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Original Research Article

Efficacy and safety of topical 1% bakuchiol oil in adults with photoaging, hyperpigmentation, acne, skin scaling and stinging: a randomized, double-blind and vehicle-controlled clinical study

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ABSTRACT

Background: Photoaging, hyperpigmentation and acne are common facial skin concerns for which effective and well-tolerated botanical alternatives are needed. This study evaluated the efficacy and safety of topical 1% bakuchiol oil in adults with mild-to-moderate facial skin concerns.
Methods: In this prospective, randomized, double-blind, vehicle-controlled, parallel-group study, 40 adults aged 25–55 years were randomized (1:1) to receive topical 1% bakuchiol oil or vehicle oil twice daily for 12 weeks. Clinical assessments and standardized facial photography were performed at baseline and weeks 4, 8 and 12. Primary endpoints were changes in photoaging and hyperpigmentation scores. Secondary endpoints included acne severity, total acne lesion count, skin scaling and stinging, skin hydration, trans epidermal water loss, subject satisfaction, tolerability and safety.
Results: All participants completed the study. Compared with vehicle, topical 1% bakuchiol oil significantly reduced photoaging (20.9%; $p<0.001$) and hyperpigmentation (44.8%; $p<0.001$) scores at week 12. Significant improvements were also observed in acne severity, acne lesion count, skin scaling and stinging, skin hydration and trans epidermal water loss ($p<0.05$ for all). Clinical photographs supported the quantitative findings. The treatment was well tolerated, with no adverse events reported in the bakuchiol group, compared with three mild, transient adverse events in the vehicle group.
Conclusions: Topical 1% bakuchiol oil improved photoaging, hyperpigmentation, acne-related parameters and skin barrier-related measures over 12 weeks and was well tolerated, supporting its potential as a botanical option for photoaged and acne-prone skin.

Keywords: Acne, Bakuchiol, Hyperpigmentation, Photoaging, Skin hydration, Skin barrier

INTRODUCTION

Photoaging is a multifactorial process resulting from chronic exposure to ultraviolet (UV) radiation superimposed on intrinsic skin aging. It is characterized by wrinkles, dyspigmentation, loss of elasticity, rough skin texture and impaired barrier function due to progressive degradation of collagen and elastin within the dermis.[1] Chronic UV exposure induces the generation of reactive oxygen species (ROS), which activate

inflammatory signaling pathways and matrix metalloproteinases (MMPs), leading to extracellular matrix degradation, collagen fragmentation and accelerated skin aging.[2,3] These molecular and structural alterations impair the skin's regenerative capacity and contribute to the characteristic clinical features of photoaging, including wrinkles, pigmentary changes, rough skin texture, reduced elasticity, dryness, scaling and increased cutaneous sensitivity, all of which adversely affect facial appearance and quality of life.[4]

Topical retinoids remain the gold-standard treatment for photoaging because they promote collagen synthesis, inhibit collagen degradation, improve epidermal turnover and reduce hyperpigmentation.

However, their clinical use is often associated with local adverse effects, including dryness, scaling and erythema, particularly in individuals with sensitive skin.[5,6] Consequently, there is growing interest in naturally derived compounds that provide comparable clinical benefits with improved tolerability. Bakuchiol is a meroterpene isolated from the seeds and leaves of Psoralea corylifolia (Cullen corylifolium), a medicinal plant widely used in traditional medicine.

Although structurally distinct from retinol, bakuchiol modulates several retinol-responsive genes involved in collagen synthesis, extracellular matrix remodeling, antioxidant defense and regulation of pigmentation, thereby improving the visible signs of photoaging.[6,7] Experimental studies have further shown that bakuchiol downregulates pro-inflammatory cytokines and inhibits ultraviolet-induced matrix metalloproteinase (MMP) expression, thereby protecting against photoaging.[8,9]

