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"A Healthy Alternative to TCA Peels: A Topical Antioxidant Biostimulating Treatment for Collagen Synthesis and Skin Rejuvenation"

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1. Introduction

Collagen declines with age and more extensively in photodamaged skin, compared to natural aged, protected skin [1]. A loss in collagen type I and III, leads to facial fine lines and wrinkles, as well as a loss of skin firmness, thus affecting facial youthfulness. Facial rejuvenation procedures including chemical peels target the outer facial skin layers to improve texture and skin firmness. These chemical peels do not directly address collagen regeneration but on ther other hand have an indirect effect due to stimulating collagen through a wound healing cascade [2].

Trichloroacetic acid (TCA) is a popular chemical peel favored by estheticians for its skin rejuvenation benefits, which are attributed to its indirect collagen stimulation. TCA peels induce epidermal and dermal injury, triggering a wound-healing cascade that leads to indirect collagen synthesis [3, 4]. Due to its inherent cytotoxic nature, TCA poses skin health and increased safety risks, particularly post-inflammatory hyperpigmentation (PIH) in skin of color individuals [5,6]. California recently, in March 2025, banned the use of topical TCA, citing risks including long-term barrier disruption, pigment alteration, and scarring [7]. Despite these limitations, chemical peel formulations have seen little innovation and advancements [8]. This lack of progress underscores a critical unmet need for the development of safer, more tolerable skin rejuvenation treatments that offer comparable clinical efficacy without compromising skin health.

An Antioxidant Biostimulating Treatment (ABT) was developed with innovative technology to support collagen synthesis while reducing downtime and improving safety across a broad patient population. The ABT utilizes a multi-acid delivery system, combining a chemical exfoliant base and a blend of antioxidant biostimulating acidic phytocompounds (ABAP). The chemical exfoliant base consisting of lactic, glycolic, and salicylic acid, dissolves corneodesmosomes allowing for optimal delivery of the ABAP. The ABAP, consisting of dicarboxylic acids, triterpenoids, and pentacyclic triterpene acids, is designed to penetrate into the dermis to support skin rejuvenation. The ABAP supports the direct production of collagen, beyond that just produced through the normal wound healing cascade, while neutralizing, scavenging, and quenching reactive oxygen and nitrogen species. Therefore, there is a total net skin health effect of skin rejuvenation.

The ABT is characterized as a superficial treatment and hypothesized to optimally deliver the ABAP into the papillary dermis to enhance collagen synthesis and improve skin rejuvenation with enhanced safety.

2. Materials and Methods

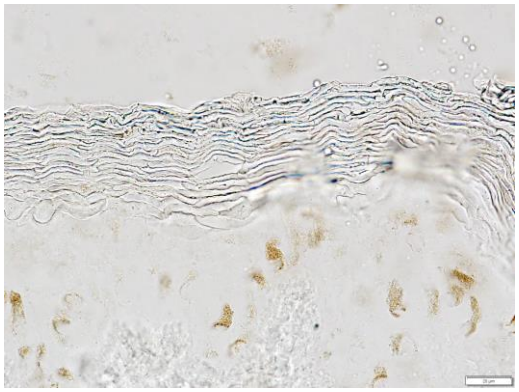
The ABT is formulated with a total concentration of 25% acids and was compared to a 33% TCA peel composed of hydrogen peroxide and kojic acid. *Ex vivo* studies were conducted to evaluate efficacy and safety, focusing on cell viability, exfoliation, and biostimulatory effects. Skin explants of a 42-year-old Caucasian with Fitzpatrick Skin Type (FST) III were topically treated with the ABT or a comparator medium-depth TCA peel at 2 mg/cm^2 on Days 0, 1, 4, 6, and 8 (n=6) or untreated (n=6). Cell viability, stratum corneum (SC) thickness, corneocyte layers, and collagen immunostaining were performed on Days 0 and 9. Microscopic images were analyzed via cellSens storing software (Olympus). Statistical analysis was performed using Student t-test, where statistical significance was achieved at $^{**}p < 0.01$ and $^{*}p < 0.05$.

A 12-week, single-center, open-label case study was conducted with 11 females, FST V to VI, with an average age 50 years, with mild to moderate global facial radiance, skin smoothness, and overall appearance. An esthetician applied the ABT to the subject's face in 3 progressive sessions spaced 4 weeks apart. VISIA® photography was performed at baseline and post-baseline and analyzed by VISIA® 8.2 software for skin features. Subject testimonials were obtained. Statistical significance was set at $^{*}p < 0.05$.

