

The effectiveness of a whitening and anti-aging double-layer serum and cream containing gamma-aminobutyric acid (GABA) 3%, dimethylaminoethanol (DMAE) 2%, cysteamine 2.5%, and bakuchiol 1%

A eficácia de um sérum e creme de dupla camada com ação clareadora e antienvelhecimento contendo ácido gama-aminobutírico (GABA) 3%, dimetilaminoetanol (DMAE) 2%, cisteamina 2,5% e bakuchiol 1%

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ABSTRACT

Background: Combination therapies targeting multiple pathways of skin aging and hyperpigmentation are increasingly explored. However, the combined efficacy of gamma-aminobutyric acid (GABA), dimethylaminoethanol (DMAE), cysteamine, and bakuchiol remains limited.

Objectives: To assess the efficacy of a double-layer serum and cream containing GABA 3%, DMAE 2%, cysteamine 2.5%, and bakuchiol 1% on skin brightness, pore count, and wrinkles.

Methods: In this 8-week, double-blind, randomized, placebo-controlled trial, 50 participants were randomized, and 44 completed the study. Subjects received either the active formulation or a placebo. Outcomes included wrinkle scores, pore counts, skin brightness (L-value), and melanin index assessed at baseline and weeks 2, 4, 6, and 8. Data were analyzed using repeated-measures MANOVA.

Results: A significant time-by-group interaction was observed for L-value ($p < 0.001$), with the treatment group showing a modest increase (+1.63) compared to minimal change in controls (-0.49). Wrinkle scores changed over time in both groups without clinically meaningful between-group differences. No significant treatment effects were observed for pore counts or melanin index.

Conclusion: The formulation improved measured skin brightness but did not demonstrate significant depigmenting or structural anti-aging effects over 8 weeks, suggesting primarily cosmetic benefits.

Keywords: GABA Agents; Cysteamine; Aging

RESUMO

Introdução: As terapias combinadas que visam múltiplos mecanismos de envelhecimento cutâneo e de hiperpigmentação para o clareamento da pele e o antienvelhecimento são cada vez mais exploradas. Contudo, a eficácia combinada de ácido gama-aminobutírico (GABA), dimetilaminoetanol (DMAE), cisteamina e bakuchiol ainda é limitada.

Objetivo: Avaliar a eficácia de um sérum e creme em camadas (double-layer) contendo GABA 3%, DMAE 2%, cisteamina 2,5% e bakuchiol 1% em relação à luminosidade da pele, diminuição dos poros e redução das rugas.

Métodos: Neste ensaio clínico randomizado, duplo-cego e controlado por placebo com duração de 8 semanas, 50 participantes foram randomizadas e 44 completaram o estudo. Os desfechos incluíram rugas, poros, luminosidade (valor L) e índice de melanina, avaliados na data de início e nas semanas 2, 4, 6 e 8. Os dados foram analisados com o uso de MANOVA de medidas repetidas.

Resultados: Houve interação tempo $\times$ grupo significativa para o valor L ($p < 0,001$), com aumento modesto no grupo tratamento (+1,63) e mudança mínima no controle (-0,49). As rugas variaram ao longo do tempo em ambos os grupos, sem diferença clinicamente relevante. Não houve efeito significativo nos poros ou no índice de melanina.

Conclusão: A formulação melhorou a luminosidade da pele, sem evidência de efeito despigmentante ou antienvelhecimento estrutural em 8 semanas.

Palavras-chave: Agentes GABAérgicos; Envelhecimento; Cisteamina

Original Article

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INTRODUCTION

Skin aging and pigmentary disorders remain major concerns in dermatological practice and cosmetic science. Common complaints include skin aging, wrinkles, pigmentation, dryness, and dull complexion. Many researchers continue to seek various strategies and solutions to address these issues.¹ Brighter skin is still regarded as an aesthetic advantage among certain ethnic groups, particularly in women of Asian and African descent with Fitzpatrick skin types IV–VI.² The preference for lighter skin among Indonesian women reflects broader beauty standards prevalent across Asia, where the market for skin-brightening products is expanding rapidly. A clinical study conducted in Yogyakarta involving 74 Indonesian women demonstrated the demand for skin lightening products.^{3,4}

Changes in the epidermal and dermal layers due to the aging process result in structural and functional alterations in the skin. New research has emerged focusing on various active compounds such as gamma-aminobutyric acid (GABA), dimethylaminoethanol (DMAE), cysteamine, and bakuchiol.²

