

ROSEMARY-LOADED MICROCAPSULES ON TEXTILE MATERIALS FOR SKINCARE

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ABSTRACT:
Cosmetic textiles are a new generation of textiles describing high-tech fabrics that incorporate personal care ingredients, which can impart skincare benefits, combating ageing, feeling of wellness or well-being, such as slimming, perfume, or moisturizing. Researches in this domain found that essentials oils had more than a therapeutic effect and could involve sales and marketing. Essential oils are natural bio-based multicomponent products containing active agents responsible for antibacterial activity, refreshing, relaxing, calming, balancing, causing euphoria and providing astringent, antiseptic, decongestant, therapeutic, toning, fortifying, cooling properties and so on. As people are used to wear textile materials in their daily life thus it is also logical to use textile as the possible basis for the delivery system of cosmetic or pharmaceutical ingredients leading to a controlled release for skincare benefits. In this respect, this study approached the experimentation of deposition by electro-spraying method of commercial rosemary microcapsules on woven cotton fabrics. An acrylate-based binder was used to improve the durability to external factors. The finished textile materials were characterized in terms of physical-mechanical and comfort characteristics. The distribution of microcapsules on the fabric surface was investigated by SEM analysis.
KEY WORDS: essential oils, rosemary, cosmetic textiles, electro-spraying

1. INTRODUCTION

Skincare products on worldwide market reached great interest with respect of cosmetotextile domain, aiming the opening of new business opportunities that will continue to evolve with further technical developments. The merging of cosmetics and textiles offers a unique platform for the delivery of cosmetic products, such as moisturisers, or sensorial active ingredients or cooling agents through wear [1].

Cosmetotextiles are examples of high-performance textiles representing a fusion of cosmetic active substances with textile materials. The active agents are attached to the textile material, which are transferred from the textile to the skin in order to reach the specific target. Despite not being accepted as cosmetic products, they are able to impart skincare benefits, fighting ageing, and promote wellness and comfort [2], [3].

Active agent release from functionalized textiles has always been interconnected with the statement that active compounds are unstable in free form, due to their sensitivity to light, oxidation, moisture, or volatility. Therefore, development of textile systems for controlled release of an active agent is a demanding process requiring protection of entrapped material, availability, controlled release, and as well as an efficiently embedding microcapsules into the textile substrate [4]. The majority of active substances applied in textile industry are delivered on skin with a controlled rate of release, otherwise known as the leaching mechanism. These agents are not chemically bonded to the substrate of textile materials; therefore their beneficial functions are exhibited based on a gradual, slow and prolonged release from a reservoir either on the fabric surface or in the interior of the fibres to their surroundings under moisture conditions [5].

Microencapsulation is excellent technology used for imparting an array of unique characteristics to a garment. Microencapsulated active compounds, such as essential oils, can be entrapped (physically or chemically) onto the fibre or even coated on a textile's surface. The particles which contain active ingredients are applied onto the fabric or garments for long lasting effects. As the wearer moves, the capsules are activated and they release the active ingredient in a controlled manner [6], [7].

Microcapsules are commonly synthesized by using degradable polymers as shell materials for drug delivery systems. The active agents are encapsulated inside of polymeric shells, allowing their controlled release in time. Particular characteristics such as, physical-chemical properties of polymers, biodegradation kinetics, thermodynamic

compatibility between polymers and active compounds and the type of active substance, generally controls the release rates [8].
Essential oils of rosemary extract, garlic, cinnamon, lavender, jasmine, eucalyptus, thyme, and oregano containing various terpenes have also been incorporated into textiles to provide cosmetic and therapeutic fabrics with specific functions such as:
•Pleasant odour and feeling;
•Moisturizing;
•Slimming;
•Antiaging;
•Energizing;
•Hair, body, and skin care;
•Refreshing;
•Pain-relieving [9], [10].
Rosemary (Rosmarinus officinalis L.) is a long-lasting evergreen aromatic herb includes phenolic constituents in its composition. Due to its composition, which mainly include 1,8-cineole, α-pinene, camphor, camphene, rosemary essential oil has many therapeutically effects. Among these effects, the most well-known ones are its antioxidant, antimicrobial, aromatherapeutic and anticarcinogenic activities [11], [12].
Durable textile finishing of encapsulated materials requires the application of binders, which will affect the final properties of the finished textile such as mass, handle, stiffness, thickness and washing durability. Thus, a final fixation method is usually applied to enhance the durability of the surface treatment [13]. Binders establish a crucial role in microcapsules coating formulation for various textile materials, as they are required to fix microcapsules on textile supports permanently. The binder is a film-forming substance composed of long-chain macromolecules which produce a three-dimensionally linked network when applied to the textile. To a large extend, binders determine the quality, washing durability and comfort of textile materials with microencapsulated ingredients [14].
The aim of this study was to develop textile materials with cosmetic purposes by applying Rosemary aqueous-based melamine microcapsules dispersions on 100% cotton and 50% cotton / 50% polyester woven fabrics.

