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Anti-aging Efficacy of a 0.1 % Pterostilbene Skincare Emulsion: A 28-Day Clinical Trial

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ABSTRACT

Pterostilbene is gaining recognition as a promising ingredient in skincare for its anti-aging benefits. This study assessed the clinical effectiveness of a 0.1 % pterostilbene-containing skincare emulsion against a control emulsion over 28 days with 31 participants. A double-blind, split-face design was used, comparing the left and right sides of the face and pre- and post-treatment conditions. Efficacy was measured using advanced tools, including the Skin Elasticity Tester Cutometer® dual MPA580, the facial imaging and analysis system VISIA®-CR, the skin microstructure 3D imaging system PRIMOS^{CR}, and the *in vivo* two-photon microscopy imaging system SUPERVISION-780, along with subjects' self-assessment after 14 and 28 days of continual use. Results demonstrated that the 0.1 % pterostilbene emulsion significantly enhanced skin elasticity R2 and firmness F4, reduced the area and volume of forehead and undern-eye wrinkles, decreased the percentage of Crow's feet wrinkles area, improved the aging index ELCOR, and increased the thickness of the epidermis layer, collagen intensity, elastic fiber fluorescence, and the standardized area of the epidermal-dermal junction (DEJ). Compared to the control emulsion, the pterostilbene emulsion showed statistically significant ($p < 0.05$) improvements in these metrics, as well as aging index SAIID and skin pore size. All subjects expressed higher satisfaction with the pterostilbene emulsion, highlighting its superior skincare benefits. The findings emphasize the potent anti-aging efficacy of pterostilbene, reinforcing its value as an active ingredient in cosmetics formulations.

1. Introduction

Pterostilbene is a polyphenolic compound naturally synthesized in plants such as blueberries, grapes, and *pterocarpus marsupoim*. Chemically known as trans-3,5-dimethoxy-4-hydroxystilbene, pterostilbene has demonstrated higher bioavailability and pharmacological potency compared to its parent compound, resveratrol.[1] Extensive research has highlighted pterostilbene's diverse biomedical applications.[2,3] It has shown promise in promoting healthy aging and longevity[4], and has been reported to prevent virus infections *in vitro*.[5] Additionally, studies in animal models have demonstrated its ability to mitigate metabolic disorders by reducing weight gain, liver fat accumulation, plasma cholesterol levels, adiposity, inflammatory biomarkers, and blood glucose.[6] Pterostilbene is also being investigated as a potential therapeutic agent for various diseases, including diabetes, cancer, cardiovascular diseases, and neurodegenerative disorders.[7–9] Its spectrum of pharmacological activities makes it an attractive candidate for both pharmaceutical and nutraceutical applications.

The skin, being the body's largest organ, act as a vital barrier with the environment and offers essential protection against external elements. In recent years, the incorporation of pterostilbene into skincare and cosmetic formulations has garnered significant attention. Research has shown that pterostilbene possesses a range of beneficial properties. *In vitro* studies have demonstrated its antioxidation, anti-inflammation, skin-whitening, autophagy-enhancing effects, as well as its ability to protect UV irradiation and add in the prevention and treatment of various skin diseases. [10–14] Additionally, *in vivo* studies have highlighted its skin-whitening efficacy and protective effects against UV-induced skin damage and skin cancer. [15–19]

This study carried out a 28-day clinical trial to assess the anti-aging efficacy of a pterostilbene-containing emulsion compared to a control emulsion. Multiple skin parameters were assessed through instrumental measurements and subjects' self-assessments.

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2. Materials and methods

2.1. Emulsion formula

The emulsion base was formulated with 78.0 % WATER, 10.0 % GLYCEROL (100 % purity; KL-Kepong Oleomas Sdn. Bhd., Malaysia), 10.0 % CAPRYLIC/CAPRIC TRIGLYCERIDE (100 % purity; Sterarinerie Dubois, France), 2.0 % C12–20 ALKYL GLUCOSIDE and C14–22 ALCOHOLS mixture (75–85 %: 15–25 %; Seppic, France). The pterostilbene-containing emulsion included 0.1 % PTEROSTILBENE (INCI: PTEROCARPUS MARSUPIUM BARK EXTRACT, white powder, 100 % purity; Jiangsu Fengwu Biopharmaceutical Technology Co. Lt. Jiangsu, China) and had 0.1 % less WATER, while maintaining the same composition for all the other ingredients.

2.2. Clinical trial

The double-blind clinical trial was designed in accordance with T/CAB 0152–2022, [20] T/TDCA 003–2021, [21] and a previously reported methodology. [22] The study was reviewed and preapproved by the ethics committee (Shanghai Weipu Testing Technology Group Co., Ltd Independent Ethics Committee) for research involving human subjects (Approval No. 202302JC12).

2.2.1. Subjects and sample application

This study employed a before- and-after control design combined with a left-right parallel control scheme. Thirty-one healthy Chinese volunteers, aged 32–53 years (mean age: 41.94 ± 0.91 years), with facial sagging, reduced elasticity, and fine lines and/or wrinkles were selected for the trial. All the subjects were not-pregnant, non-breastfeeding, and not planning a pregnancy. They had no history of systemic diseases, severe skin conditions, cosmetic or other allergies, and had not recently undergone medication or medical treatments. The trial was conducted from May to June, 2023. Subjects were instructed on how to use the pterostilbene-containing emulsion on one side of their face and the control base emulsion to the other side, twice daily (morning and evening) for 28 consecutive days. The entire experimental process was closely monitored through daily video supervision to ensure compliance.

2.2.2. Instrumental assessment of therapeutic efficacy

Instrumental measurements were conducted on day 0 (D0), 14 (D14), and 28 (D28) during subjects' visit to the clinical testing laboratory. Prior to each measurement session, subjects cleaned their faces with a cleansing product, dried the skin with dry tissue, and waited for 20 min in a controlled laboratory environment set to a temperature of 21 ± 1 °C and a relative humidity of 50 ± 10 % RH.

The elasticity R2 and firmness F4 of the skin on the cheeks were assessed using the Skin Elasticity Tester Cutometer® Dual MPA580 (Courage & Khazaka, Germany). This device operates based on the principles of suction and tension. Negative pressure is applied to the skin, drawing it into a specialized test probe equipped with an optical testing system consisting of a light transmitter and receiver. The amount of the skin drawn into the probe is proportionally correlated to the ratio of transmitted to received light. The skin's elasticity and firmness were then analyzed using the MPA software.

