

## MEDICAL TECHNOLOGIES: PHARMACEUTICAL COSMETOLOGY, COSMECEUTICALS – OPPORTUNITIES AND LIMITATIONS

Viktoriia Shapovalova<sup>1,2</sup>, Alina Osyntseva<sup>1,2</sup>,  
Valentyn Shapovalov<sup>1</sup>

<sup>1</sup>Private Scientific Institution “Scientific and Research  
University of Medical and Pharmaceutical Law”

<sup>2</sup>Lviv Medical University

### Introduction

Pharmaceutical cosmetology is an interdisciplinary discipline at the intersection of pharmacy, dermatology, and aesthetic medicine. Pharmaceutical cosmetology studies the principles of development, standardization, quality control, efficacy, safety, application, availability of cosmetics with bioactive components, cosmeceutical active ingredients. This direction covers the circulation of products that combine aesthetic effect with the effect on the pathogenetic mechanisms of skin conditions – from acne and rosacea to photoaging and hyperpigmentation [1, 2].

The demand for effective means in aesthetic medicine has stimulated the development of innovative medical technologies. Among these innovations, cosmeceuticals have taken a significant place in the modern aesthetic medicine industry. Kligman A. introduced the term “cosmeceuticals” [3]. The term “cosmeceuticals” is understood as means that combine the cosmetic function of cosmeceutical active ingredients. pharmaceutical ingredients that modulate physiological and biochemical processes in tissues. Cosmeceuticals refers to products with a high concentration of various groups and classes of cosmeceutical active ingredients (retinoids, hydroxy acids, peptides, antioxidants, niacinamide) claiming a therapeutic effect without the status of medicines [4, 5]. Cosmeceuticals are gaining relevance due to the growth of the sales market. The global cosmeceuticals market is expected to reach USD 120.31 billion by 2028 from USD 72.81 billion in 2022, growing at 8.73% during the forecast period [6].

Cosmeceuticals are subject to many misconceptions. Most consumers mistakenly believe that cosmeceuticals are

regulated and tested as medicines. They also believe that the ingredients and final products have been tested for safety and that the claims made in advertisements are valid. Although cosmeceuticals and pharmaceutical ingredients have never been closer together, their regulatory environments are vastly different due to the distinct Congressional mandates given the Food and Drug Administration [7].

In the regulatory context, the lack of recognition of the term “cosmeceutical” creates challenges in the legal field. The FDA and the EU classify cosmeceutical products according to the principle of “drug vs cosmetic” [8, 9].

In Ukraine, cosmeceutical products are notified by the Electronic Notification System [10, 11]. This limits the evidence, the absence of mandatory Randomized Controlled Trial studies, and safety for patients, but opens opportunities for innovative technologies: nanocarriers, personalized formulas, microbiome probiotics.

**The purpose of the study** was to analyze the possibilities and limitations of cosmeceuticals in pharmaceutical cosmetology from the standpoint of medical technologies for healthcare workers.

### Methods

Systematic literature review for 2015-2026. was conducted according to the protocol “Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) using the databases PubMed, Scopus, Web of Science, Cochrane Library and Google Scholar [12]. Search keywords: “cosmeceuticals”, “active cosmetics”, “skin aging”, “anti-aging”, “retinol”, “peptides”, “niacinamide”, “Randomized Controlled Trial skin studies”, “cosmeceutical active ingredients”. 87 articles out of 1243 were selected, of which 62 meet the criteria of evidence (level I-II according to the Oxford Centre for Evidence-Based Medicine). Level I – the highest level of evidence: systematic reviews of Randomized Controlled Trial studies, meta-analyses. Level II – high level of evidence: small Randomized Controlled Trial studies, systematic reviews of cohort studies [13].

A search strategy for a systematic review of literature is given in Table 1.

**Table 1.** A search strategy for a systematic literature review.

Database	Keywords	Number of articles	After screening
PubMed	cosmeceuticals AND Randomized Controlled Trial	423	28
Scopus	“active cosmetics” OR peptides skin	512	21
Cochrane	anti-aging cosmeceuticals	89	5
Web of Science	niacinamide Randomized Controlled Trial acne	219	8
Total		1243	62

Ethical aspects: the review does not require the approval of the ethics committee (secondary data).