2. EXPERIMENTAL

2.1 Materials

100% cotton fabric with the mass per unit area of 168 g/m^2 and 50% cotton / 50% polyester fabric with the mass per unit area of 196 g/m^2 were used for the functionalization treatments. Rosemary aqueous-based melamine microcapsules dispersions containing 50% active content supplied by AITEX, (Spain), with particle size ranging between 5 to 10 µm, have been used in order to develop textiles for cosmetic purpose (Figure 1). Kemapon PC/LF (Kem Color S.p.a, Italy) – nonionic wetting agent and detergent based on fatty alcohol polyglycol ether, Kemaxil Liq. (Kem Color S.p.a, Italy) – H_2O_2 stabilizer with dispersing and sequestering properties based on disodium salt of aminopolycarboxilic acid, Kemapol SR 40 Liq. (Kem Color S.p.a, Italy) – sequestering agent for calcium and magnesium salts, dispersing and colloid protector agent have been used for preliminary treatments. Itobinder AG (LJ Specialities, UK) has been used for binding of microcapsules on the surface of textile materials.

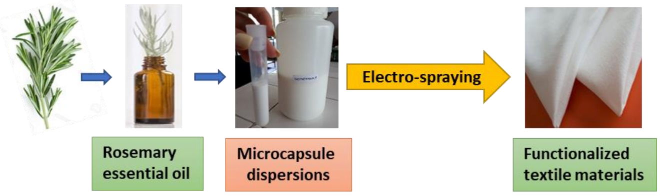


Figure 1. Rosemary microcapsules dispersions and functionalized textile materials

2.2 Preliminary treatments

Prior to functionalization treatments the textile fabrics were subjected to preliminary preparation by hot alkaline treatment and bleaching. Hot alkaline treatment was performed at 1:10 MLR (material to liquor ratio) at 98°C for 90 minutes, the treatment bath containing 8 mL·L^{-1} NaOH 38°Bé, 3 g·L^{-1} Na_2CO_3, 3 g·L^{-1} Na_3PO_4, 2 g·L^{-1} Kemapon PC/LF and 1.5 mL Kemapol SR 40 Liq. The woven fabrics were then repeatedly rinsed at 80°C, 60°C, 40°C and at room temperature for 10 minutes. Bleaching of woven fabrics was performed at 98°C for 60 minutes in the presence of 20 mL·L^{-1} H_2O_2, 4 mL·L^{-1} 38°Bé NaOH, 2 mL·L^{-1} Kemaxil Liq., 1 mL·L^{-1} Kemapon PC/LF.

2.3 Functionalization treatments

The deposition of rosemary microcapsules on the textile materials was performed by electro-spraying method using a Microbecide® TC-320 Electrostatic Sprayer equipment (Singapore) (Figure 2) with the following specifications: electrostatic charging voltage - 0.6 – 1.2 KV; electrostatic charge polarity: negative; droplet size: 40 microns; liquid line – pressure: 1.0 bar (15 psi); air line – pressure: 2.1 bar (30 psi); flow rate adjustable: 20 – 240 ml/min; operating voltage: 220VAC/50Hz. The Microbecide® TC-320 Electrostatic Sprayer is a powerful, compact and quiet electrostatic sprayer optimized for water-based coatings, designed for continuous operation. The TC-320 electrostatic sprayer utilizes patented, induction charging nozzle technology. For laboratory experiments the samples were placed in a box at 0.8 m distance for the nozzle and sprayed on both sides.

