IFSCC 2025 full paper (628)

"The efficacy and safety of physical osmosis technology synergized with peptide anti-aging eye serums"

Wu Meifang[1], Wang Shuyu[1], Han Ruifang[1], Zhou Jian[1], Li Juntong[1], Cui Bin[1,*]

[1] MOYAL LAB, Shenzhen Moore Vaporization Health & Medical Technology Co., Ltd., Shenzhen, China

1. Introduction

Lifestyle changes and rising healthcare demands have led to a boost in the popularity of skincare products. Eye-area anti-aging products are now in higher demand in the beauty market. Aging manifests through seven main signs: fine lines and wrinkles, alterations in skin color and texture, a dull complexion, enlarged pores, blotches, age spots, and dryness, with fine lines and wrinkles being the most common.[1] As skin collagen decreases gradually with age, skin firmness is lost, certain substances accumulate, and both fine and deep wrinkles form.[2] The periorbital area, being delicate, is often one of the first to show these signs The under-eye skin, in particular, is extremely thin and ages more quickly.[3,4] Premature aging here, appearing as darkening, puffiness, and wrinkles, can be caused by genetics, UV exposure, stress, and lifestyle.[5,6] Though physically harmless, periorbital aging can lead to psychosocial and functional issues.[7,8]

Currently, various topical treatments such as creams, lotions are employed to eliminate the signs of aging in the eye area. [9,10] However, the ingredients mainly stay on the surface of the skin, making it is difficult to have a significant anti-aging effect.[11] With the development of transdermal delivery technology, penetration-enhancing of Physical methods have gradually been applied to the field of beauty and skin care.[12] Common electro-assisted enhanced permeation includes iontophoresis and electroporation. Electroporation utilizes microsecond to millisecond scale high-voltage electrical pulses to disrupt the structure of the lipid bilayer in the stratum corneum, thereby creating additional temporary pathways to deliver active substances into cells and tissues.[13–15] Iontophoresis uses an external electrode to apply a micro-current from a few minutes to several hours, driving molecules through the SC by

electrophoresis, and the rate of material transfer is usually proportional to the applied current.[16,17]

This study developed a system to enhance transdermal absorption of active ingredients. We paired an anti-aging eye serum with an osmotic facilitator to test how well physical osmotic facilitation methods can boost the effectiveness of anti-aging products. The system combines atomization and physical penetration technologies. Atomization sprays the essence evenly on the skin, lowering its viscosity and controlling particle size distribution. Another approach is photoelectric penetration technology, which uses electroporation and iontophoresis to promote the intracellular pathway of transdermal absorption.

2. Materials and Method

2.1 Materials and Instrument

The eye serum product was provided by Shenzhen Moore Vaporization Health & Medical Technology Co., Ltd. Contains 10% WKPep® SRMPeptides PLUS (Acetyl Hexapeptide-8, Acetyl Tetrapeptide-9, Palmitoyl Pentapeptide-4, Palmitoyl Tetrapeptide-7), and 10% WKPepM®-3000-01 (Palmitoyl Tetrapeptide-7, Palmitoyl Tripeptide-1) as active ingredients. The atomizer and photoelectric beauty instrument, named MOYAL® Luminous Essence Atomizer and MOYAL® Radiant Penetration Enhancer, were provided by Shenzhen Moore Vaporization Health & Medical Technology Co., Ltd.

2.2 Subjects and study protocol

This clinical trial involved 35 healthy female participants aged 35–58 years (mean age: 42.1 years ±5.4 years). A 28-day experiment was designed to evaluate the specific cosmetic efficacy of the eye serum and penetration enhancement system in 35 healthy women with naturally aged skin. The study recruited 35 subjects to conduct a split-face controlled trial, in which each subject's bilateral facial regions were randomly allocated to either the sample group or the control group. It should be noted that the control group applied the eye serum product directly, while the sample group used a atomizer to aerosolize the eye serum product and then employed a penetration enhancer for further penetration. The test product was applied from Day 1 until Day 28. Subjects were instructed to apply the test product to the eye area twice daily (in the morning and evening). After cleansing their face with water, the skin biophysical parameters of the subjects were measured at baseline (the day before Day 1), on Day 14, and on Day 28 of product use by the attending researcher.