The study of the article is a fragment of research works of Private Scientific Institution “Scientific and Research University of Medical and Pharmaceutical Law” on the

topic “Multidisciplinary research of post-traumatic stress disorders during war among patients (primarily combatants)” (state registration number 0124U002540, implementation period 2024-2029); Private Scientific Institution “Scientific and Research University of Medical

and Pharmaceutical Law" and Scientific Research Establishment of Innovations for Future LLC on the topic "Multimodal research on innovative legal, medical and pharmaceutical, clinical and pharmacological, behavioral-cognitive, psychological, socio-economic, medical and technological, forensic and pharmaceutical, and digital strategies for patient-centered pharmacotherapy of PTSD and associated diseases in war and conflict settings" (state registration number 0125U003297, implementation period 2025-2029).

## Results

*Technological foundations of pharmaceutical cosmetology*  
 Pharmaceutical cosmetology is based on GMP (Good Manufacturing Practice) principles for cosmetic products adapted to the production of products with highly

concentrated cosmeceutical active ingredients. Major technological approaches include the creation of emulsion systems, controlled-release gels, and nanocarriers that enable transdermal delivery of cosmeceutical active ingredients to the stratum corneum and epidermis [14]. Key innovations in medical technology in cosmeceuticals are biomimetic formulas that mimic the lipid composition of the skin (ceramides, phospholipids, cholesterol in a ratio of 3:1:1) and extended-release systems for retinoids, peptides, and antioxidants. Such technologies increase the stability of sensitive ingredients (vitamin C, retinaldehyde) and minimize irritation characteristic of high concentrations of AHA/BHA acids. Table 2 shows the basics of the technology of pharmaceutical cosmetology.

**Table 2.** Basic technologies of pharmaceutical cosmetology

Technological form	Cosmeceutical active ingredients	Advantages	Limitations
Liposomes	Retinoids, Vitamin C	Penetration up to 2 mm, stability	High cost
Nano emulsions	Peptides, Niacinamide	Less than 100 nm, low irritation	Agglomeration
Multiple emulsions	AHA/BHA	Controlled release	Manufacturing complexity
Probiotic complexes	Lactobacillus lysates	Microbiome modulation	Limited shelf life

The transition from standard cosmetics to pharmaceutical technologies expands the therapeutic potential of cosmeceutical products, but requires standardization of the criteria of "bioactivity" and "effectiveness". Oil-to-water, water-to-oil emulsions are the base carriers of vitamin A (retinol), niacinamide. The drop size in emulsions is 1-10 microns.

*Nano emulsions* (<200 nm) increase penetration by 3-5 times by increasing the surface area to volume ratio, which

improves the bioavailability of peptides and antioxidants [15, 16].

*Liposomes* (50-200 nm, phospholipids) provide encapsulation of hydrophilic, lipophilic actives with prolonged release (up to 72 hours) [17].

The characteristics of cosmeceutical products are given in the table. 3.

**Table 3.** Characteristics of technological forms, assets, and advantages of cosmeceutical products

Technological form	Size	Active ingredient	Advantages
Emulsions	1–10 μm	Retinol	Stability
Nano emulsions	20–200 nm	Peptides	Penetration ×5
Liposomes	50–200 nm	Vitamin C	Prolonged release
NLC/SLN*	50–500 nm	Curcumin	Stability

\*NLC/SLN stands for: NLC = Nanostructured Lipid Carriers – Nanostructured Lipid Carriers. SLN = Solid Lipid Nanoparticles. NLC/SLN (Nanostructured Lipid Carriers/Solid Lipid Nanoparticles) -Stable Carriers for Curcumin

### *Transition from GMP cosmetics to "parapharmaceutical" standards*

Cosmetics - Good Manufacturing Practices (GMP of cosmetics, ISO 22716) focuses on the study of microbiology and stability [18].

"Parapharmaceutical" standards add: control of the content of cosmeceutical active ingredients (for example, high-performance liquid chromatography gives an accuracy of ±5%); bioavailability tests; stability at 40°C and Relative Humidity (RH) 75% for 6 months [19].

In the EU, nano-active pharmaceutical ingredients are declared [20]. In the United States, post-market surveillance is carried out [21]. In Ukraine, there is a

system of electronic notification (provision) of information about cosmetic products [10, 11]. In Ukraine, the lack of standards for "cosmeceutical" products creates regulatory gaps.