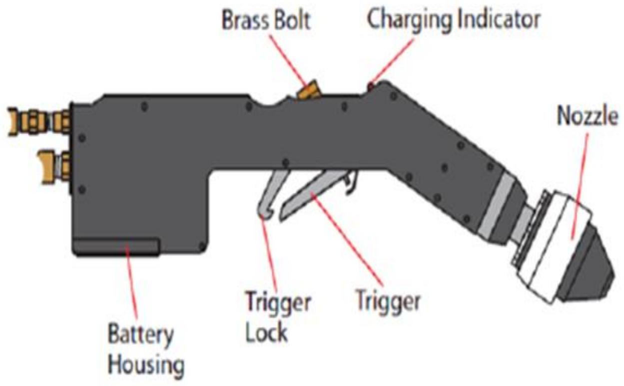


Figure 2. TC-320 Electrostatic Sprayer equipment

Textile fabrics were sprayed with 30 $g \cdot L^{-1}$ microcapsule dispersions and 80 $g \cdot L^{-1}$ Itobinder AG. The treated fabrics were dried 2 minutes at 100°C and then cured 1 minute at 150°C. Drying and curing operations were carried out on the drying / curing/ heat-setting equipment, model TFO/S 500 mm (ROACHES, UK).

2.3 Methods

2.3.1 Mechanical properties

The treated fabrics were characterized in terms of the main physical-mechanical characteristics, respectively: mass per unit area (SR EN 12127-2003), number of thread per unit length (SR EN 1049-2: 2000-Method A, B), maximum force at break (SR EN ISO 13934-1/2013), elongation at maximum force (SR EN ISO 13934-1/2013), tearing strength (SR EN ISO 13937-3:2002), water vapor permeability (STAS 9005: 1979), permeability to air (SR EN ISO 9237: 1999).

2.3.2 Scanning electron microscopy (SEM)

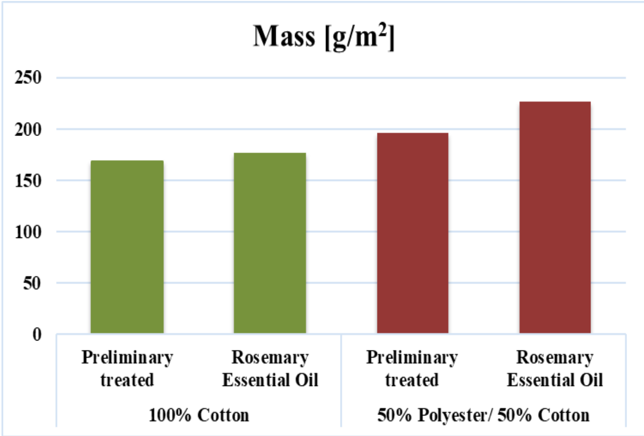
SEM analysis was used to investigate the distribution of microcapsules on the fabrics surface by using a FEI Quanta 200 Scanning Electron Microscope with a GSED detector and accelerating voltage of 12.5 kV – 20 kV.

3. RESULTS AND DISCUSSIONS

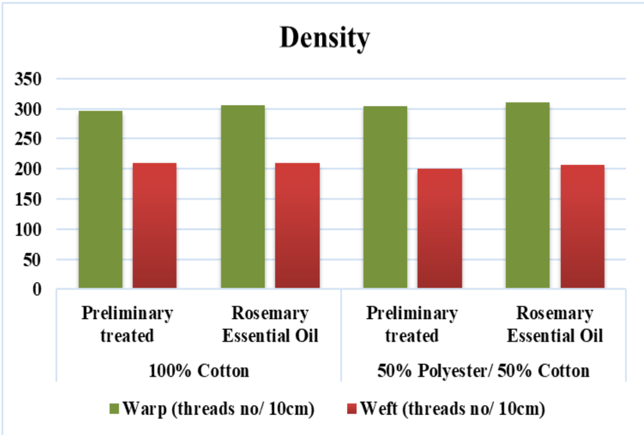
3.1 Physical-mechanical characteristics

The main physical-mechanical and comfort characteristics of 100% cotton and 50% polyester / 50% cotton and fabrics treated with rosemary microcapsules are shown in Figure 3 - 5.

