**INTRODUCTION**

Legislations and scope of cosmetics have some differences in various countries. 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 borders with medicines, medical devices, biocidal products, toys, textiles and nutrition products. Functional textiles are fall in the scope of borders 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.

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:

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

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. A molecule such as various types of cyclodextrins or a particle such as microcapsule, nanocapsule, microsphere, nanosphere, liposome, nanosome, solid lipid nanoparticle etc. can be used in this process.

Cosmetic textiles are produced using various techniques such as dipping into raw materials, grafting onto fiber, yarn or fabric surface, direct coating or encapsulation and microencapsulation. Microencapsulation 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. 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. Nanofiber cosmetic structures can be categorized as face masks and skin cleansers, skin health promoting and regenerating products, and skin wound healing products. 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.

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. 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. It should not be toxic or carcinogenic. Active ingredients in cosmetotextiles should not cause skin irritation. 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:

- PD CEN/TR 15917, Textiles. Cosmetotextiles.
- prEN ISO 3175-1, Textiles - Dry cleaning - Part 1: Methods for cleanliness 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. 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.  

Coneometry for moisturizing/skin barrier functionality; Cytometry, Ballistometry, Torcmetry for tightening/increasing skin elasticity Skin pH meter for skin pH measurement Profiometry 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. 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. Gallic acid was encapsulated in poly-e-caprolactone microspheres and then incorporated into polyamide for obtaining the cosmetotextile with an increased antioxidant activity by another group of researchers. 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. Başyiğit et al. 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 cosmetotextile 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, electrosprun nanofibers are one of the promising cosmetotextiles in recent years. In a study, electrosprun 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 acneus and has opened new horizons for the new generation of cosmetotextiles.

CONCLUSION  

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.

REFERENCES  

1. Regulation (EC) No1223/2009 on Cosmetics Products. https://ec.europa.eu/health/sites/default/files/endocrine_disruptors/docs/cosmetic_1223_2009_regulation_en.pdf Accessed 24 May 2021  
2. Borderline products manual on the scope of application of the Cosmetics Regulation (EC) No 1223/2009 (Art. 2(1)(a)) (September 2020, version 5.2) (1 MB). https://ec.europa.eu/growth/sectors/cosmetics/products/borderline-products_en Accessed 24 May 2021.  
3. Federal Food, Drug, and Cosmetic Act, FD&C Act Reference Information. United States Code, Title 21, 2018. https://www.fda.gov/regulatory-information/laws-enforced-fda/federal-food-drug-and-cosmetic-act-fdact Accessed 24 May 2021.  
4. Cosmetics Act No. 15947, Dec. 11, 2018 https://elaw.kli.re.kr/eng_service/View.do?serviceId=ENG Accessed 24 May 2021.  
5. Elsner P, Maibach HI. Cosmeceuticals: Drugs vs. Cosmetics. New York: Marcel Dekker Inc 2000; 3-142.  
6. Heide M, Möhring U, Hansel R, Stoll M, Wollina U, Heinig B. Antimicrobial-finished textile three-dimensional structures. in: biofunctional textiles and the skin. Eds: Hipler UC, Elsner P. Vol 33, Basel: Karger Inc 2006;179-199. https://doi.org/10.1159/000093945  
7. Singh MK, Varun VK, Behera BK. Cosmetotextiles: state of art, fibres and textiles in Eastern Europe 2011:19; 4(87):27-33.  
8. Buschmann HJ, Schollmeyer E. Cosmetic textiles—a new functionality of clothes. Cosmetics Toilet 2004; 119(5): 105-12.  
9. PD CEN/TR 15917:2009 Textiles-Cosmetotextiles.
10. Subramanian K, Govindan I. Integration of Cosmetics with Textiles- An emerging area of Functional Textiles - A review. Lat Trends Text Fashion Des 2018; 1(1): 122-124. https://doi.org/10.3247/LTTFD.2018.01.000126

11. Rivero PJ, Ureña C, Goicoechea J, Arregui FJ. Nanomaterials for functional textiles and fibers. Nanoscale Res Lett 2015; 10(1): 501. https://doi.org/10.1186/s11671-015-1959-6

12. Bhaskara-Amit UR, Agrawal PB, Warnoeskerken MMCG. Applications of beta -cyclodextrins in textiles. AUTEX Res J 2011; 11(4): 94-101. http://www.autex.org/Nov-2011/0920_11.pdf

13. Sawhney APS, Condon B, Singh KV, Pang SS, Li G, Hui D. Modern Applications of Nanotechnology in Textiles. Textile Res J 2008; 78: 731. https://doi.org/10.1177/0040517508091066

14. Singh MK, Behera BK, Varun VK. Cosmetotextiles: state of art. Fibers Text East Europe 2011; 19(4): 87-27, 33, 2011

15. Manjanna K, Shivakumar B, Kumar T. Microencapsulation: an acclaimed novel drug delivery system for NSAIDs in arthritis, Critical Reviews™, Therap Drug Car Syst 2010; 27(6):501-532. https://doi.org/10.1615/CritRevTherDrugCarrierSyst.v27.i6.20

16. Doğan G. Investigation of the possibilities of using biopolymer nanofibers obtained by electrospinning method in tissue engineering and drug release applications. PhD thesis, Institute of Science, Ege University, İzmir, Turkey, 2014.

