Abstract

The study aimed to evaluate and optimize the effect of ingredients X and Y on the visible light protection in sunscreen serum formulation using a three-level and two-factor factorial design approach, and also assess the product stability. A UV-Vis spectrophotometer was used to measure visible light protection and SPF values. Key parameters such as organoleptic properties, pH, viscosity, and spreadability were evaluated along with stability testing under various temperature conditions. Results demonstrated that Ingredients X and Y numerically increased visible light protection compared to the placebo, but did not show a significant difference ($p>0.05$) in the protection and in the SPF values as well. All formulations comply with the acceptable pH range (7.0-7.5), and more thickener is required to achieve the target viscosity (800-2000 cP) for the placebo. Spreadability exceeded the target range (5-7 cm) but was still acceptable as it suggests better skin penetration. Stability testing showed minor changes in appearance and viscosity after cycling and storage, with darker coloration likely due to oxidation of the UV filters. At 50 °C, formulations darkened and developed a stronger odor, while at 5 °C, crystallization and sedimentation occurred, except in F3. In contrast, formulations remained stable at room temperature (25 °C). Although Ingredients X and Y did not significantly enhance protection and the formula cannot be optimized by the factorial design approach, the formulations showed acceptable stability and performance overall. Further optimization is recommended, including improved UV-Vis measurement methods, cytoprotective assay, and formulation adjustment to enhance efficacy and stability.

Keywords: Sunscreens, serum, visible light, ultraviolet light, hyperpigmentation, UV-vis spectroscopy