2.3 Instrumental assessment

The measurements were performed under air conditioning (temperature: 20°C~22°C, relative humidity: 40%~60%) following a minimum 30-min acclimatization period. Various biophysical techniques were used to assess the clinical skin parameters.

Skin hydration was assessed using a Corneometer (Courage & Khazaka GmbH, CM 825, Cologne, Germany). The Corneometer measures skin-surface hydration by detecting changes in the dielectric constant of a precision capacitor. Tests were conducted at the intersection of a vertical line from the eye and a horizontal line from the cheekbone.[18,19]

Skin elasticity was determined using a Cutometer MPA580 (Courage & Khazaka Electronic GmbH) in the lateral canthus area ("crow's feet"). The Cutometer uses suction to draw skin into its probe's aperture, then releases it. R-parameters indicate visco-elastic properties, with R2 linked to overall elasticity. F-parameters show skin fatigue and firmness correlations, with F3/F4 linked to firmness.[20]

Wrinkle analysis and skin imaging around the "crow's feet" were done using a PRIMOS CR (Canfield Scientific GmbH), based on digital strip projection. Sa parameters, calculated from gray-level image analysis, describe fine lines/microstructures. The system assesses wrinkles' number, length, and volume in the area between the eye corner and hair border, providing a score where lower values mean fewer wrinkles. [21]

The melanin index (MI) was measured using a Mexameter MX18 (Courage + Khazaka Electronic, Köln). Melanin was measured at a wavelength corresponding to its absorption rate, while erythema was measured at the hemoglobin absorption peak wavelength.[22]

2.4 Self-assessment

Participants completed self-assessment questionnaires on the eye cream's effectiveness and safety after 4 weeks of use. A 100-point scale was used, with results shown as the percentage of satisfied subjects. Participants reported concurrent therapies and adverse events at each visit.

2.5 Statistical analysis

Statistical analysis was conducted using R-3.6.3 and GraphPad Prism. For in vitro experiments, two-tailed t-tests were performed, with data presented as mean ± standard deviation. In clinical assessments, paired t-tests compared pre-and post-treatment differences and inter-group variations between product and control groups. Data here were displayed as mean ± standard error. A significance level of $p < 0.05$ was applied.

3. Results and discussions

3.1 Skin biophysics analysis

As shown in Table 1-3, all parameters related to wrinkle characterization indicated a statistically significant decrease in the number, depth, and volume of skin deformations ($p < 0.0001$ for each). In particular, the crow's feet depth decreased by 5.97% and 12.28% on Day 14 and 28, respectively. Under-eye wrinkle depth decreased by 14.70% and 4.59%, while the cleavage depth decreased by 11.63% and 12.40%. The crow's feet volume decreased by 16.33% and 31.87%, and under-eye wrinkle volume decreased by 31.70% and 16.98%. The cleavage volume decreased by 29.84% and 22.51%. The mean decrease in Sa values were 6.23% ($p = 0.017$) after 14 days and 7.59% ($p = 0.009$) after 28 days of treatment; thus, the eye serum showed a significant firming effect.

In addition to wrinkle-related improvements, significant changes were observed in the melanin index (MI) and F3/F4 ratio. The MI value decreased by 15.25% on Day 14 and 12.99% on Day 28, indicating a reduction in melanin content ($p < 0.001$). This suggests that the eye serum may have a lightening effect on the skin. Furthermore, the F3/F4 ratio, which is associated with skin firmness, increased by 20.81% on Day 14 and 25.36% on Day 28 ($p < 0.001$). This further supports the firming effect of the eye serum, as a higher F3/F4 ratio is linked to greater skin resistance to deformation. These results collectively demonstrate the eye serum's multifaceted benefits in improving skin appearance and texture.