GABA is widely distributed among cortical neurons, reducing neuronal excitability by decreasing the frequency of neuronal action potentials. In dermatological applications, GABA has been shown to significantly enhance dermal cell proliferation, delay skin aging processes, alleviate epidermal cell senescence, and improve skin hydration.^{5,6}

DMAE is considered an indirect precursor of acetylcholine. It contributes to dermal collagen synthesis and plays a role in anti-aging mechanisms.⁷

Bakuchiol is a natural phenolic meroterpene isolated from the fruits of the plant *Psoralea corylifolia*. It is recognized for its wide range of pharmacological effects, including anti-aging, anti-inflammatory, antioxidant, antimicrobial, and anti-cancer activities. Cysteamine is known as an effective and safe agent for treating melasma by reducing melanin content. Depigmentation occurs through inhibition of tyrosinase activity.⁷

The use of serums and creams aimed at skin brightening and anti-aging has increased substantially in many countries, including Indonesia. However, studies demonstrating the effectiveness of combined GABA, DMAE, cysteamine, and bakuchiol as brightening and anti-aging agents remain limited. Therefore, the aim of this study was to assess the effectiveness of a brightening and anti-aging double-layer serum and cream containing these active components.

OBJECTIVE

To determine whether, compared with placebo, an 8-week double-layer serum-cream regimen containing GABA 3%, DMAE 2%, cysteamine 2.5%, and bakuchiol 1% improves skin L-value at week 8 and affects wrinkle score, pore score, melanin index, and harms in women aged 30–50 years with Fitzpatrick phototypes III–V.

MATERIALS AND METHODS

Trial design and setting

This was a single-center, 2-group, parallel, superiority, double-blind, randomized, placebo-controlled trial with 1:1 individual allocation and 8 weeks of follow-up. The trial was conducted at the Department of Dermatology and Venereology, Faculty of Medicine, Hasanuddin University/Hasanuddin University Hospital, Makassar, South Sulawesi, Indonesia, from March to August 2025.

The study was approved by the Health Research Ethics Committee, Faculty of Medicine, Hasanuddin University (93/UN4.6.4.5.31/PP36/2025). All participants provided written informed consent. The trial was registered retrospectively at ClinicalTrials.gov (NCT07477288) in March 2026.

Patient and public involvement

Patients and members of the public were not involved in the design, conduct, analysis, interpretation, or reporting of this trial.

Changes to the protocol

No important changes were made to the eligibility criteria, interventions, primary or secondary outcomes, follow-up duration, or target sample size after the trial had begun.

Participants

Eligible participants were women aged 30–50 years with Fitzpatrick skin phototypes III–V who attended participating dermatology clinics, were willing to follow the study regimen, and signed informed consent forms. The protocol also specified no use of vitamin C, selenium, or other antioxidant supplements during the preceding month.

Exclusion criteria were pregnancy, breastfeeding, menopause, hormonal therapy or hormonal contraception, use of topical or systemic skin-whitening treatment during the preceding month, hyperpigmented lesions at the measurement sites (including melasma, lentigines, or ephelides), and a history of hypersensitivity to GABA, DMAE, cysteamine, or bakuchiol.

Sample size

The protocol calculated a minimum of 20 participants per group using assumed response proportions of 80% and 40%, a 2-sided alpha of 0.05 ($Z\alpha = 1.96$), and 80% power ($Z\beta = 0.84$). After a 10% allowance for attrition, the target was 22 participants per group (44 total). Recruitment was increased to 25 participants per group. Fifty participants were ultimately randomized.

Randomization, allocation, and blinding

Participants were assigned in a 1:1 ratio by simple randomization to the active group (Group A) or to the placebo group (Group B). Participants and outcome assessors were blinded. Active and placebo products were supplied using identical-looking packaging. Simple randomization was used without stratification or blocking. Participants and outcome assessors were blinded to treatment allocation.

Interventions

Participants in both groups cleansed their faces with 5 drops of the supplied facial wash in the morning and evening. The active group then applied 2 drops of active serum to the entire face, waited 1 minute, and applied one fingertip unit of active cream to the entire face. The same sequence was repeated twice daily for 8 weeks. The active products contained GABA 3%, DMAE 2%, cysteamine 2.5%, and bakuchiol 1%.