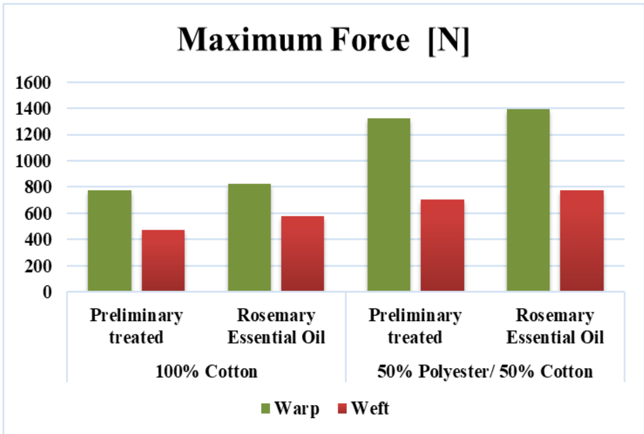
Functionalization treatments performed by electrostatic spraying do not cause diminishing of the mechanical properties of the tested materials, compared to the preliminary treated samples. The increase in mass per unit area values by 5-10% in the case of 100% cotton fabric and by 15-20% in the case of 50% polyester / 50% cotton fabric was determined by the density increase in both directions (warp and weft) due to the fabric shrinkage phenomenon during the curing process at high temperatures.



a.

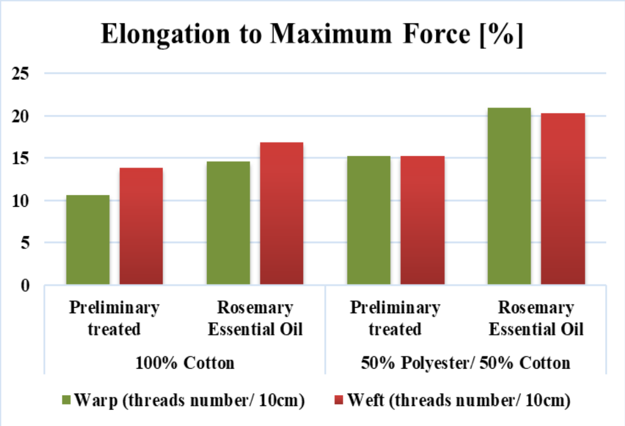


b.

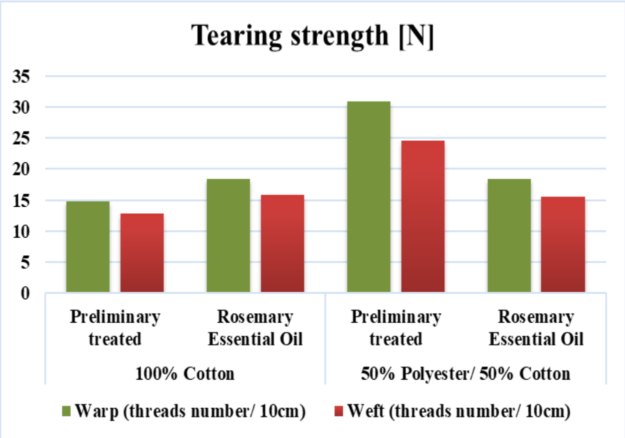


c.

Figure 3. Physical-mechanical properties of 100% cotton and 50% polyester / 50% cotton fabrics, namely: a. mass; b. density; c. maximum force;

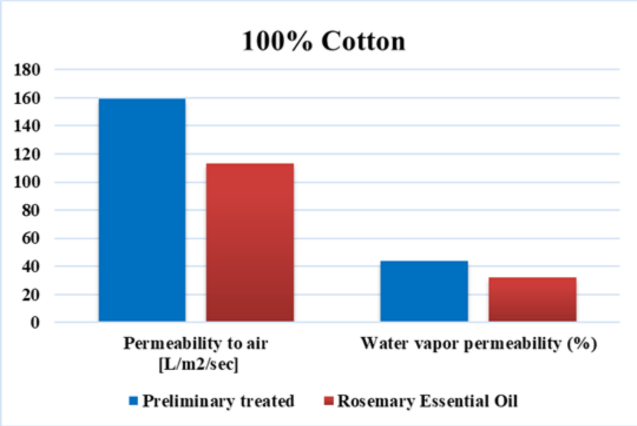


a.

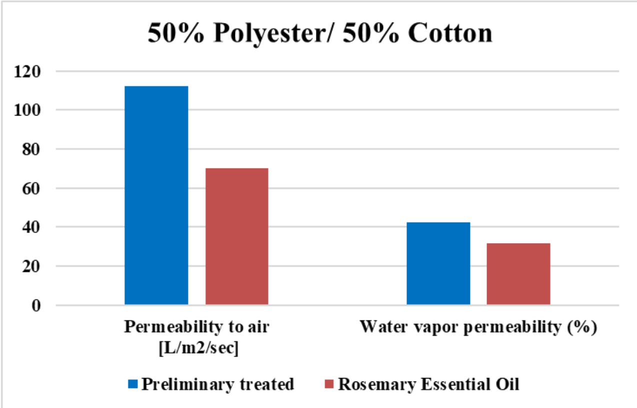


b.