Table 1. Changes in the skin parameters in the sample group.

Parameters	Baseline	T30min	Day 28	*Δ*1	*Δ*2	*p*1	*p*2
Crow's feet depth (Sv in μm)	69.06	64.94	60.58	-5.97%	-12.28%	0.040	0.027
Under the eyes wrinkle depth (Sv in μm)	71.10	60.65	67.84	-14.70%	-4.59%	<0.001	0.130
cleavage depth (Sv in μm)	97.10	85.81	85.06	-11.63%	-12.40%	<0.001	0.001
Crow's feet volume (mm3)	2.51	2.10	1.71	-16.33%	-31.87%	<0.001	<0.001
Under the eyes wrinkle volume (mm^3)	2.65	1.81	2.20	-31.70%	-16.98%	<0.001	0.001
cleavage volume (mm^3)	1.91	1.34	1.48	-29.84%	-22.51%	<0.001	<0.001
Parameters	Baseline	Day 14	Day 28	*Δ*1	*Δ*2	*p*1	*p*2
MI value	177	150	154	-15.25%	-12.99%	<0.001	<0.001
Skin hydration (corneometer units)	64.8	74.9	76.4	15.59%	17.90%	<0.001	<0.001
R^2 ratio	0.505	0.605	0.625	19.80%	23.76%	<0.001	<0.001
F3/F4 ratio	0.418	0.505	0.524	20.81%	25.36%	<0.001	<0.001

Note: Date at baseline, Day0 T30min/Day 14 and Day 28 were indicated as mean ± SD; SD, standard deviation; Δ1, percentage changes on Day0 T30min/Day 14 (vs. baseline); Δ1, percentage changes on Day 28 (vs. baseline); P1, p-value on Day0 T30min/Day 14 (vs. baseline) with the Paired Sample T test; P2, p-value day on Day 28 (vs. baseline) with the Paired Sample T test; Sa value, skin roughness; R2 ratio, skin elasticity; F3/F4 ratio, skin firmness; MI value, dark circle degree.

When comparing the sample group and the control group, the sample group showed significantly greater improvements in most parameters. For example, the crow's feet depth in the sample group decreased by 12.28%, while in the control group it only decreased by 1.67%. Similarly, the crow's feet volume in the sample group decreased by 31.87%, compared to 11.93% in the control group. The MI value in the sample group decreased by 12.99%, while in the control group it decreased by 10.47%. The F3/F4 ratio in the sample group increased by 25.36%, compared to 24.47% in the control group.

These results indicate that the eye serum itself has anti-aging and dark circle-reducing effects. When combined with the penetration enhancement system, the anti-aging effects of the eye serum are significantly enhanced. The penetration enhancement system helps the active ingredients in the eye serum to better penetrate the skin, thereby improving the efficacy of the product.

Table 2. Changes in the skin parameters in the control group.

Parameters	Baseline	T30min	Day 28	*Δ*1	*Δ*2	*p*1	*p*2
Crow's feet depth (Sv in μm)	59.71	60.00	58.71	0.49%	-1.67%	0.840	0.975
Under the eyes wrinkle depth (Sv in μm)	68.45	61.06	66.94	-10.80%	-2.21%	<0.001	0.203
cleavage depth (Sv in μm)	94.03	87.71	90.55	-6.72%	-3.70%	0.020	0.325
Crow's feet volume (mm^3)	2.18	1.99	1.92	-8.72%	-11.93%	0.001	0.001
Under the eyes wrinkle volume (mm^3)	2.64	1.96	2.37	-25.76%	-10.23%	<0.001	0.032
cleavage volume (mm^3)	1.97	1.66	1.64	-15.74%	-16.75%	<0.001	0.007
Parameters	Baseline	Day 14	Day 28	*Δ*1	*Δ*2	*p*1	*p*2
MI value	172	148	154	-13.95%	-10.47%	<0.001	<0.001
Skin hydration (corneometer units)	65.0	73.9	74.0	13.69%	13.85%	<0.001	<0.001
R2 ratio	0.497	0.587	0.603	18.11%	21.33%	<0.001	<0.001
F3/F4 ratio	0.409	0.486	0.505	18.83%	23.47%	<0.001	<0.001