The area of pores on the cheeks and wrinkles in the Crow' feet region were measured with the VISAR®-CR facial imaging and analysis system (Canfield Scientific, United States). This system employs a combination of standard, UV, cross polarized and parallel polarized lighting to enhance skin visibility, alongside mirror photo management techniques to facilitate comparative image analysis.

Forehead and under-eye wrinkles were evaluated using the PRIMOS CR skin microstructure 3D imaging system (Canfield Scientific, United States). This instrument uses a digital micro-fringe projector. During testing, sinusoidal fringe light is projected onto the skin surface. The bending and deformation of the stripe pattern, caused by variations in skin height, are captured by a CCD camera positioned at a specific angle. By analyzing the positional changes of the fringe pattern and the gray-scale values of all image points, a detailed 3D digital reconstruction of the forehead and under-eye skin surface was generated for analysis.

Advanced imaging techniques were employed to evaluate various parameters in the Crow's feet region. These included the standardized area of the epidermal-dermal junction (DEJ), aging indices such as the elastin-to-collagen ratio (ELCOR) and the collagen-specific second harmonic generation (SHG) relative to elastin-specific autofluorescence (AF) aging index (SAAID). Additionally, measurements were taken for the thickness of the epidermis layer, the fluorescence intensity of elastic fibers, and the harmonic intensity of collagen fibers using the *in vivo* two-photon microscopy imaging system SUPERVISION-780 (Transcend Viviscope, China). This compact and mobile two-photon microimaging platform, was specifically designed for microscopic imaging of skin biocells. It integrates laser scanning confocal microscopy and two-photon excitation. In this system, photons from a pulsed laser are focused using a high numerical aperture objective, with the photon density peaking at the focal point. While single photon excitation is limited to the focal point, eliminating the need for a confocal pinhole and enhancing fluorescence detection efficiency. This technology enables high-resolution autofluorescence imaging and second harmonic imaging of the skin's surface epithelial cells, providing detailed insights into the structural and biochemical properties of the crow's feet region.

For easier understanding, the measured parameters and their corresponding mechanisms are summarized in Table 1.

A dermatologist analyzed the collected data. The skin parameters after 14 and 28 days of product use was calculated using the following formula:

$$Change\ rate = \left(\frac{Mean_{D14/D28} - Mean_{D0}}{Mean_{D0}}\right) \times 100\%$$

2.2.3. Subject self-assessment

Any skin reaction or systemic adverse effects observed during the experiment were recorded. These included erythema, infiltration, papules, herpes and bullous reactions. Detailed documentation encompassed the manifestation of the adverse events, the time of occurrence, the treatment measures implemented, and the regression process. On D24 and D28, each subject completed two self-assessment questionnaires to evaluate the performance of the pterostilbene emulsion and the control base emulsion, respectively. The questionnaires employed a five-point scale (1 = very disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) to assess various aspects of the skin improvement. Subjects rated whether their skin felt more moisturized, refined, smoother, translucent, radiant, brighter, and toned. They also evaluated the reduction in the visibility of wrinkles (e.g. forehead, under-eye area, nasolabial folds) and improvements in elasticity and firmness. Additionally, subjects assessed whether the product were gentle and non-irritating. Finally, overall satisfaction with the product was evaluated.

2.3. Statistical analysis

The results were expressed as mean ± standard error (SEM). The data were analyzed using SPSS. Shapiro-Wilk Test was performed to check the value distribution. Two-tailed T-test and Wilcoxon signed rank test were applied for normal and non-normal distribution values, respectively, and $p < 0.05$ was considered as a significant difference.

3. Results

3.1. Pterostilbene emulsion showed anti-wrinkle and firmness efficacies

The measured values of skin ageing parameters are summarized in Table 2 and presented as Fig. 1. The results showed that the half face treated with the pterostilbene emulsion demonstrated significant

Table 1
Summary of the measured parameters and their corresponding mechanisms.

Equipment	Measured parameters	Measurement Area	Description
Cutometer dual MPA580	1. Skin elasticity R2 2. Skin firmness F4	Cheeks	The testing principle relies on suction and tension mechanisms. A negative pressure is applied to the surface of the skin being tested, drawing it into a specialized test probe. The extent to which the skin is drawn into the probe is measured using a non-contact optical measurement system. The test probe comprises a light transmitter and receiver. The ratio of light (i.e., the proportion of transmitted light to received light) is directly proportional to the length of the skin that has been drawn into the probe. Finally, the skin's tightness performance is evaluated through analysis using MPA software.
Visia-CR	1. Percentage of Crow's feet wrinkles area 2. Percentage of pores area	Taking full face photos and analyzing crow's feet and cheeks	The VISIA-CR system features a variety of light source modes, including standard light, UV light, cross-polarized light, and parallel-polarized light. These multiple light sources significantly enhance the visibility of the skin being analyzed, allowing for a more comprehensive assessment. Canfield's proprietary RBX technology, which draws on extensive research in color science, provides researchers with detailed insights into melanin and blood vessel conditions in the deeper layers of the skin. This innovative method offers a new way to detect, display, and analyze the skin's subsurface features. The photography process involves multiple light source modes and can capture up to seven different images. The VISIA-CR instrument is equipped with specialized software, Mirror Photo Tools, for efficient image management. This software allows captured images to be directly stored on a computer, facilitating easy retrieval and comparison.
Primos-CR	1. Area of forehead wrinkles 2. Volume of forehead wrinkles 3. Area of under eye wrinkles 4. Volume of under eye wrinkles	Forehead wrinkle region and under eye region	The testing principle is a digital optical 3D image analysis instrument developed on the basis of digital micro fringe projector. During the test, the fringe light with sinusoidal density is projected onto the skin or the surface of the tested object. Due to the uneven height of the skin or the surface of the measured object, the stripe light will be bent and deformed, and the CCD camera placed at a specific angle will record this change at the same time. By testing the position change of stripe light and the gray value of all image points, the digital 3D image of the entire test skin surface or test object can be obtained. Different fringe light can be selected for projection according to different test tasks.
Supervision−780	1. Standardized area of the epidermal dermal junction DEJI 2. Aging index ELCOR 3. Aging index SAAID 4.Thickness of the epidermis layer 5. Elastic fiber gluorescence intensity 6. Collagen fiber harmonics intensity	Crow's feet wrinkles	The SUPERVISION−780 is a portable, miniaturized two-photon microimaging system specifically designed for microscopic imaging of skin biocells. This advanced technology integrates laser scanning confocal microscopy with two-photon excitation, offering enhanced imaging capabilities. When a high numerical aperture objective lens focuses photons from a pulsed laser, the photon density reaches its peak at the focal point. While single-photon excitation occurs along the entire light path, two-photon excitation is confined strictly to the focal point of the objective lens. This unique property eliminates the need for a confocal pinhole, resulting in significantly higher fluorescence detection efficiency. Leveraging the principles of two-photon microimaging, the SUPERVISION−780 enables both autofluorescence imaging and second harmonic imaging of body surface epithelial cells and tissues, depending on the specific application requirements.