In addition to its anti-aging effects, bakuchiol exhibits antimicrobial and anti-inflammatory activity against Cutibacterium acnes, reduces sebaceous gland inflammation and inhibits melanogenesis through modulation of tyrosinase activity.[6,8,9] Clinical evidence supporting bakuchiol has increased in recent years. A randomized, double-blind clinical trial demonstrated that topical bakuchiol produced significant improvements in facial wrinkles and hyperpigmentation comparable to retinol while causing significantly less scaling and stinging.[9] Subsequent clinical studies have reported improvements in skin firmness, elasticity, hydration, pigmentation and overall skin appearance with favourable tolerability, supporting its potential as a multifunctional cosmeceutical ingredient.[10,11]

Nevertheless, randomized, vehicle-controlled clinical trials evaluating multiple dermatological outcomes within a single study remain limited, particularly in the Indian population. Therefore, the present randomized, double-blind, vehicle-controlled clinical study was undertaken to evaluate the efficacy and safety of topical 1% bakuchiol oil compared with vehicle in improving the clinical manifestations of mild-to-moderate photoaging in healthy adults over a 12 weeks treatment period.

METHODS

Study design

This was a single-centre, randomised, double-blind, vehicle-controlled superiority study conducted at Gita Poly Clinic, Bangalore, India between February and May 2026. The study evaluated the efficacy and safety of topical 1% bakuchiol oil in improving photoaging, hyperpigmentation, acne, skin scaling, stinging, skin hydration and skin barrier function.

Ethical approval

The protocol was approved by the Independent Ethics Committee (Approval No. PIEC/AP/2025/13/01 dated 30 December 2025) of Pharexcel Consulting Pvt. Ltd. Banglore, Karnataka, India. It was conducted accordance with Indian Council for Medical Research guidelines, The International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use E6 (R3), Guideline for Good Clinical Practice, Good Clinical Laboratory practices, Declaration of Helsinki and applicable regulatory requirements. The trial registered with the Clinical Trials Registry–India (CTRI/2026/02/103403).

Informed consent

The study procedure, risks and benefits were explained to subjects by investigator before screening.

Written informed consent was obtained from all participants before enrollment.

Study subjects

Forty healthy adults aged 25–55 years with Fitzpatrick skin phototypes I–V and mild-to-moderate photoaging were enrolled. Participants receiving topical retinoids, corticosteroids, depigmenting agents or undergoing cosmetic procedures within the washout period, pregnant or lactating women, individuals with active dermatological disorders, known hypersensitivity to study products or significant systemic illness were excluded.

Study objectives

The primary objective was to evaluate the efficacy of topical Bakuchiol in improving the clinical signs of photoaging and hyperpigmentation after 12 weeks of application compared with baseline. The secondary objectives were to assess its effects on skin scaling, stinging, acne severity and lesion count and to evaluate the safety and tolerability of topical Bakuchiol following 12 weeks of use.

Study procedure

Participants were randomized (1:1) to receive either topical 1% bakuchiol oil or a matching vehicle (coconut oil). Both products were identical in appearance and packaging to maintain blinding. Approximately 4–5 drops of the assigned product were applied evenly over the face twice daily for 84 days following facial cleansing. Participants were instructed to avoid introducing new skincare products, cosmetic procedures and excessive sun exposure during the study. Clinical assessments were performed at baseline and on Days 28, 56 and 84.

Efficacy and safety assessment

The primary efficacy outcomes were changes in photoaging and hyperpigmentation scores. Secondary outcomes included acne severity, acne lesion count, skin scaling, stinging, skin hydration, trans epidermal water loss (TEWL), Investigator Global Assessment, participant self-assessment and treatment tolerability. Skin hydration and TEWL were measured using a Corneometer® and Tewameter®, respectively, after a 20-minute acclimatization period under standardized environmental conditions. Standardized digital facial photographs (front, left lateral and right lateral views) were obtained at baseline (day 0), week 4 (day 28), week 8 (day 56) and week 12 (day 84) under identical lighting, camera settings, participant positioning, facial expression and camera-to-subject distance to qualitatively document changes in photoaging and hyperpigmentation. Safety was assessed throughout the study by monitoring adverse events, local skin reactions, treatment compliance and dermatological examinations, including erythema, edema, burning, itching, dryness and scaling, at each study visit.