Note: Date at baseline, Day0 T30min/Day 14 and Day 28 were indicated as mean ± SD; SD, standard deviation; Δ1, percentage changes on Day0 T30min/Day 14 (vs. baseline); Δ1, percentage changes on Day 28 (vs. baseline); P1, p-value on Day0 T30min/Day 14 (vs. baseline) with the Paired Sample T test; P2, p-value day on Day 28 (vs. baseline) with the Paired Sample T test; Sa value, skin roughness; R2 ratio, skin elasticity; F3/F4 ratio, skin firmness; MI value, dark circle degree.

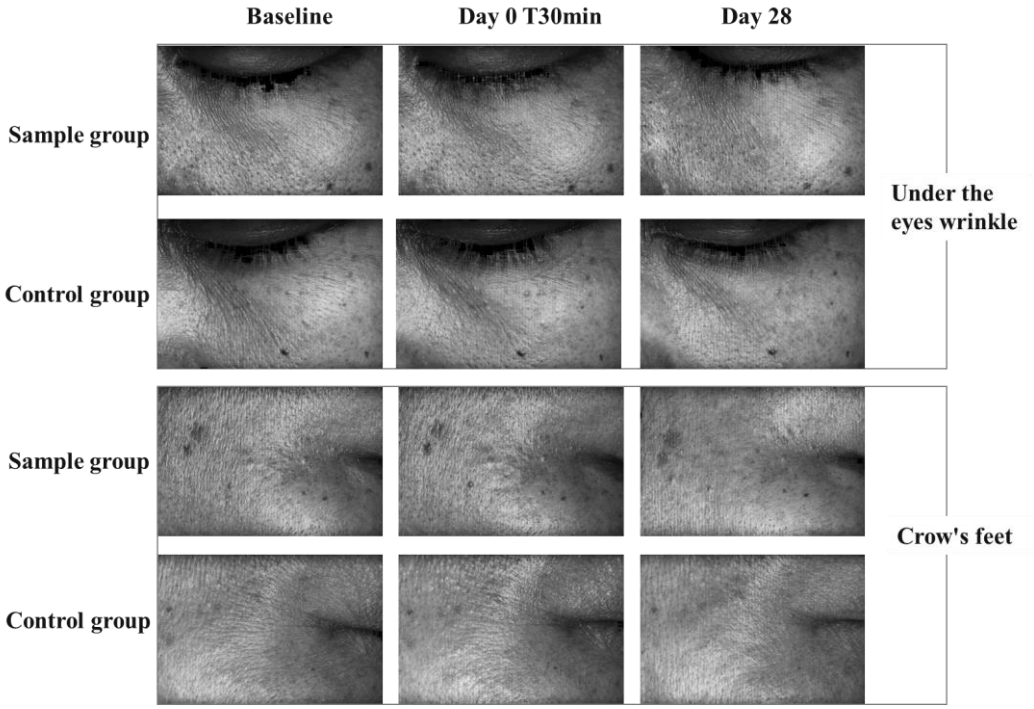
Table 3. Comparison of parameter changes between control and sample groups.

Parameters	control group	sample group	Δ1	p1
Crow's feet depth (Sv in μm)	-1.67%	-12.28%	10.60%	0.035
Under the eyes wrinkle depth (Sv in μm)	-2.21%	-4.59%	2.38%	0.811
cleavage depth (Sv in μm)	-3.70%	-12.40%	8.70%	0.015

Crow's feet volume (mm^3)	-11.93%	-31.87%	19.95%	0.039
Under the eyes wrinkle volume (mm^3)	-10.23%	-16.98%	6.75%	0.025
cleavage volume (mm^3)	-16.75%	-22.51%	5.76%	0.309
MI value	-10.47%	-12.99%	2.53%	0.092
Skin hydration (corneometer units)	13.85%	17.90%	-4.06%	0.033
R^2 ratio	21.33%	23.76%	-2.43%	0.366
F3/F4 ratio	23.47%	25.36%	-1.89%	0.393

Note: Δ1, control group vs. sample group on Day 28. Sa value, skin roughness; R2 ratio, skin elasticity; F3/F4 ratio, skin firmness; MI value, dark circle degree.