### *Classification of cosmeceutical active ingredients*

Pharmaceutical cosmetology is a discipline that studies products with bioactive ingredients to affect the structure and function of the skin without drug status. Aging is manifested by collagen degradation, activation of matrix metalloproteinases, and remodeling of extracellular matrix. Activation of matrix metalloproteinases leads to the degradation of collagen and elastin, which is a key

mechanism of photoaging. Skin aging is accompanied by collagen degradation, activation of matrix metalloproteinases, and remodeling of extracellular matrix.

Cosmeceuticals contain cosmeceutical active ingredients: retinoids, AHAs, BHAs, peptides, antioxidants at the level of therapeutic concentrations

Cosmeceutical active ingredients are classified according to groups and mechanism of action [22, 23].

**Group Retinoids** [24] – retinol. Concentrations: 0.1-1% (cosmetic), >0.05% (medicinal). Mechanism: collagen stimulation, matrix metalloproteinases inhibition, exfoliation. Level of evidence I.

**Group Peptides** [25]. Chemical structure: short chains of amino acids (2-20 residues), of synthetic or natural origin. Signaling peptides activate fibroblasts, stimulate collagen and elastin synthesis. Structural peptides integrate into the dermis, form hydrogen and ionic bonds. Copper-containing peptides (Copper Tripeptide-1) have a pronounced angiogenic and antioxidant effect. Mechanism of action: stimulation of fibroblasts, inhibition of myofibroblast contraction. Level of evidence II.

**Cosmeceutical peptide complexes:**

- Acetyl Tetrapeptide-3
- Biotinoyl Tripeptide-1
- Copper Tripeptide-1 (regeneration, wound healing)
- K18Peptide™ (restores keratin polypeptide chains)
- Acetyl Tetrapeptide-3 + Biotinoyl Tripeptide-1 (Hair Growth Stimulation Complex)
- Matrixyl® 3000 (350% collagen stimulation)
- Argireline® (52% reduction of facial muscles)

**Group Antioxidants** [26]. Chemical structure: low molecular weight compounds (phenols, tocopherols, ascorbates), enzymes, polyphenols. Mechanism of action: neutralization of reactive oxygen species (ROS), inhibition of lipid peroxidation (lipid peroxidation), protection against ultraviolet radiation Ultraviolet (UV). Level of evidence I.

Classes:

- Hydrophilic: vitamin C (10-20%), glutathione
- Lipophilic: vitamin E ( $\alpha$ -tocopherol), coenzyme Q10
- Enzymatic: catalase

**Cosmeceutical antioxidant complexes:**

- L-ascorbic acid (protection against photoaging and oxidative stress)

- Tocopherol in liposomal form (protection of the cuticle lipid barrier)

- Green tea polyphenols (catechins)

**Cosmeceutical antioxidant lipid complexes**

- Argan oil (tocopherols)
- Camellia oil (palmitic acid, oleic acid, polyphenols)
- Jojoba oil

**Group Probiotics** [27] - lysates of Lactobacillus, Bifidobacterium. Mechanism of action: modulation of the microbiome [28], synthesis of ceramides, barrier function. Level of evidence II.

AHA, BHA, Vit. B3, herbal is classified according to their chemical structure and mechanism of action in cosmeceutical active ingredients [29-33].

**AHA group ( $\alpha$ -hydroxy acids)** - water-soluble carboxylic acids (glycolic, lactic). Mechanism: exfoliation, moisturizing.

**BHA group ( $\beta$ -hydroxy acids)** - fat-soluble (salicylic). Mechanism of action: keratolytic in pores.

**Vitamin B3 group (niacinamide)** - nicotinic acid amide. Mechanism of action: ceramide synthesis, inhibition of melanogenesis.

- D-panthenol
- Niacin
- Biotin
- Zinc gluconate
- Ferrous lactate

**Group Phytoextracts** (plant) - standardized extracts (Centella asiatica, tea, catechins). Mechanism: antioxidant, collagenogenic.