Table 2
Summary of the measured skin parameters. Compared with the D0, and for comparison between two emulsion treatments, "n.s" means $p > 0.05$, "*" means $0.01 < p < 0.05$, "**" means $0.001 < p < 0.01$, "***" means $p < 0.001$. Subjects: N = 31.

Parameters	Sample	D0	D14			D28		
		Mean ± SEM	Mean ± SEM	Improvement	*p*	Mean ± SEM	Improvement	*p*
Skin elasticity R2	Pterostilbene	0.46 ± 0.01	0.56 ± 0.00	21.74 %* **	* **	0.61 ± 0.01	32.61 %* **	* **
	Control base	0.46 ± 0.01	0.47 ± 0.01	2.17 %		0.47 ± 0.01	2.17 %*	
Skin firmness F4	Pterostilbene	6.59 ± 0.10	6.32 ± 0.08	4.1 %* **	* **	6.11 ± 0.08	7.28 %* **	* **
	Control base	6.57 ± 0.09	6.58 ± 0.09	−0.15 %		6.50 ± 0.09	1.07 %*	
Area of forehead wrinkles	Pterostilbene	50.57 ± 3.21	45.64 ± 3.26	9.75 %* **	* **	43.55 ± 2.86	13.88 %* **	* **
	Control base	53.77 ± 2.49	53.45 ± 2.54	0.60 %		52.02 ± 2.45	3.25 %*	
Volume of forehead wrinkles	Pterostilbene	3.18 ± 0.27	2.88 ± 0.29	9.43 %* **	n.s	2.69 ± 0.25	15.41 %* **	n.s
	Control base	3.17 ± 0.23	3.08 ± 0.29	2.84 %		2.89 ± 0.25	8.83 %	
Area of underneath eye wrinkles	Pterostilbene	67.93 ± 1.61	63.85 ± 1.65	6.01 %* **	* *	63.16 ± 1.56	7.02 %* **	* **
	Control base	65.13 ± 1.71	64.09 ± 1.75	1.60 %		63.67 ± 1.83	2.24 %	
Volume of underneath eye wrinkles	Pterostilbene	9.11 ± 0.54	8.84 ± 0.55	2.96 %	n.s	8.57 ± 0.50	5.93 %* *	n.s
	Control base	9.08 ± 0.54	9.05 ± 0.68	0.33 %		8.95 ± 0.63	1.43 %	
Percentage of crow's feet wrinkles	Pterostilbene	0.020 ± 0.003	0.019 ± 0.003	2.53 %	n.s	0.017 ± 0.003	13.64 %* *	*
	Control base	0.020 ± 0.003	0.020 ± 0.003	0.50 %		0.020 ± 0.003	0.50 %	
Aging index ELCOR	Pterostilbene	0.82 ± 0.05	0.63 ± 0.05	23.17 %* *	* **	0.67 ± 0.05	18.29 %	*
	Control base	0.86 ± 0.05	0.94 ± 0.06	−9.30 %		0.94 ± 0.08	−9.30 %	
Aging index SAAID	Pterostilbene	−0.23 ± 0.06	−0.07 ± 0.06	69.57 %*	* **	−0.12 ± 0.06	47.83 %	* **
	Control base	−0.24 ± 0.06	−0.26 ± 0.06	−8.33 %		−0.31 ± 0.05	−29.17 %	
Thickness of the epidermis layer	Pterostilbene	75.34 ± 1.85	78.79 ± 2.53	4.58 %*	*	81.58 ± 2.12	8.28 %* **	* **
	Control base	73.23 ± 1.72	70.70 ± 1.96	−3.45 %		71.21 ± 1.64	−2.76 %	
Collagen intensity harmonics fiber	Pterostilbene	3492 ± 382	4141 ± 370	18.58 %	* *	4190 ± 398	19.96 %* **	*
	Control base	3473 ± 380	3084 ± 329	−11.19 %		3439 ± 338	−0.97 %	
Fluorescence intensity of elastic fiber	Pterostilbene	2493 ± 291	3206 ± 433	28.62 %*	* *	4413 ± 466	77.04 %* **	* **
	Control base	2327 ± 240	2418 ± 334	3.91 %		2764 ± 281	18.80 %	
Standardized area of the epidermal dermal junction DEJI	Pterostilbene	2.35 ± 0.04	2.49 ± 0.05	5.96 %*	* *	2.52 ± 0.05	7.23 %*	*
	Control base	2.37 ± 0.03	2.38 ± 0.05	0.42 %		2.33 ± 0.05	−16.90 %	

