IFSCC 2025 full paper (IFSCC2025-1324)

Long-term clinical efficacy of a cosmetic formulation containing Brazilian berry extract in reducing signs of skin photoaging

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1. Introduction

The skin is the primary barrier between the body and the external environment, constantly exposed to physical, chemical, and biological aggressors. Among these, ultraviolet (UV) radiation is considered one of the most detrimental factors in the skin aging process, promoting oxidative stress, inflammation, and structural degradation of dermal components [1]. Chronic sun exposure—especially in areas such as the face and forearms—leads to photoaging, characterized by rough texture, hyperpigmentation, loss of elasticity, and deep wrinkles [2,3].

As a result, increasing attention has been given to topical strategies that can reduce the effects of photodamage. In this context, plant-based bioactives have gained significant relevance in modern dermatological science due to their multifunctionality and safety [4,5].

One promising ingredient is the Brazilian berry (*Plinia cauliflora*) extract, which is known for its potent antioxidant capacity and high content of phenolic compounds [6,7]. Recent studies have demonstrated its moisturizing properties, as well as its ability to improve skin texture and barrier function when incorporated into cosmetic formulations [7].

In this context, the clinical evaluation of Brazilian berry extract presents an interesting alternative for exploring natural strategies for reducing the signs of skin photoaging. Assessing its performance on the photo exposed skin regions, such as the face and forearms, allows for a comprehensive understanding of its efficacy in different levels of cumulative sun damage. Thus, the aim of this study was to evaluate the long-term clinical efficacy of a cosmetic formulation containing Brazilian berry extract in reducing signs of skin photoaging by advanced biophysical and skin imaging techniques.

2. Materials and Methods

Studied Formulation

A cosmetic emulsion formulation was developed based on Polyglyceryl -10 Pentastearate, Behenyl Alcohol, Sodium Stearoyl Lactylate, and Acryloyldimethyltaurate/VP Copolymer, emollient, humectant, preservative, and antioxidant. This formulatioons was added with or not (vehicle - V) 4% of Plinia cauliflora (*Brazilian berry*) fruit extract (FJ), standardized and registered under SisGen (AE821C2).

The formulations were submitted to stability testing by centrifugation (three cycles of 3000 rpm), pH determination, and organoleptic evaluation over a 28-day period of study.

Study Design

A long-term, randomized, and controlled clinical study was carried out following the Declaration of Helsinki and received approval from the Ethics Committee for Clinical Research of the School of Pharmaceutical Sciences of Ribeirão Preto (CEP/FCFRP - CAAE: 66403822.7.0000.5403). A total of ten female participants, aged between 40 and 63 years, with visible signs of photoaging participated in the study after providing informed consent.

The FJ formulation was applied once a day at night to the entire face and one of the forearms (randomized), while the V formulation was applied only in the forearm. The study region on the face was the nasolabial area, and on the forearms, it was the posterior region (photo exposed - PE).

A standardized sunscreen formulation (SPF 45) was applied to all tested areas during the day.

Instrumental measurements

All instrumental evaluations were performed at baseline (T0) and after 60 (T60), 120 (T120), and 180 (T180) days of formulations application, under controlled temperature (22 ± 2 °C) and humidity (50 ± 5%) conditions. Participants underwent a 20-minute acclimatization before each the beginning of the measurements.

High-Resolution Facial Imaging

VisioFace® RD (Courage & Khazaka) was used to capture standardized high-resolution images of the entire face under white light illumination. The images were analyzed for spot, pore size, and pore count, using integrated software [8].

Skin Microrelief Analysis

Skin surface texture was evaluated using the Visioscan® VC 20plus (Courage & Khazaka), which utilizes optical profilometry to measure the SEsm parameter, related to the skin smoothness. This measurement was performed in triplicate on the nasolabial region [9].

Dermis Echogenicity

A high-frequency ultrasound system (Dermascan® C, Cortex Technology) was employed to quantify dermal echogenicity. Echogenicity was calculated as the ratio of low echogenic pixels (LEP) to total echogenic pixels (TEP). This measurement was performed in triplicate on the nasolabial region of the face and in the photo exposed region of the forearm [9].

