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FUNCTIONAL TEXTILES BY APPLYING OF BIOLOGICALLY ACTIVE COMPOUNDS: REVIEW

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Abstract: *In the last years the cosmetic industry using plant derivatives grow significantly for whole domains in which activates. Essentials oils and plant extracts are assumed to be ecologically sound and there is generally an absence of unwanted side effects arising from the use of them. Essential oils present a particular interest due to multiple benefits it shows such as antiviral, antifungal, antibacterial, antioxidant, insecticidal, radical scavenging properties, anti-inflammatory, antiseptic, germicide, healing and cosmetic effects. 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 substances. Bioactive systems are applied to the textile materials by a variety of techniques. Microencapsulation technology offers many opportunities to improve the properties of textiles or enhance them with value added functions. One major advantage of using microencapsulation technology that acts as the delivery system of cosmetic substances is its ability to protect active ingredients from hazardous environment. Another important advantage is its controlled release properties that seem to be the best choice for increasing the efficiency and minimization of environmental damage. When different active substances for body care or health are embedded into textiles, they are then later releasing them systematically being gradually transferred to the skin by natural movement, pressure or the effect of the skin's natural warmth and enzymes. Microcapsules can be applied to the textiles by different methods: padding, coating, spraying or immersion methods.*

Key words: textiles for cosmetic use, microcapsules, wellness, controlled releasing

1. INTRODUCTION

In recent years, world textile industry is moving rapidly toward the manufacture of high added value textile structures and functional products such as medical textiles, protective textiles and smart textiles and some products, including cosmetic textiles and healthcare textiles, are currently available in the market [1]. However, with the growing demand of enhancing beauty with health, customers request that the apparels and home textiles not only have the original basic characteristics such as maintaining warmth and providing comfort, but also carry extra functions such as antimicrobial, odor absorption, UV protection, self-cleaning properties, moisture and temperature management, in an attempt to provide a more natural and healthier life [2]. The current "green" trend is moving away from the use of chemical and non-sustainable products, in favor of those considered

not harmful to nature. In addition, health and wellness benefits, the replacement of artificial scent with essentials oils that are naturally derived can be considered environmentally friendly.

With a growing market share in herbal products, research shows that the uses of essential oils for fragrance are underrepresented in everyday product applications as compared to chemical fragrances. Essentials oils and plant extracts are assumed to be ecologically sound and there is generally an absence of unwanted side effects arising from the use of them. Essential oils present a particular interest due to multiple benefits it shows such as antiviral, antifungal, antibacterial, antioxidant, insecticidal, radical scavenging properties, anti-inflammatory, antiseptic, germicide, healing and emollient effects.

2. ESSENTIAL OILS WITH COSMETIC EFFECT

The whole essential oil has to be considered in all its complexity, which comprises the mixture of possibility, hundreds of different of molecules, their molecular energy and their overall synergy. The main effects induced by essential oils on the body systems are: refreshing, relaxing, calming, balancing, provides astringent, antiseptic and decongestant properties, therapeutic properties, toning, fortifying, cooling and so on. The essential oils present also extraordinary antioxidant effects having an important role in the prevention of cell aging, wrinkles, sunspots, or hyperpigmentation caused by the free radicals coming from internal and external damage factors (Table 1).

Table 1: *Essential oils with cosmetic application*

Essential oil	Effect
Kenaf seed	Antioxidant
Red pepper seed	Antimicrobial
Jojoba	Antioxidant, anti-aging, moisturizing, increases skin elasticity, smoothness
Nut	Antioxidant and anti-aging
Sea buckthorn	Therapeutic role in atopic dermatitis
Avocado	Moisturizing and antioxidant
Oregano	Antioxidant, antimicrobial
Mint	Antimicrobial and antioxidant
Basil	Antibacterial, antifungal and antioxidant
Rosemary	Antibacterial, antifungal, antiseptic, astringent and antioxidant
Lippia sidoides	Antiseptic, anti-infective, antimicrobial and acaricide
Lemongrass	Antimicrobial
Lemon myrtle	Antimicrobial and antioxidant
Cinnamon leaf	Antimicrobial, antifungal, antioxidant and anti-inflammatory
Tea tree	Germicidal and antibacterial, antiseptic, acne treatment
Thyme	Antimicrobial and antioxidant
Coffee	Reduction of the wrinkles and pigmentation
Coconut	Emollient, toning and healing properties
Pomegranate seed	Regenerating the skin and even lightening the pigmented skin

3. EMBEDDING TECHNIQUES OF ESSENTIAL OILS

Losses by evaporation and difficulties in their controlled release make the essential oils in commercial application to be limited. In this case, nanocarrier systems (lipid-based particles, nanoemulsions and biocompatible polymer-based particles) can provide an ideal solution for realizing a controlled and targeted delivery of the essential oil.