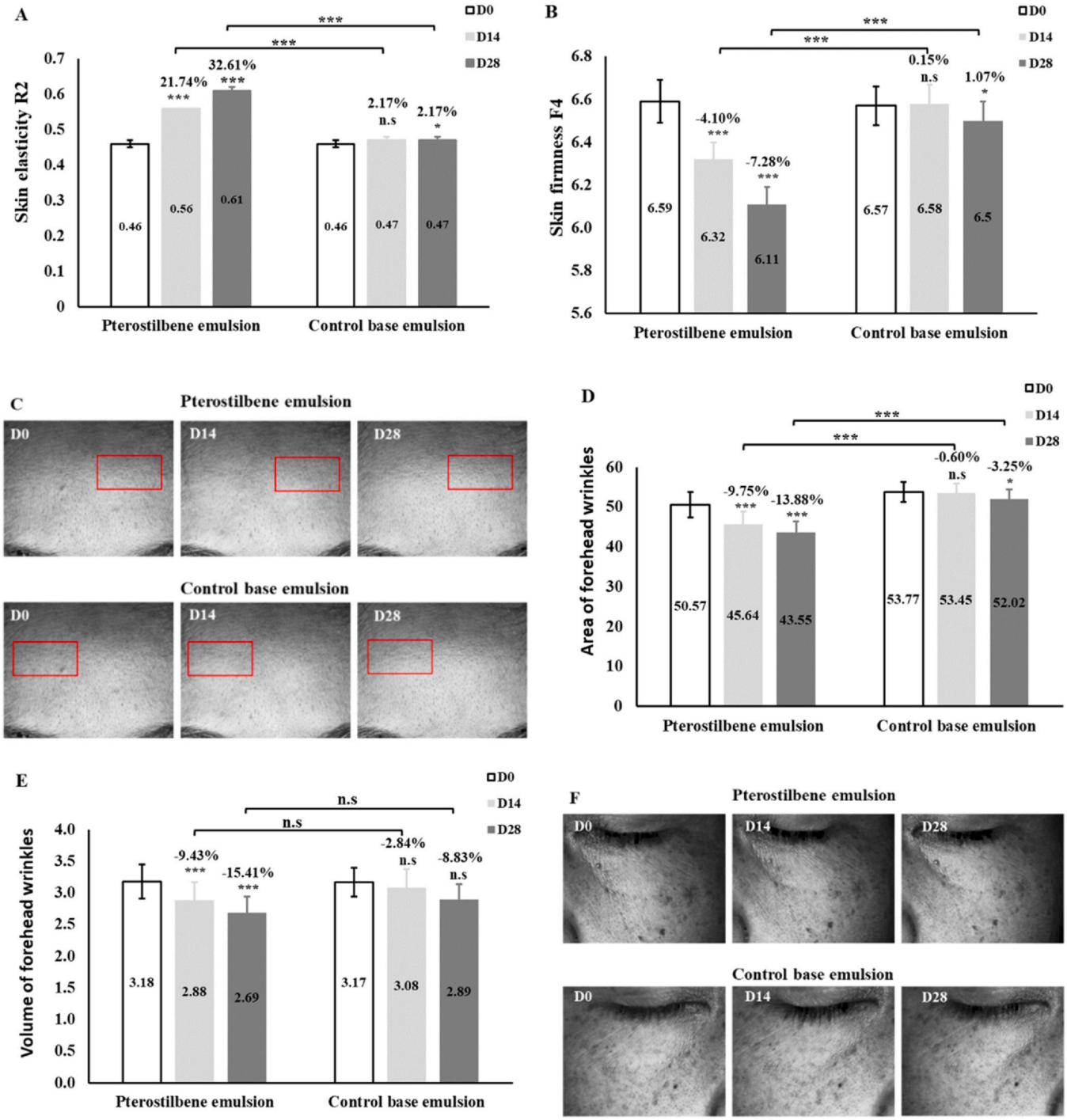

Fig. 1. The instrumental analysis of anti-aging efficacy of pterostilbene emulsion and control base emulsion. A: skin elasticity, B: skin firmness F4, C: forehead wrinkles, D: area of forehead wrinkles, E: volume of forehead wrinkles, F: underneath eye wrinkles, G: area of under-eye wrinkles, H: volume of under-eye wrinkles, I: Crow's feet wrinkles, J: percentage of Crow's feet wrinkles, K: ageing index ELCOR, L: ageing index SAAID, M: epidermis layer, N: epidermis layer (vertical section), O: thickness of the epidermis layer, P: collagen fiber, Q: collagen intensity harmonics fiber, R: fluorescence intensity of elastic fiber, S: standardized area of the epidermal dermal junction (DEJ). Data was presented as mean ± SEM. For comparison with D0, and comparison between two emulsion treatments, "n.s" means $p > 0.05$, "*" means $0.01 < p < 0.05$, "**" means $0.001 < p < 0.01$, "*** " means $p < 0.001$. Subjects: N = 31.

improvement in skin elasticity and firmness, and wrinkles reduction compared to the baseline (D0) at both D14 and D28. Specifically: Skin elasticity (R2) increased significantly ($p < 0.001$) from 0.46 (D0) to 0.56 (D14, + 21.74 %) and 0.61 (D28, + 32.61 %) (Fig. 1A), skin firmness (F4) improved significantly ($p < 0.001$) with readings reduced by 4.10 % at D14 and 7.28 % at D28 (Fig. 1B), forehead wrinkles (Fig. 1C) area decreased significantly ($p < 0.001$) by 9.75 % at D14 and 13.88 % at D28 (Fig. 1D), while wrinkle volume reduced by 9.43 % and 15.41 % at D14 and D28, respectively (Fig. 1E), under-eye wrinkle (Fig. 1F) area decreased significantly ($p < 0.001$) by 6.01 % (D14) and 7.02 % (D28) (Fig. 1G), with wrinkle volume decreased by 5.93 % at D28 (Fig. 1H), Crow's feet wrinkle (Fig. 1I) decreased significantly ($p < 0.01$) by 13.64 % at D28 (Fig. 1J), aging index ECLOR decreased significantly ($p < 0.001$) by 23.17 % at D14 and 18.29 % at D28 (Fig. 1K), and aging index SAIID improved by 69.57 % ($p < 0.05$) at D14 and 47.83 % ($p > 0.05$) at D28 (Fig. 1L).