Statistical analysis

Statistical analyses were performed using SAS® version 9.1 (SAS Institute Inc., Cary, NC, USA). Efficacy was analyzed in the intent-to-treat (ITT) and per-protocol (PP) populations, while safety was evaluated in the Safety population (participants receiving at least one application of the study product). Continuous variables are presented as mean±standard deviation (SD) and categorical variables as frequencies and percentages. Within-group changes from baseline were analyzed using repeated-measures ANOVA (RM-ANOVA), between-group comparisons using independent-samples t-tests and categorical variables using the Chi-square or Fisher's exact test, as appropriate. All tests were two-sided, with $P<0.05$ considered statistically significant.

RESULTS

Study population

Between 10 February 2026 and 15 February 2026, a total of 40 healthy adults were enrolled and randomized equally to the Bakuchiol (n=20) and Vehicle (n=20) groups. All participants completed the 12 weeks study and no withdrawals or losses to follow-up occurred (Figure 1). Therefore, efficacy and safety analyses were performed on all randomized participants. Mean product compliance was 95% in the bakuchiol group and 85% in the vehicle group.

Baseline characteristics

Baseline demographic and clinical characteristics were comparable between the Bakuchiol and vehicle groups (Table 1). No statistically significant between-group differences were observed for age, height, body weight, sex distribution, smoking status, alcohol consumption, educational status, ethnicity, Fitzpatrick skin type, dietary habits, exercise pattern, sun exposure duration or baseline skin concerns (all $p>0.05$). These findings indicate that the treatment groups were well balanced with respect to the assessed baseline characteristics.

Photoaging

The Bakuchiol group showed a significant improvement in photoaging compared with the vehicle group over the 12-week treatment period, with a 20.9% reduction in photoaging score from baseline at Week 12 ($p<0.001$). The two groups were comparable at baseline ($p=0.712$). A significant between-group difference was observed at Week 8 ($p=0.004$) and was maintained at Week 12 ($p=0.001$), with lower photoaging scores in the Bakuchiol group. Representative clinical photographs supported the quantitative findings, showing visible improvement in facial photoaging, including fine lines and skin texture (Tables 2 and 3, Figure 2).

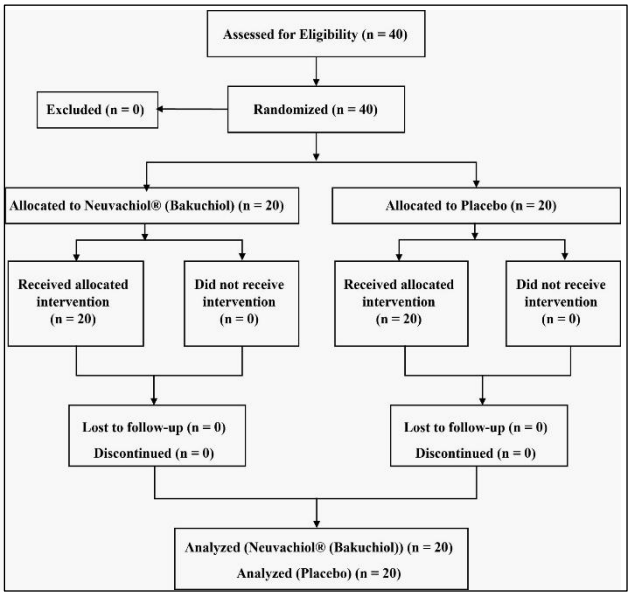


Figure 1: CONSORT Diagram: The figure appeared blurry. The revised, high-resolution version is attached. Kindly replace the existing figure with the revised version.