The placebo group followed the same sequence of cleansing, serum application, waiting, and cream application using placebo products without the active ingredients. Adherence was assessed by participant self-report during follow-up visits; a quantitative adherence threshold was not specified. The use of concomitant whitening agents and antioxidant supplements was not allowed, as defined in the eligibility criteria. Treatment adherence was assessed by participants at each follow-up visit.

Outcomes and assessments

The prespecified primary outcome for this report was the change in skin brightness (L-value) from baseline to week 8. Secondary outcomes were changes in wrinkle score, pore score, and melanin index. Assessments were performed at baseline and weeks 2, 4, 6, and 8.

Skin brightness was measured with a Chromameter (Konica Minolta, Japan), for which L = 0 represents black and L = 100 represents white. Melanin index was measured with a Mexameter MX 18 (Courage + Khazaka, Germany). The protocol specified measurements on the forehead and both cheeks, repeated 3 times at the same locations. Wrinkle and pore scores were obtained using the Janus-III Facial Analysis System (PIE Co., South Korea).

At each visit, participants were asked about tolerability and adverse events, including itching or stinging, erythema, irritation, and blistering. Serious adverse events and treatment discontinuations due to harms were monitored throughout the 8-week period.

Clinical photography

Facial photographs were obtained at baseline through week 8 using a Nikon D3100 camera with an 18–55-mm lens and the Janus-III Facial Analysis System. Photographs were obtained using the same facial position, camera distance, illumination, and background at each visit.

Harms and adherence

No serious adverse events were reported. The number and type of non-serious adverse events, withdrawals due to harms, and quantitative adherence data were not available in the supplied analysis output.

Statistical analysis

Analyses were performed using SPSS version 22.0. Continuous variables are summarized as means and standard de-

viations. Between-group comparisons at individual visits used independent-samples t tests for normally distributed data and Mann-Whitney U tests for non-normally distributed data. Repeated-measures multivariate analysis of variance (MANOVA) using Pillai's trace assessed time, group, and time-by-group effects. Two-sided $p < 0.05$ was considered statistically significant, and partial eta squared was reported as an effect-size measure.

The efficacy analysis was a complete-case analysis of participants with data through week 8, analyzed in their randomized groups; no missing-data imputation or sensitivity analysis was performed. Between-group differences in baseline-to-week-8 change and 95% confidence intervals were calculated post hoc from the corresponding repeated-measures contrast error terms. No interim analysis or stopping guideline was used.

RESULTS

Of the 50 participants, 44 completed the 8-week follow-up and were included in the final analysis (Figure 1). During follow-up, 3 participants in the active group and 3 in the placebo group were lost to follow-up. Baseline characteristics were comparable between groups. The mean age of the participants in Group A was 38 years, compared to 39 years for Group B. All participants were categorized as Fitzpatrick skin phototype III. BMI, ethnicity, baseline hyperpigmentation severity, and categorical skin type were not recorded in the study dataset. Changes over time were observed in pore counts, wrinkle scores, L-value, and melanin index across both groups during the 8-week period. Adverse events were monitored throughout the study period. No serious adverse events were reported.

Efficacy outcomes

At week 8, the mean L-value increased from 48.21 to 49.84 in the active group, corresponding to a mean change of