17. Yılmaz F, Celep G, Teted G. Nanofibers in cosmetics. Nanofiber Research—Reaching New Heights, 1st ed., Rahman M, Aziz AM, Eds. Croatia: Intechopen, 2016, 127-146. https://doi.org/10.3390/inventions2020009

18. Issazadeh-Baltorki H, Khodamian A. Cyclodextrin-coated denim fabrics as ingredient deliverers to the skin. Carbohydrate Polym 2014; 110513-517. https://doi.org/10.1016/j.carbpol.2014.03.008

19. Erkan G. Microencapsulation of some antifungal agents and their application to textile materials. PhD thesis, Institute of Science and Technology, Dokuz Eylül University, İzmir, Turkey, 2008. https://doi.org/10.1016/j.jbiomac.2019.10.197

20. Alonso C, Martí M, Martínez V, Rubio L, Parra JL, Coderch L. Antioxidant cosmeto-textiles: skin assessment. Eur J Pharm Biopharm 2013; 84(1):192-9. https://doi.org/10.1016/j.ejpb.2012.12.004

21. Kan C, Yuen C. Cosmetic textiles. Textile Asia 2005; 36, (6):29-35.

22. Borkow G. Cosmetotextiles - sometimes the simple things work. J Cosmetol Trichol 2016;2(1):1-2. http://dx.doi.org/10.4172/2471-9323.1000e103

23. pEN ISO 3175-1, Textiles-Dry cleaning - Part 1: Methods for cleanliness assessment of textiles

24. EN ISO 3758, Textiles-Label codes using symbols

25. EN ISO 6330, Textiles-Hand washing and drying procedures for Textiles

26. EN ISO 22716, Cosmetics- Good Manufacturing Practices (GMP)

27. Wright CY, Karsten AE, Wilkes M, Singh A, du Plessis J, Albiers PN, Karsten PA. Diffuse Reflectance Spectroscopy Versus Metamer(®) MX18 Measurements of Melanin and Erythema in an African population. Photochem Photobiol 2016; 92(4):632-6. https://doi.org/10.1111/php.12607

28. LoMauro A, Martorana C, Aliverti A, Nosetti M, Palleschi A, Privitera E. European Resp J 2019; 54(63): PA2194. https://doi.org/10.1183/13993003.congress-2019.PA2194

29. Ghaheh FS, Noro J, Vatankhah E, et al. The comfort properties of cosmeto-textiles functionalized with protein-based nanoemulsions encapsulating Vitamin-E J Nat Fib 2021; 1-13. https://doi.org/10.1080/15440478.2021.1921657

30. Sayit G, Tanrverdi ST, Özer Ö, Özdoğan E. Preparation of allantoim loaded liposome formulations and application for cosmetic textile production. The J Text Inst 2021; 1-12. https://doi.org/10.1183/10400450.2021.1903197

31. Alonso C, Martí M, Barba C, Lis M, Rubio L, Coderch L. Skin penetration and antioxidant effect of cosmeto-textiles with gallic acid. J Photochem Photobiol B: Biology 2016; 156: 50-55. https://doi.org/10.1016/j.photobiol.2016.01.014

32. Abdullah MB, Azizi N, Baffoun A, Chevalier Y, Majdoub M. Fragrant microcapsules based on β-cyclodextrin for cosmetotextile application. J Renewable Mat 2019; 7(12): 1347-62. https://doi.org/10.32604/jrm.2019.07926

33. Başyapıt ZÖ, Dilek KUT, Yenilmez E, Eyupoğlu Ş, Hocaoglu E, Yazan Y. Vitamin E loaded fabrics as cosmeto textile products: formulation and characterization. Tekstil ve Konfeksiyon 2018; 28(2):162-169.

34. Yılmaz F, Celep G, Gamze T. Nanofibers in cosmetics. Nanofiber research-reaching New heights 2016; 127-145. https://doi.org/10.32604/jrm.2019.07926

35. Baskan H, Esentürk I, Dösler S, Karakas H. Electrospun nanofibers of poly (acrylonitrile-co-itaconic acid)/silver and polyacrylonitrile/silver: In situ preparation, characterization, and antimicrobial activity. J Indust Text 2019; 50(10): 1594-1624. https://doi.org/10.17771/520083719868170

36. Tang Y, Liu L, Han J, et al. Fabrication and characterization of multiple herbal extracts-loaded nanofibrous patches for topical treatment of acne vulgaris. Fibers Polym 2021; 22(2): 323-33. https://doi.org/10.1007/s12221-021-0156-1