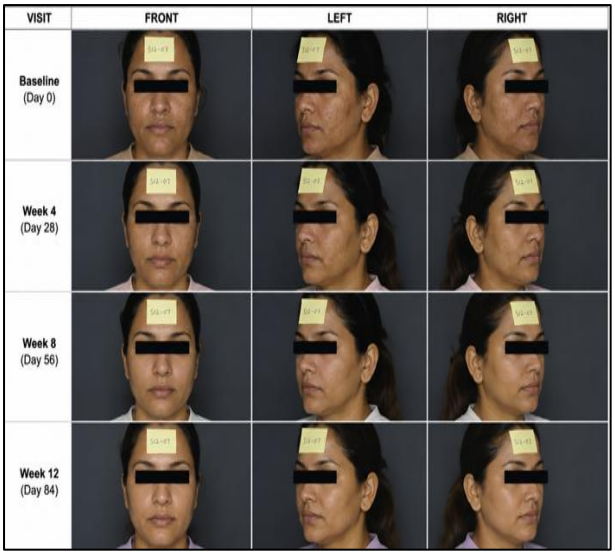


Figure 2: Representative serial clinical photographs of a study participant captured at baseline (day 0), week 4 (day 28), week 8 (day 56) and week 12 (day 84) in front, left lateral and right lateral views. Progressive improvement in the primary efficacy endpoints, including facial photoaging (fine lines, skin texture and overall skin appearance) and hyperpigmentation (pigmented spots and skin tone uniformity), is evident over the 12-week treatment period. All photographs were obtained under standardized imaging conditions using consistent lighting, camera angle, distance and participant positioning.

Hyperpigmentation

The Bakuchiol group showed a significant improvement in hyperpigmentation compared with the vehicle group over the 12 weeks treatment period, with a 44.8% reduction in hyperpigmentation score from baseline at week 12 ($p<0.001$). The groups were comparable at baseline ($p=0.934$). Significant between-group differences were observed from week 4 and were maintained through week 12, with lower hyperpigmentation scores in the bakuchiol group ($p\leq0.001$). Clinical photographs supported the quantitative findings, showing progressive reduction in facial hyperpigmentation and improved skin tone uniformity from baseline to week 12 (Tables 2 and 3, Figure 2).

Acne severity

Acne severity decreased progressively following Bakuchiol treatment, with a 31.98% reduction from baseline by week 12 ($p=0.034$). Baseline acne severity was comparable between the treatment groups ($p=0.850$) and no significant between-group difference was observed at week 4 ($p=0.138$). In contrast, between-group comparisons demonstrated significantly lower severity grades in the bakuchiol group at week 8 ($p=0.003$) and week 12 ($p<0.001$) (Tables 2 and 3).

Total acne lesion count

By week 12, total acne lesion count had decreased by 48.9% from baseline in the Bakuchiol group ($p=0.009$). No significant baseline difference was observed between the treatment groups. Comparative analysis indicated a significantly lower lesion burden with bakuchiol beginning at week 4 and persisting through week 12 ($p=0.011$, $p<0.001$ and $p<0.001$, respectively) (Tables 2 and 3).

Skin scaling and stinging

Skin scaling and stinging scores decreased by 33.3% from baseline at week 12 in the bakuchiol group ($p=0.032$). No significant between-group difference was observed at baseline. Subsequent comparisons showed significantly lower scores in the bakuchiol group at week 8 ($p=0.002$) and week 12 ($p<0.001$) compared with the vehicle group (Tables 2 and 3).

Skin hydration

A 64.0% increase in skin hydration from baseline was recorded at week 12 in the bakuchiol group ($p<0.001$). In contrast, hydration remained essentially unchanged in the vehicle group ($p=0.298$). The two groups had comparable baseline hydration values ($p=1.000$); however, significantly higher hydration was observed with bakuchiol at weeks 4, 8 and 12 (all $p<0.001$) (Tables 2 and 3).

Skin barrier function

By week 12, TEWL was reduced by 36.6% from baseline in the bakuchiol group ($p<0.001$), indicating an improvement in skin barrier function. In the vehicle group, TEWL showed no significant change over the study period ($p=0.281$). Although baseline values were not significantly different between groups, significantly lower TEWL was observed in the Bakuchiol group at all post-baseline assessments, with the largest between-group difference at week 12 ($p<0.001$) (Tables 2 and 3).