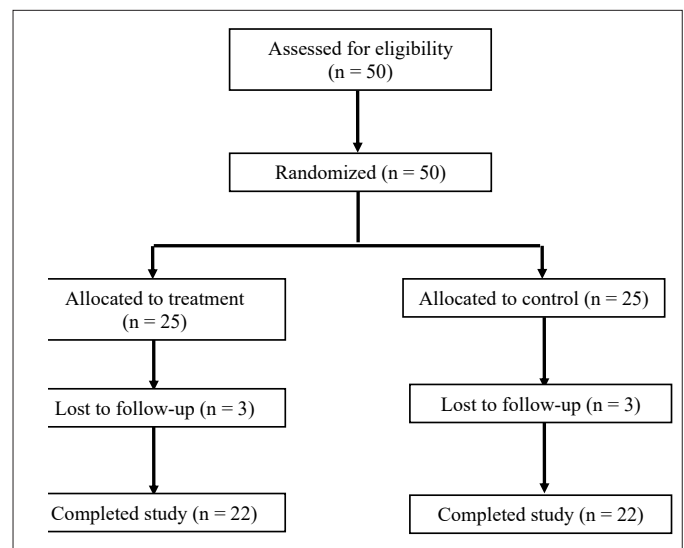


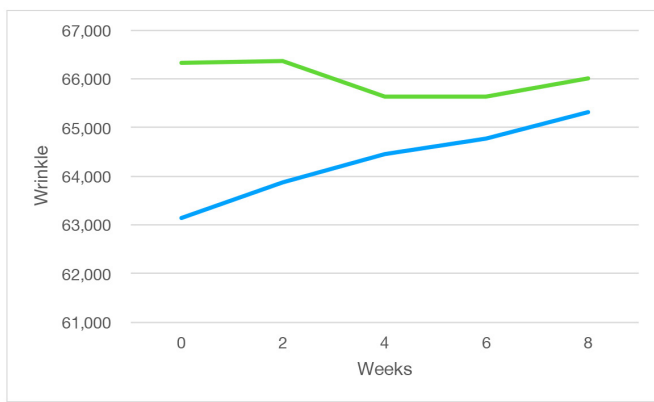
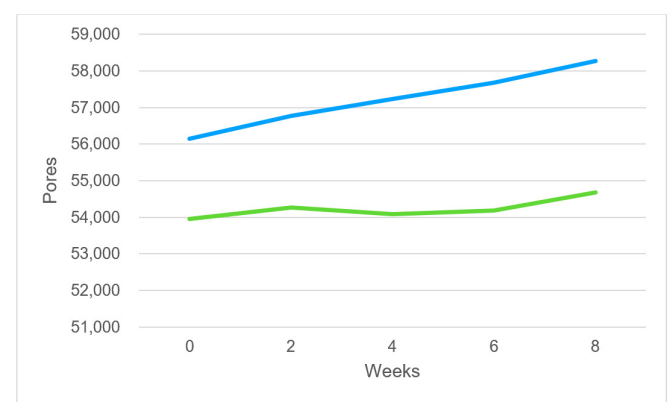
FIGURE 1: CONSORT Flow Diagram

TABLE 1: Comparison of wrinkle scores in study participants during the 8-week treatment period

	Group A	Group B	Total
Wrinkle W-0	63,136	66,318	64,727
Wrinkle W-2	63,864	66,364	65,114
Wrinkle W-4	64,455	65,636	65,045
Wrinkle W-6	64,773	65,636	65,205
Wrinkle W-8	65,318	66,000	65,659

TABLE 2: Comparison of pore scores in study participants during the 8-week treatment period

	Group A	Group B	Total
Pores W-0	56,136	53,955	55,045
Pores W-2	56,773	54,273	55,523
Pores W-4	57,227	54,091	55,659
Pores W-6	57,682	54,182	55,932
Pores W-8	58,273	54,682	56,477

**FIGURE 2:** Changes in wrinkle scores (blue = Group A, green = Group B) in study participants during the 8-week treatment period. Source: authors' own archive**FIGURE 3:** Changes in pore scores (blue = Group A, green = Group B) in study participants during the 8-week treatment period. Source: authors' own archive

+1.63. In the placebo group, the mean L-value decreased from 48.62 to 48.13, corresponding to a mean change of -0.49 . The between-group difference in change was 2.11 units (95% CI, 0.90–3.33; $p = 0.001$). A significant time-by-group interaction was also observed ($p < 0.001$).

The mean wrinkle score changed from 63.14 to 65.32 in the active group and from 66.32 to 66.00 in the placebo group. The between-group difference in change was 2.50 points (95% CI, 1.33–3.67; $p < 0.001$), representing an improvement. The clinical relevance of the difference observed remains uncertain (Figure 2).

No statistically significant time-by-group interaction was observed for pore score ($p = 0.236$). No significant treatment effect was observed for melanin index over the 8-week follow-up. At baseline, wrinkle scores were comparable between groups (mean [SD]: treatment 63.14 [6.01] vs. control 66.32 [4.55]). Wrinkle scores changed over time (within-subject effect, Pillai's trace; $p = 0.009$) (Table 1, Figure 2).

Wrinkle scores changed over time in both groups (within-subject effect, $p = 0.009$). While a significant time-by-group interaction was observed for wrinkle scores ($p < 0.001$),

the clinical magnitude of this change was minimal and did not represent a substantial reduction in wrinkle severity over the 8-week period.

