Review / Derleme

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Cosmetic microbiology

Kozmetik mikrobiyoloji

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Abstract

Historically, cosmetics have signified not only aesthetic enhancement but also social identity and status. Today, cosmetic products are evaluated for both their aesthetic value and their safety and health implications. Cosmetic microbiology focuses on preventing microbial contamination throughout the production-to-consumer process, assessing the efficacy of biocidal preservatives, and ensuring compliance with national and international standards. This review discusses the historical development of cosmetic products, microbiological risks, and the principal bacterial and fungal species responsible for contamination. It also examines biocidal preservatives used in cosmetic production, their mechanisms of action, permitted concentration limits, and potential toxic effects. This review evaluates current methods, including preservative efficacy tests [International Organization for Standardization (ISO) 11930] and microbiological limit values (ISO 17516). It also emphasizes microbially specific criteria, particularly for products intended for children, periocular use, and infants. In summary, cosmetic microbiology is essential for product safety, consumer health protection, and industry sustainability. Effective biocide selection, appropriate production conditions, and standardized microbiological testing collectively enhance cosmetic product reliability.

Keywords: Cosmetic microbiology, microbial contamination, biocidal preservatives, preservative efficacy tests, ISO 17516, ISO 11930, cosmetic safety, microbiological quality control, antimicrobial preservatives, consumer health

Öz

Kozmetikler tarih boyunca estetik görünümün yanı sıra toplumsal kimlik ve statünün de bir göstergesi olmuştur. Günümüzde ise kozmetik ürünlerin yalnızca güzellik amacıyla değil, aynı zamanda güvenlik ve sağlık boyutuyla da değerlendirilmesi gerekmektedir. Kozmetik mikrobiyolojisi, ürünlerin üretiminden tüketiciye ulaşmasına kadar geçen süreçte mikrobiyal kontaminasyonun önlenmesini, biyosidal koruyucu maddelerin etkinliğinin değerlendirilmesini ve ulusal-uluslararası standartlara uygunluğun sağlanmasını hedefleyen bir alandır. Bu derlemede kozmetik ürünlerin tarihsel gelişimi, mikrobiyolojik açıdan riskleri ve kontaminasyona neden olabilecek başlıca bakteri ve mantar türleri ele alınmıştır. Ayrıca kozmetik üretiminde kullanılan biyosidal koruyucu ürünler, etki mekanizmaları, izin verilen konsantrasyon limitleri ve olası toksik etkileri ayrıntılı olarak tartışılmıştır. Koruyucu etkinlik testleri [Uluslararası Standardizasyon Örgütü (ISO) 11930] ve mikrobiyolojik sınır değerler (ISO 17516) çerçevesinde güncel kalite kontrol yöntemleri değerlendirilmiş; ürün kategorilerine göre (özellikle çocuk, göz çevresi ve mukozal ürünler) farklılaştırılan mikrobiyolojik güvenlik kriterleri vurgulanmıştır. Kozmetik mikrobiyoloji; ürün güvenliği, tüketici sağlığı ve sektörün sürdürülebilirliği açısından kritik öneme sahiptir. Etkin biyosid seçimi, uygun üretim koşulları ve standardize edilmiş mikrobiyolojik testler sayesinde kozmetik ürünlerin güvenilirliği artırılabilmektedir.

Anahtar Kelimeler: Kozmetik mikrobiyoloji, mikrobiyal kontaminasyon, biyosid koruyucular, koruyucu etkinlik testleri, ISO 17516, ISO 11930, kozmetik güvenliği, mikrobiyolojik kalite kontrol, antimikrobiyal koruyucular, tüketici sağlığı

Introduction

The term "cosmetic" is defined by the Food and Drug Administration (FDA) as follows: Products applied to the external surfaces of the human body, namely the hair, skin, and nails, for cleansing, beautifying, promoting attractiveness, or altering appearance[1]. In the relevant legislation, the Ministry of Health of the Republic of Türkiye defines a cosmetic product as all preparations or substances intended to be applied to various external parts of the human body, such as the epidermis, nails, hair, lips, and external genital organs, as well as to the teeth and oral mucosa, with the sole or primary purpose of cleaning these parts, perfuming them, changing their appearance and/or correcting body odors and/or protecting them or keeping them in good condition[2].