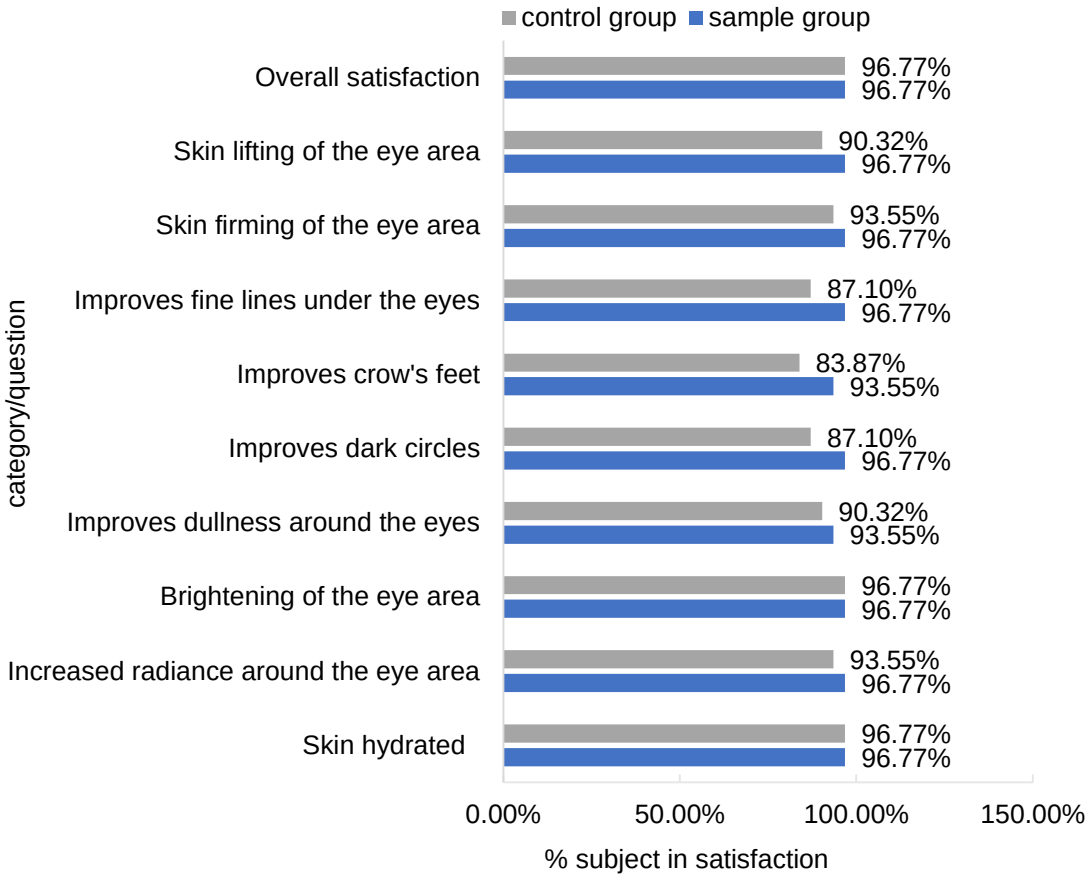
Figure1. Representative images of the skin-surface changes of the subjects.



3.2 Subject assessment

Figure 2 shows the results of the questionnaires regarding the efficacy of the eye serum and the aesthetic devices after 28 days of use. Subject satisfaction with the products tested was high, with 96.77 and 96.77% of subjects reporting overall satisfaction with the appearance of their skin in the sample and control groups, respectively. Additionally, subjects reported that their skin around the eyes looked more radiant (96.70%), brighter (96.77%), and dark circles were more noticeable (96.77%) when using the device versus the applicator group.