Baseline pore counts were similar between groups (treatment 56.14 [10.82] vs. control 53.96 [12.23]). Pore measurements changed over time (within-subject effect; $p = 0.006$), reflecting an overall change across visits (Table 2, Figure 3).

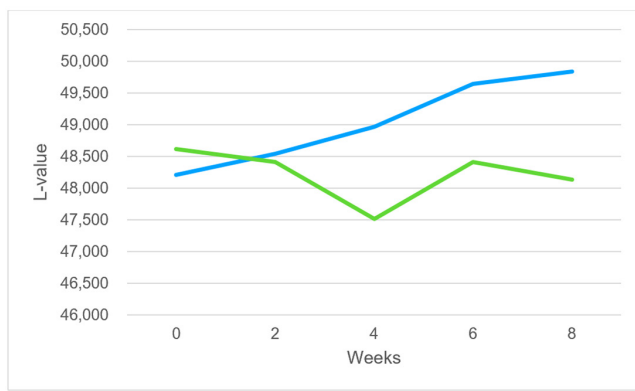
However, the time-by-group interaction was not significant ($p = 0.236$), and no consistent between-group differences were observed at individual time points, indicating that the temporal change observed was not attributable to the assigned treatment.

Mean baseline L-values were similar (treatment 48.21 [4.25] vs. control 48.62 [2.49]). The overall effect of time on L-values approached but did not reach conventional significance ($p = 0.065$). Crucially, there was a time-by-group interaction ($p < 0.001$), indicating that treatment and control groups had different brightness trajectories over time (Table 3, Figure 4).

In absolute terms, the treatment group showed a small increase in L-values from baseline to week 8 ($\approx +1.63$), while the control group showed minimal change (≈ -0.49), which is

TABLE 3: Comparison of L-value scores in study participants during the 8-week treatment period

	Group A	Group B	Total
L-value W-0	48,207	48,615	48,411
L-value W-2	48,544	48,413	48,478
L-value W-4	48,965	47,509	48,237
L-value W-6	49,642	48,411	49,027
L-value W-8	49,835	48,129	48,982

**FIGURE 4:** Changes in L-Value scores (blue = Group A, green = Group B) in study participants during the 8-week treatment period. Source: authors' own archive

consistent with an increase in measured skin brightness even without a significant reduction in melanin index. Although statistically measurable, the magnitude of L-value change was relatively modest, and its clinical perceptibility remains uncertain. Baseline Mexameter values were similar between groups (treatment 218.5 [63.4] vs. control 211.3 [34.7]) (Table 4, Figure 5).

The overall time effect showed a trend towards improvement ($p = 0.051$), but the time-by-group interaction was not significant, and there were no statistically significant between-group differences at individual visits. Thus, Mexameter readings did not show a clear treatment effect over 8 weeks.

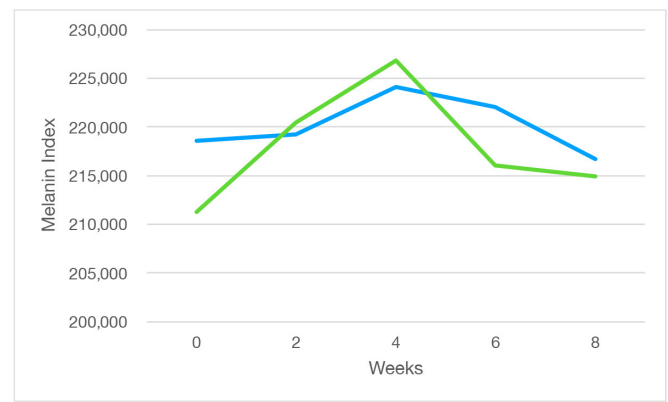
Representative standardized clinical photographs from 2 participants in the active group and 2 participants in the placebo group at baseline and week 8 are shown in figures 6 and 7. These photographs are presented for visual illustration only and were not used as substitutes for the prespecified quantitative outcome measures.