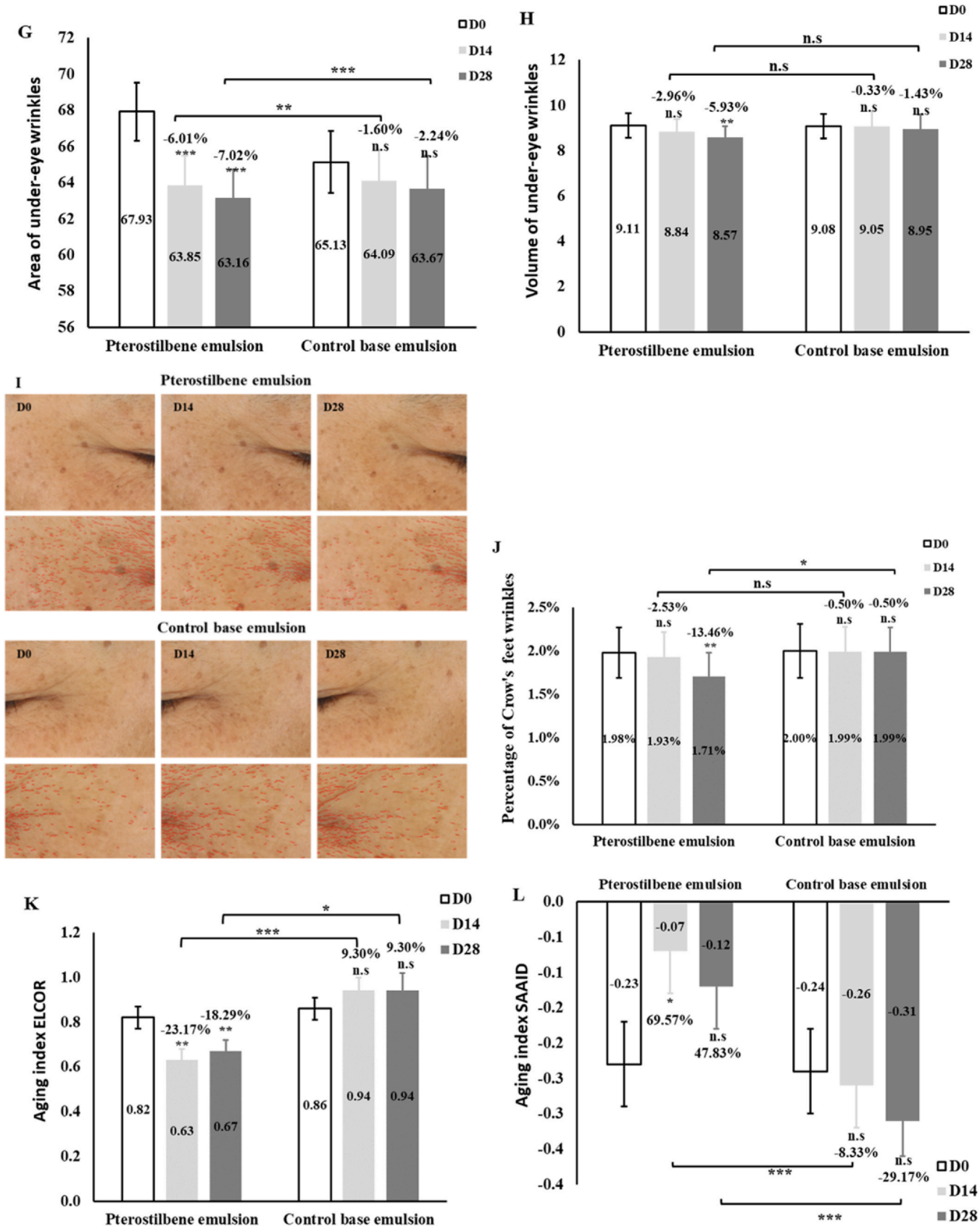

Fig. 1. (*continued*)

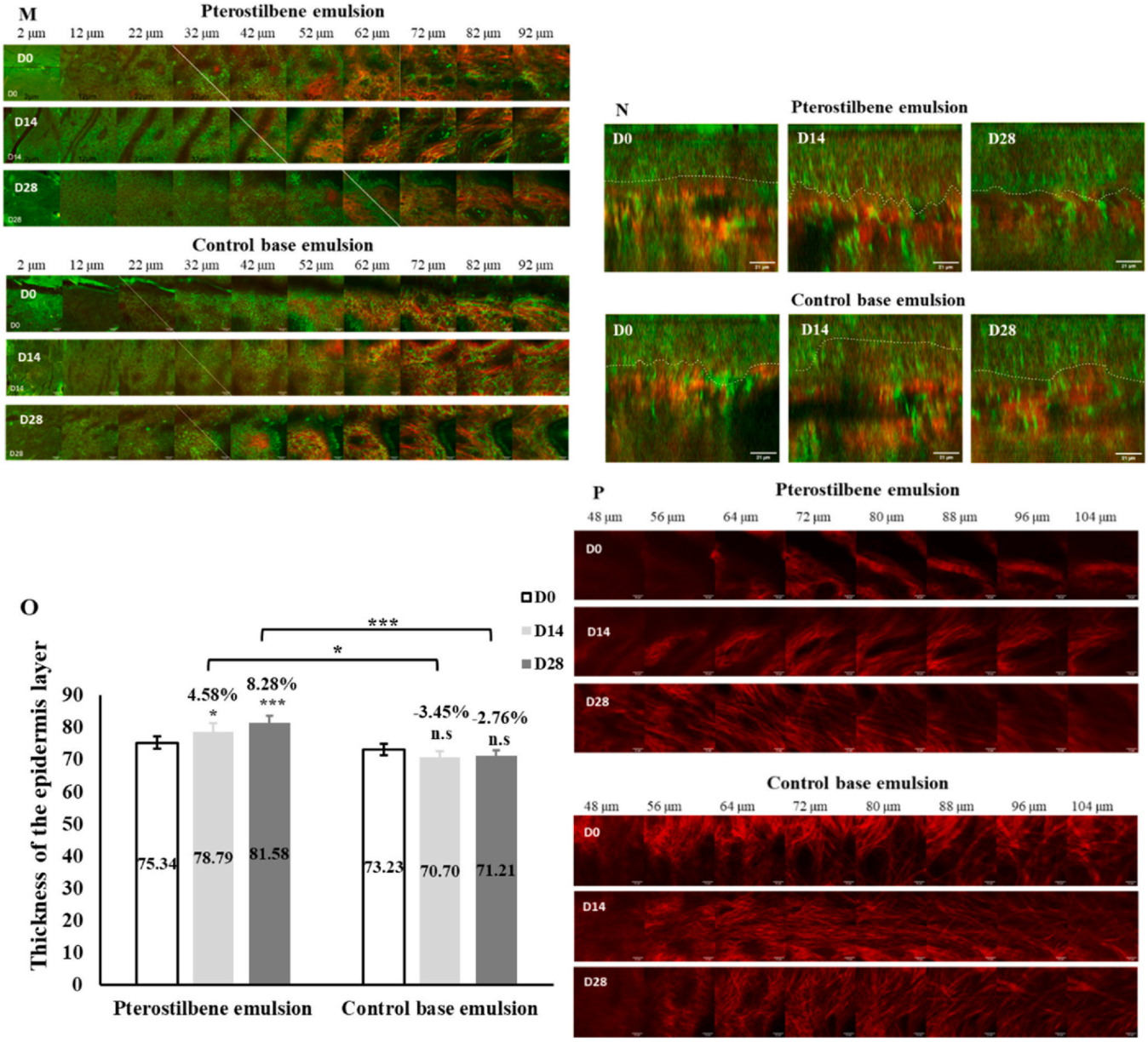

Fig. 1. (*continued*)

