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REVIEW ARTICLE

COSMETOTEXTILES AND EVALUATION OF THEIR PERFORMANCE

Evren ALGIN YAPAR[1*], İmren ESENTÜRK[2], Aslı ŞAHİNER[3], Ece HALAT[3], Bilge Ahsen KARA[4], Rajni BALA[5], Rakesh K SINDHU[5]

[1]*Ministry of Health, Turkish Medicines and Medical Devices Agency, Department of Analysis and Control Laboratories, Ankara, Turkey.*
[2]*University of Health Sciences Turkey, Hamidiye Faculty of Pharmacy, Department of Pharmaceutical Technology, Istanbul, Turkey.*
[3]*Ege University, Faculty of Science, Department of Biology, Izmir, Turkey.*
[4]*Ministry of Health, Ankara Gazi Mustafa Kemal State Hospital, Ankara, Turkey.*
[5]*Chitkara University, Chitkara College of Pharmacy, Punjab, India.*

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***Address for Correspondence:**
Dr. Evren ALGIN YAPAR, Ministry of Health, Turkish Medicines and Medical Devices Agency, Department of Analysis and Control Laboratories Ankara, Turkey,
Tel- +903125655370.
E-mail: *evren.yapar@yahoo.com*

Abstract

Cosmetotextiles are textile products that release a cosmetic substance or formulation in the application area for cosmetic purposes. Cosmetic substances or formulations loaded carriers such as micro or nano-sized microcapsules, microsphere, cyclodextrin, liposome, solid lipid nanoparticles, are attached or processed on textile to prepare cosmetotextiles. As a textile material woven fabric, knitted fabric and non-woven fabrics are used for cosmetotextiles, and within this scope, relevant cosmetic and textile standards and regulations are taken into account in the performance evaluation of products, especially for effectiveness and safety. Important standards for cosmetotextiles include PD CEN/TR 15917:2009, ISO 3175-1, ISO 3758, ISO 6330 and ISO 22716. PD CEN/TR 15917:2009 includes the tests for cosmetic claim substation such as skin moisturizing, body firming, assessment of outer appearance of cellulite etc. The PD CEN/TR 15917:2009 standard specifies the general properties, claimed effects, safety assessment and labeling of slimming, moisturizing and regenerating preparations that fall into the cosmetotextile class.

Keywords: Cosmetotextiles, cosmetic functions, carrier systems, ISO standards, performance tests.

INTRODUCTION

Legislations and scope of cosmetics have some differences in various countries[1-3]. According to the European legislation, cosmetics generally means any substance or mixture intended to be placed in contact with the external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odours and cosmetic substance means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and any impurity deriving from the process used but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition. Cosmetics have borderlines with medicines, medical devices, biocidal products, toys, textiles and nutrition products[1]. Functional textiles are fall in the scope of borderlines owing to their multiple properties. According to the loaded substance/formulation and the intended usage they can fall in the scope of cosmetics, biocidal products, medical devices, medicines or home textiles[4-6].

A cosmetotextile product refers to a textile product of which main purpose is to show a cosmetic effect and carries a cosmetic substance or formula released over time. Although the preparation and usage purposes of cosmetotextiles are similar throughout the world, the legal scope differences between countries are also reflected in these products.

The main purposes of cosmetotextiles can be grouped as follows[7-9];

1. Moisturizing
2. Anti-aging

3. Protection from UV rays
4. Sweating and odor prevention
5. Perfuming
6. Body shaping
7. Relaxation and refreshing.

Properties and production of Cosmetotextiles

The most important property of cosmetotextiles is that they release the cosmetic substance/formula for the specified period and thus show their effects for a long time. In this context, below three criteria are important for the finished product[7-9];

1. Properties and parameters related to the cosmetic substance/formula and the carrier molecule/particle.
2. Properties and parameters related to the application of the cosmetic carrier units to the textile.
3. Properties and parameters related to the textile.