In the last few years, the application of biocompatible and biodegradable polymer-based formulations as a controlled release form has generated an immense interest [3]. Bioactive systems are applied to the textile materials by a variety of techniques. Microencapsulation is actually a micro packaging technique that involved production of microcapsules or microspheres which act as barrier walls of solids or liquids. One major advantage of using microencapsulation technology, which acts as the delivery system of bioactive substances, is its ability to protect active ingredients from hazardous environment (oxidization, heat, acidity, alkalinity, moisture or evaporation). Another important advantage is its controlled release properties that seem to be the best choice for increasing the efficiency and minimization of environmental damage. The biocompatibility of the delivery system of biological active substance should be nontoxic and noncarcinogenic with no interest in the related issues of mutagenicity and teratogenicity. Being an ex-vivo application, the body care textiles should not cause any irritation of skin while releasing the active ingredients in the same time.

The microcapsules are formed from an active ingredient which represents the core and the external phase which represents the shell. Usually, the shell of the microcapsules gives the properties, such as: size, shape, releasing type of active compound, the process efficiency or the stability of microcapsules and depending on the destination, it choice the methods to prepare them. In the shell construction polymers and natural biomaterials (carbohydrates and proteins) are used [4]. In Fig. 1 the main microcapsule models are presented.

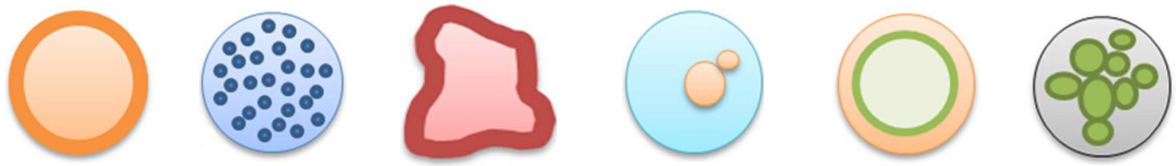

Fig. 1: *Various types of microcapsules: a) simple microcapsule, b) matrix (microsphere), c) irregular microcapsule, d) multicore microcapsule, e) multiwall microcapsule, and f) assembly of microcapsule.*

The microencapsulation technology presents various advantages such as: protection of active compound against environmental conditions prevents the interaction between active ingredient and other chemical species from system and controlled releasing of active compound [5], [6]. In order to maintain the unaltered properties of the core material, the microcapsules can present spherical or distorted shape and according to the Table 1, they have sizes between 0.1–200 μm, containing one or more active compound wrapped into a synthetic or natural material, which dictates the release type. The core may contain a solid or liquid substances, solutions or suspensions and mixture of solids or liquids.

The efficiency of the microcapsules is given by the compatibility between core and shell material. The size of the core material is a parameter which plays an important role in the diffusion, permeability and the releasing of the active compound, when most often the material type of the shell consists of a polymer which must present: physical-chemical compatibility with the core, flexibility, impermeability and stability. The shell of the material offers temporarily or permanently protection of the core from external influences and may be: permeable, semipermeable (impermeable to the active compound and permeable to liquids with low molecular weight), waterproof (active ingredient is released following degradation of the shell) [7]. The biocompatibility of the delivery system of biological active substance should be nontoxic and noncarcinogenic with no interest in the related issues of mutagenicity and teratogenicity.

Table 2: *Physical-chemical characteristics of microcapsules obtained through the main industrial processes*

Procedures	Size (□m)	Particle size distribution	Morphology	Encapsulation rate (%)	Release type
Polimerization in dispersed medium	0.1-15	Narrow	Microsphere	<50	Prolonged release by diffusion Triggered release pH effect, dehydration, mechanical effect, dissolution, enzymatic attack
Interfacial polycondensation	0.1-50	+/- large	Microcapsule	<80	
Interfacial polyaddition	0.2-5	+/- large	Microcapsule	<80	
Spray-drying	1-50	large	Microsphere	<40	
Complex coacervation	5-200	+/- large	Microcapsule	70-90	
Simple coacervation	20-200	+/- large	Microsphere Microcapsule	<60	Prolonged release
Emulsion - solvent extraction	0.5-200	+/- large	Microsphere	<25	
Thermal gelification of emulsions	10-100	+/- large	Microsphere	<20	
Extrusion / spheronization	>200	Narrow	Microsphere	<50	
Spray drying	>100	Narrow	Microcapsule	60-90	Triggered release by thermal effect or pH effect
Gelification or freezing of gout	>200	Narrow	Microsphere	<30	

4. APPLICATION METHODS OF MICROCAPSULES ON TEXTILES

Many textiles are excellent media for transferring bioactive compounds (essential oils, plant extracts, vitamins, moisturizing and anti-aging agents) and have the relatively lower incidence of adverse effects of herbal products as compared to modern synthetic pharmaceuticals. In the textile industry the development of cosmetic textiles by nano- and micro- technologies represents a dynamic field in scientific research. It is wanted to develop sustainable cosmetic textiles to reduce the necessity for daily application of the cosmetic or medicinal ingredient.

