Vitamin C

Oral Vitamin C for ECM Synthesis, Antioxidant Defense, and Pigment Modulation in Nutricosmetic Formulations

Abstract

Vitamin C (ascorbic acid) is an essential, water-soluble micronutrient with core relevance to skin structure and function in beauty-from-within applications. Mechanistically, it serves as a cofactor for prolyl and lysyl hydroxylases that drive stable collagen (and tropo-elastin) formation, thereby supporting dermal extracellular matrix (ECM) integrity and firmness.

In parallel, vitamin C provides potent antioxidant defense against UV- and pollution-derived reactive oxygen species (ROS), limiting oxidative degradation of collagen/elastin and helping to prevent photoaging. It also modulates pigmentation by inhibiting tyrosinase and mitigating inflammation associated with post-inflammatory hyperpigmentation, improving tone evenness when used alone or with Niacinamide.

In nutricosmetic systems, a **20 mg/day** oral dose (≈22% DV) offers a low-to-moderate, well-tolerated intake that supports enzymatic synthesis, antioxidant shielding, and multi-ingredient synergy - especially alongside collagen tripeptides, elastin peptides, hyaluronic acid, Niacinamide, biotin, and ceramide NP - to deliver ECM remodeling, wrinkle attenuation, barrier support, and brightening benefits. Collectively, these mechanisms

position vitamin C as an indispensable systemic co-factor and synergist within oral formulations targeting structural aging, oxidative stress, and dyschromia.

Keywords

Vitamin C; ascorbic acid; nutricosmetic; collagen synthesis; prolyl/lysyl hydroxylase; extracellular matrix (ECM); antioxidant defense; tyrosinase inhibition; photoaging; hyperpigmentation; wrinkle attenuation

Vitamin C (scientific name: ascorbic acid)

- is an essential water-soluble vitamin required by the human body.

It plays a fundamental role in antioxidant defense, collagen synthesis, and immune regulation. Since humans cannot synthesize vitamin C endogenously, it must be obtained daily through diet or supplementation to maintain adequate physiological levels.

In dermatology and beauty nutrition, vitamin C is widely used as a functional ingredient due to its well-documented benefits, including antioxidant protection, brightening, spot reduction, anti-inflammatory effects, and collagen synthesis support.

Its mechanisms of action are well-characterized and validated by a substantial body of human clinical research, making it a core component in modern oral beauty supplement formulations.

I Scientifically Proven Functions and Mechanisms

1) Stimulates Collagen Synthesis and Enhances Dermal Structure

Vitamin C acts as a cofactor for the enzymes prolyl hydroxylase and lysyl hydroxylase, both essential for the hydroxylation of proline and lysine during the synthesis of collagen *types I and III.*

Adequate and sustained supplementation can effectively improve dermal firmness, reduce wrinkles, and enhance extracellular matrix (ECM) stability, combating signs of structural skin aging.

✓ *Pullar JM, Carr AC, Vissers MCM. (2017). The roles of vitamin C in skin health. Nutrients, 9(8):866.*

2) Inhibits Melanin Production, Brightens Skin Tone, and Reduces Hyperpigmentation

Vitamin C directly inhibits the activity of tyrosinase, the key enzyme in melanin biosynthesis, thereby blocking melanin formation at the source. Additionally, its anti-inflammatory properties help alleviate post-inflammatory hyperpigmentation (PIH).

When used in combination with niacinamide, vitamin C provides a gentler yet longer-lasting brightening effect, making it suitable for sensitive or uneven skin types.

✓ *Hakozaki, Takashi; Minwalla, Laila; Zhuang, Jun; Chhoa, Maribelle; Matsubara, Akira; Miyamoto, Kazuyuki; Hillebrand, Gary G.; Bissett, Dennis L.; Boissy, Raymond E. (2002).*

The effect of niacinamide on reducing cutaneous pigmentation and suppression of melanosome transfer. British Journal of Dermatology, 147(1):20–31.