Figure 2. Subject questionnaire results for Day 28.



4. Discussion

The eye serum demonstrated remarkable anti-aging effects in this study. After 28 days of use, significant improvements were observed in wrinkle reduction, dark circle minimization, and skin firmness enhancement. Doctor evaluations and subject self-assessments both confirmed these benefits.

The active peptides in the eye serum's formula play a crucial role in its anti-aging effects. The peptides, such as acetyl hexapeptide-8 and palmitoyl pentapeptide-4, are known to stimulate collagen production, improve skin elasticity, and reduce wrinkle depth. These peptides signal the skin to repair and regenerate, leading to a more youthful appearance.[28–30]

The study also highlighted the advantages of combining the eye serum with a physical penetration enhancement system. This system, utilizing Atomization technology, electroporation and iontophoresis, significantly improved the product's efficacy. Atomization technology sprays the essence evenly on the skin, reducing its viscosity and controlling the particle size distribution. This helps the active ingredients to better penetrate the skin, thereby amplifying the anti-aging effects.[26,27] The physical penetration enhancement can temporarily and reversibly loosen the tight junctions between ocular epithelial cells, thereby

increasing the permeability of ocular membranes. Moreover, physical enhancers can modify the lipid bilayers of these cells, further enhancing membrane permeability and facilitating the absorption of active ingredients.[28–29]

However, some limitations should be considered. The study duration was relatively short-term. Long- term effects of the eye serum and penetration system remain to be investigated in future research. Additionally, the study focused on a specific population. Further studies should include diverse groups to confirm the universality of these results.

5. Conclusion

This clinical trial confirms that the eye serum is a safe and effective anti- aging product. It effectively reduces wrinkles, minimizes dark circles, and enhances skin firmness. When used with the penetration enhancement system, its anti- aging effects are significantly amplified. This study provides a new solution for periorbital anti- aging, offering a promising approach for those seeking to combat signs of aging in the eye area.

Reference

1. Mawalia, Reveny J, Harahap Utilization of water extract of yellow potato (*solanum tuberosum l.*) in hydrogel eye mask as anti-aging formulation. *ScienceRise: Pharmaceutical Science.* 2022;38(4):80-88.
2. Assistant Professor, Department of Pharmacy, World University of Bangladesh, Green Road, Dhanmondi, Dhaka, Bangladesh., Ak M. Skin Aging & Modern Age Anti-Aging Strategies. *IJCDR*. Published online August 29, 2019:209-240.
3. Kołodziejczak A, and Rotsztejn H. The eye area as the most difficult area of activity for esthetic treatment. *Journal of Dermatological Treatment*. 2022;33(3):1257-1264.
4. Rathore G, Das K, Landau M, et al. Clinical Assessment, Diagnosis, and Management of Infraorbital Wrinkles and Pigmentation. *Dermatologic Clinics*. 2024;42(1):79-88.
5. Hussein RS, Dayel SB, Abahussein O, El-Sherbiny AA. Influences on Skin and Intrinsic Aging: Biological, Environmental, and Therapeutic Insights.
6. Shin JW, Kwon SH, Choi JY, et al. Molecular Mechanisms of Dermal Aging and Antiaging Approaches. *International Journal of Molecular Sciences*. 2019;20(9):2126.
7. Tao BK, Butt FR, Dhivagaran T, et al. Periocular Aging Across Populations and Esthetic Considerations: A Narrative Review. *Journal of Clinical Medicine*. 2025;14(2):535.
8. Chng WQ, Samuel M, Naidoo K, et al. Topical treatments and skin‐resurfacing techniques for skin ageing-Chng, WQ-2021 | Cochrane Library. Accessed April 27, 2025.

