Assessing Photoprotective Efficacy of Stick Sunscreen: Single vs. Double-Layer Application

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Introduction

In vivo Sun Protection Factor (SPF) testing follows a standard application of 2 mg/cm² (ISO 24444), but actual usage varies, potentially reducing photoprotection. Stick sunscreens are increasingly popular, yet there is no consensus on the number of applications.

This study evaluated the effectiveness of a stick sunscreen with hyaluronic acid, comparing label SPF with single- and double-layer application.

Methods

SPF was determined according to ISO 24444:2019, and UVA protection factor (UVAPF) and critical wavelength were assessed following ISO 24443:2021. Ultra-long UVA (380–400 nm), visible light transmittance, and water resistance were evaluated. In 34 volunteers, hydration was measured by corneometry at 15 minutes and 6 hours. Perceived efficacy (30 days), ophthalmological evaluation, and comedogenic/acnegenic potential were assessed. To simulate real-life use, the sunscreen was applied to the infrascapular region in single and double layers. Deposited amounts were quantified and used for in vitro SPF determination (Diffey method), with transmittance measured from 290 to 400 nm at 1 nm intervals.

Results

The in vivo SPF was 93.9, the UVA protection factor was 42.4, with a critical wavelength of 379 nm. The formulation achieved 59% visible light blockage. After 80 minutes of water immersion, the SPF remained 52.6, supporting the classification of very high water resistance.

Corneometry analysis (Figure 1) demonstrated a 30% increase in skin hydration at 15 minutes and 11.8% at 6 hours post-application ($p<0.05$). All participants (100%) showed increased hydration compared to baseline.

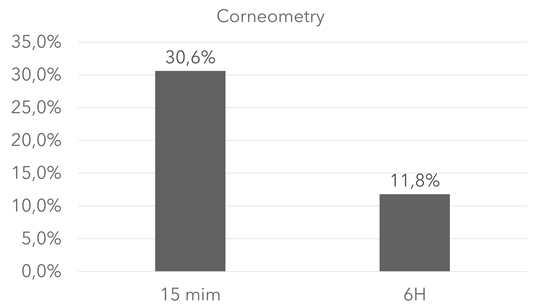

Figure 1: Percentage increase in skin hydration measured by corneometry at 15 minutes and 6 hours after product application.

Clinical assessment confirmed uniform film formation with one or two layers, without discomfort. The sunscreen was ophthalmologically evaluated and showed no comedogenic or acnegenic potential.

Using the Diffey in vitro method, single-layer application resulted in a mean deposited dose of 1.5 mg/cm² and an SPF of 105.9, while double-layer application achieved 2.4 mg/cm² and an SPF of 114.8 (Figure 2).

In Vitro SPF Evaluation: Single vs. Double-Layer Application

LAYERS	WEIGHT	SPF
1 layer	1,5 mg/cm²	105,9
2 layers	2,4 mg/cm²	114,8

Figure 2: Mean deposited dose (mg/cm²) and corresponding in vitro SPF values following single- and double-layer application, determined using the Diffey method.

The mean spectral transmittance curves of the stick sunscreen following single- and double-layer application are presented in Figures 3 and 4, respectively.

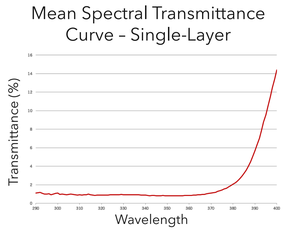

Figure 3: Mean spectral transmittance curve of the stick sunscreen following single-layer application.

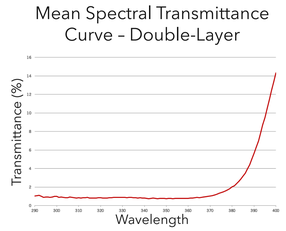

Figure 4: Mean spectral transmittance curve of the stick sunscreen following double-layer application.

Discussion

Although in vivo SPF testing follows the ISO standard dose of 2 mg/cm², real-world application often deviates from this recommendation. Using the Diffey in vitro method, single- and double-layer application yielded high SPF values at deposited doses of 1.5 and 2.4 mg/cm², respectively. As expected, in vitro SPF values exceeded in vivo measurements. Increasing the deposited dose resulted in only a moderate rise in SPF, and high values were already observed at 1.5 mg/cm², below the ISO-recommended dose.

The formulation also demonstrated broad-spectrum protection, including long and ultra-long UVA blocking, high water resistance, hydration benefits, and good tolerability, supporting its suitability for daily use.

Conclusion

The results demonstrate that the sunscreen stick maintains high photoprotective performance in both single and double layer applications. Although increasing the applied dose raised the SPF values, substantial protection was achieved even below the ISO recommended dose. These results confirm the product's reliable performance under real-world conditions, reinforced by its moisturizing benefits and good tolerability.

Disclosures

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References

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Further information

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