Reflectance Confocal Microscopy (RCM)

Reflectance Confocal Microscopy (RCM) (VivaScope™ 1500; Lucid, New York, NY, USA) was employed to assess epidermis thickness, skin hyperpigmentation and morphological characteristics. RCM employs a laser source (830 nm) and an immersion objective capable of detecting twenty images per second. Microscopic images were captured using Vivastack, which represents multiple deep images at predetermined locations in the tissue. The images were taken at intervals of 3 by 3 µm until reaching a depth of 150 µm. The following parameters were analyzed: stratum corneum reflectance, furrow size and morphology, honeycomb pattern interkeratinocyte reflectance in the granular layer, basal layer reflectante and dermal papillae depth. The morphological features were scored semi-quantitatively from 0 (low) to 3 (high) [8,10].

Statistical analysis

The statistical analysis was conducted using GraphPad Prism 9.0. software. Statistical analyses were performed using one-way ANOVA with Tukey's post-test for data with a normal distribution and the Kruskal–Wallis test with Dunn's post-test for non-normally distributed data. The statistical significance was defined at $p < 0.05$

3. Results

The formulations showed stability during the study period, with no significant ($p>0.05$) alterations observed in organoleptic characteristics, phase separation or pH values.

The continuous use of the FJ formulation in the malar region of the face showed an increase in the reflectance of both the stratum corneum and the granular layer over time, with a higher proportion of participants reaching the highest classification scores at T180, which suggest an increase in the skin hydration. A reduction in furrow size and an improvement in

furrow morphology were also observed, indicating an improvement in the skin surface. The honeycomb pattern became more regular throughout the study period. In addition, a gradual reduction in basal layer hyperpigmentation was noted (Figure 1). Quantitative measurements showed a significant increase in stratum corneum thickness ($p<0.05$) and papillary dermis depth ($p<0.05$), particularly at T120 and T180.