Subject-reported outcomes and safety

Subject-reported tolerability, treatment satisfaction and willingness to continue product use were more favorable in the bakuchiol group than in the vehicle group (Table 4). Very good tolerability was reported by 55% of participants receiving bakuchiol compared with 20% receiving vehicle. Overall satisfaction (very satisfied or satisfied) was reported by 85% and 45% of participants in the bakuchiol and vehicle groups, respectively. Similarly, 85% of participants in the bakuchiol group expressed willingness to continue using the product compared with 50% of those in the vehicle group. The study treatments were well tolerated. No adverse events were reported in the bakuchiol group. In the vehicle group, three mild and transient adverse events were recorded, comprising two

cases of mild burning sensation (10%) and one case of mild itching (5%). All adverse events resolved spontaneously without medical intervention. No serious adverse events, treatment discontinuations due to adverse events or other safety concerns were observed during the study.

Table 1: Baseline demographic, anthropometric characteristics at screening and other baseline characteristics (n=40).

Parameters	Bakuchiol (n=20)	Vehicle (n=20)	P value
Demographic and anthropometric characteristics			
Age (in years)	32.5±3.69	32.7±3.57	0.862
Height (cm)	168.6±8.06	166.5±6.43	0.360
Weight (kg)	68.65±10.02	69.10±8.93	0.880
Sex, N (%)			
Male	10 (50.0%)	11 (55.0%)	0.723
Female	10 (50.0%)	9 (45.0%)	
Clinical and lifestyle characteristics			
Fitzpatrick skin type, N (%)			
Type III	6 (30.0)	5 (25.0)	0.885
Type IV	10 (50.0)	11 (55.0)	
Type V	4 (20.0)	4 (20.0)	
Dietary habit, N (%)			
Vegetarian	8 (40.0)	9 (45.0)	0.752
Mixed diet	12 (60.0)	11 (55.0)	
Exercise habit, N (%)			
Regular exercise	7 (35.0)	8 (40.0)	0.801
Occasional exercise	9 (45.0)	8 (40.0)	
No exercise	4 (20.0)	4 (20.0)	
Daily sun exposure, N (%)			
<1 h/day	5 (25.0)	6 (30.0)	0.688
1–3 h/day	10 (50.0)	9 (45.0)	
>3 h/day	5 (25.0)	5 (25.0)	
Primary skin concern, N (%)			
Acne vulgaris	7 (35.0)	6 (30.0)	0.874
Hyperpigmentation	8 (40.0)	9 (45.0)	
Mild dryness/scaling	5 (25.0)	5 (25.0)	

Table 2: Changes in clinical efficacy parameters from baseline to week (n=40).

Parameters	Group	Baseline (mean±SD)	Week 4	Week 8	Week 12	Change from baseline (%)	Within group P value
Photoaging score	Bakuchiol	8.10±1.71	7.05±1.23	6.50±1.32	6.40±1.10	20.9	<0.001*
	Vehicle	7.90±1.68	7.85±1.35	7.75±1.20	7.65±1.13	3.2	0.312
Hyperpigmentation score	Bakuchiol	5.43±1.13	4.00±1.15	3.54±1.12	3.00±1.10	44.8	<0.001*
	Vehicle	5.40±1.12	5.35±1.10	5.30±1.08	5.20±1.06	3.7	0.312
Acne severity grade	Bakuchiol	1.72±0.52	1.54±0.34	1.31±0.25	1.17±0.07	32.0	0.034
	Vehicle	1.75±0.50	1.71±0.48	1.66±0.47	1.66±0.47	5.1	0.268
Total acne lesion count	Bakuchiol	22.17±5.80	18.67±5.10	14.67±4.30	11.33±3.80	48.9	0.009
	Vehicle	23.50±6.20	23.50±6.20	22.50±6.00	21.50±5.70	8.5	0.187
Skin scaling and stinging	Bakuchiol	3.00±0.82	2.60±0.52	2.32±0.38	2.00±0.41	33.3	0.032
	Vehicle	3.00±0.76	3.00±0.76	2.88±0.64	2.75±0.46	8.3	0.241
Skin hydration	Bakuchiol	30.8±2.3	37.3±2.4	43.3±2.5	50.5±2.6	64.0	<0.001*
	Vehicle	30.8±2.2	30.8±2.2	29.8±2.1	29.8±2.1	3.2	0.115
Skin barrier function	Bakuchiol	14.5±0.9	12.9±0.8	11.1±0.7	9.2±0.8	36.6	<0.001*
	Vehicle	15.4±0.5	15.6±0.58	15.9±0.63	16.1±0.7	4.5	0.281

*Values are presented as mean±SD.