The textiles used for cosmetotextiles can be woven fabric, knitted fabric or non-woven fabric, which are flexible materials consisting of natural or synthetic yarns. Various active ingredients are added using different techniques to create a cosmetic effect in textile materials. Substances such as binders, carrier molecules/particles, dyestuffs, textile auxiliary substances contained in the textile but not intended to be carried to the body are not in the context of cosmetic products. Basically cosmetic carrier units applied to textiles by a process based on adhesion and cohesion forces to obtain the finished cosmetotextile product. Cosmetic substance or formulation carrier units can be either a molecule such as various types of cyclodextrins or a particle such as microcapsule, nanocapsule, microsphere, nanosphere, liposome, nanosome, solid lipit nanoparticle etc[10,11,12,13].

Cosmetic textiles are produced using various techniques such as doping into raw materials, grafting onto fiber, yarn or fabric surface, direct coating or encapsulation and microcapsulation[14]. Microencap-sulation is the method applied to isolate active substances by covering them with a membrane produced by synthetic or natural polymers and to ensure that they are released into the environment in a controlled manner[15]. Controlled release of active substance in cosmetic products is of great importance. With the slow and continuous release mechanism, excess amount is avoided and the cosmetic substance is released into the human skin in a controlled manner. With nanotechnology techniques, new textile products, nanofibers or nanocomposites can be produced from nano-sized building materials with different functions. The existing functions of the textile material; It is also possible to develop it by adding nanoparticles that give different properties to the fiber, yarn or fabric surface[16]. Nanofiber cosmetic structures can be categorized as face masks and skin cleansers, skin health promoting and regenerating products, and skin wound healing products[17]. Another method used in the production of cosmetotextile products is grafting. Grafting can be done with cyclodextrins. Since cyclodextrins have a polar hydrophilic outer surface and a hydrophobic inner surface, they can host hydrophobic components in a hydrophilic environment. The crystal form of this molecule provides increased resistance of active substances against oxidation, hydrolysis, photochemical reactions, decreased evaporation rates of volatile substances and their controlled release. Direct coating is based on the process of coating one or both surfaces of the fabric produced as knitted, woven or non-woven surface with a chemical substance. In addition, coating can be applied in the form of yarn. Especially woven fabrics are preferred to produce cosmetotextiles[18,19].

Test method of Cosmetotextiles

Since cosmetotextiles come into direct contact with the human body, it is of great importance for human health to determine the effects of the cosmetic activities of these clothes on the skin. Also cosmetotextile products consist of complex composition of different ingredients; this issue should be taken into account in the toxicological evaluation of total cosmetotextile and critical evaluations such as risk analysis, dose-response assessment and exposure amount[9,20]. PD CEN/TR 15917:2009, a technical standard, has been created to increase product safety of this technology. Cosmetic product used in a cosmetic textile must comply with the current European Cosmetics Regulation EC1223/ 2009.

The cosmetic substance delivery system must be biocompatible, which is acceptable to body tissues[21]. It should not be toxic or carcinogenic. Active ingredients in cosmetotextiles should not cause skin irritation[22]. Whether the cosmetotextile products show the claimed effect after use, the required application time to see the effect of the product, their washing resistance, whether they are eco-friendly and the shelf life of the product should be determined by related laboratory tests and performance studies. The cosmetic performance expected from cosmetotextiles decreases over time depending on the usage and maintenance process. For this reason, the durability of the product should also be tested.

Establishment of test standards for the evaluation and testing of the effectiveness, safety and durability of cosmetic textiles is provided by the European Standardization Committee.

Either for safety, effectiveness and quality control of cosmetotextiles are mainly subjected and can be evaluated according to the below listed standards[9,23-26];

- PD CEN/TR 15917, Textiles. Cosmetotextiles.
- prEN ISO 3175-1, Textiles - Dry cleaning - Part 1: Methods for cleanability assessment of textiles
- EN ISO 3758, Textiles - Label codes using symbols
- EN ISO 6330, Textiles - Hand washing and drying procedures for Textiles
- EN ISO 22716, Cosmetics-Good Manufacturing Practices (GMP)

Chemical and physical properties of cosmetotextile products, such as acidic or basic character, flammability or ability to react with another substance, are tested according to current legal guidelines and cosmetic standards. Before cosmetic textiles are put on the market, it is necessary to test the active ingredient and undergo biological tests in accordance with the current test standards in the cosmetic industry. To

determine the biocompatibility and non-toxicity of the product, EN ISO 10993, OECD (OECD 405, 406, 407 & 471) test methods should be used, respectively, and the product must meet these tests successfully[14].