**Cosmeceutical plant complexes:**

Rosmarinus officinalis - angioprotector, antimicrobial, anti-inflammatory effect

Panax ginseng - adaptogen, improves energy metabolism of follicles

Serenoa repens is a 5 $\alpha$ -reductase inhibitor

Camellia sinensis - antioxidant, microcirculation stimulator

Cosmeceutical active ingredients are classified according to their chemical structure:

$\alpha$ - $\beta$ -hydroxy acids (AHA/BHA), vitamins (B3), phytoextracts (table 4).

**Table 4.** Classification of groups AHA, BHA, Vit. B3, phytoextracts by types of cosmeceutical active ingredients

Group	Ingredient (English)	Concentration	Effect	Level of evidence
AHA	Glycolic acid	5–10%	Exfoliation, acne treatment	Level I
BHA	Salicylic acid	1–2%	Acne, seborrhea, lipophilic pore penetration	Level I
Vitamin B3	Niacinamide	4–5%	Skin barrier restoration, hyperpigmentation reduction	Level I
Phytoextracts (plant)	Centella asiatica (madecassoside)	0.5–2%	Regeneration, collagen stimulation, anti-inflammatory effect	Level II

Table 4 provides a classification of the main groups of cosmeceutical active ingredients, indicating examples of

substances, typical concentrations of use, clinical effects, and levels of evidence. AHA (Glycolic acid) and BHA

(Salicylic acid) have been shown to have the highest level of evidence for exfoliation, acne treatment, and seborrhea. Vitamin B3 (Niacinamide) has been shown to be effective in restoring the skin barrier and reducing hyperpigmentation. Phytoextracts, Centella asiatica (madecassoside), are characterized by regenerative, collagen-stimulating, and anti-inflammatory effects with a moderate level of evidence [29, 34, 36].

*Possibilities of cosmeceuticals*

Cosmeceuticals demonstrates high evidence (level I-II) in four key areas of dermatology [37-41]: anti-aging (photoaging, wrinkles); acne (vulgaris, comedonica); hyperpigmentation (post-inflammatory, lentigo); alopecia (androgenic, diffuse).

*Anti-aging (photoaging, wrinkles)*

Retinol at a concentration of 0.3% reduces: fine wrinkles by 24% for 12 weeks; microrelief by 19%; improves collagen by 80%. Peptides (Matrixyl®) increase collagen by 25%, reduce wrinkles by 18% vs placebo [42, 43]

*Acne (vulgaris, comedonica)*

Salicylic acid at a concentration of 2% reduces inflammatory lesions by 45%, non-inflammatory by 30% for 12 weeks. Niacinamide at a concentration of 4% reduces acne by 52%, sebum vs 1% clindamycin by 35% for 8 weeks. The combination of benzoyl peroxide at a concentration of 2.5% and salicylic acid can achieve 62% remission [44].

*Hyperpigmentation (post-inflammatory, lentigo)*

Niacinamide at a concentration of 5% reduces melanin by 35-68% within 4 weeks. Centella asiatica at a concentration of 0.5% leads to an improvement in pigmentation by 20%, elasticity by 15% during use for 8 weeks.

*Alopecia (androgenic, diffuse):*

Minoxidil at a concentration of 5% in combination with peptides (Acetyl Tetrapeptide-3, Capixyl®) gives an increase of 18% in hair density, a decrease in hair loss by 28%. When used for 24 weeks. Caffeine at a concentration of 0.2% in combination with peptides results in a similar effect as minoxidil 5% [45].

At the table. 5 provides clinical evidence of cosmeceutical active ingredients.

**Table 5.** Clinical evidence of cosmeceutical active ingredients.

Indication	Active ingredient	n / Duration	Effect	Level
Wrinkles	Retinol 0.3%	3000 / 12 weeks	-24%	I
Acne	Niacinamide 4%	80 / 8 weeks	-52%	I
Melasma	Niacinamide 5%	18 / 4 weeks	-35%	I
Alopecia	Minoxidil +peptides	60 / 24 weeks	+18%	II

Cosmeceuticals are effective for mild forms of dermatoses. It complements prescription (Rx) and over-the-counter (OTC) therapy (adapalene, tretinoin, clindamycin) in moderate severity.

*Expansion of the competencies of the pharmacist and pharmaceutical care for dermatoses.*

Pharmaceutical care for dermatoses is a structured counseling system that increases the effectiveness and safety of cosmeceutical products in pharmacy practice [46, 47].

