

The same procedure was followed to test the insect repellent behavior of microencapsulated fabric finished with microcapsules prepared through gum acacia + eucalyptus oil. It was found that after 2 hours most of the silverfish (22) moved towards bottle consisting untreated fabric through plastic pipe. It was noted that after 4 hours all silverfishes (30) had moved towards the bottle consisting untreated fabric through pipe. It was observed that after 18 hours maximum silverfish (24) were found dead in the insect repellency tester. This may be due to the intense smell of eucalyptus oil.
This experiment results that microencapsulated fabric with gum acacia + eucalyptus oil had better ability to repel silverfish as compare to microencapsulated fabric with gum acacia + cedar wood oil [8,9].

IV. CONCLUSION

Eucalyptus tree is a natural source of essential oil. It is easily available in India and can be sufficiently used as a replacement of synthetic insecticides which are very harmful for the human being. Present study set a new approach to repel insects like silverfish from the bookshelves and clothing wardrobes [10]. Lining of insect repellent

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microencapsulated finished fabric can be added in these shelves and wardrobes. To commence today's demand of eco-friendly products this research is very constructive in the field of functional textiles.

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