Historically, cosmetic products have indicated both aesthetics and cultural or social status. In recent decades, cosmetics have transitioned from providing solely visual benefits to being evaluated

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as health-oriented products within established safety and quality frameworks. Microbiological safety has thus become a central concern. Factors such as raw materials, hygienic conditions in production areas, employee practices, and packaging type indirectly influence the microbiological quality of cosmetic products. Bacterial and fungal contamination can cause product deterioration and pose health risks to users. Cosmetic microbiology focuses on detecting microorganisms in cosmetic products, establishing limit values, and developing effective preservative strategies. National and international standards [e.g., International Organization for Standardization (ISO) 17516, ISO 11930] guide cosmetic product safety evaluation. This review addresses microbiological contamination risks, biocidal preservatives, preservative efficacy tests, and the core principles of cosmetic microbiology in accordance with current guidelines.

History

According to archaeological findings dating back five hundred thousand years, paleoanthropologists believe that the first cosmetics were used by Homo erectus, who painted the body with red pigment containing iron oxide. The transition from Homo erectus to Homo sapiens occurred during these years. Homo sapiens, which evolved approximately three hundred thousand years ago, painted their dead red before burial. Cosmetics likely became widespread with the transition to settled life 40.000 years ago. During this period, women and men in Iraq and Egypt began to use kohl around their eyes. Eyes outlined with kohl were considered more attractive; however, kohl contained toxic metals such as ground lead sulfide (galena) or antimony sulfide. Following the first use of cosmetic pigments containing iron oxide, cosmetics spread among human populations across different continents. Around 5000 BC, Egyptian women were dyeing their hair. Red color on the lips and cheeks became a symbol of social status even then. Since cosmetics have a certain cost, they continue to represent social status today[3-5].

The history of bacteria predates the history of cosmetics. Scientists think the first bacteria appeared on Earth 3.5 million years ago. Microbiology as a science dates back about 300 years, when the Dutch scientist Antonie Philips van Leeuwenhoek first observed small living organisms ("animalcules")[6]. The term cosmetic is derived from the Greek word "kosmeticos." It means "to make more beautiful and more attractive"[5]. The history of cosmetic microbiology, however, is much more recent, dating back only about 70 years. In the 1930's, during World War II, the first major cosmetic companies began to be established. When the FDA was established in 1930, the major challenge in the quality control of cosmetics was mold contamination. At that time, parabens were widely used as effective preservatives[7]. In the 1930s, René Dubos discovered an enzyme capable of degrading the polysaccharide capsule of type III pneumococci. It was subsequently proposed that this enzyme could be used to inhibit bacteria such as *Pseudomonas* and *Klebsiella*, which can contaminate cosmetic products[8].

In the 1950's, antibacterial skin creams, toothpastes, mouthwashes, deodorants, soaps, anti-dandruff shampoos, and surgical cleansing products emerged. In the 1960's, the term "good manufacturing" began to be used. In the 1970's, following reports of blindness in individuals using mascara contaminated with Pseudomonas, the FDA developed efficacy control tests for cosmetics used around the eyes in 1975. In the 1980's, instead of using animals for cosmetic toxicity testing, researchers began performing toxicity tests on cells in cell culture plates.

During this period, researchers developed in vitro test methods to assess the efficacy of biocidal products used as preservatives. In the 1990's, new concepts such as clean air, clean water, and protection of nature also influenced the cosmetics industry. From the 2000's to the present, major advances have been made in controlling cosmetics through microbiological testing. Methods and targets within cosmetic products have changed, and applications that detect microbiological contamination and eliminate microorganisms much more rapidly have been developed[3].

Microorganism Control in the Cosmetics Industry

Biocidal preservative products are used during cosmetic production to protect raw materials and the final product from microorganisms. Disinfectant substances used for this purpose are generally referred to as biocides. During production, many control steps are required, ranging from personnel hygiene, environmental cleaning, and air control to the use of insecticides and pesticides for pest control[9,10]. A visual graphic including the control steps in the cosmetics industry is presented below (Figure 1).