DISCUSSION

In chronological aging, reactive oxygen species (ROS) are produced mainly through cellular oxidative metabolism,

TABLE 4: Comparison of melanin index scores in study participants during the 8-week treatment period

	Group A	Group B	Total
Mexameter W-0	218,544	211,288	214,916
Mexameter W-2	219,182	220,424	219,803
Mexameter W-4	224,136	226,818	225,477
Mexameter W-6	222,015	216,015	219,015
Mexameter W-8	216,682	214,955	215,818

**FIGURE 5:** Changes in melanin index scores (blue = Group A, green = Group B) in study participants during the 8-week treatment period. Source: authors' own archive

whereas in extrinsic aging results from the loss of redox equilibrium caused by environmental factors, such as ultraviolet (UV) radiation.⁸ Skin pigmentation is largely determined by melanin synthesis in melanocytes. Abnormal pigmentation is a common symptom accompanying aging skin.⁹ UV and visible light upregulate melanocyte-specific genes (tyrosinase, Tyrp1, and dopachrome tautomerase) and stimulate alpha-melanocyte-stimulating hormone (α -MSH) production.¹⁰ Advanced glycation end products (AGEs) accumulate in dermal collagen and elastin, engage receptors for AGEs (RAGE) on melanocytes, and activate extracellular signal-regulated kinase (ERK) and cAMP response element-binding protein (CREB) phosphorylation, leading to increased microphthalmia-associated transcription factor (MITF) and tyrosinase expression.¹¹

UV and intrinsic ROS activate mitogen-activated protein kinase (MAPK) pathways, leading to activator protein 1 (AP-1) formation, which stimulates transcription of several collagen-degrading enzymes including matrix metalloproteinase-1 (MMP-1), -3, and -9.¹² AGE-mediated intracellular buildup generates ROS, damaging dermal proteins and triggering inflammatory signaling that contributes to photoaging, such as wrinkling.¹¹



FIGURE 6: Clinical photographs of Group A and B



FIGURE 7: Clinical photographs of Group A and B

Thinning of the dermis is thought to be caused by reduced collagen secretion by dermal fibroblasts.

Thinning of the dermis is responsible for major morphological changes in skin wrinkles.¹³ Skin pores are enlarged openings of the pilosebaceous follicles that can be affected by age, gender, genetics, exposure to UV light, ethnicity, and sebum secretion.¹⁴ Chronic UV exposure induces degradative enzymes in the dermis, reducing collagen and elastin and exacerbating pore dilation.¹⁵

In this trial, we observed the effects of double-layer regimen comprising a serum and cream containing GABA 3%, DMAE 2%, cysteamine 2.5%, and bakuchiol 1% on skin brightness (L-value), pore counts, and wrinkle scores. Although statistically detectable, the magnitude of L-value change was modest and may not represent a clinically meaningful improvement. The absence of significant changes in melanin index suggests that a true depigmenting effect was not demonstrated within the 8-week period.

GABA has been shown to enhance filaggrin expression, thereby promoting the proper formation and function of the skin barrier.¹⁶ Treatment with GABA increases type I collagen transcript levels while suppressing the expression of MMP-1, an enzyme responsible for collagen degradation. Through this mechanism, GABA regulates type I collagen expression, contributing to improved skin elasticity.¹⁷ It also helps alleviate epidermal cell senescence and enhances skin hydration, collectively improving the overall integrity and appearance of the skin.¹⁶

GABA inhibits α -MSH-induced melanogenesis through activation of GABA_A and GABA_B receptors, leading to downregulation of the cAMP–CREB–MITF–tyrosinase signaling cascade and suppression of intracellular Ca²⁺ levels. Because Ca²⁺ acts as a key secondary messenger mediating melanocyte activation via G protein-coupled receptors (GPCRs) such as MC1R, its elevation promotes both melanin synthesis and melanosome transfer to keratinocytes. GABA attenuates α -MSH-driven melanin biosynthesis primarily by reducing intracellular Ca²⁺ signaling, underscoring its regulatory role in melanogenic modulation.¹⁸

DMAE is considered an indirect precursor of acetylcholine or an analog of the B vitamin choline. Its proposed mechanism of action involves participation in muscle contraction beneath the dermis, as well as in cell adhesion between the epidermis and dermis. Increased muscle tonicity may provide a nonsurgical lifting effect. In addition, DMAE may influence dermal collagen synthesis.^{7,19} It exhibits hydroxyl radical-scavenging activity that competes with proline and hydroxyproline, both of which can reduce hydroxyl radicals ($\bullet$ OH) and form nitroxyl radicals. This finding demonstrates the ability of DMAE to neutralize hydroxyl free radicals, thereby suggesting its anti-aging mechanism of action.⁷ DMAE 3% gel has been shown to be safe and effective in the mitigation of forehead lines and periorbital fine wrinkles, and in improving lip fullness and shape and the overall appearance of facial skin.¹⁹ The improvements

in wrinkle-related outcomes are supported by the established biological effects of the active ingredients. The contributions of DMAE and GABA may be mediated by dermal firming, membrane stabilization, and modulation of neurogenic inflammation or cutaneous muscle tone, thereby complementing collagen-stimulatory actions.