9. Ramos-e-Silva M, Da Silva Carneiro SC. Elderly skin and its rejuvenation: products and procedures for the aging skin. *Journal of Cosmetic Dermatology*. 2007;6(1):40-50.
10. Ng A, Evans K, North RV, Jones L, Purslow C. Impact of Eye Cosmetics on the Eye, Adnexa, and Ocular Surface. *Eye & Contact Lens*. 2016;42(4):211. Accessed April 27, 2025.
11. Kouassi MC, Grisel M, Gore E. Multifunctional active ingredient-based delivery systems for skincare formulations: A review. *Colloids and Surfaces B: Biointerfaces*. 2022;217:112676.
12. Han R, Wang S, Li J, et al. The efficacy study of trinity permeation synergism on anti-aging. *Journal of Dermatologic Science and Cosmetic Technology*.
13. Bose VG. Electrical Characterization of Electroporation of Human Stratum Corneum.
14. Gonzalez CA, Rubinsky B. Electroporation of the Skin. In: *Current Technologies To Increase The Transdermal Delivery Of Drugs*. Bentham Science Publishers; 2012:78-95. Accessed April 27, 2025.
15. Parhi R, Suresh P, Patnaik S. Physical Means of Stratum Corneum Barrier Manipulation to Enhance Transdermal Drug Delivery. 2015. Accessed April 27, 2025.
16. Hu X, He H. A review of cosmetic skin delivery. *Journal of Cosmetic Dermatology*. 2021;20(7):2020-2030.
17. Donnelly RF, Singh TRR. *Novel Delivery Systems for Transdermal and Intradermal Drug Delivery*. Wiley-Blackwell; 2015.
18. Li F, Chen H, Chen D, et al. Clinical evidence of the efficacy and safety of a new multi-peptide anti-aging topical eye serum.
19. Choi JW, Kwon SH, Huh CH, Park KC, Youn SW. The influences of skin visco-elasticity, hydration level and aging on the formation of wrinkles: a comprehensive and objective approach. Accessed April 27, 2025.
20. Hojan-Jezierska D, Matthews-Kozanecka M, Kubisz L. The use of cutometer to evaluate the skin elasticity on the face. *Journal of Face Aesthetics*. 2022;5(1):18-24.
21. Fujimura T, Haketa K, Hotta M, Kitahara T. Global and systematic demonstration for the practical usage of a direct in vivo measurement system to evaluate wrinkles. *International Journal of Cosmetic Science*. 2007;29(6):423-436.
22. Matias AR, Ferreira M, Costa P, Neto P. Skin colour, skin redness and melanin biometric measurements: comparison study between Antera® 3D, Mexameter® and Colorimeter®. *Skin Research and Technology*. 2015;21(3):346-362.

23. Flagler MJ, Tamura M, Laughlin T, et al. Combinations of peptides synergistically activate the regenerative capacity of skin cells in vitro. *International Journal of Cosmetic Science*. 2021;43(5):518-529.
24. Lungu C, Considine E, Zahir S, Ponsati B, Arrastia S, Hallett M. Pilot study of topical acetyl hexapeptide-8 in the treatment for blepharospasm in patients receiving botulinum toxin therapy. *European Journal of Neurology*. 2013;20(3):515-518.
25. Zhang L, Falla TJ. Cosmeceuticals and peptides. *Clinics in Dermatology*. 2009;27(5):485-494.
26. Li J, Wang S, Han R, et al. A cutting-edge atomization-based methodology for enhancing formulation ability to resist photoaging. *Journal of Dermatologic Science and Cosmetic Technology*. 2024;1(4):100045.
27. Mohandas A, Luo H, Ramakrishna S. An Overview on Atomization and Its Drug Delivery and Biomedical Applications. *Applied Sciences*. 2021;11(11):5173.
28. Kale M, Kipping T, Banga AK. Modulated delivery of donepezil using a combination of skin microporation and iontophoresis. *International Journal of Pharmaceutics*. 2020;589:119853.
29. Ita K. Transdermal iontophoretic drug delivery: advances and challenges. *Journal of Drug Targeting*. 2016;24(5):386-391.