3. Results

Ex vivo results demonstrated the exfoliative and biostimulatory action of the ABT without disrupting skin health. The cell viability of the epidermal and dermal structurs was assessed by formalin-fixed, paraffin-embedded skin section and assesed by microscopial observation. Cell viability was not altered by the ABT, however cell viability of both epidermal and dermal structures were clearly impacted by the TCA peel. The ABT decreased the stratum corneum thickness by 15% ($^{*}p < 0.01$), while the TCA peel increased stratum corneum thickness by 2% ($p = 0.65$) compared to untreated control. At day 9 of the study, untreated control had 9 corneocyte layers. The ABT and TCA peel treatments decreased the number of corneocyte layers by 10% ($^{**}p < 0.1$) and 16% ($^{*}p < 0.05$), respectively, when compared to the untreated control; however the difference between the ABT and TCA was not significant, indicating comparable exfoliative activity (Figure 1).

(**a**)



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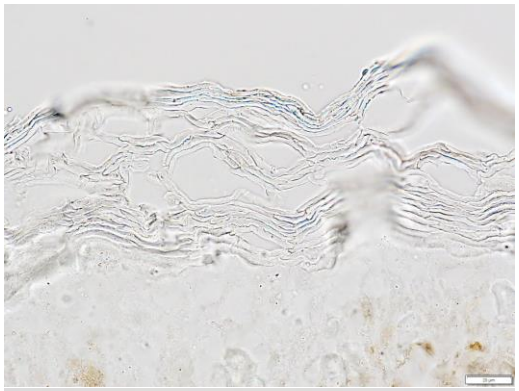

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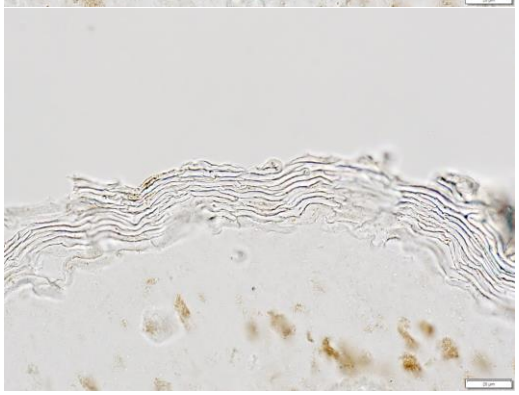
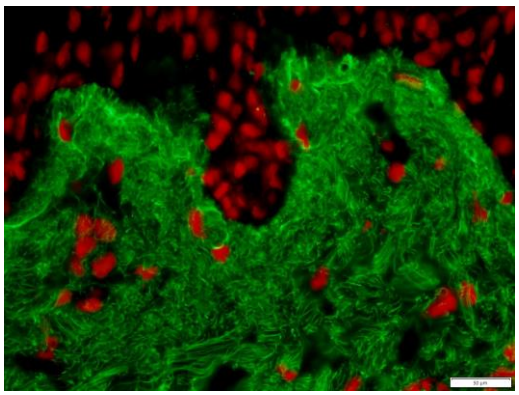


Figure 1. Mackenzie Test to determine stratum corneum thickness and the number of corneocyte layers at Day 9 of the treatment (a) untreated tissues, (b) TCA peel treated tissues, and (c) ABT treated tissues. Scale bar = 20 µm.

The ABT and TCA similarily increased collagen I by 13% (**$p < 0.01$) and 16% (*$p < 0.05$), respectively compared to untreated control (Figure 2). The difference in collagen I expression between ABT and TCA was not statistically significant ($p = 0.5600$), indicating that both treatments demonstrated comparable efficacy in stimulating collagen I production.

(**a**)



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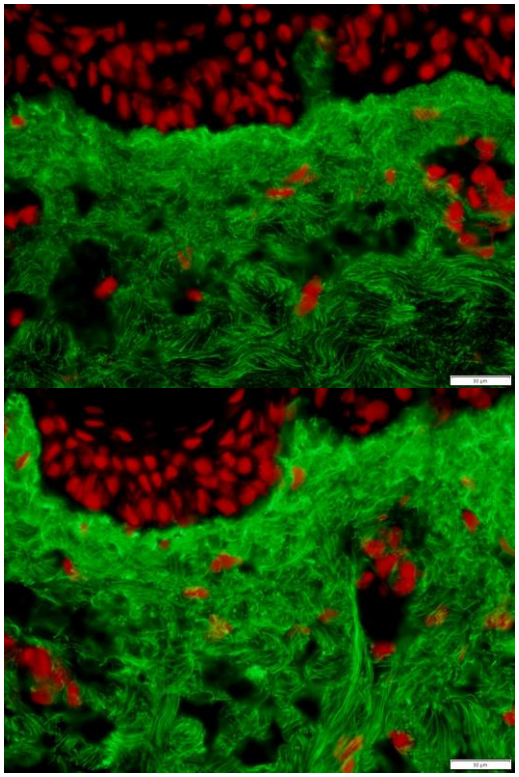

Figure 2. Immunostaining of Collagen I (green) and nuclei (red) of the papillary dermis on (a) untreated tissues, (b) TCA peel treated tissues, and (c) ABT treated tissues at Day 9. Scale bar = 50 µm.