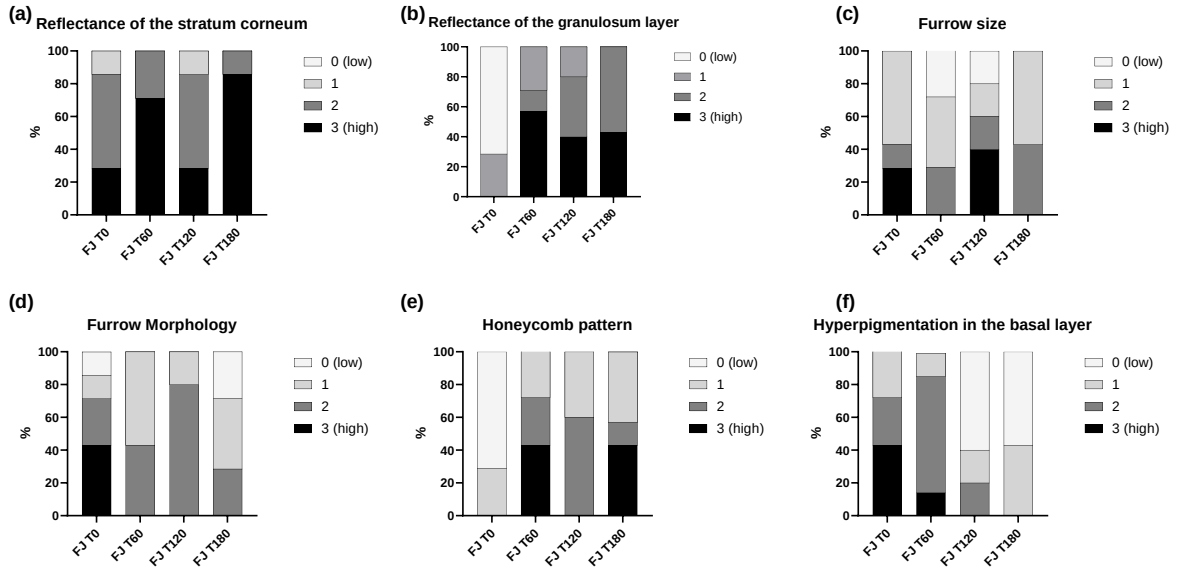

Figure 1. Morphological skin parameters in the malar region at baseline (T0), and after 60 (T60), 120 (T120), and 180 (T180) days of application of the formulation containing Brazilian berry extract (FJ). Evaluation was performed using reflectance confocal microscopy. (a) Reflectance of the stratum corneum; (b) Reflectance of the granular layer; (c) Furrow size; (d) Furrow morphology; (e) Honeycomb pattern; (f) Hyperpigmentation in the basal layer. Data are presented as the percentage (%) classified in each score category.

Regarding skin microrelief, a reduction in the SEsm parameter was observed, indicating a smoother and more uniform skin surface.

The echogenicity ratio (ratio between the number of low and total echogenic pixels) showed a significant reduction at T120 ($p < 0.001$) and T180 ($p < 0.05$) compared to baseline (T0) in the FJ-treated area (Figure 2). This decrease suggests an increase in dermal echogenicity associated with continued use of the formulation with Brazilian berry extract.

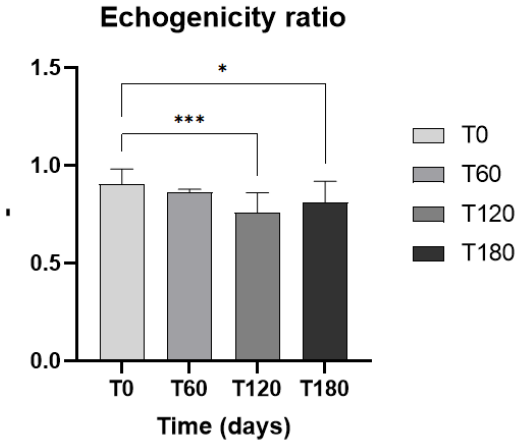

Figure 2. Echogenicity ratio (ratio between the number of low and total echogenic pixels) in the nasolabial region at baseline (T0), and after 60 (T60), 120 (T120), and 180 (T180) days of application of the formulation containing Brazilian berry extract (FJ). *p < 0.05; ***p < 0.001.

In the high-resolution imaging analysis, the pore count showed a significant reduction ($p < 0.05$) after continuous application of the FJ formulation. Although a decrease in pore size was also observed over time, this change was not statistically significant ($p > 0.05$). In addition, the evaluation of color difference (ΔE) between the lesional and perilesional regions demonstrated a significant reduction throughout the 180-day treatment period with the FJ formulation. A significant decrease in ΔE values was observed at T60 ($p < 0.01$) compared to baseline (T0), with further reductions at T120 and T180 ($p < 0.001$) (Figure 3).

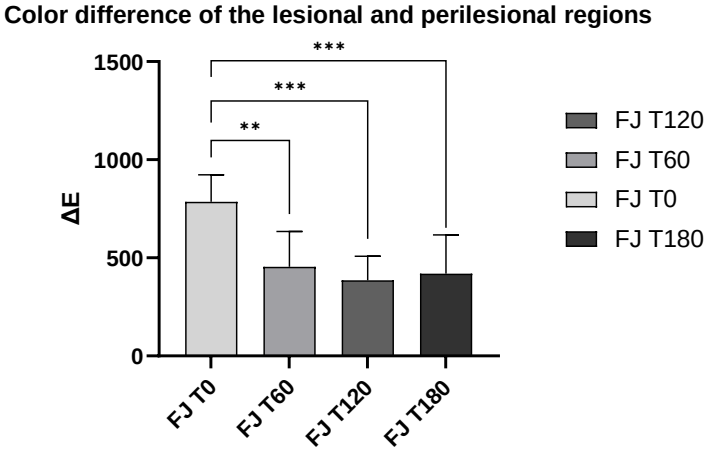

Figure 3. Color difference (ΔE) between the lesional and perilesional regions at baseline (T0) and after 60 (T60), 120 (T120), and 180 (T180) days of application of the formulation containing Brazilian berry extract (FJ). **p < 0.01; ***p < 0.001.

