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PHYSICAL AND MECHANICAL CHARACTERIZATION OF COSMETIC TEXTILES WITH ANTI-ACNE EFFECT

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Abstract: *Functionalized textiles are rapidly becoming a promising area of research because of their potential applications in a variety of fields, including biomedicine, environmental protection, and consumer products. One of the most promising methods for functionalizing textiles is the use of dispersions. The use of dispersions containing natural products such as plant extracts and clays can also provide additional benefits such as sustainability and environmental friendliness. In this study, we have dealt with the physical-mechanical characterization of cotton fabrics treated with two different dispersions. The dispersions used contain a combination of freeze-dried plant extracts such as propolis, aloe vera, calendula, plantain, and blue clay. A cosmetotextile product should have physical-mechanical properties that allow the user to wear it comfortably and obtain the desired benefits. First, contact angle analysis was used to investigate the textile's ability to absorb liquids. Second, resistance to acid and alkaline perspiration was analysed to determine the durability of the applied finishing treatment using a SEM in conjunction with a EDS. Finally, a water vapor transmission analysis was performed to determine the extent to which the treatment affects the breathability of the textile.*
Overall, these analyses provide information for the development of functionalized textiles and demonstrate the potential benefits of using dispersions containing natural products in textile treatment.
Our study is part of a larger project to develop new functionalized textiles with improved efficacy in curing certain forms of acne. Therefore, further testing of the antimicrobial activity of the treated textiles will be conducted as the ultimate goal is to validate the product: Toxicity tests on various primary cells and macrophages, as well as in vitro tests on wound infection.

Key words: *antibacterial, functionalized textile,* lyophilized extract, dispersion, blue clay.

1. INTRODUCTION

In today's world, textiles have become an essential part of our lives, and the demand for fabrics with additional functions has increased tremendously. Recently, a new category of textile materials has emerged with specific applications in the cosmetic field. This has led to the development of a wide range of cosmetic textiles that are now available on the market.

Textiles are an important interface between people and their environment and can provide a sense of protection and comfort. There are two main methods for the production of cosmetotextiles: the bonding of microencapsulated cosmetic components onto textiles and the coating of textiles with active finishes [1].

Chemical finishing of textiles involves the application of chemical substances that can confer various functions or properties and can be applied in the form of an aqueous solution or emulsion by various techniques. Of course, in all these treatments, their ecological character must also be evaluated [2]. Apart from being effective against microorganisms, any antibacterial treatment of a textile material should be non-toxic to the consumer and the environment [3]. Functionalization of textiles can be achieved by printing processes, film production, incorporation, fulmination, etc. [4]. Innovative techniques bring the application of chemicals, new alternative carriers such as microencapsulation. These alternatives are very important today, especially when a long-term effect or controlled release of chemicals is desired. The advent of nanotechnologies also offers a wide range of new possibilities in the field of functionalization of textiles [5,6].

Both dispersions used to treat the textile material consist of natural compounds. For example, the blue clay is 100% natural, according to the manufacturers. The analyzes of the mineralogical content carried out at MINESA Mining Research and Design Institute in Cluj Napoca have revealed the high content of silicates and oxides, but also of minerals and trace elements such as calcium, magnesium, potassium, iron, silicon, cobalt, sodium, etc. Blue clay can be used as: antiseptic, antibacterial, antifungal, and anti-inflammatory [7].

One of the lyophilized plant extracts used is propolis. Propolis has a complex chemical composition, and therefore has both antibacterial, antifungal, antiviral, antiparasitic, anti-inflammatory, and antioxidant properties [8,9,10,11].

Aloe vera is a very effective plant for treating epidermis problems and healing superficial wounds. Due to its anti-inflammatory and bacterial properties, it is also used to combat acne by reducing or even eliminating acne pimples [12,13].

Calendula is a medicinal plant with a very ancient history that plays an important role in skin care, healing eczema, wounds, sunburn, or stings [14].

Several studies have shown that plantain is effective as a wound healer as well as an anti-inflammatory, antibacterial and antiviral agent. Moreover, plantain is a good antioxidant and an ally against free radicals [15].

2. MATERIALS AND METHOD

2.1 Textile functionalization

The chosen textile material is a fabric made of 100% cotton (CO), because it is available on the market, has low acquisition costs, but also because of its multiple properties. The following dispersions were used to treat the materials:

- Dispersion 1, consisting of distilled water, lyophilized extract (1 g/L), blue clay (1 g/L) and DMSO (10%)
- Dispersion 2, prepared from distilled water, lyophilized extract (1 g/L), blue clay (1 g/L), nano-halloysite (1 g/L) and DMSO (10%)

The binder Itobinder AG was used to fix the blue clay and nano-halloysite to the textile support. The sample codification is displayed in Table 1.