Cysteamine is an aminothioliol compound physiologically synthesized within human cells and functions as a depigmenting agent. It has been shown to be effective and safe in the treatment of melasma by reducing melanin content. Depigmentation occurs through inhibition of tyrosinase activity, an enzyme that plays a crucial role in the melanogenesis process.²⁰

Cysteamine is a potent endogenous antioxidant that degrades hydrogen peroxide in cells and theoretically can act as an anti-aging agent. Topical cysteamine can significantly decrease the hyperpigmentation of solar lentigines, even without a mixture of retinol or glycolic acid. Cysteamine exerts its antimelanogenic effect partly through its metal-chelating capacity. It binds transition metal ions, including iron and copper, and neutralizes hydroxyl radicals produced via Fenton-type reactions, thereby indirectly downregulating the melanogenesis cascade.²¹ In an open-label controlled trial, patients with melasma who received 5% cysteamine showed an 11.5% decrease in melanin content at 12 weeks compared with baseline.²² The observed increase in L-value may be explained by the known pharmacological properties of the individual components.

However, this increase occurred without corresponding reductions in melanin index, suggesting that optical or surface-level effects may have contributed to the outcome. In a 16-week case series involving 7 participants, topical application of a cysteamine–isobionamicamide complex resulted in a noticeable reduction in pore size and enhancement of skin texture on 3-dimensional imaging, accompanied by visible softening of fine lines and wrinkles.²¹

Bakuchiol has been shown to inhibit melanin synthesis and suppress the formation of primary cilia in dendritic cells, leading to the inhibition of melanogenesis.²³ The proposed mechanism involves the downregulation of tyrosinase expression and the inhibition of Rho-dependent signaling pathways, both of which play key roles in the regulation of melanogenesis. Furthermore, bakuchiol can block the activity of α -MSH and tyrosinase, ultimately resulting in a reduction of pigmentation intensity on the skin surface.²⁴

A serum containing a combination of bakuchiol extract has been shown to prevent excessive expression of IL-8 and p16 in skin exposed to UVA radiation, thereby exerting a skin-firming effect. Bakuchiol also promotes the synthesis of type I, III, and IV collagen, contributing to improved dermal structure and elasticity. In addition, bakuchiol enhances skin permeability, supporting the delivery of active ingredients, and exhibits anti-aging, moisturizing, and rejuvenating properties that collectively improve overall skin condition and appearance.²⁴

Bakuchiol has been shown to have potent antioxidant and anti-inflammatory effects and to exert retinol-like antiaging

benefits without the typical adverse reactions associated with retinoids. It serves as an effective scavenger of linoleic acid peroxy radicals, DPPH radicals, hydroxyl radicals, and glutathionyl radicals. Moreover, its antioxidant capacity has been shown to inhibit the upregulation of MMP-9 expression *in vivo*.²⁵ It also can inhibit the activity of MMP-1 more effectively than retinol.²⁶

Although each component has demonstrated individual dermatological benefits, their combined clinical efficacy remains uncertain. The lack of significant changes in melanin index despite the presence of known depigmenting agents such as cysteamine may be explained by the relatively short duration (8 weeks), insufficient delivery of the active ingredients, or formulation-related penetration limitations. The relatively small sample size and short duration may limit the generalizability of the findings and the abi-

lity to detect subtle changes, particularly in melanin-related outcomes. Future studies with longer follow-up periods and larger sample sizes are required to confirm clinical relevance.

CONCLUSION

This randomized, double-blind study demonstrates that a double-layer serum and cream containing GABA 3%, DMAE 2%, cysteamine 2.5%, and bakuchiol 1% is a potential cosmetic formulation for enhancing skin brightness and modulating skin appearance. Over 8 weeks, the double-layer formulation improved skin brightness (L-value) but did not show a clinically meaningful improvement in wrinkle scores. However, no significant effects were observed on melanin index or pore counts. These findings suggest a cosmetic benefit in enhancing skin appearance rather than confirmed depigmenting effects. ●

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