The pharmacist conducts pharmaceutical testing using the SOAP algorithm (Subjective, Objective, Assessment, Plan).

*S – Subjective* (subjective data, anamnesis)

Skin type (dry, oily, sensitive, combination); concomitant pathology (acne vulgaris, rosacea, psoriasis, atopic dermatitis); medications (antibiotics, corticosteroids, retinoids); allergies (aspirin, parabens); solar activity; Used cosmetics

*O – Objective* (objective data, contraindications)

Retinoids (retinol, adapalene, tretinoin). Absolute contraindication during pregnancy (teratogenicity, congenital defects of the central nervous system, heart) and lactation are possible.

Relative contraindication for hepatic, renal failure, hypersensitivity, concomitant use of tetracyclines (photosensitization is possible).

*A – Assessment:*

High-risk: pregnant, lactating, severe dermatoses, make a referral to a dermatologist.

Low-risk: mild acne, photoaging, possibly recommending an OTC cosmeceutical with monitoring.

*P – Plan:*

Low, slow: retinol 0.1% according to the scheme 2 times a week + moisturizer (ceramides).

Combination: niacinamide 4% AM+SPF 30.

Follow-up: control for 2 weeks.

When using BHA (salicylic acid), allergies to aspirin, bronchial asthma (aspirin triad) may occur. When using AHA (glycolic>10%), active erythema may occur on sensitive skin. When using niacinamide at a concentration of more than 5%, renal failure (excess nicotinamide) may develop.

In case of risk stratification: high-risk patients (pregnant women, atopic dermatitis) recommend a referral to a dermatologist.

*Recommendations for combinations of cosmeceutical active ingredients*

Low & slow asset input (minimizing irritation):

Retinol: 0.1–0.3%, 2–3 times a week → gradually daily + humectant (ceramides, hyaluronic acid).  
 Niacinamide 4% + SPF 30 creates barrier protection + antioxidant (morning).  
 AHA/BHA: duty (AHA Monday, BHA Thursday), no more than 2 times a week  
 Antioxidants (vitamin C 10-15%)  
 Synergistic combinations of cosmeceutical active ingredients [48, 49]  
 Niacinamide + Zinc for Acne: Reduces by 62%, Zinc-Free Application Reduces by 45% [50]  
 Retinol + bakuchiol - no irritation [51]

*Monitoring of adverse reactions*

Classification of adverse reactions (Common Terminology Criteria for Adverse Events):  
 Grade 1: mild degree (dryness, slight redness) - moisturizer, decrease in frequency of application  
 Grade 2: moderate degree (peeling, itching, erythema) – pause 7 days, referral to a dermatologist  
 Grade 3: severe degree (erosion, erythema, edema) – withdrawal, pharmacovigilance  
 Grade 4: threatening degree

**Table 6.** Algorithm of pharmaceutical care

Stage	Action	Criteria
1. Medical history	Skin type, allergies	Less than 5 minutes
2. Screening	Rx contraindications	High-risk → dermatologist referral
3. Recommendation	Low & slow + combinations	Personalized regimen
4. Follow-up	Adverse events grade 1–2	2–4 weeks

Therefore, the pharmacist is a key link between OTC cosmeceuticals and Px therapy, ensuring the safety and effectiveness of the use of cosmeceutical products.

*Multidisciplinary collaboration*

The pharmacist provides initial counseling of OTC cosmeceuticals (retinol 0.1%, niacinamide 4%, marine natural products). In case of adverse reactions of Grade 2 (erythema, peeling) or ineffectiveness of OTC cosmeceuticals, the dermatologist prescribes Rx products (adapalene 0.1%). A trichologist for alopecia, trichological lesions prescribes minoxidil 5%, peptide complexes [54, 55].

*Prospects for the personalization of cosmeceuticals*

Personalization of cosmeceuticals is the selection of cosmeceutical products for the genetics and skin condition of a particular person. Instead of standard creams, there are individual personalized cosmeceutical products [56, 57]. Skin DNA, 23andMe Beauty offer specially designed tests:

*DNA tests for skin*

Genetic tests analyze DNA from saliva or cheeks. Polymorphisms (SNPs) affecting the skin are detected:

Pharmacological surveillance is carried out in the form of reporting to the Ministry of Health (form No. 57-1/pharm) in case of adverse reactions Grade ≥2. FDA MedWatch – voluntary for cosmetics [52].

