

Mechanism of Benzoyl Peroxide and Benzoyl Peroxide Irritation

Marissa Parker, Dr. Benjamin Wicker

Benjamin.wicker@selu.edu

Southeastern Louisiana University, Hammond, Louisiana, United States

Mechanism of Action

Benzoyl peroxide's mechanism of action promotes bacterial protein degradation by a free-radical mechanism that leads to the death of acne vulgaris. Once absorbed into the dermal layer of the epidermis, topical treatments of benzoyl peroxide are converted to benzoic acid. Approximately 5% of the acid is systematically absorbed and excreted. Despite this 5% absorption, BPO has no systemic availability. As for the remainder of the benzoic acid, it is metabolized by cysteine in the skin, which then releases active free-radical oxygen species, furthermore resulting in the oxidation of bacterial proteins.

Relation of Irritation to the Mechanism of Action

It is observed that benzoyl peroxide irritation has various causes. When comparing said irritations to the mechanism of action, one must recall the conversion of BPO to benzoic acid. Individuals with a benzoic acid allergy or sensitivity could experience an identical reaction when using a topical BPO product. Furthermore, any patients with a hypersensitivity to cinnamon as well as other benzoic acid derivatives are advised to be cautious with BPO usage as cross-sensitivity may potentially occur. UV exposure also presents risk of developing phototoxicity as well as irritations (see irritations/hypersensitivity section) because BPO is a photosensitive drug; its irritant effect increases the turnover rate of epithelial cells, thereby peeling off the outermost layer of the skin. Usage of multiple drugs for treatment can be recommended but regardless, not all drugs will interact favorably with BPO use. For example, the topical ointment Adapalene (also used to treat acne vulgaris) is resistant to BPO oxidation and would be considered an acceptable product for combination use. However, application of products such as topical Tretinoin or use of oral Isotretinoin with BPO has been reported to result in both decreased efficacy as well as heightened irritation symptoms.