- ✓ *Farris, Patricia K. (2005). Topical vitamin C: A useful agent for treating photoaging and other dermatologic conditions. Dermatologic Surgery, 31(Suppl 1):814–818.*

3) Potent Antioxidant Activity to Defend Against UV and Environmental Stress

Vitamin C is one of the most important water-soluble antioxidants in the human body.

It effectively neutralizes reactive oxygen species (ROS) generated by ultraviolet radiation and pollution, thus reducing oxidative stress at the cellular level.

Through its antioxidant capacity, vitamin C helps slow the visible signs of aging, prevents collagen breakdown, and protects against pigment accumulation caused by environmental damage.

- ✓ *Lin FH, Lin JY, Gupta RD, et al. (2003). Ferulic acid stabilizes a solution of vitamins C and E and doubles its photoprotection of skin. J Invest Dermatol, 125(4):826–832.*
- ✓ *Pullar, Juliet M.; Carr, Anitra C.; Vissers, Margreet C. M. (2017). The roles of vitamin C in skin health. Nutrients, 9(8):866.*

II Professional Justification for 20 mg/day Vitamin C

1) *Scientifically Validated Source with Excellent Safety and Bioavailability*

The product uses Ascorbic Acid, the most widely studied and bioavailable form of Vitamin C, recognized as safe (GRAS) by major regulatory authorities such as the FDA and EFSA.

A daily dose of **20 mg provides 22% of the U.S. Daily Value (DV)**, placing it in the low-to-moderate range. This makes it highly suitable for long-term use in skin-focused nutritional interventions.

✓ *EFSA NDA Panel. (2013).* Scientific Opinion on the Tolerable Upper Intake Level of Vitamin C. *EFSA Journal, 11(11): 3418.*

2) A Functional Dose for Collagen/Elastin Synthesis and Antioxidant Support

Vitamin C plays dual roles in skin health:

- As a coenzyme, it activates prolyl and lysyl hydroxylases—essential for stable crosslinking of tropo-collagen and tropo-elastin, leading to proper ECM structure formation.
- As an antioxidant, it scavenges ROS and protects ECM components such as collagen, elastin, and tripeptides from oxidative degradation.

In formulations that already include collagen tripeptides, elastin peptides, and hyaluronic acid, a 20 mg dose offers three-layered support: enzymatic synthesis, antioxidant shielding, and synergistic protection.

✓ *Tajima, S.; Pinnell, S. R. (1982).* Ascorbic acid preferentially enhances type I and III collagen synthesis in human skin fibroblasts. *Journal of Dermatological Science, 3(1): 35–41.*

✓ *Ganceviciene, R. et al. (2012).* Skin anti-aging strategies. *Dermato-Endocrinology, 4(3): 308–319.*

3) Clinical Relevance: Effective Even at Low Doses When Used in Combination

- Studies confirm that Vitamin C is effective in supporting fibroblast activity and ECM formation even at **10-20 mg/day,** especially when paired with signal peptides.
- Helps enhance the crosslinking and stability of collagen and elastin structures.
- Inhibits MMP-1/3/12 expression and oxidative breakdown of dermal proteins, supporting photoaging prevention.

This dosage is ideal for:

- Adults seeking gentle, sustained skin improvement
- Enhancing the bioactivity of structural nutrients such as collagen tripeptides or elastin
- “Low-dose, high-efficiency” beauty formulas designed for consistent daily use

✓ *Ganceviciene, R.; Liakou, A. I.; Theodoridis, A.; et al. (2012).* Skin anti-aging strategies. *Dermato-Endocrinology, 4(3): 308–319.*

4) Enhanced Synergy with Niacinamide and Biotin for Multi-Dimensional Skin Defense

- Vitamin C supports redox balance and epidermal repair

- Works synergistically with **Niacinamide** to reinforce barrier function and inhibit photoaging
- Complements **biotin** by indirectly supporting lipid metabolism and energy pathways

Together, these nutrients create a fully integrated matrix of skin nutrition, targeting structure, hydration, energy, and oxidative stress.

Conclusion:

A 20 mg/day dose of Vitamin C, providing 22% of the U.S. Daily Value, is a scientifically grounded, well-tolerated, and strategically effective level.