A replacement variant of ointments, creams or lotions by using the textile materials containing cosmetic or medicinal ingredients is a more efficient way from volume control point of view, uniformity and by controlled releasing of active ingredients directly from the reservoir attached to the polymer fibers on the superficial layer of the skin, without additional steps. Current, cosmetotextiles in the market claim to be moisturizing, cellulite reducing, perfumed, body slimming, energizing, rejuvenating, refreshing, improving the firmness and elasticity of skin, or reducing the appearance of fine lines and wrinkles. When different active substances for body care or health are loaded/embedded into textiles, they are then later releasing them systematically (that means they interact with the body), being gradually transferred to the skin by natural movement, pressure or by the effect of the skin's natural warmth and enzymes (Fig. 2).

Bioactive systems are applied to the textile materials by a variety of techniques. Microencapsulation technology offers many opportunities to improve the properties of textiles or enhance them with value added functions. Many textile chemical companies have put forth much investigation in this area and offer various microencapsulation treatments that aim for body care benefits. Also, many effective approaches to microencapsulation bioactive compounds are based on using of cyclodextrins which are the best regarding safety to the human body, because β-cyclodextrin has no skin irritation, no skin sensitization and no mutagenic effect [8], [9].

Furthermore, cyclodextrins embedded on textile materials do not affect the material properties, and keep their ability to form inclusion complexes with other suitable molecules. Also, chitosan and sodium alginate are two kinds of commonly used natural polymers that have no toxicity, are good biodegradable, have high biocompatibility properties and are widely applied as wall materials.

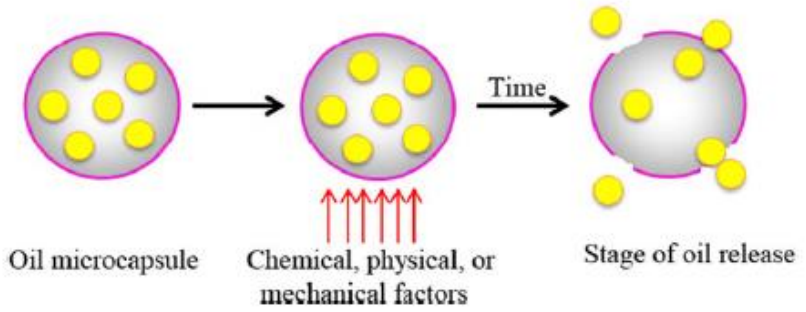

Fig. 2: Schematic representation of essential oil controlled release mechanism

One of the manufacturing processes of textiles for body care is based on functionalization of synthetic fibers (e.g. Novarel, Nilit Breeze, Emana) or of man-made fibers (e.g. Tencel C) by fixing microparticles (e.g. bioactive minerals, chitosan) or microcapsules (with content of Vitamin E, Aloe Vera, natural oils) in their structure. Another method to manufacture textile materials for body care benefits consists in the fabrics functionalization by microcapsule fixing on the external surface of the fabric, resulting in an end-product for beauty, healthcare and wellbeing. When microcapsules are applied to textiles, commonly used shells are not reactive otherwise, they would stick together. As a result of that chemical stability, no chemical reaction can be applied between microcapsule and fibers. Thus, in order to improve durability to washing or the handle, some auxiliary products based on acrylic, polyurethanes or silicone resins are used to fix the microcapsules to the fiber surface.

Microcapsules can be applied to the textiles by different methods: padding, coating, spraying or immersion methods [9]. The padding technique assumes the impregnation of the textile support in a chemical solution which contains microcapsules and other functionalization agents using cylinders under pressure, being followed by a curing process where the functionalization agents are fixed onto the textile surface. One of the most significant factors in the padding process is represented by the absorption capacity of chemical solution. In the case of exhaustion process, the functionalization agents (microcapsule dispersions) are dispersed in a solution and, in this manner, the microcapsules are transferred to the textile fibres due to the affinity between functionalization agent and fibre [9]. Another way to apply the microcapsules can be the finishing by spraying. Regarding this technique there are two main options: compressed air spraying and hydraulic spraying. In the first case, the technology is based on the applying of chemical substances to spray media or spray guns using compressed air. This technique presents the disadvantage of an inhomogeneous distribution of the finishing agents. In the second case the minimum quantity of the required solution is scattered under very high airless pressure as a carrier medium for application finishing agents (microcapsule dispersions) in homogeneous behaviour on the textile support. The main advantages of this technique consist in: the absence of the cylinders under high pressure may contributes significantly to the risk elimination of solution breakdown, the reduction of water consumption, the reduction of energy costs, the decreasing consumption of chemical agents and shorter times than other techniques [9].

5. CONCLUSIONS

The desire for a healthier and more productive lifestyle will continue to generate a market for textiles that promote 'well-being'. Textiles that 'interact' with the consumer, reducing stress, promoting comfort and relaxation, are possible through active delivery of microcapsules. The cosmetotextiles field is growing year by year and is starting to use natural ingredients, which are more eco-friendly than synthetic alternatives. One challenge in this field is represented by the optimization of procedure for the incorporation of active ingredient with wellness effects in a polymeric shell and the application of microcapsules on the surface of textile supports.

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