Skin permeation of tyrosinase inhibitor α-arbutin via commercial microneedles and dissolving microneedles

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Background: Hyperpigmentation is a common dermal condition with localised darkening of the skin due to an increase in melanin. The excessive synthesis and accumulation of these pigments lead to an increased incidence of skin disorders, including Japanese acanthosis, melasma, perioral hyperpigmentation and skin cancer. Whereas tyrosinase is an enzyme that catalyses melanin production, targeting tyrosinase can inhibit melanin production in cells. α-arbutin is widely used as a tyrosinase inhibitor for the treatment of hyperpigmentation. However, α-arbutin is hydrophilic and therefore has a difficulty of permeating through stratum corneum into melanocytes in the basal layer. Compelling evidence shows that microneedles may provide a promising approach to resolve this issue. Therefore, it is necessary to explore the application of commercial microneedles (CMNs) or polymer dissolving microneedles (PDMs) and determine their effectiveness to improve skin permeation of α-arbutin.

Methods: The skin permeation of three different formulations of commercial α-arbutin products was firstly determined by applying products on the pig full thickness skin mounted on Franz cell for 24hrs, afterwards α-arbutin within residues remaining in each part of the skin were analysized by HPLC. The effectiveness of CMNs in delivering commercial α-arbutin products into the dermis was further assessed using the oscillating microneedle device Dermapen as a pre- or post-treatment application. PDMs containing α-arbutin were produced, and the effectiveness of PDMs in promoting α-arbutin permeation was then evaluated.

Results: Permeation of commercial α-arbutin products to the skin is very limited, with less than 1% of α-arbutin remaining within the skin and acting on the target area after 24hrs. The application of CMNs as a pre-treatment has less enhanced permeation of α-arbutin. However, when CMNs were applied via post-treatment, the amount of α-arbutin remaining within the skin was significantly increased to around 4%, albeit with large variations. When DMNs were applied, the amount of α-arbutin remaining within the skin increased to about 4.5%, with small variations.

Conclusions: Overall, CMNs and DMNs significantly improved permeation of α-arbutin to the skin. In particular DMNs showed a more sustainable capacity of enhancing permeation. In addition, there is a potential scope to optimize and improve such delivery systems. Therefore, finding more efficient delivery methods is the focus of subsequent studies.