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# Efficacy of Polyphenol-Enriched Creams in Reducing UV-Induced Dermal Damage

**Kubiak Sadler***

*Department of Cosmetology, Shanghai Jiao Tong University School of Medicine, Shanghai, China*

## Introduction

Ultraviolet (UV) radiation is a major environmental factor contributing to photoaging and carcinogenesis of the skin. Chronic UV exposure leads to structural and functional degradation of the dermal matrix, resulting in wrinkling, laxity, pigmentation disorders, and immune suppression. UVB (290–320 nm) primarily affects the epidermis, causing DNA damage and sunburn, while UVA (320–400 nm) penetrates deeper into the dermis, generating Reactive Oxygen Species (ROS) that degrade collagen and elastin. In response to the detrimental effects of UV radiation, the skincare industry has increasingly turned to antioxidant-rich formulations to complement traditional sunscreens. Among these, polyphenol-enriched creams have gained prominence for their potent antioxidant, anti-inflammatory, and photoprotective properties. Polyphenols-naturally occurring compounds in plants-include flavonoids, phenolic acids, stilbenes, and lignans that can neutralize ROS, inhibit Matrix Metalloproteinases (MMPs), and support DNA repair mechanisms [1-3].

UVB induces Cyclobutane Pyrimidine Dimers (CPDs), leading to mutations and carcinogenesis. UVA penetrates deeper, generating ROS such as superoxide anions, hydrogen peroxide, and hydroxyl radicals. UV upregulates matrix metalloproteinases (MMP-1, MMP-3, MMP-9), which degrade collagen and elastin. Induces the release of IL-1, IL-6, TNF-α, and prostaglandins, exacerbating tissue damage. Disrupts Langerhans cells and impairs immune surveillance, increasing the risk of skin cancer. These mechanisms contribute to the visible and histological signs of photoaging, including wrinkles, hyperpigmentation, rough texture, telangiectasias, and loss of elasticity. Do not neutralize ROS generated by UVA or visible light Have limited impact on inflammatory cascades. Thus, antioxidants like polyphenols offer a complementary strategy to enhance skin protection and repair. Polyphenols are secondary metabolites in plants, classified based on chemical structure.

## Description

Polyphenols combat UV-induced dermal damage through several interrelated mechanisms. Scavenge ROS before they damage lipids, proteins, and DNA. Regenerate other antioxidants like vitamin C and E. Enhance expression of endogenous antioxidant enzymes: catalase, Superoxide Dismutase (SOD), glutathione peroxidase. Polyphenols downregulate UV-induced MMP expression, preserving extracellular matrix components. EGCG and genistein have been shown to inhibit MMP-1 and MMP-3, reducing collagen degradation. Polyphenols reduce the formation of CPDs and 8-oxo-dG (oxidized guanine), a DNA damage marker. They activate Nrf2 pathways, upregulating DNA repair genes. By inhibiting NF-κB and MAPK signaling pathways, polyphenols reduce pro-inflammatory cytokines and prostaglandin synthesis. Polyphenols can absorb UV radiation and regulate melanogenesis by inhibiting tyrosinase, reducing hyperpigmentation and uneven skin tone. EGCG reduces MMP-1 expression and ROS levels in human dermal fibroblasts. Topical EGCG applied before UVB exposure reduced erythema, epidermal hyperplasia, and oxidative DNA damage.

When combined with vitamins C and E, ferulic acid stabilizes and enhances UV protection. Studies show this combination provides photoprotection equivalent to SPF 20, while reducing oxidative stress markers. A soy isoflavone that inhibits UVB-induced inflammation and oxidative damage. Shown to prevent UV-induced skin tumors in mouse models. Rich in proanthocyanidins, powerful antioxidants that improve dermal thickness, elasticity, and reduce wrinkle depth. To maximize polyphenol efficacy in topical products, formulation scientists face several challenges. Polyphenols are prone to oxidation and photodegradation. Due to hydrophilicity and large molecular size, polyphenols have limited dermal penetration. Polyphenol-enriched creams are generally well tolerated and considered safe. Reported side effects are rare and typically mild. Allergic reactions are uncommon but possible, particularly with complex plant extracts. Extensive in vivo and patch testing support their use across all skin types, including sensitive and aging skin [4,5].

## Conclusion

Polyphenol-enriched creams represent a scientifically supported, consumer-friendly, and biologically active class of cosmeceuticals that offer multifaceted protection against UV-induced dermal damage. By neutralizing free radicals, modulating inflammation, inhibiting collagen-degrading enzymes, and supporting DNA repair, polyphenols effectively slow the cutaneous aging process and enhance skin resilience. Their ability to complement sunscreens, enhance antioxidant capacity, and improve skin tone, elasticity, and texture positions them as powerful tools in both preventive and reparative dermatology. While further research is needed to optimize delivery, standardization, and long-term impact, the future of polyphenol-based skincare is bright, promising a safer and more natural route to healthy, youthful skin.

## Acknowledgment

None.

## Conflict of Interest

None.

***Address for Correspondence:** Ueland Kardas, Department of Cosmetology and Hair Research, University of Cape Town, Cape Town, South Africa; E-mail: uelandkardas@as.za*



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