Table 1: Codifications used for the treated cotton fabric

Sample	Composition of treatment bath
$CO_{I.D1}$	Dispersion 1
$CO_{I.D2}$	Dispersion 2
$CO_{II.D1}$	Dispersion 1

	Itobinder AG 20 g/L
$CO_{II.D2}$	Dispersion 2
	Itobinder AG 20 g/L
$CO_{III.D1}$	Dispersion 1 improved with Itobinder AG 20 g/L
$CO_{III.D2}$	Dispersion 2 improved with Itobinder AG 20 g/L

The untreated textile (initial) has been noted with: Fabric 100% Cotton – $CO_{initial}$.

2.2 Sample characterization

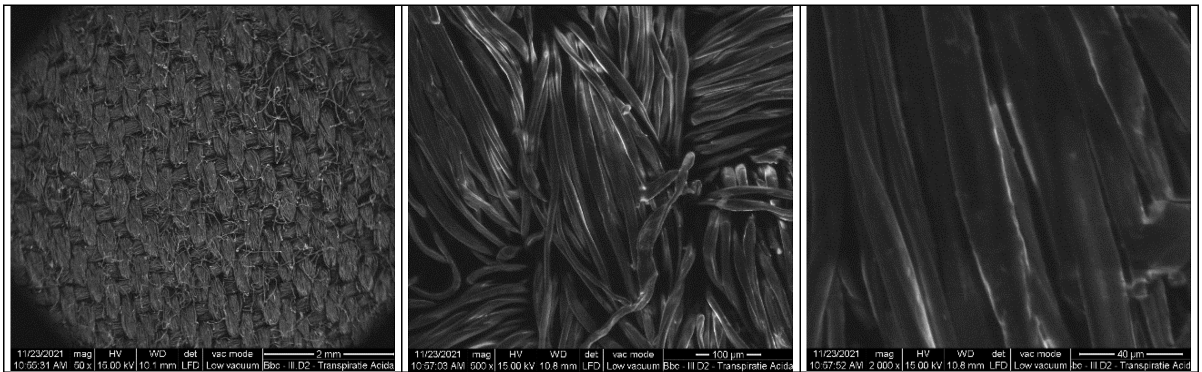
Resistance to acid and alkaline perspiration

The samples were cut into squares of 5 × 5 cm and placed in vials containing acid or alkaline sweat solution (the composition of these solutions is given in Table 2) for 30 minutes at room temperature, stirring the textile material periodically to wet it. The ratio is 50 ml solution /1 g sample.

After 30 minutes, the sample was dried on a flat surface. Resistance to acid and alkaline sweat was evaluated by electron scanning microscopy combined with dispersive X-ray spectroscopy (Figure 1 and Figure 2).

Table 2. Composition acid and alkaline sweat solution

Acid sweat solution **pH = 5,5**	**Alkaline sweat solution** **pH = 8**
0,5 g L-histidine monohydrate	0,5 g L-histidine monohydrate
5 g sodium chloride	5 g sodium chloride
2,2 g monosodium hydrogen phosphate	5 g disodium hydrogen phosphate