Table 3: Instrumental skin assessments and between-group comparison at week 12 (n=40).

Parameters	Bakuchiol (mean±SD)	Vehicle (Mean±SD)	Mean difference±SE	95% CI	P value
Photoaging score	6.40±1.10	7.65±1.13	−1.25±0.35	−1.96 to −0.54	0.001
Hyperpigmentation score	3.00±1.10	5.20±1.06	−2.20±0.34	−2.89 to −1.51	<0.001
Acne severity grade	1.17±0.07	1.66±0.47	−0.86±0.14	−0.86 to –0.30	<0.001
Total acne lesion count	11.33±3.80	21.50±5.70	−10.17±1.53	−13.17 to −7.17	<0.001
Skin scaling and stinging	2.00±0.41	2.75±0.46	−0.75±0.14	−1.02 to −0.48	<0.001
Skin hydration (AU)	50.5±2.6	29.8±2.1	20.70±0.75	19.23 to 22.17	<0.001
Skin barrier function (TEWL)	9.2±0.8	16.1±0.5	−6.90±0.24	−7.37 to −6.43	<0.001

DISCUSSION

The present randomized, double-blind, vehicle-controlled study demonstrated that topical bakuchiol significantly improved photoaging, hyperpigmentation, acne severity, skin hydration and skin barrier function compared with the vehicle over 12 weeks. These findings are consistent with previous studies demonstrating that bakuchiol improves photoaging by stimulating collagen synthesis and reducing wrinkle formation, decreases hyperpigmentation through inhibition of melanogenesis, alleviates acne by exerting anti-inflammatory and antibacterial effects, enhances skin hydration by improving moisture retention and strengthens skin barrier function by reducing trans epidermal water loss and restoring epidermal integrity. Collectively, these findings support topical bakuchiol as an effective non-retinoid alternative for managing multiple manifestations of photoaging.

The observed improvement in photoaging and hyperpigmentation is consistent with the randomized clinical trial by Dhaliwal et al who reported that topical bakuchiol produced significant anti-aging effects comparable to retinol while exhibiting superior tolerability.[9] Similarly, Khan et al demonstrated significant improvement in facial pigmentation and overall skin appearance following topical bakuchiol treatment.[12] A significant reduction in acne severity and total acne lesion count was also observed in the present study. These findings are supported by previous evidence showing that bakuchiol possesses antibacterial, anti-inflammatory and antioxidant properties, which contribute to the reduction of acne lesions and associated inflammation.[6]

In addition, bakuchiol significantly improved skin hydration and reduced trans epidermal water loss, indicating restoration of epidermal barrier function. Similar improvements in skin hydration, elasticity and overall skin quality have been reported by Rastogi and Gholap following regular use of a bakuchiol-containing facial formulation.[10] The treatment was safe and well tolerated throughout the study. No adverse events were reported in the bakuchiol group, whereas only mild, transient adverse events occurred in the vehicle group. These findings further support previous reports that bakuchiol provides retinol-like clinical benefits with a lower risk of irritation.[9] The quantitative improvements observed in the primary efficacy endpoints were further supported by representative serial clinical photographs, which demonstrated visible reductions in fine lines, improved skin texture and a more even skin tone following 12 weeks of treatment (Figure 2). The major strengths of this study include its randomized, double-blind, vehicle-controlled design and comprehensive evaluation of both clinical and instrumental skin parameters.

However, the relatively small sample size and single-centre design may limit the generalizability of the findings. Larger multicentre studies with longer follow-up are warranted to confirm these results. Overall, topical bakuchiol demonstrated significant clinical efficacy and excellent tolerability, suggesting that it is a promising non-retinoid alternative for improving multiple signs of skin aging and maintaining skin health.

CONCLUSION

Topical bakuchiol significantly improved photoaging, hyperpigmentation, acne, skin hydration and barrier function compared with the vehicle, with excellent tolerability and no treatment-related adverse events. These findings support bakuchiol as a safe and effective non-retinoid option for improving overall skin health.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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