Further analysis revealed significant improvements in skin structure at the Crow's feet wrinkle area: Epidermis layer increased by 4.58 % ($p < 0.05$) at D14 and 8.28 % ($p < 0.001$) at D28 (Fig. 1M-O), collagen intensity harmonics fiber (Fig. 1P) increased by 19.96 % ($p < 0.001$) at D28 (Fig. 1Q), elastic fiber fluorescence intensity increased by 28.62 % ($p < 0.05$) at D14 and 77.04 % ($p < 0.001$) at D28 (Fig. 1R), and epidermal dermal junction (DEJ) increased significantly ($p < 0.05$) by 5.96 % at D14 and 7.23 % at D28 (Fig. 1S).

In contrast, the control base emulsion resulted in modest improvement: skin elasticity (R2) increased by 2.17 % ($p < 0.05$), skin firmness (F4) reduced by 1.07 % ($p < 0.05$), and forehead wrinkle area decreased by 3.25 % ($p < 0.05$) at D28. No significant effects ($p > 0.05$) were observed for other parameters. These results indicate the placebo effects was very limited.

These results collectively demonstrated the superior anti-aging efficacy of the pterostilbene emulsion through multiple mechanisms, including enhanced skin elasticity, wrinkle reduction, and improved skin structure.

3.2. Pterostilbene emulsion refined skin pores

The effect of pterostilbene on skin pores was also evaluated. As show in Table 3 and Fig. 2, the half-face treated with the control base emulsion exhibited increasingly prominent pores at D14 ($0.01 < p < 0.05$) and D28 ($p < 0.001$), likely influenced by the progressively hotter weather during the clinical trial period. In contrast, the half-face treated with the pterostilbene emulsion showed a mild, though statistically insignificant ($p > 0.05$), reduction in pore area. Notably, when compared to the control base emulsion, the pterostilbene emulsion significantly reduced pores area at both D14 ($0.01 < p < 0.001$) and D28 ($p < 0.001$), highlighting its efficacy in minimizing pores despite environmental factors.

3.3. Subjects preferred pterostilbene emulsion then control base emulsion

The subjects' self-assessment on the anti-aging efficacy of the two emulsions is present in Fig. 3. For the pterostilbene emulsion, all

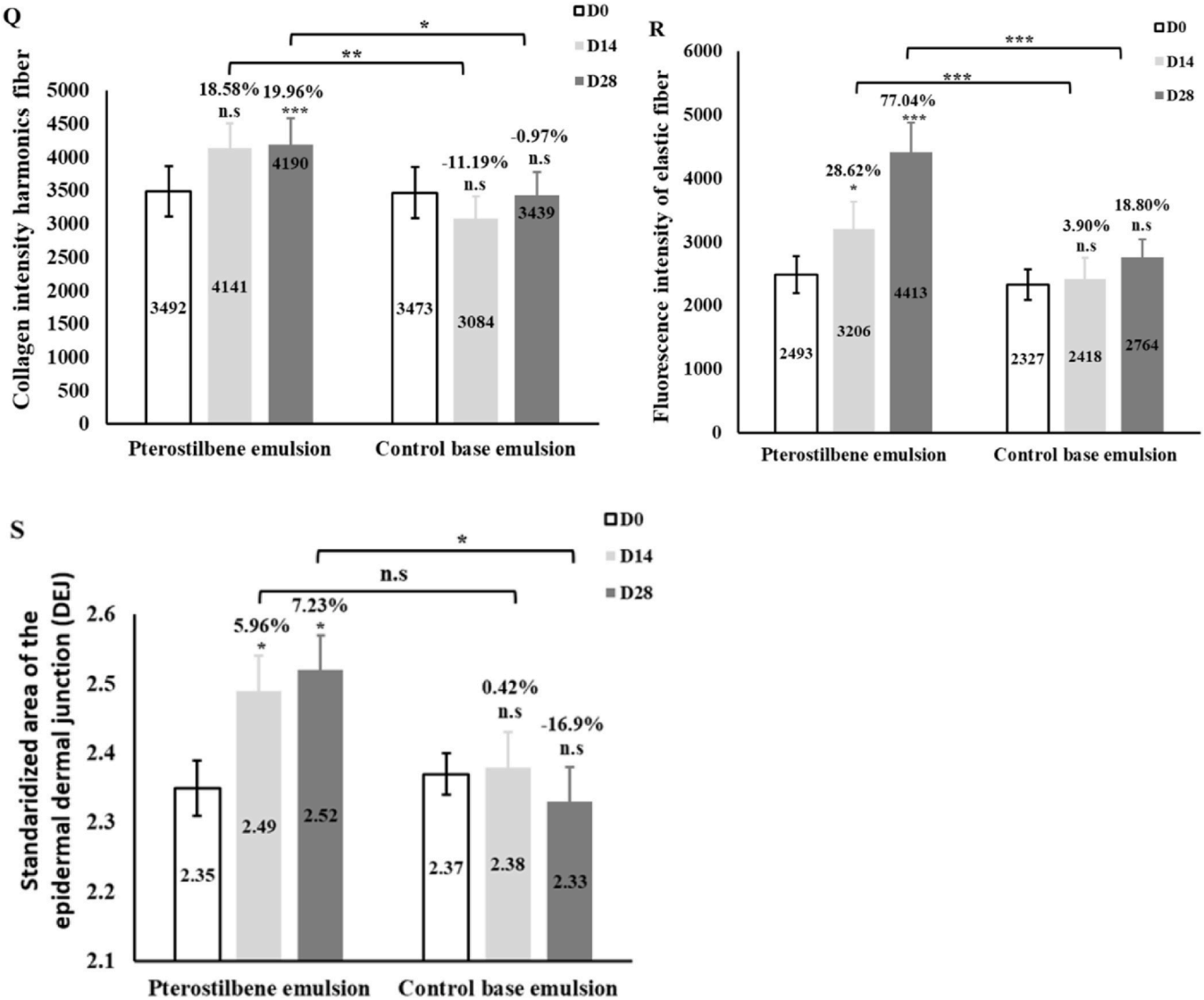

Fig. 1. (*continued*)

Table 3
The measured skin pores' area. Compared with the D0, and for comparison between two emulsion treatments "* " means $0.01 < p < 0.05$, "** " means $0.001 < p < 0.01$, "* ** " means $p < 0.001$. Subjects: N = 31.