50×	500×	2000×

Fig. 1: SEM Images for $CO_{III.D1}$ sample- after acid perspiration

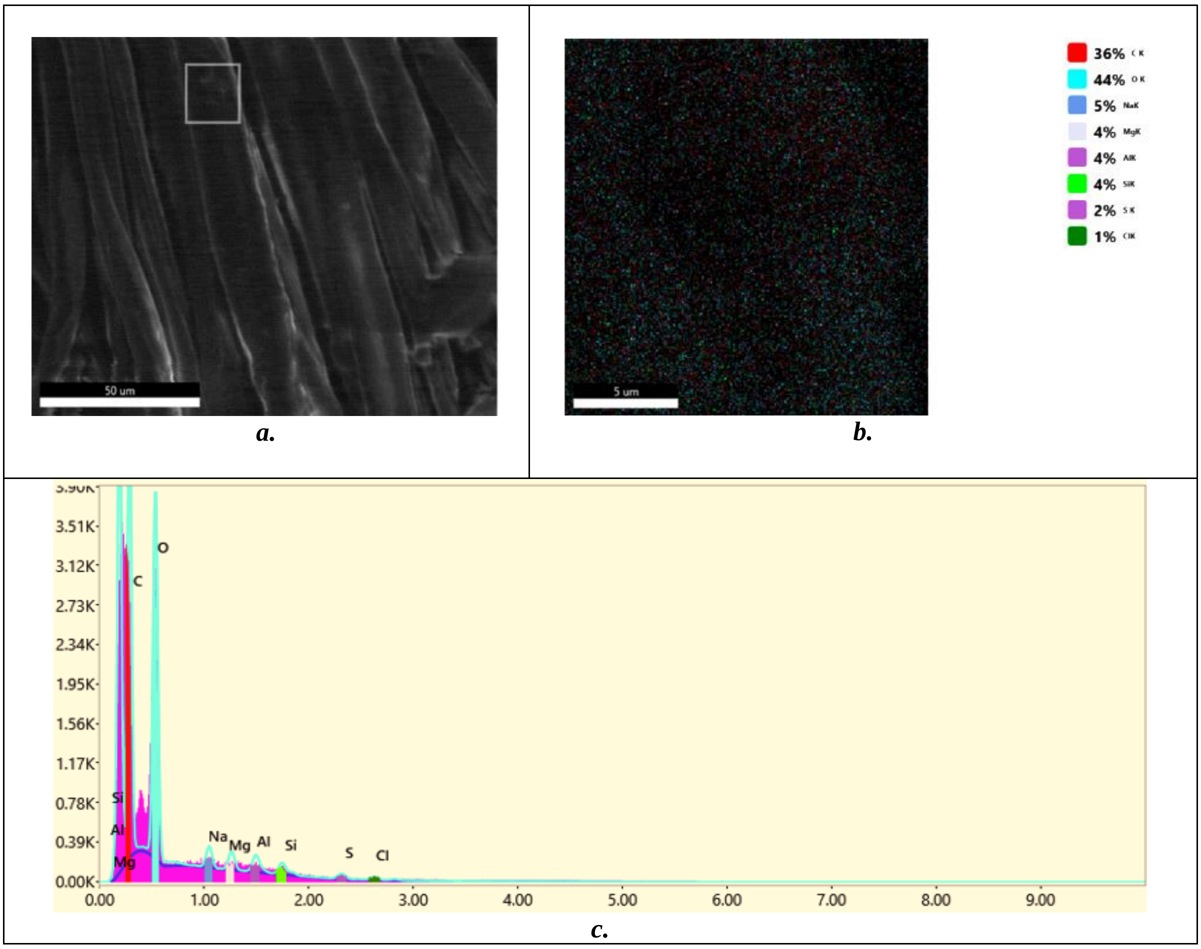


Fig. 2: EDS Results for $CO_{III.D1}$ sample - after acid perspiration - a. analyzed microscopic area; b. overlapping of the analyzed element/zone; c. EDS spectrum.

Water vapor permeability

The standard STAS 9005:1979 "Determination of water vapor permeability" has been used to assess the permeability of water-treated textile materials [16].

Mean results of the experimental values are shown in Table 3.

Tabel 3: Water vapor permeability results for cotton samples (%)

$CO_{initial}$	24,7
$CO_{I.\ D1}$	24,1
$CO_{II.\ D1}$	26,1
$CO_{III.\ D1}$	24,9
$CO_{I.\ D2}$	25,5
$CO_{II.\ D2}$	25,3
$CO_{III.\ D2}$	27,0

The highest value obtained was for sample $CO_{III.D2}$, which was 27%. This increased by 2.3% compared to the water vapor permeability obtained on the initial fabric.

Contact angle

The test was performed to evaluate the effect of treatment on the hydrophilic/hydrophobic properties of the original textile materials.

All treated cotton samples had angles less than 90°, so the material is considered hydrophilic.

3. CONCLUSIONS

In this study, laboratory experiments were conducted on the technological processes of deposition of dispersions of bioactive compounds with blue clay on a cotton textile material. The resulting functionalized textile was evaluated physically and mechanically.

Thus, one type of fabric was functionalized by the fullardation process (dispersion impregnation only, dispersion impregnation and dry impregnation with Itobinder AG 20g/L and modified dispersion impregnation with Itobinder AG 20g/L).

After the applied treatments, except for sample $CO_{I.D1}$, where the water vapor permeability decreases very slightly, the values of this parameter increase compared to the initial material, indicating a positive contribution of the treatment products, since they increase the breathability of these materials. The higher the value of this parameter, the more the product allows water vapor to pass through, which increases comfort.

The treatments applied to the textile materials do not affect the hydrophilicity or hydrophobicity of the starting materials, which retain their properties.

The materials treated and after exposure to acid and alkaline sweat solutions showed the following behaviour.

- all cotton samples have the elements included in the composition of the applied treatments (Al, Si, Na, Mg, Fe). Of these, in the case of $CO_{I.D1}$, $CO_{II.\ D1}$, $CO_{II.\ D2}$ and $CO_{III.D2}$ (example in Figure 1 and Figure 2), the elemental composition of the dispersions was the best preserved (most of the elements of the clay composition used in the dispersion are present).

- the action of acid and alkaline sweat solutions on the treated samples does not affect the element concentration of the main components, which indicates that the applied final treatment is resistant to these solutions.

Against the backdrop of an increased trend towards treatments based on high quality products made from plant extracts and functional textiles that come into contact with human skin, the research carried out brings added value in these areas.

With this research, we aimed to contribute to the development of sustainable and effective solutions for the control of bacterial infections and to open new opportunities for the development of alternative therapies.

It is proposed to continue the work with tests for product verification and validation: Toxicity tests on various primary cells and macrophages and in vitro tests for wound-specific bacteria, but also tests of textiles from antimicrobial and physicochemical points of view.

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