Cosmetic manufacturers bear two primary responsibilities concerning the microbiological quality of their products. First, they must ensure that the finished product does not contain microorganisms in quantities or types that could compromise product quality or consumer health. Second, they must incorporate appropriate preservatives to prevent microorganisms introduced during normal use from adversely affecting product quality or safety. Microbial load is especially critical for cosmetic materials that come into direct contact with the skin.

Based on the "guideline on microbiological control of cosmetic products," laboratory studies on cosmetic products have become mandatory. Under this guideline published by the Ministry of Health, cosmetic product manufacturers must produce in accordance with the "good manufacturing practices guideline" and relevant directives. National and international guidelines are listed below.

1. Ministry of Health of the Republic of Türkiye. Turkish Medicines and Pharmacy Agency, Cosmetics Law No. 5324, 2005. The institution's name was later changed to the Turkish Medicines and Medical Devices Agency (TITCK).
2. Ministry of Health of the Republic of Türkiye. Turkish Medicines and Medical Devices Agency, Cosmetics Regulation, 8 May 2023.
3. Ministry of Health of the Republic of Türkiye. Turkish Medicines and Medical Devices Agency, Guideline on the Microbiological Control of Cosmetic Products. Version 3.0.
4. ISO 17516 "Cosmetics-Microbiology-Microbiological limits", 2014.
5. ISO 21149 "Cosmetics-Microbiology-Enumeration and detection of aerobic mesophilic bacteria", 2006.
6. ISO 16212 "Cosmetics-Microbiology-Enumeration of yeast and mould", 2008.
7. ISO 21150 "Cosmetics-Microbiology-Detection of *Escherichia coli*", 2006.
8. ISO 22717 "Cosmetics-Microbiology-Detection of *Pseudomonas aeruginosa*", 2006.

Turkderm - Turk Arch Dermatol Venereol
2026;60(3):140-146

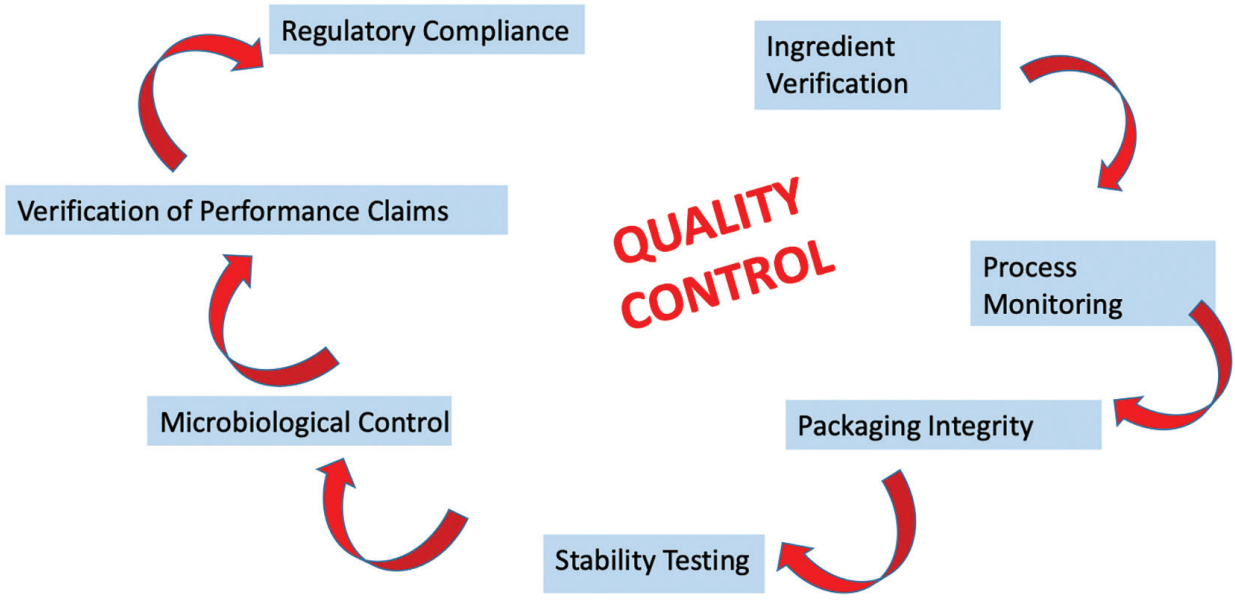


Figure 1. Quality control steps in cosmetic production[11]