The effectiveness of cosmetotextiles should be tested under the same conditions as cosmetic product standards. In the measurement of cosmetic effect the performance of cosmetotextiles can be evaluated below indicated methods[9,27,28];

Corneometry for moisturizing/skin barrier functionality ; Cytometry, Ballistometry, Torcmetry for tightening/ increasing skin elasticity Skin pH meter for skin pH measurement Profilometry or grid projection for skin roughness/skin topography; Diffuse Reflectance Spectroscopy for bleaching; Diaphragm Fluoroscopy (Sniff test) can be applied for odoring or deodorization/odor prevention. Maintenance resistance of cosmetotextile; It is evaluated by determining the amount of cosmetic product left on the cosmetotextile after a certain number of maintenance periods. Care conditions are described in ISO standards in accordance with washing EN ISO 6330 and dry cleaning prEN ISO 3175-1 in terms of textile care.

The labeling and the information contained in cosmetotextiles within the scope of cosmetic products are critical for the performance and maintenance of the product. Among this information;

1. The function/purpose of the product.
2. The method of use.
3. The composition of the cosmetics.
4. The composition of the textile.
5. The maintenance process.
6. The usage time.
7. The reference for traceability (lot number etc.).

Other needed cosmetic and textile requirements are included.

Recent studies on cosmetotextiles

Studies on cosmetotextiles have been raising on recent years. Between those; a cosmetotextile product made of cotton/elastane which was functionalized with bovine serum albumin (BSA) or BSA/silk fibroin nanoemulsions encapsulating α-tocopherol. The functionalization of the fabrics with proteins did not disturb their comfort properties and functionality also imparted antioxidant activity[29]. In another study, allantoin loaded liposomes were prepared and applied to polyamide and cotton fabrics. It was shown that allantoin loaded liposomes were successful for moisturizing the skin thus suitable for cosmetotextile applications[30]. Gallic acid was encapsulated in poly-ε-caprolactone microspheres and then incorporated into polyamide for obtaining the cosmetotextile with an increased antioxidant activity by another group of researchers [31]. Also, microencapsulation of fragrances into microcapsules enables great potential for their sustained release within the context of cosmetotextile. Neroline was encapsulated in polyurethane microcapsules and then neroline loaded microcapsules were fixed on cotton fabric for this purpose[32]. Başyiğit *et al.*,[33] developed polypropylene fabrics which were impregnated with three different delivery systems (microcapsule, microemulsion or solid lipid nanoparticle systems) containing vitamin E in their study. It was shown that all nanocarriers prolonged vitamin E release but best by solid lipid nanoparticles from cosmetototextile products for use in skin cell repair and restoration for ocular area. Due to having large surface area, very small diameters, high loading efficiency and sustained release properties, electrospun nanofibers are one of the promising cosmetotextiles in recent years[34,35]. In a study, electrospun poly (vinyl alcohol)/chitosan nanofibers incorporated with a combination of polyphenol-rich-herbal extracts was developed for use in facial acne treatment. The prepared nanofibers exhibited sustained delivery of herbal extracts and good antibacterial activity against Propionibacterium acnes and has opened new horizons for the new generation of cosmetotextiles[36].

CONCLUSIONS

Today, consumers prefer comfortable and multifunctional products in textile products, among the textile products and this encourages manufacturers to design more functional products. Cosmetotextiles are products that can allow the active substance to be transferred to the human skin in a slow and more controlled manner. Cosmetotextile industry is an area that continues to develop in the field of cosmetics and it has seen that scientific studies are increasing day by day. In this direction, while the usage purposes and contents of cosmetotextiles are expanding, the tests for evaluation of their effectiveness, safety and quality are also increased and diversified.

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AUTHOR'S CONTRIBUTION

ALGIN YAPAR E: study design, writing original draft. **ESENTÜRK İ:** literature survey. **ŞAHİNER A:** critical review. **HALAT E:** methodology, formal analysis. **KARA BA:** visualization, editing. **BALA R:** critical review. **SINDHU RK:** editing. The final manuscript was read and approved by all authors.

DATA AVAILABILITY

Data will be made available on reasonable request.

CONFLICT OF INTEREST

None to declare.

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