Parameters	Sample	D0	D14			D28		
		Mean ± SEM	Mean ± SEM	Improvement	p	Mean ± SEM	Improvement	p
Percentage of pores' area	Pterostilbene	0.0753 ± 0.0018	0.0751 ± 0.0018	0.27 %	* *	0.0746 ± 0.0017	32.61 %	* **
	Control base	0.0755 ± 0.0016	0.0766 ± 0.0016	−1.46 %*		0.0778 ± 0.0016	2.17 %* **	

subjects reported high overall satisfaction after 14 and 28 days of continual use. They noted significant improvements in their skin attributes, including increased moisture, refinement, smoothness, translucency, radiance, brightness, tone, elasticity, and firmness. Additionally, wrinkles - such as those on the forehead, undern-the eyes, and in the nasolabial folds- were perceived as less visible. All subjects also agreed that the product was gentle and non-irritating, with no adverse skin reactions reported. In comparison, the control base emulsion received less favorable feedback, with subjects reporting fewer positive feedback.

4. Discussion

Pterostilbene is a natural stilbenoid and a demethylated analogue of resveratrol. Both compounds have been used as active ingredients in cosmetics, and resveratrol is more widely recognized and familiar to the general public. The mechanism underlying resveratrol's cosmetic applications include its antioxidant activity against UV radiation and ability to enhance collagen production, up-regulate expression of sirtuin 1 gene, inhibit collagenase, elastase, matrix metalloproteinases (MMPs) and inflammation [11,22] However, resveratrol's instability has

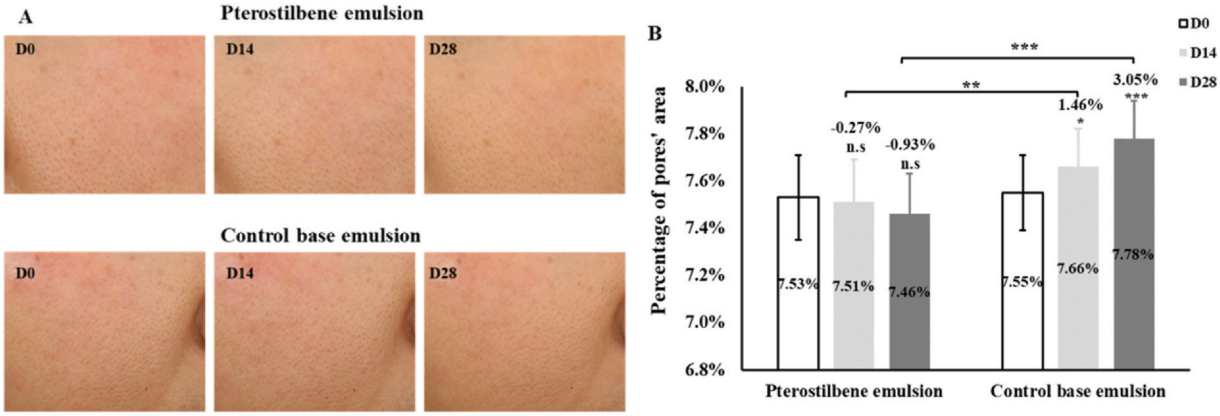

Fig. 2. The instrumental analysis of pores improvement efficacy of pterostilbene emulsion and control base emulsion. A: pores in the cheeks, B: percentage of pores' area. Data was presented as mean ± SEM. Compared with the D0, and for comparison between two emulsion treatments, "n.s" means $p > 0.05$, "* " means $0.01 < p < 0.05$, "* *" means $0.001 < p < 0.01$, "* ** " means $p < 0.001$. Subjects: N = 31.