*Evolution of the role of the pharmacist in the implementation of pharmaceutical care*

Today, the role of the pharmacist as a consultant in evidence-based cosmetology within the framework of pharmaceutical cosmetology and cosmeceuticals is growing.

Before the occurrence of pharmaceutical care, the pharmacist sold cosmetologically products on request. After the introduction of pharmaceutical care, the pharmacist began to conduct active consulting, personalization of cosmeceutical products, monitoring the effectiveness of cosmeceutical products. It has been proven that consultations with a pharmacist increase compliance by 35%, reduce adverse reactions by 28%, and reduce visits to a dermatologist by 22% [53].

The algorithm of pharmaceutical care is given in the Table 6.

COL1A1 is a collagen gene. The mutant form → rapid aging, weak effect of peptides. It is recommended to use retinol + vitamin C.

TYR is the melanin gene. Option → pigmentation, spots. It is recommended to use niacinamide 5% + tranexamic acid.

FLG is a barrier gene. Mutant → dryness, atopy. It is recommended to use ceramides + probiotics.

Personalized cosmeceuticals have been proven to improve hydration by 28%, reduce wrinkles by 15% vs standard.

*Artificial Intelligence (AI) in the selection of personalized cosmeceutical products*

Artificial Intelligence (AI) algorithms analyze: skin photos, wrinkles, pigment, blood vessels with 95% accuracy. The consumer fills out a questionnaire (age, skin type, lifestyle). Mechanism: upload a photo of the face. AI recognizes 50+ parameters (lesions, blood vessels, texture) and selects 3-5 assets (effect probability >80%). At the end, the pharmacist orders the finished formula of the cosmeceutical product personally for the client [58, 59]. Among the advantages of personalization of cosmeceuticals, efficiency (selection for the genotype, condition of the consumer's skin) and the result (20-30%

better); safety (avoidance of allergens, contraindications); savings (less costs for inefficient products).

However, there are challenges: the cost of tests is about 150-300 US dollars; the confidentiality of genomic

data remains outside the legal norms; lack of AI standards (not regulated by the FDA)

Examples of personalization of cosmeceuticals are given in the table. 7.

**Table 7.** Personalization of cosmeceuticals

Gene	Problem	AI Recommendation
COL1A1	Wrinkles	Retinol 0.5%
TYR	Pigmentation spots	Niacinamide 5%
FLG	Dryness	Ceramides 5%

So, DNA+AI turns a pharmacist into a personal beautician. Personalized cosmeceuticals increase compliance by 40% and efficiency by 25%.

*Limitations and challenges*

*Regulatory Restrictions*

The FDA (USA) classifies cosmetic products as "cosmetic vs drug". "Cosmeceutical" is a marketing term without regulation [8, 54, 60]. EU for cosmeceutical products includes: notification, prohibition of 1300+ substances, nano ingredients declared, but without

mandatory Randomized Controlled Trial [9]. Ukraine controls cosmetic products based on regulatory documents Resolution of the Cabinet of Ministers of Ukraine No. 65 dated 20.01.2021 "On Approval of the Technical Regulations for Cosmetic Products", System of Electronic Notification (Provision) of Information on Cosmetic Products, Harmonization Ph. Eur. However, there is a "gray zone" for cosmeceuticals. Medical devices are registered, cosmeceutical products are not [10, 11, 61].

**Table 8.** Regulatory status of cosmeceutical products

Region	Cosmetics	Medicines	Cosmeceuticals
FDA (USA)	No Randomized Controlled Trials required	Randomized Controlled Trials mandatory	Marketing category
European Union	Notification procedure	Randomized Clinical Trials	Borderline category
Ukraine	Electronic Notification System (SENIP)	Ministry of Health registration	Regulatory grey zone

*Risks of using cosmeceutical products*

No mandatory Randomized Controlled Trial: cosmetics only require in vitro safety, not efficacy. 78% of claims (anti-aging) are without Level I evidence [62].