9. ISO 22718 "Cosmetics-Microbiology-Detection of *Staphylococcus aureus*", 2006.
10. ISO 18416 "Cosmetics-Microbiology-Detection of *Candida albicans*", 2007.
11. ISO 29621 "Cosmetics-Microbiology-Guidelines for the risk assessment and identification of microbiologically low-risk products", 2017.
12. "European Pharmacopoeia 9.0, 2.6.12. Microbiological examination of non-sterile products: Microbial enumeration tests", 2017.
13. "European Pharmacopoeia 9.0, 2.6.13. Microbiological examination of non-sterile products: Test for specified microorganisms", 2017.

Cosmetics should be manufactured under aseptic conditions. Methods such as sedimentation and filtration remove microorganisms from cosmetics. For the physical and chemical killing of microorganisms, high temperature, low temperature, drying, high or low pH, anaerobic atmosphere, addition of disinfectants or biocides, radiation, and mechanical removal may be used[11]. Cosmetic products are evaluated in two separate categories. Category 1 includes products intended for children under 3 years of age, products applied around the eyes, and products applied to mucous membranes. Category 2 includes all other cosmetic products. According to ISO 17516:2014, the total microbial load for products within Category 1 should be ≤100 colony-forming units/gram (CFU/g) or mL. For other cosmetics, this limit may be ≤1000 CFU/g or mL[10,11].

Microorganisms that must absolutely not be present in cosmetics are as follows: *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Burkholderia cepacia, Serratia marcescens, Enterobacter* spp., *Klebsiella* spp., *Salmonella* spp., *Clostridium species* (particularly *Clostridium botulinum* and *Clostridium perfringens*, which are dangerous due to toxin production), *Candida albicans, Aspergillus* spp., and *Penicillium* spp[12]. Table 1 shows cosmetic products and the microorganisms that should not be present in their contents[12,13].

Regulations in Our Country

The "Guideline on the Safety Assessment of Cosmetic Products, Version 3.0," published by the TITCK, specifies the microbiological characteristics that cosmetic products should possess. In this guideline, cosmetic products are grouped into two categories in terms of microbiological quality control, with particular emphasis on the microbiological specifications of cosmetic products intended for use around the eyes, on mucous membranes, on sensitive skin, in children under three years of age, in elderly individuals, or in individuals with compromised immune responses. Table 2 shows the microbiological

Table 1. Microorganisms prohibited according to cosmetic product type[12,13]

Cosmetic product type	Prohibited microorganisms
Eye products	*Pseudomonas aeruginosa*: always prohibited. Other *Pseudomonas* species, *Staphylococcus aureus*, *Serratia marcescens*, and *Serratia liquefaciens*: generally prohibited.
Non-sterile oral products	All enteric pathogens: *Salmonella* spp. and *Escherichia coli*: always prohibited. Other enteric microorganisms, *Enterobacter* spp., *Citrobacter* spp., *Pseudomonas* spp., *Clostridium* spp., and *S. aureus*: generally prohibited. *Candida albicans* and mycotoxin-producing molds: generally prohibited.
Non-sterile topical products	*Pseudomonas aeruginosa*, *Klebsiella* spp., *S. aureus*, *S. marcescens*, and *Clostridium* spp.: generally prohibited.
Genitourinary system products	*Escherichia coli*, *Proteus* spp., *S. marcescens*, and *Pseudomonas aeruginosa*: always prohibited. *Klebsiella* spp. and *Acinetobacter* spp.: generally prohibited.

Table 2. Microbiological limit values for cosmetic products according to the EN ISO 17516 standard in the guideline published by TITCK

Microorganism type	Category 1	Category 2
Total aerobic mesophilic microorganism count (bacteria + molds + yeasts)	≤$1x10^2$ CFU/g or mL	≤$1x10^3$ CFU/g or mL
Escherichia coli	Must not be present in 1 g or mL	Must not be present in 1 g or mL
Pseudomonas aeruginosa	Must not be present in 1 g or mL	Must not be present in 1 g or mL
Staphylococcus aureus	Must not be present in 1 g or mL	Must not be present in 1 g or mL
Candida albicans	Must not be present in 1 g or mL	Must not be present in 1 g or mL

TITCK: Turkish Medicines and Medical Devices Agency, CFU: Colony-forming unit

limit values for cosmetic products according to the EN ISO 17516 Standard, as stated in the guideline published by TITCK.

