Quality by design based development and evaluation of a herbal gel for hair growth and dandruff control

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ABSTRACT

The present study employed a quality by design (QbD) approach for the systematic development of a multifunctional herbal hair gel aimed at promoting hair growth and controlling dandruff. Aloe vera was used as the gel base, while extracts of rosemary, ginger, clove, fenugreek, shikakai, amla, flaxseed, and neem were incorporated owing to their traditional therapeutic benefits for scalp and hair health. The formulation was evaluated for physicochemical characteristics, phytochemical composition, antifungal efficacy, and dermatological safety. Parameters including homogeneity, stability, pH, spreadability, viscosity, and washability were assessed to ensure formulation robustness. The gel exhibited physical stability without phase separation, a uniform texture, and a pleasant color and odor, with a near-neutral pH (6.02) suitable for scalp application. Spreadability (18.34 g·cm/s) and viscosity (4800 cP at 10 RPM) confirmed easy application and shear-thinning behavior. Phytochemical screening revealed the presence of carbohydrates, alkaloids, saponins, and flavonoids. The formulation was non-irritant and easily washable. Antifungal studies using the agar diffusion method demonstrated significant inhibitory zones of 18 mm against Aspergillus niger and 16 mm against Candida albicans, comparable to the standard drug miconazole. Overall, the QbD-based herbal hair gel exhibited desirable stability, safety, and antifungal activity, supporting its potential as a natural, effective, and safe alternative for hair growth promotion and dandruff management.

Keywords: Antifungal activity, dandruff management; hair growth promotion, herbal hair gel, quality by design