In the forearm region, the area treated with the FJ formulation showed a progressive increase in the reflectance of both the stratum corneum and the granular layer, with a greater number of participants reaching the highest classification scores at T180. Conversely, the V-treated area exhibited a consistent variation in these parameters over time. Improvements in skin surface were also observed in the FJ group, evidenced by a reduction in furrow size and enhanced furrow morphology, while no changes were noted in the control area. A more regular honeycomb pattern was progressively improved after using the FJ formulation, suggesting better epidermal organization. Furthermore, a visible reduction in hyperpigmentation in the basal layer was detected exclusively in the FJ group (Figure 4). Quantitative measurements confirmed a significant increase in papillary dermis depth at T180 ($p < 0.05$) in the area treated with FJ, with no significant differences found in the V-treated forearm ($p > 0.05$).

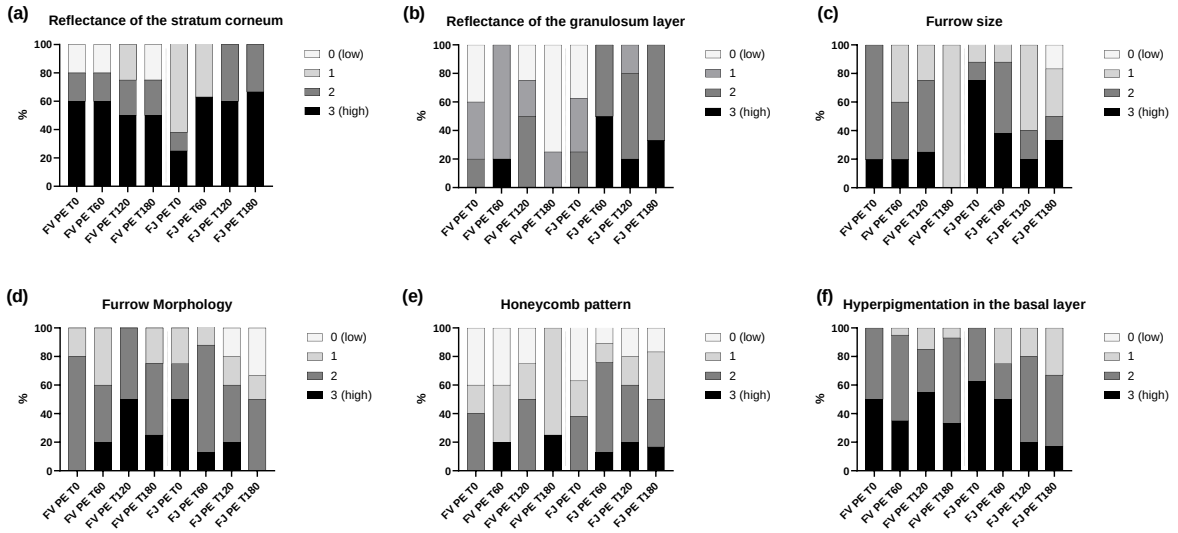

Figure 4. Morphological skin parameters in the forearm after application of the vehicle (V) and the formulation containing Brazilian berry extract (FJ) over 180 days. Evaluation was performed by reflectance confocal microscopy at baseline (T0), and after 60 (T60), 120 (T120), and 180 (T180) days. (a) Reflectance of the stratum corneum; (b) Reflectance of the granular layer; (c) Furrow size; (d) Furrow morphology; (e) Honeycomb pattern; (f) Hyperpigmentation in the basal layer. Data are presented as the percentage (%) classified in each score category.

The evaluation of dermis echogenicity in the forearm showed a significant reduction in echogenicity ratio values at T60 for both the FJ-treated and V-treated groups ($p < 0.001$ and $p < 0.0001$, respectively) compared to baseline. However, at T120 and T180, a significant reduction in echogenicity ratio was maintained only in the group treated with FJ formulation ($p < 0.0001$), while no further significant differences ($p > 0.05$) were observed for the other group.