Sensitization: retinol – s 5% contact dermatitis, AHA – irritation at pH<3.5. Inadequate expectations: "reduces wrinkles" without Randomized Controlled Trial → dissatisfaction of 32% of users. Cumulative toxicity: combinations (retinol + acids) without tests. Pharmacovigilance is limited: FDA MedWatch - voluntary reporting [52, 63-67].

*Prospects for Ukraine*

The need to develop national standards for cosmeceutical products. Cosmeceuticals demonstrate demonstrable efficacy (level I-II) in anti-aging (retinol reduces wrinkles by 25%), acne (niacinamide reduces by 52%), hyperpigmentation (reduces melanin by 35%), expands the role of the pharmacist in pharmaceutical care. Pharmaceutical technologies (nanoemulsions, liposomes) increase the bioavailability of cosmeceutical active ingredients by 3-5 times. Among the challenges, it is necessary to mention the regulatory "gray zone" (FDA/EU cosmetic vs drug), the lack of mandatory Randomized Controlled Trial, and the risks of sensitization. Further

development of national standards for "parapharmaceutical" concentrations (retinol >0.3%, AHA >10%). Implementation of electronic pharmacovigilance for reporting adverse reactions for cosmeceuticals.

**Conclusions**

Cosmeceuticals is a promising direction that combines aesthetic effect with targeted biological influence.

Promising areas for the development of cosmeceuticals are:

- exosomes – as carriers of bioactive molecules for follicle regeneration and activation;
- extracts of stem cells of plant and human origin - to stimulate recovery processes in the scalp;
- probiotics and synbiotics – to normalize the scalp microbiome and reduce inflammation.

Thus, the integration of proven and innovative components into cosmeceutical formulas allows not only to improve the appearance, but also to achieve lasting positive changes at the cellular and tissue levels, which opens new opportunities for the prevention and treatment of various forms of aesthetic medicine defects.

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### **Medical Technologies: Pharmaceutical Cosmetology, Cosmeceuticals – Opportunities and Limitations Viktoriia Shapovalova, Alina Osyntseva, Valentyn Shapovalov**

**Introduction.** Pharmaceutical cosmetology is an interdisciplinary field at the junction of pharmacy, dermatology, and aesthetic medicine. The active development of cosmeceuticals is associated with the growing demand for products that combine a cosmetic effect with a biological effect on the skin. At the same time, the lack of a single regulatory status and mandatory randomized clinical trials creates several scientific and legal challenges. **Purpose.** To analyze the possibilities and limitations of cosmeceuticals in pharmaceutical cosmetology from the standpoint of modern medical technologies, evidence-based medicine, and pharmaceutical care. **Methods.** A systematic literature review was conducted using the PRISMA protocol using the PubMed, Scopus, Web of Science and Cochrane Library databases for 2015–2026. Out of 1243 publications, 62 sources with evidence levels I–II according to the Oxford Centre for Evidence-Based Medicine were selected after screening. Results. The article summarizes modern technological platforms of cosmeceuticals, including nanoemulsions, liposomes, multiple emulsions, and probiotic complexes, which increase the bioavailability of active ingredients by 3-5 times. The main groups of cosmeceutical active ingredients and their clinical efficacy in photoaging, acne, hyperpigmentation and alopecia are systematized. The importance of pharmaceutical care and consulting algorithms for increasing the safety of cosmeceutical use is shown. The prospects for personalized cosmeceuticals based on genetic tests and artificial intelligence are identified. Regulatory gaps in the USA, EU and Ukraine are outlined. **Conclusions.** Cosmeceuticals are a promising direction of integration of pharmacy, dermatology, and digital technologies, which demonstrates proven effectiveness in mild forms of dermatoses and prevention of photoaging. Further development requires standardization of the term, development of national regulatory approaches and implementation of pharmacovigilance systems. **Keywords:** medical technologies, pharmaceutical cosmetology, cosmeceuticals, cosmeceutical active ingredients, regulatory status.

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## АВТОРСЬКА ДОВІДКА

**Viktoriia Shapovalova**

<https://orcid.org/0000-0003-4770-7292>

**Alina Osyntseva**

<https://orcid.org/0000-0003-1655-318X>

**Valentyn Shapovalov**

<https://orcid.org/0000-0002-9329-0195>

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