

Title : Formulation and Development of a Natural Bioactive-Loaded Hydrogel Patch for Cosmetic Applications

Author(s) :

1. Ms.Premika Sankanut	Student ID : 650510074
2.	Student ID :
3.	Student ID :

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Advisor(s) :

1. Assistant Professor Dr. Kanchana Dumri
- 2.
- 3.

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ABSTRACT

Hydrogel-based delivery systems have attracted increasing interest in functional cosmetics due to their high hydration capacity, biocompatibility, and ability to provide localized delivery of bioactive compounds. This study developed carrageenan–Gellan gum hydrogel patches incorporating berberine chloride (BC) and niacinamide and successfully generated a scalable cosmetic prototype. The formulations were evaluated for physicochemical properties, antioxidant activity, moisture retention, and preliminary dissolution behavior. Berberine chloride exhibited antioxidant activity with an IC_{50} of 1.17 mg/mL (DPPH assay), which guided formulation optimization to ensure sufficient antioxidant availability following dissolution from the polymer matrix. UV–visible spectrophotometric analysis identified characteristic maximum absorption wavelengths (λ_{max}) at 349 and 429 nm for BC and 261 nm for niacinamide. These wavelengths were employed to monitor in vitro dissolution and quantify percentage dissolution using validated calibration curves. Three formulations were prepared: F0 (blank), F1 (BC), and F2 (BC + niacinamide). All demonstrated skin-compatible pH and maintained physical stability after storage at 4 °C and room temperature (27 ± 2 °C) for 21 days. F2 exhibited a slower dissolution rate, likely due to enhanced polymer network interactions. The developed prototype demonstrates strong potential for further optimization and translation into commercially viable cosmetic products.

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