4. Discussion

The long-term clinical efficacy application of the formulation containing *Plinia cauliflora* extract promoted progressive improvements in multiple skin parameters related to photoaging, especially in chronically exposed areas such as the malar region and posterior forearm. These effects are in line with previous studies reporting the antioxidant and protective activity of Brazilian berry extracts, which are rich in polyphenols and other bioactive compounds [6,7].

The observed reduction in the number of large pores following the continuous application of the formulation containing Brazilian berry extract can be attributed to improvements in skin surface hydration and barrier function [7]. Previous studies have showed that restoring the hydrolipidic balance of the skin contributes to better epidermal cohesion and reduces the appearance of dilated pores, particularly in mature skin [11]. Similarly, the progressive reduction in color difference between lesional and perilesional areas suggests a beneficial effect of the formulation on skin tone uniformity. Hyperpigmented regions often reflect oxidative stress and dysregulation of melanogenesis, processes that can be modulated by topical antioxidants [12]. These results also correlate with the confocal analysis, which demonstrated a reduction in hyperpigmentation in the basal layer, reinforcing the efficacy of the formulation in modulating pigmentation at both microscopic and macroscopic levels.

Improvements in epidermal hydration were demonstrated by the increased reflectance of the stratum corneum and granular layer, particularly after 120 and 180 days of use. These findings support previous observations showing the moisturizing properties of cosmetic formulations containing this extract [7]. Enhanced epidermal organization was also evidenced by the improvement in furrow morphology and the improvement of the honeycomb pattern, parameters that reflect cellular organization and surface uniformity (Costa and Maia Campos, 2024).

The improvement observed in the SEsm parameter reflects enhanced skin smoothness. This finding corroborates with the confocal microscopy results, which showed a reduction in furrow size and improved furrow morphology. While RCM provides a high-resolution view of skin morphology, the Visioscan captures the macroscopic image related to the skin surface [8-10,14]. Therefore, the association between both techniques supports the interpretation that continuous use of the FJ formulation contributed to a more regular surface texture.

A reduction in hyperpigmentation in the basal layer was observed in both the malar and forearm regions, suggesting the potential of the FJ formulation in modulating skin tone uniformity. Phenolic compounds present in Brazilian berry extract have previously demonstrated inhibitory activity on melanin synthesis, which may explain this effect [14,15].

Natural polyphenols have been widely studied for their ability to improve skin health, particularly in reducing the effects of aging [16]. In addition to epidermal benefits, quantitative

analyses indicate that Brazilian berry extract contributes to dermal improvement by increasing papillary dermis depth and reducing the echogenicity ratio in the nasolabial region. These findings are consistent with previous research highlighting the role of polyphenols in promoting collagen synthesis and enhancing dermal density. By modulating molecular pathways associated with cellular senescence, polyphenols help maintain skin structure and function, thereby contributing to the delay of visible aging signs [16,17].

Finally, the results support the efficacy of the FJ formulation in improving structural, hydration and pigmentation parameters of photoaged skin, reinforcing the potential of Brazilian natural actives as a multifunctional ingredient for innovative cosmetic applications.

5. Conclusion

The long-term clinical application of the formulation containing Brazilian berry extract led to progressive improvements in several parameters associated with skin photoaging. Relevant changes were observed in epidermal hydration, skin surface, and pigmentation, as evidenced by instrumental measurements. These effects were observed across multiple noninvasive techniques, reinforcing the impact of the formulation on both microscopic and macroscopic skin structure. Additionally, reductions in pore count, skin hyperpigmentation, basal layer hyperpigmentation, improvements in skin microrelief, and a decrease in dermal echogenicity ratio indicate that the formulation contributes to skin renewal. Finally, these findings confirm the clinical efficacy of Brazilian berry ex-tract in improving the general aspects of photoaged skin and reinforce its potential as a safe and multifunctional active ingredient for cosmetic applications.

