



Micro- and nano-encapsulation of limonene and permethrin for mosquito repellent finishing of cotton textiles

Gizem Ceylan Türkoğlu¹ · Ayşe Merih Sarıışık¹ · Gökhan Erkan¹ · Mehmet Salih Yıkılmaz² · Oya Kontart³

Received: 9 August 2019 / Accepted: 17 February 2020 / Published online: 2 March 2020
© Iran Polymer and Petrochemical Institute 2020

Abstract

The aim of this study was to prepare mosquito repellent textiles. To compare bio-based and synthetic mosquito repellent agents, limonene and permethrin were encapsulated with ethyl cellulose shell. Coacervation was employed, which is a simple and reproducible method for the encapsulation with high production efficiency. Morphological assessment showed that the capsules had smooth surfaces and their shape was spherical. The homogenous size distribution of the capsules was supported by laser diffraction analysis. The capsules showed narrow size distribution and the mean particle size of the optimum formulations for limonene and permethrin was 1 and 1.3 μm , respectively. The size of the produced capsules was considered suitable for textile applications. The FTIR spectra revealed the similarity of the chemical structure of capsules with shell material. Cotton fabrics were treated separately with limonene and permethrin capsules by padding method. The presence of capsules on the fabrics was determined after 20 washing cycles. Insecticide activity was evaluated against common house mosquitoes (*Culex pipiens*), with respect to cone bioassay of World Health Organization (WHO). Mosquitoes were tended to stay away from treated fabrics, and mortality rates of mosquitos were noted as 41% and 54% for limonene and permethrin, respectively. Although efficacy of fabrics decreased with increasing washing, the fabrics still showed repellency after 20 washing cycles. This study showed that the developed product might be used as an alternative to the other products in the market for avoiding mosquito-borne diseases.

Keyword Insect repellent textiles · Insecticide · Mosquitocide · Limonene · Permethrin · Ethyl cellulose · Microencapsulation

Introduction

Insects have many functions that can be considered both beneficial and harmful to human beings and they play a considerable part in human life. They transmit many diseases, which may adversely affect human life. They can cause significant damages to agricultural products and materials made from natural raw materials such as wool and cotton used in textile industry [1]. Some of them may be annoying by stinging or biting, and some can only disturb human beings with

their sounds or appearance. On the other hand, they have a significant role in natural balance. They transfer pollen and help the cultivation of agricultural products, and serve as nutrients of many upper organisms in the food chain. They transform various organic wastes, and from time to time, they are useful as human food. By considering all the above points, their destruction by mass purge would damage our living environment and cause ecological disaster [2].

Mosquitoes are one of the most harmful insects. They carry and transmit arboviruses such as malaria, dengue fever, and zika [3]. There are numerous methods developed to protect humans from mosquitoes. Besides mass insecticide applications, there are several types of personal applications. One of the most common methods is to keep away the insects by a simple mosquito net. However, it can only be used when the person is motionless. Also, mosquito coils, which are insecticide-impregnated spiral shaped incenses, candles, lanterns, and torches, are generally used outdoors. Even they are relatively effective, the smoke of incense may

✉ Gizem Ceylan Türkoğlu
gizem.turkoglu@deu.edu.tr

¹ Department of Textile Engineering, Faculty of Engineering, Dokuz Eylul University, Izmir, Turkey

² Department of Biology, Faculty of Science, Ege University, Izmir, Turkey

³ Organik Kimya Sanayive Tic. A.S., Istanbul, Turkey