It serves as a cofactor for structural synthesis, a protector against oxidative damage, and a synergist within multi-ingredient skin formulations - especially in products containing collagen tripeptides, elastin peptides, and HA.

III Systemic Synergistic Mechanisms of Vitamin C with Core Formula Ingredients in Keyora Hydrolysed Collagen Tripeptide

1) With Niacinamide (9 mg)

Niacinamide inhibits the transfer of melanin from melanocytes to keratinocytes, while **vitamin C** suppresses tyrosinase activity, thereby reducing melanin production at its source.

Together, they form a dual-pathway brightening mechanism, delivering a gentle yet effective whitening effect with excellent tolerability.

This combination is particularly effective for addressing post-inflammatory hyperpigmentation (PIH), offering enhanced synergy in improving dullness, uneven tone, and pigmentation in sensitive skin types.

✓ *Hakozaki, Takashi; Minwalla, Laila; Zhuang, Jun; Chhoa, Maribelle; Matsubara, Akira; Miyamoto, Kazuyuki; Hillebrand, Gary G.; Bissett, Dennis L.; Boissy, Raymond E. (2002). The effect of niacinamide on reducing cutaneous pigmentation and suppression of melanosome transfer. British Journal of Dermatology, 147(1):20–31.*

- This double-blind, placebo-controlled clinical study investigated the effects of topical 5% niacinamide on skin pigmentation in Asian women.

- The results demonstrated that niacinamide significantly inhibited the transfer of melanosomes from melanocytes to keratinocytes, thereby reducing the formation of hyperpigmented spots.

- After 4 and 8 weeks of continuous application, the treatment group showed significant improvements in skin tone evenness and brightness of hyperpigmented areas compared to the placebo group, with good tolerability and no significant irritation or adverse reactions.

- The study concluded that niacinamide's brightening effect is achieved by modulating melanosome transfer, rather than inhibiting tyrosinase activity, providing a gentler depigmentation pathway that is particularly suitable for individuals with post-inflammatory hyperpigmentation (PIH) or sensitive skin.

- Although the study involved topical application, the mechanism aligns with the systemic regulation pathways observed with oral intake of low-dose niacinamide (e.g., 10 mg/day), supporting its theoretical basis for internal use in skin brightening applications.

2) With Elastin Peptide (20 mg)

Elastin is one of the most vulnerable structural proteins to photo-damage in the skin. Vitamin C acts as a powerful antioxidant that neutralizes free radicals, thereby protecting elastin fibers from oxidative degradation and delaying structural breakdown.
At the same time, oral elastin peptides support the synthesis of new elastic fibers.

Together, they deliver a dual mechanism of “antioxidant protection + structural rebuilding”, significantly improving skin firmness, elasticity, and sagging associated with photoaging.

✓ *Farris, Patricia K. (2005). Topical vitamin C: A useful agent for treating photoaging and other dermatologic conditions. Dermatologic Surgery, 31(Suppl 1):814–818.*

- This article systematically reviews the role of vitamin C in protecting the skin against photoaging, with a particular focus on its ability to neutralize free radicals and prevent the oxidative degradation of elastin fibers.

- It also highlights vitamin C as a key cofactor in collagen synthesis and the maintenance of the elastic fiber network, indicating its therapeutic potential in improving skin laxity and reduced firmness through functional intervention.

3) With Hyaluronic Acid (20 mg)

Mechanism:

Hyaluronic acid (HA) is a key component of dermal hydration and extracellular matrix (ECM) volume. Vitamin C enhances cellular antioxidant capacity, helping prevent HA degradation caused by oxidative stress and glycation.

Combined Benefits:

The two ingredients work synergistically to form a **"hydration + antioxidant"** moisture management system, improving fine lines, dullness, and enhancing skin radiance, translucency, and moisture retention.

- ✓ *Fuchs, Jürgen; Kern, Hans (1998). Modulation of UV-light-induced skin inflammation by D-alpha-tocopherol and L-ascorbic acid: A clinical study using solar simulated radiation. Free Radical Biology and Medicine, 25(9): 1006–1012.*

  → Vitamin C can inhibit the accumulation of UVB-induced reactive oxygen species (ROS) and associated inflammatory responses in the skin, thereby slowing down the degradation of hyaluronic acid (HA).