In a study conducted in Türkiye, researchers examined 127 cosmetic products (43 unopened and 84 used) in different packaging types (cream, lotion, cleansing lotion, and tonic) for microbiological contamination. Products packaged in jars and tubes showed the highest contamination, whereas sprays were reported to be safer. Among both unopened and used packaging groups, jars had the highest contamination rate. They found that 18.60% of unused cosmetic product samples were contaminated with bacteria and 2.33% with yeasts, whereas 47.62% of used samples were contaminated with bacteria and 5.95% with yeasts[14].

These findings indicate that packaging type is a critical determinant of microbiological safety in cosmetic products. Jar-type packaging is particularly susceptible to contamination, as the product is exposed to environmental microorganisms with each use. In contrast, spray formulations are generally more reliable because they reduce contact risk. Consequently, microbiological quality control should consider both product formulation and packaging strategies.

Preservative Products Used in Cosmetics and Efficacy Tests

Preservatives in cosmetics keep products safely free from microbial contamination. Biocidal products are generally used for this purpose. Biocides are classified into two main groups: those that bind to electrons (electrophilic) and those that act on the membrane. Electrophilic biocides are divided into oxidizing and non-oxidizing agents. Oxidizing electrophiles include chlorine, bromine, ozone, and peroxides, whereas non-oxidizing electrophiles include isothiazolines, aldehydes, carbamates, copper, silver, and mercury. Membrane-active biocides are divided into two groups: lytic agents and protonophores. Lytic biocides include quaternary ammonium compounds, biguanides, phenols, and alcohols. Protonophores include weak acids, parabens, and pyrithiones. Water-free (solid) products such as talcum powder, mineral oil, and roll-on deodorants do not require preservatives because they lack sufficient water to support microbial growth. However, some manufacturers also add preservatives to anhydrous products to prevent microbial deterioration that may occur if consumers accidentally add water during use (or misuse). Water-containing products require antimicrobial components such as alcohols, surfactants, and quaternary ammonium compounds during production. In addition, since users do not maintain sterility during use, products may subsequently become contaminated[15]. Preservatives are biocides that affect microbial cell membrane integrity, metabolism, enzyme function, protein conformation, and macromolecular synthesis. Many preservative chemicals are toxic to humans. Preservatives are safe and effective only at permitted concentrations. They are not used above these levels[16]. Table 3 shows the biocidal products used as preservatives in cosmetics and their maximum permitted levels. The preservative effect of a biocide against microorganisms is generally thought to result solely from the chemical formula of the preservative used; however, preservative chemicals do not act independently, and factors such as pH and contact time may also alter the preservative effect of any formulation. Even a change in pH alone may affect the degree of inhibition of the bacteria and fungi present. Acidic or alkaline transformation creates an antimicrobial effect in the product. Free fatty acids (i.e., lauric and myristic acids) in soap-based emulsions or liquid soap formulations are antimicrobial. Non-ionic surfactants such as polysorbate 80 inhibit molds to a certain extent[17]. Parabens that may be used include methylparaben, ethylparaben, propylparaben, and butylparaben. They inhibit fungi and bacteria. They are widely used in skin care products, shampoos, makeup products, and moisturizers. Since some studies have reported that they exhibit estrogen-like effects, the inclusion of parabens in cosmetic products is controversial. Another biocide, phenoxyethanol, is an alternative to parabens and has broad-spectrum antibacterial and antifungal properties. It is found in lotions, baby care products, eye makeup removers, and shampoos.