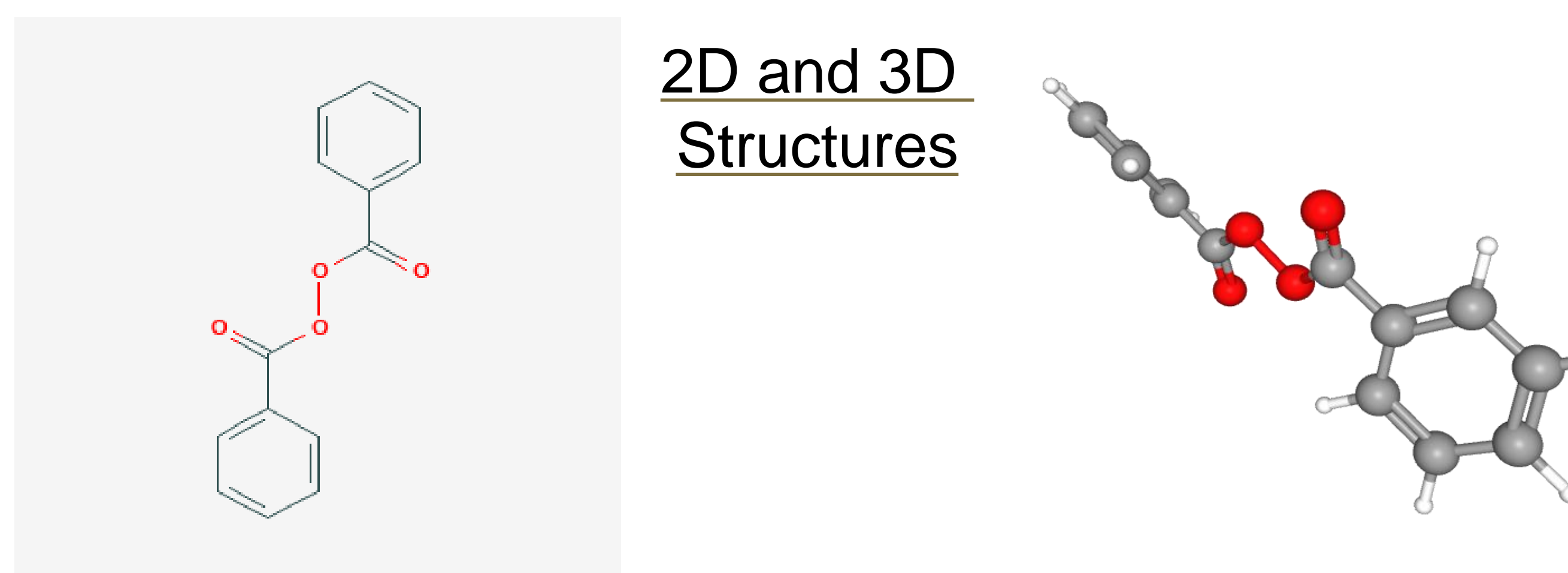
Contact Dermatitis

Extreme Redness

Peeling/ Crusting of the Skin

Introduction

Benzoyl peroxide (BPO or BzO₂) is an antibacterial agent that is applied topically and has been a pillar in the treatment of acne vulgaris. It is manufactured as both an over-the-counter topical medication as well as an FDA approved prescription medication. BPO is considered to be one of the first modern treatments for acne vulgaris, being first utilized in the 1930's. Its popularity in the world of medicine stems from the inability of acne vulgaris to produce resistance mechanisms to the medication. Despite these groundbreaking features, BPO does possess irritant activities and contact hypersensitivity can be observed with usage. Because of this, the question posed throughout this research project is: "What in relation to the mechanism of action could be a silent culprit in the severe irritations being observed?"



2D and 3D Structures

Molecular Formula: **C₁₄H₁₀O₄** or **C₁₄H₁₀O₁₄**
Benzoyl peroxide consists of two benzoyl groups joined by a peroxide group.

Irritations/ Hypersensitivity

At any concentration, benzoyl peroxide has the potential to cause mild skin dryness, erythema, scaling, bleaching of the skin, and contact dermatitis. Currently, there are no initial testing parameters identified for BPO hypersensitivity. The only recommendation is to test a small, specific infected area of skin to monitor for both tolerability and sensitivity.

Irritations/ Hypersensitivities include but are not limited to:

- Contact allergy
- Burning/ itching
- Extreme redness
- Swelling of/ around the treated area
- Oozing blisters
- Crusting of the skin

Dermatologists do not typically recommend benzoyl peroxide for sensitive skin types. This patient population is prone to hypersensitivity and more severe irritations. BPO is also not recommended for use if the patient has pre-existing skin conditions such as eczema or seborrheic dermatitis.

Administration

Benzoyl peroxide is available in varying concentrations (2.5%, 5%, and 10%) as a topical treatment for acne vulgaris. Administering BPO onto the skin for treatment requires an appropriate concentration to avoid unnecessary and avoidable irritations and hypersensitivity. For example, facial skin is considered rather sensitive so a recommended concentration for that area is no more than 4%. However, infected areas that require treatment such as the chest and back are thought to be more resilient and can tolerate higher concentrations. Products provided for treatment use include lotions, creams, gels, foams, solutions, cleansing bars, cloths, pads, and masks. These vehicles of delivery promote BPO absorption and aid in the eradication of *Propionibacterium acnes* (*P. acnes*) and *Cutibacterium acnes* (*C. acnes*). Elimination of these bacteria from the skin and hair follicles prevents the formation of papules and pustules.

Conclusions

Due to the fact that topical treatments of benzoyl peroxide are converted to benzoic acid once absorbed into the skin, it can be concluded that previous allergies to this acid as well as allergies to benzoic acid derivatives may be the root of benzoyl peroxide irritations. In addition, drug interactions with medications susceptible to degradation via oxidation mechanisms can further promote irritations.

Sources

- "Benzoyl Peroxide." National Center for Biotechnology Information. PubChem Compound Database. U.S. National Library of Medicine. Accessed February 1, 2020. <https://pubchem.ncbi.nlm.nih.gov/compound/Benzoyl-peroxide>.
- Matin, Taraneh. "Benzoyl Peroxide." StatPearls [Internet]. U.S. National Library of Medicine, March 16, 2020. <http://www.ncbi.nlm.nih.gov/books/NBK537220/>.
- Cherney, Kristeen. "How to Treat Acne with Benzoyl Peroxide (Side Effects and Precautions)." www.healthline.com/health/benzoyl-peroxide-for-acne#types-of-products. Healthline Media, July 12, 2019.
- Gomollón-Bel2016-11-16T17, Fernando. "Benzoyl Peroxide." Chemistry World, November 16, 2016. <http://www.chemistryworld.com/podcasts/benzoyl-peroxide/1017704.article>.
- "Benzoyl Peroxide." Benzoyl Peroxide - an overview | ScienceDirect Topics. Accessed February 6, 2020. <http://www.sciencedirect.com/topics/chemistry/benzoyl-peroxide>.