ABSTRACT

In the 21st century, the occurrence of deadly viruses, mosquito-borne and pathogenic diseases have increased significantly. One of the best strategies to avoid the spread of these diseases is to use protective textile products such as functional apparels (antibacterial, antioxidant, antiviral, mosquito repellent), functional mask, scarf, gowns, curtains and bedsheets. New strategies are being explored for the functionalization of textiles by finding alternatives to highly toxic and synthetic chemicals. Since ancient times, essential oils (EOs) are being used for medicinal propose because of their inherent biological properties. However, the use of essential oils (EOs) for the functionalization of textiles is limited owing to their volatile nature. Several attempts have been made to enhance their durability to attain excellent pharmaceutical effects through the textiles. The present research revolves around the development of multifunctional textiles using microencapsulated novel essential oil (EOs) in functional polymers.

In the first part of this research, an attempt was made to develop *in-situ* synthesized chitosan-phosphate microcapsules loaded with thyme oil. Seventeen runs were performed to optimize the polymer-to-oil concentration by measuring encapsulation yield and encapsulation efficiency of the microcapsules. The obtained microcapsules offered more than 71% encapsulation efficiency for all the runs, which was quite significant. The developed microcapsules were applied to the linen fabric using an acrylic binder to impart functional properties. The microcapsules were spherical and owned a matrix type of morphology. Interestingly, the oil release from the microcapsules was found to be governed by diffusion and swelling mechanism. The results were impressive, which showed the presence of oil on the fabric even after 20 washes. The EOs are highly flammable; however, this research attempted to prepare the flame retardant microcapsules loaded with thyme oil. The finished fabric exhibited excellent mosquito repellency (100 %), antioxidant activity (>96 %), pleasant aroma

and moderate flame retardancy. The finished fabric also exhibited excellent antibacterial activity even after repeated launderings. The marginal change was observed in the mechanical properties and air permeability of the fabric. Another attempt was made to confirm the authenticity of this research by changing the EOs (rosemary essential oil). Moreover, the results showed similar trends as observed in the previous section. These results motivate us to explore the new polymers and oils to enhance the microcapsules' encapsulation efficiency and achieve better functional properties.

In the second part of the research, an attempt was made to explore the effect of polymer mixture on the encapsulation efficiency and release kinetics of the microcapsules. The microcapsules were developed using a mixture of chitosan-gelatin as a shell material and rosemary oil as a core material. The prepared microcapsules showed matrix and reservoir type of morphology. The microcapsules offered a sustained oil release profile, which was governed by a diffusion mechanism. The obtained microcapsules offered more than 68 % encapsulation efficiency. The finished fabric showed excellent mosquito repellency, antibacterial activity, antioxidant activity and a pleasant aroma even after repeated launderings. Another attempt was made to confirm the authenticity of the research by changing the EO (Cinnamon bark oil). The obtained microcapsules offered a similar kind of morphology and released mechanism as found in a previous section of the second part of the research. However, the microcapsules offered better encapsulation efficiency as compared to microcapsules loaded with rosemary essential oil. Interestingly, cinnamon bark oil was found more effective as it offered better functional properties compared to rosemary essential oil.

In the third part of the research, an attempt was made to prepare microcapsules using pullulan as a shell material and thyme oil as a core material. It was interesting to see higher encapsulation efficiency (>85%) of pullulan microcapsules compared to microcapsules

prepared in the other parts of the research. The oil release kinetics of the microcapsules was found to be governed by diffusion mechanism. The result revealed retention of more than 16% of the initial oil present on the finished fabric even after 20 washes. Hence, the better mosquito repellency of the finished fabric was observed even after 20 washes compared to the finished fabrics developed in previous parts of the research. In this research, the finished fabric exhibited 95.21% and 93.11% antibacterial activity against *S. aureus* and *E. coli* bacteria, respectively. The finished fabric also showed more than 90% antioxidant activity and a pleasant aroma. The exciting trends in the durability of functional properties were obtained. The result revealed that mosquito repellency was subject to the presence of aroma on the finished fabric. Hence, the mosquito repellency was retained till the fabric remained fragrant. However, the antibacterial and antioxidant activity was subject to the amount of phenolic content on the finished fabric. Once the amount of phenolic content gets reduced, the effectiveness of the finish toward bacterial colony reduction and radical scavenging was also reduced.