The table does not include other antimicrobial agents. Benzoic acid and its derivatives include sodium benzoate and potassium benzoate. They protect against fungi and bacteria. They are particularly used in water-containing formulations. Formaldehyde-releasing preservatives include dimethylol dimethyl hydantoin, imidazolidinyl urea, diazolidinyl urea, chlorhexidine (CHX), and quaternium-15. They protect against microorganisms by slowly releasing formaldehyde. They may cause skin sensitivity in some individuals[18]. Isothiazolinones, in the forms of methylisothiazolinone (MI) and methylchloroisothiazolinone, are widely used in shampoos, soaps, wet wipes, and creams because of their

Table 3. Maximum permitted concentrations of biocidal products used as preservatives in cosmetics[16]

Preservative	Maximum permitted concentration (%)
Alcohol	0-1
Chlorhexidine	0-3
Chlorphenesin	0-3
Methylparaben, propylparaben, ethylparaben, butylparaben, isopropylparaben, isobutylparaben	0-8
Phenoxyethanol	0-1
Sorbic acid	0-6

Turkderm - Turk Arch Dermatol Venereol
2026;60(3):140-146

broad-spectrum antibacterial and antifungal effects. MI was selected as the Contact Allergen of the Year by the American Contact Dermatitis Society in 2013. The use of isothiazolinones has been restricted in some countries because they risk causing allergic contact dermatitis. Alcohols and organic alcohols, including ethanol, benzyl alcohol, and propanol, rapidly eliminate microorganisms. They are widely found in perfumes, deodorants, hand sanitizers, and some skin care products[19]. CHX has antiseptic properties and is most commonly used in mouthwashes, baby wipes, and hand sanitizers. Sorbic acid and its derivatives, sodium sorbate and potassium sorbate, mainly have antifungal activity. They are widely used in natural and organic cosmetics. Hydrogen peroxide acts by breaking DNA strands in the cell. Peracetic acid disrupts cellular enzymes by generating free radicals. Phenol disrupts the cell membrane[20]. Triclosan has antibacterial and antifungal activity and is found in deodorants, soaps, toothpastes, and antibacterial cleansers. Some countries have banned it because of its adverse environmental effects. It inhibits an enzyme called enoyl-ACP reductase (FabI enzyme), which plays an important role in bacterial cellular fatty acid synthesis. This enzyme is required for fatty acid synthesis, an essential building block of the bacterial membrane. Triclosan binds to FabI's active site and inhibits enzyme activity. Because bacteria cannot produce the lipids required for cell membrane synthesis, cell growth stops, and the bacteria cannot proliferate. This mechanism is particularly effective against Gram-positive bacteria (e.g., *Staphylococcus aureus* and *Streptococcus pyogenes*). At the same time, triclosan directly damages the cell membrane. At high concentrations, it causes changes in the permeability of the bacterial cell membrane. It destabilizes the cell membrane, disrupts ion balance, and causes cell death. It impairs enzyme function by denaturing proteins. This effect is particularly pronounced in Gram-negative bacteria (e.g., *Escherichia coli* and *Pseudomonas aeruginosa*). Triclosan may also be effective against fungi, but its mechanism differs from its effect on bacteria. It inhibits fungal growth by disrupting sterol synthesis in the cell membrane. Some bacteria may develop resistance to triclosan by using alternative versions of the FabI enzyme (e.g., FabK and FabL enzymes). Long-term triclosan use may trigger bacterial resistance mechanisms and contribute to cross-resistance. In addition, it may accumulate in the environment and adversely affect the ecosystem[21,22].

Preservative Efficacy Tests

Preservative efficacy tests, or "challenge tests," are tests performed to determine the minimum effective antimicrobial preservative concentration required for adequate protection[23]. The ISO 11930:2019 Preservative Efficacy Test standard evaluates the effectiveness of the preservative content of cosmetic products in protecting against microbial contamination[24]. It applies to water-soluble cosmetics.

Preservative efficacy tests typically involve adding 0.1 mL of an organism suspension to a 50 g product sample to obtain an initial count of approximately 10^6 CFU/mL. The samples are mixed, and aliquots are taken at various time points (typically at 4 or 6 hours initially, 24 hours, 7 days, 14 days, 21 days, and 28 days). Colony counts are performed to determine the remaining CFU/mL of each test organism at each time point. The number of remaining organisms (CFU/mL at a given time point) is used to determine the effectiveness of the product preservative. These criteria are expressed as the number of logarithmic reductions at a given time point (for example, a reduction from 10^6 to 10^3 CFU/mL in 7 days) or as the decimal reduction time (D-value). The D-value is the time required to kill 90% of the test-organism population (1-log reduction) and is determined by calculating the negative reciprocal of the slope of the survival curve. The survival curve for each test organism is generated by plotting the logarithmic number of viable microorganisms recovered from the contaminated sample against the time the sample was taken[25-27].