Figure 4. Physical-mechanical properties of 100% cotton and 50% polyester / 50% cotton fabrics, namely: a. elongation to maximum force, b. tearing strength.



a.



b.

Figure 5. Comfort indices of: a. 100% cotton fabrics; b. 50% polyester / 50% cotton fabrics

The increased mass values per unit area may also be caused by the additions of chemical agents remaining attached to the textile materials at the end of the functionalization process.

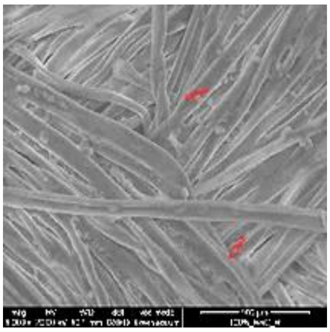
Also, the maximum force at break and the elongation at maximum force registered for both fabrics did not record lower values compared with the untreated fabrics, the all obtained values being higher in comparing with those obtained for untreated fabric.

The applied functionalization treatments negatively influenced the tearing strength of 50% polyester / 50% cotton fabrics, the values decrease of this characteristic being with 40% on warp direction and with 36% in weft direction.

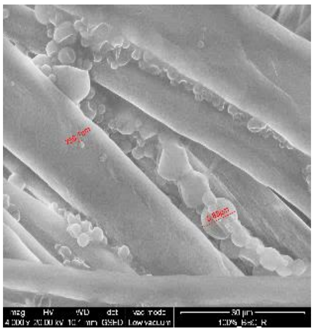
Air and water vapor permeability decreases after the functionalization treatments due to the polymeric substances deposited on the fabrics surface as a semi-permeable film (Figure 5). However, the obtained values are acceptable for the product's destination and do not affect in a negative sense the thermal comfort of end-user, providing ventilation necessary to remove sweating from the skin.

3.2 Scanning electron microscopy

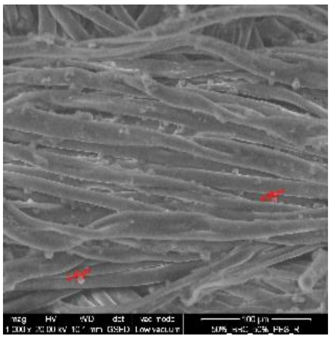
Figure 6 present the SEM images recorded at 1000 and 4000 x magnification on textile fabrics after the functionalization treatments.



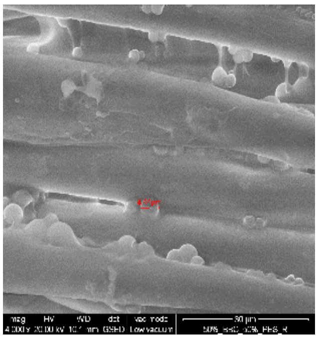
a. x 1000



b. x 4000



c. x 1000



d. x 4000

Figure 6. SEM images of: 100% cotton fabrics (a, b) and 50 % cotton / 50% polyester fabrics (b, c)

The SEM images recorded for treated fabrics, highlight the fact that microcapsules have been successfully immobilized on the textile fabrics surface. Some microcapsules are deformed, collapsed or broken, or are in the form of conglomerates of various sizes, adhering to the fabrics surface. The deformation or breakage of the adherent microcapsules on the surface of textile materials may be caused by the mechanical pressure exerted during finishing operations or high temperature applied during heat setting operation, while the collapse of the microcapsules could have occurred due to the conditions which were applied to the sample during the analysis.

4. CONCLUSIONS

The melamine-based microcapsules with rosemary essential oil content were embedded onto 100% cotton and 50% polyester / 50% cotton fabrics by using electro-spraying method. In terms of physical-mechanical characteristics, fabrics shrinkage occurred during finishing, leading to increased values of the mass per unit area and increased number of threads per unit length in comparison with the untreated fabrics.

Maximum force at break and elongation at maximum force were not negatively influenced by the finishing process. Tearing strength has decreased only in case of 50% polyester / 50% cotton fabric. The research on the potential of microcapsules with rosemary essential oil content for multifunctional properties (skin care and aromatherapeutic) development on textile materials is in progress.

5. ACKNOWLEDGEMENTS

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