6. References

[1] Passeron T, Krutmann J, Andersen ML, Katta R, Zouboulis CC. Clinical and biological impact of the exposome on the skin. J Eur Acad Dermatol Venereol. 2020;34:4-25.

[2] Fossa Shirata MM, Alves GDA, Maia Campos PMBG. Photoageing-related skin changes in different age groups: a clinical evaluation by biophysical and imaging techniques. Int J Cosmet Sci. 2019;41(3):265-273.

[3] Infante VH, Maia Campos PM, Darvin M, Lohan S, Schleusener J, Schanzer S, et al. Cosmetic formulations with Melaleuca alternifolia essential oil for the improvement of photoaged skin: A double-blind, randomized, placebo-controlled clinical study. Photochem Photobiol. 2023;99(1):176-183.

[4] Bharadvaja N, Gautam S, Singh H. Natural polyphenols: a promising bioactive compound for skin care and cosmetics. Mol Biol Rep. 2023;50:1817-1828.

[5] Aguirre-Cruz G, León-López A, Cruz-Gómez V, Jiménez-Alvarado R, Aguirre-Álvarez G. Collagen hydrolysates for skin protection: Oral administration and topical formulation. Antioxidants. 2020;9(2):181.

[6] Cabral BRP, de Oliveira PM, Gelfuso GM, Quintão TDSC, Chaker JA, de Oliveira Karnikowski MG, et al. Improving stability of antioxidant compounds from *Plinia cauliflora* (jabuticaba) fruit peel extract by encapsulation in chitosan microparticles. J Food Eng. 2018;238:195-201.

[7] Maia Campos PM, Kakuda L, Souza CR. Film-Forming, Moisturizing, and Sensory Properties of a Cosmetic Formulation Containing Tara Gum and Brazilian Berry Extracts. AAPS PharmSciTech. 2024;25(4):71.

[8] Pavezi JC, Kakuda L, Campos PMBG. Morphological characteristics of normal and oily skin in different phototypes. Int J Cosmet Sci. 2025.

[9] Stettler H, Crowther J, Boxshall A, Bielfeldt S, Lu B, de Salvo R, et al. Biophysical and subject-based assessment of the effects of topical moisturizer usage on xerotic skin—Part II: Visioscan® VC 20plus imaging. Cosmetics. 2021;9(1):5.

[10] Kakuda L, Campos PMBG, Zanin RB, Favaro LN. Development of multifunctional sunscreens: Evaluation of physico-mechanical and film-forming properties. Int J Pharm. 2023;635:122705.

[11] Kakuda L, Melo MOD, Campos PMBG. Hydrolipidic characteristics and clinical efficacy of a dermocosmetic formulation for the improvement of homeostasis on oily mature skin. Life. 2022;13(1):87.

[12] D'Angelo Costa GM, Maia Campos PMBG. Development of cosmetic formulations containing olive extract and *Spirulina* sp.: Stability and clinical efficacy studies. Cosmetics. 2024;11(3):68.

[13] D'Angelo Costa GM, Maia Campos PMBG. Efficacy of topical antioxidants in the skin hyperpigmentation control: A clinical study by reflectance confocal microscopy. J Cosmet Dermatol. 2021;20(2):538–545.

[14] Fanian F, Mac-Mary S, Jeudy A, Lihoreau T, Messikh R, Ortonne JP, et al. Efficacy of micronutrient supplementation on skin aging and seasonal variation: a randomized, placebo-controlled, double-blind study. Clin Interv Aging. 2013;8:1527-1537.

[15] Ebanks JP, Wickett RR, Boissy RE. Mechanisms regulating skin pigmentation: the rise and fall of complexion coloration. Int J Mol Sci. 2009;10(9):4066-4087.

[16] Csekes E, Račková L. Skin aging, cellular senescence and natural polyphenols. Int J Mol Sci. 2021;22(23):12641.

[17] Żynda W, Ruczaj A, Galicka A. Natural compounds with beneficial effects on skin collagen type I and mechanisms of their action. Antioxidants. 2025;14(4):389.