In vivo, the ABT improved overall facial youthfulness, fine lines, skin radiance, and skin smoothness after 3 ABT sessions, spaced 4 weeks apart. Particularly, subjects demonstrated a mean 20% reduction in facial pore count after one ABT session compared to before treatment (***$p < 0.001$*) The authors hypothesize the improvement in pore reduction may be attributed to the exfoliative nature and dermal collagen network restructuring of the ABT.

Further supporting cell viability, the ABT was well tolerated and positively perceived by the subjects. Subjects reported an overall positive experience with the treatment series, noting visible improvements in skin appearance and a healthy post-treatment glow. Skin peeling and flaking were described as minimal, often localized to small areas like the nose, chin, and cheeks, and typically occurred later in the treatment course. Importantly, subjects appreciated the lack of pain and downtime, with some confidently returning to work shortly after treatment. Safety assessed by the board-certified dermatologist revealed no adverse events, including the development of post-inflammatory hyperpigmentation in this patient population investigated (FST V-VI).

Subject Testimonials:

- “Overall, my skin felt great and there were noticeable improvements in my skin.” - 49 years, FST V.

- “Overall, the peeling and flaking after the treatment for me was minimal and occurred mostly around the corners of my nose. I had no extra hyperpigmentation” 50 years, FST V.

- "I felt my skin appearance after the treatment was great. I had a glow for days" - 56 years, FST V.
- "Overall, the process was painless. There was minimum peeling a week to 10 days after the 2nd and 3rd treatments, typically around my nose, chin, and cheeks" – 51 years, FST VI.
- "I was able to confidently go back to work with just a small amount of skin peeling" – 45 years, FST V.

4. Discussion

Facial skin rejuvenation procedures, including chemical peels, remain in high demand due to their well-recognized clinical benefits. However, innovation in this category has been relatively limited. There is a clear need to expand therapeutic options for patients while also enhancing efficacy and ensuring safety across diverse skin types and patient populations.

The paradoxical increase in stratum corneum thickness observed with TCA, despite a reduction in corneocyte layers, reflects disrupted corneocyte cohesion—a histological marker of disorganized exfoliation[9]. This structural disruption suggests that TCA promotes surface desquamation through aggressive chemical injury. In contrast, the ABT demonstrated a uniform reduction in both stratum corneum thickness and corneocyte layers, indicating a more regulated exfoliative mechanism. This suggests the ABT facilitates an exfoliative activity that preserves skin structure and viability, offering a more predictable and tolerable approach to exfoliation with minimal risk of barrier impairment.

While the TCA peel likely induces collagen synthesis as a secondary response to controlled dermal injury—a process mediated through the wound-healing cascade—the ABT achieves a comparable increase in collagen I expression without triggering cellular damage. This suggests that the ABT mechanism of action is direct and biostimulatory, rather than reparative, engaging cellular pathways associated with collagen production independently of inflammation or injury. Additionally, the antioxidant biostimulating acidic phytocompounds further support skin rejuvenation resolving inflammation in the skin caused by intrinsic and extrinsic factors [10, 11]. The subject testimonials in the *in vivo* study, which highlighted minimal peeling, little to no discomfort, and the absence of post-inflammatory hyperpigmentation, further support the well-tolerated profile of ABT and reinforces its potential as a safe and effective collagen-boosting treatment for darker skin tones. The ABT is an innovative approach that integrates the principles of chemical peels and biostimulatory therapies to deliver superior benefits to traditional invasive and non-invasive therapies, while reducing the risk of adverse events.

5. Conclusion

Delivery of the ABAP formulated in the ABT demonstrated improvement in collagen synthesis without compromising skin health compared to the TCA peel, which induced epidermal alterations. The ABT effectively stimulates both epidermal renewal and collagen production, achieving clinically relevant outcomes through non-damaging, cell-preserving pathways. In contrast to traditional peels that rely on injury-induced repair mechanisms, the ABT

offers a novel, well-tolerated skin rejuvenation benefits, while minimizing downtime and the risk of adverse outcomes, particularly PIH.

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