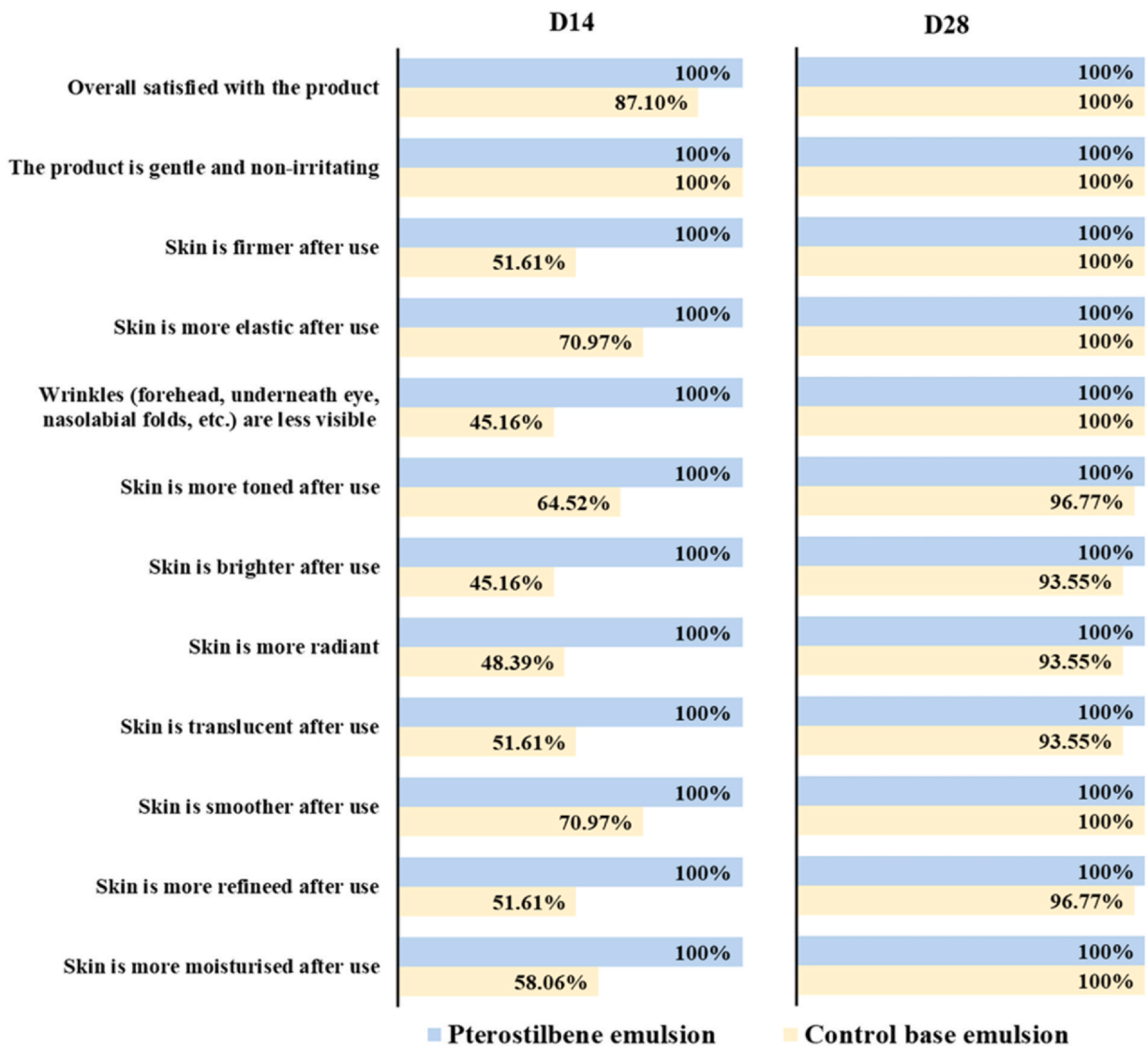

Fig. 3. The percentage of the subjects reporting positively (score ≥ 4) to various indicators after continuous use of the two emulsions for 14 and 28 days. Subjects: N = 31.

limited its use in skincare formulations, necessitating advanced emulsification technologies to improve its stability.[23] In comparison, pterostilbene is reported to be less irritating, more stable, more lipophilic, and has higher bioavailability than resveratrol,[24] making it a more favorable candidate for cosmetic applications.

In this study, a clinical experiment was conducted to evaluate the anti-aging efficacy of a pterostilbene-containing emulsion using emulsion base as a control. After 14 and 28 days of continuous application, the half-face treated with the pterostilbene emulsion demonstrated significant improvements in skin elasticity, firmness, and the aging index ELCOR. It also showed reductions in forehead wrinkles, under-eye wrinkles, and Crow's feet, along with thickened epidermis, increased collagen and elastic fibers, and reduced pore size. These results were further supported by the subjects' self-assessments, which indicated noticeable improvements in skin appearance and texture. Additionally, these findings align with those of a previous clinical study, which reported that a 0.4 % pterostilbene formulation was "highly effective in reducing markers of aging and induces even skin tone." Significant improvements were observed in aging parameters, including skin elasticity, forehead wrinkles, under-eye wrinkles, Crow's feet wrinkles, and skin texture after continual use for 4 weeks, and these improvements were further enhanced after 8 weeks of use.[18] Together, these clinical results highlight the strong potential of pterostilbene as an active ingredient in anti-aging cosmetics.

Despite its extensive investigation in biomedical applications[2–9], pterostilbene is a relatively new ingredient in cosmetics. Encouragingly, both the present and previous studies have consistently demonstrated the safety and excellent anti-aging efficacy of pterostilbene at formulation concentrations up to 0.4 %. Parallel to this article, the anti-ageing potential of pterostilbene as cosmetics ingredient was evaluated using UVA and UVB irradiated fibroblasts and *in vitro* skin models. [25] The results showed that pterostilbene effectively mitigated UV irradiation damage to fibroblasts by decreasing the levels of matrix metalloproteinase-1 (MMP-1) and MMP-3, while increasing collagen I content. Additionally, pterostilbene alleviated damage to in vitro skin by enhancing epidermal thickness and boosting the levels of collagen IV, collagen VII, and fibroblast growth factor-β (FGF-β), as well as reducing collagen fiber degradation. These findings underscore the promising anti-aging potential of pterostilbene as an effective cosmetic ingredient, highlighting its potential to address key aspects of skin ageing and UV-induced damage.

5. Conclusion

In conclusion, the pterostilbene emulsion significantly improved skin elasticity and firmness, reduced wrinkles (including forehead, under-eye, and Crow's feet wrinkles), enhanced collagen and elastin fiber levels, thickened the epidermal layer, and refined skin pores. Future research should explore the anti-aging effects of varying concentrations of pterostilbene, the effects of pterostilbene to other ethnic groups and other ages groups, and assess its long-term benefits in skincare applications.

Ethical statement

The research protocol was examined and approved by the China-norm Ethics Committee for Clinical Research (Approval No. 202302JC12). Benefits, risks, and potential complications were explained to the subjects. All subjects voluntarily participated in this study and signed an informal consent form.

CRediT authorship contribution statement

Zongxiao Cen: Project administration, Methodology, Data curation. **Zhiyuan Chen:** Supervision, Resources, Conceptualization. **Ding Wang:** Methodology, Investigation, Formal analysis. **Yuqin Zuo:** Validation, Formal analysis, Data curation. **Junyuan Chen:** Validation, Investigation. **Xueping Chen:** Writing – review & editing, Writing – original draft, Formal analysis.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Zongxiao Cen, Zhiyuan Chen, Ding Wang, Yuqin Zuo were employed by Guangzhou Luanying Cosmetics Co., LTD, Xueping Chen was employed by Research Institute of Tsinghua, Pearl River Delta and Vitargent (International) Biotechnology Limited, and Junyuan Chen was employed by Vitargent (International) Biotechnology Limited. The research project was funded by Guangzhou Luanying Cosmetics Co., LTD.

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