The microorganisms that must be used in these tests are as follows:

- *Staphylococcus aureus* (ATCC 6538P)
- *Escherichia coli* (ATCC 8739)
- *Pseudomonas aeruginosa* (ATCC 15442)
- *Candida albicans* (MTCC 3017)
- *Aspergillus niger* (ATCC 16888)

The test method involves incubating cosmetic products with specific microorganisms and measuring microbial survival at defined intervals. Logarithmic reduction values are calculated. The results are compared with the limit values[28,30]. Figure 2 presents a graphical summary of the test. A result indicating that the preservative biocidal product contained in a product is effective in protecting the product is considered to be a ≥3-log reduction for bacteria on days 7, 14, and 28, and no increase or a ≥1-log reduction for yeasts and molds[29,30].

Testing the Microbial Load of Cosmetics

When testing the cosmetic product for microbial load in the final product, the aerobic mesophilic bacterial count and yeast and mold counts are determined. For this purpose, the plate count method, most probable number method, pour plate method, and membrane filtration method are used with Tryptic Soy Agar (TSA) and Sabouraud Dextrose Agar (SDA). In this example, the "United States Pharmacopeia (USP) 61" test can be used for the aerobic mesophilic bacterial count. Dissolve the product in buffered sodium chloride-peptone solution (pH 7.0), phosphate buffer solution (pH 7.2), or tryptic soy broth. A 10 g or 10 mL amount of the product is used. Figure 3 provides a schematic representation of the USP 61 test[31]. In the "most probable number method," which is also used for water samples in addition to cosmetics, the sample solution is transferred into tubes. Incubate all tubes at 30-35 °C for 3-5 days. For each dilution level, the number of tubes showing microbial growth is recorded. The most probable number of microorganisms per g or mL of product is determined[32]. In the pour plate method, at least two Petri dishes are prepared for each dilution level. TSA plates are incubated at 30-35 °C for 3-5 days, and SDA plates are incubated at 20-25 °C for 5-7 days. The arithmetic mean of the counts for each culture medium is calculated, and the number of CFU per g or mL of product is determined[32]. In the membrane filtration method, a filtration apparatus designed to allow transfer of the filter to the culture medium is used. An appropriate amount of the sample solution is transferred to each of two membrane filters and immediately filtered. Each filter is washed with diluent or neutralizing solutions. One of the membrane filters is transferred onto the surface of TSA. The other membrane is transferred onto the surface of SDA. The TSA plate is incubated at 30-35 °C for 3-5 days, and the SDA plate is incubated at 20-25 °C for 5-7 days. The number of CFU per g or mL of product is calculated[32,33].

