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Controlled release of niacinamide from fibrous silica nanocarrier in face serum formulation

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ABSTRACT

The current study offers controlled release of niacinamide from fibrous silica (KCC-1) loaded in a face serum formulation. Furthermore, three drug loading methods, namely physical mixing, melting, and solvent evaporation, denoted as (Phy)/Nia-KCC-1, (Mel)/Nia-KCC-1, and (Sol)/Nia-KCC-1, respectively, were implemented, and the percentage loading efficiencies were compared. (Mel)/Nia-KCC-1 demonstrated the highest percentage of drug loading at 33%, followed by (Phy)/Nia-KCC-1 and (Sol)/Nia-KCC-1 at 25% and 17%, respectively. Likewise, the in vitro release study also revealed a similar pattern, with (Mel)/Nia-KCC-1 recording the highest percentage release at 29%, followed by (Phy)/Nia-KCC-1 and (Sol)/Nia-KCC-1 at 24% and 21%, respectively. As the (Mel)/Nia-KCC-1 sample unveiled decent results in transporting the sample drug, the respective sample was then further loaded into the face serum formulation, and the pH stability was observed for 7 days. The pH readings remained constant at pH 4.3 throughout the 7 days, within the acceptance range according to the derma-cosmetic product that states the effective pH should lie between pH 4 and pH 6. Therefore, it can be stated that the (Mel)/Nia-KCC-1 loaded serum fulfills the acceptance criteria for the pH requirement of derma-cosmetic products.

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1. Introduction

Niacinamide (Nia), also known as nicotinamide, is a water-soluble vitamin (B3) that has been used in various topical applications [1]. This small substance exhibits fascinating biological properties. It has been reported to have a moisturizing effect in alleviating dry skin conditions by reducing underlying chronic inflammatory processes and improving the function of the stratum corneum barrier [2]. Clinical reports have also demonstrated the efficiency of niacinamide in reducing hyperpigmentation [3]. Furthermore, this vitamin has been recognized as an anti-wrinkle cosmetic ingredient [4]. Researchers have discovered that niacinamide plays an excellent role in skin lightening by preventing the transfer of melanin pigment (responsible for skin darkening) to skin cells (keratinocytes). Prolonged use of this active ingredient as part of a skincare routine may decrease hyperpigmentation and lighten the skin. In a recent report by Lee et al. [5], niacinamide was loaded into starch-based biomaterials for the treatment of hyperpigmentation. The results showed a 55.8% inhibition of tyrosinase activity and a 73.0% antioxidant inhibitory effect.

In the cosmeceutical field, nanotechnology has been regarded as a promising approach to deliver active ingredients onto and into the skin, leading to extensive studies on various nanocarriers. Conducting drug loading studies is crucial to ensure the effective delivery of active ingredients into the body system. Several drug loading methods can be employed to incorporate drugs or active pharmaceutical ingredients into nanocarriers, such as physical mixing, melting, solvent evaporation, and others. A previous report successfully loaded niacinamide into organo-modified SBA-15 siliceous materials using the solvent evaporation method, resulting in an adsorption of 119 mg/g niacinamide in ethyl acetate [6]. Another study by Koch et al. [7] demonstrated that the melting method showed promising results for loading ibuprofen compared to other methods. The choice of method depends on factors such as the physicochemical properties of the drugs, the carrier material, and the desired release profile.

Silica-based nanocarriers have drawn significant interest from the scientific community, particularly for their potential in revolutionizing-controlled release studies of active ingredients. The remarkable properties of silica, such as its simple synthetic

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