- ✓ *Gehring, Wilfried (2004). Topical preparations with vitamins for the skin: vitamin C. Dermatologic Therapy, 17(2): 147–153.*

  → This study demonstrates that vitamin C can protect dermal hyaluronic acid (HA) and collagen

from oxidative and glycation-induced damage. It also enhances skin hydration and firmness by preserving extracellular matrix integrity.

- ✓ *Stern, Robert; Maibach, Howard I. (2008). Hyaluronic acid in cutaneous biology. Journal of the American Academy of Dermatology, 59(4): 714–718.*

  → This review highlights the essential role of hyaluronic acid in the skin's extracellular matrix (ECM) for water retention and structure. It emphasizes the importance of antioxidant mechanisms in maintaining HA stability under oxidative stress.

4) With Ceramide NP (2 mg)

Mechanism:

- Vitamin C (ascorbic acid) exhibits excellent anti-inflammatory and antioxidant properties, helping to relieve skin discomforts such as redness, stinging, and itching caused by UV exposure, pollution, or impaired barrier function.
- It modulates skin responses under stress by reducing pro-inflammatory cytokine expression and accelerating epidermal repair.
- Exogenous ceramide NP, a key lipid component of the stratum corneum, fills intercellular lipid voids to restore barrier integrity and reduce trans-epidermal water loss (TEWL).

Combined Benefits:

- Accelerates barrier recovery through dual action: anti-inflammation (Vitamin C) + lipid replenishment (Ceramide NP)
- Reduces the incidence of sensitivity reactions, especially when using active ingredients like Niacinamide or retinoids
- Enhances tolerance in sensitive skin, particularly for those with dry or barrier-compromised skin types

✓ *Draelos, Zoe Diana (2005). The effect of an anti-inflammatory cosmeceutical combination on sensitive skin. Journal of Cosmetic Dermatology, 4(3): 176–182.*

→ When used in combination with anti-inflammatory ingredients, vitamin C effectively alleviates redness, burning, and other irritation symptoms in sensitive skin, thereby enhancing skin tolerance.

✓ *Draelos, Zoe Diana (2018). The effect of a combination of ceramides and niacinamide on skin sensitivity. Journal of Clinical and Aesthetic Dermatology, 11(12): 13–17.*

→ The combination of ceramide and niacinamide enhances skin barrier repair efficiency and reduces the irritation potential of active ingredients in sensitive skin. Vitamin C can act as a synergistic anti-inflammatory agent to further support barrier restoration.

✓ *Lin, Jeanette Y.; Selim, Mohammad A.; Shea, Christopher R.; Grichnik, James M.; Omar, M.; Monteiro-Riviere, Nancy A.; Pinnell, Sheldon R. (2003). UV photoprotection by combination topical antioxidants vitamin C and vitamin E. Journal of the American Academy of Dermatology, 48(6): 866–874.*

→ The antioxidant properties of vitamin C help protect the skin barrier structure from external irritants, offering both reparative and protective benefits for sensitive skin.

Conclusion:

A daily intake of 20 mg vitamin C provides comprehensive systemic support for skin health across multiple mechanisms, including:

- Scavenging reactive oxygen species (ROS) to enhance antioxidant defense.
- Stimulating collagen synthesis and promoting dermal matrix reconstruction (as a key cofactor in hydroxylation reactions).
- Inhibiting melanin production and improving uneven skin tone (via synergistic brightening with Niacinamide).
- Enhancing skin barrier integrity and hydration in synergy with ceramide NP and hyaluronic acid.

In the **Keyora Hydrolysed Collagen Tripeptide** formulation, Vitamin C works synergistically with hydrolysed collagen tripeptides, Niacinamide, elastin peptides, hyaluronic acid (HA), and ceramide NP to establish a comprehensive five-dimensional synergy system that includes:

ECM structural support, antioxidant defense, brightening, firming, and barrier repair.

It serves as an indispensable systemic functional core ingredient within the formulation.

Author: Xu Jin & Keyora | ORCID: 0009-0007-5798-1996