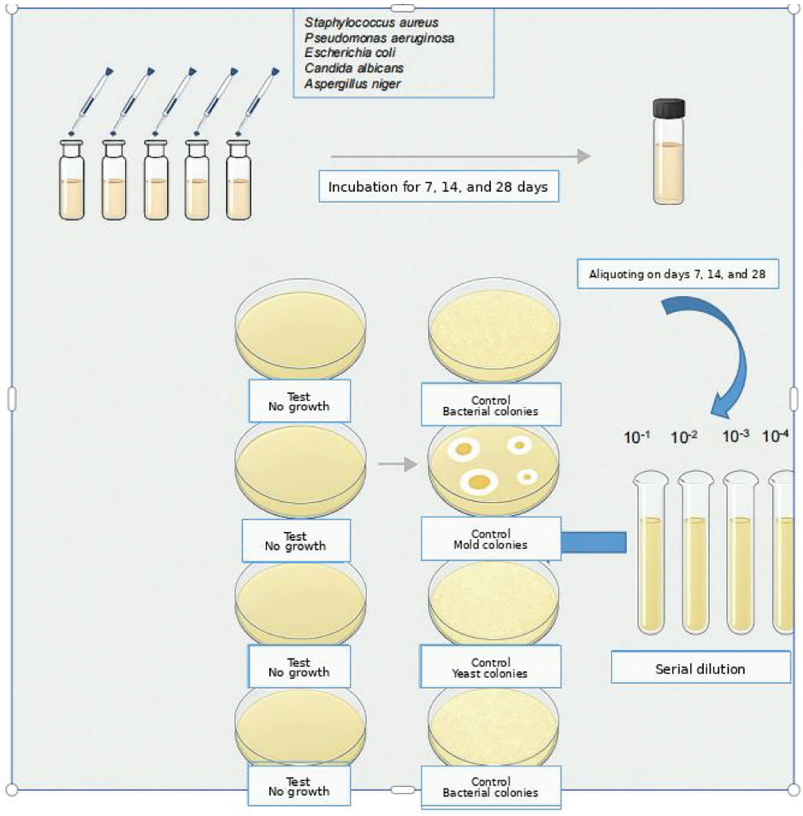


Figure 2. Schematic representation of the ISO 11930 test
ISO: International organization for standardization

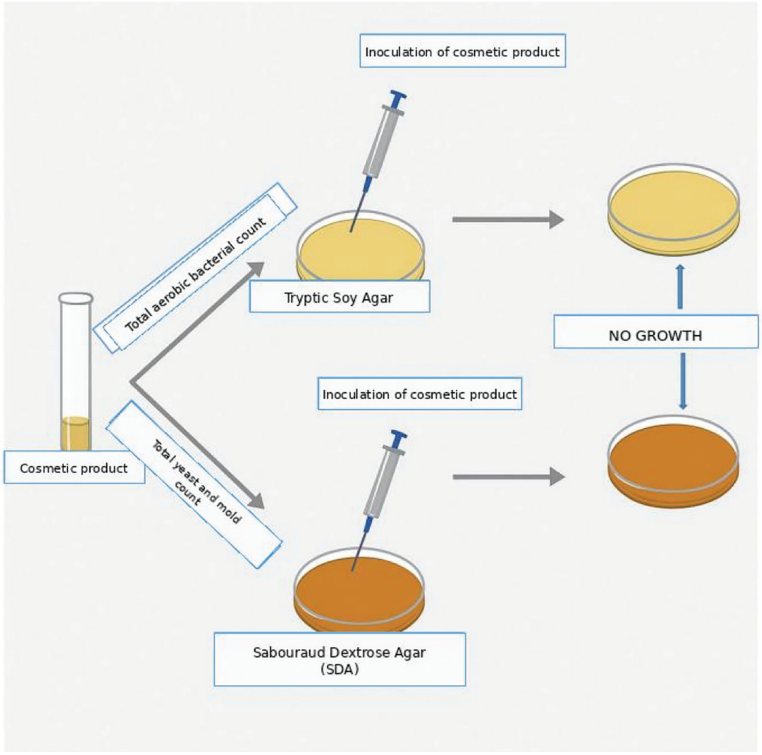


Figure 3. USP 61 test (original illustration by the author)
USP: United States Pharmacopeia

Turkderm - Turk Arch Dermatol Venereol
2026;60(3):140-146

Conclusion

In conclusion, cosmetic microbiology has become increasingly significant for both aesthetics and public health, evolving from prehistoric practices to modern standards. The selection of biocides, maintenance of hygienic production environments, and management of microbiological contamination risks are key determinants of product quality and consumer safety. Cosmetic products are categorized by microbiological limit values based on their composition and intended use, with stricter standards applied to products for the eyes, mucous membranes, and children. Preservative efficacy tests, conducted in accordance with national and international guidelines such as ISO 17516 and ISO 11930, provide a scientific foundation for product safety. Careful formulation, considering preservative type, mechanism of action, legal limits, and potential toxicities, is essential. Ultimately, maintaining microbiological quality requires not only biocide use but also comprehensive planning and monitoring throughout production and distribution. This integrated approach safeguards consumer health and promotes industry sustainability.

Footnotes

Authorship Contributions

Concept: A.K., D.S.G., Design: A.K., D.S.G., Data Collection or Processing: A.K., D.S.G., Analysis or Interpretation: A.K., D.S.G., Literature Search: A.K., D.S.G., Writing: A.K., D.S.G.

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