Preparation and Characterization of Dissolving Ulvan Microneedle for Transdermal Delivery System

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Outline

1. Introduction
2. Ulvan extraction and chemical analysis
3. Microneedle fabrication and characterization
4. Microneedle insertion capability and dissolution properties
5. In vitro drug diffusion and permeation from microneedle
6. Conclusion

Abstract

Transdermal drug delivery system (TDDS) is a noninvasive method of delivering drugs across the skin. However, TDDS is limited by stratum corneum barrier, thus only small (MW < 500 Da) and hydrophobic molecules can be delivered. Microneedle (MN) can enhance the efficiency of TDDS via minimally invasive and pain-free method. Recently, a dissolving MN made of natural polymers has gain many attentions due to its rapid dissolving ability and good biocompatibility. In this study, we are the first group to fabricate and characterize a dissolving MN made from ulvan (UMN), a sulfated polysaccharide extracted from *Ulva lactuca*. The UMNs were fabricated through an easy and mild two-step casting method. The MN had two layers, the needle layer is made from ulvan and loaded with ascorbic acid 2-glucoside (AA2G), and the backing layer is made from a mixture of polyvinylpyrrolidone (PVP) and carboxymethyl cellulose (CMC). The UMN has pyramidal-shaped needles, 652-682 μm in height, 248-280 μm in base width and 2.47-2.75 in aspect ratio. 4% UMN had the nearest aspect ratio to the master mold and used as the base material of the needle layer. The *in vitro* skin insertion study showed the MN successfully penetrated the porcine skin and Parafilm layers. The incorporation of 2.0% AA2G into the MN can increase the insertion ratio and depth of UMN. The *in vitro* dissolution studies showed that UMN completely dissolved after inserted for approximately 2 min. The confocal laser scanning microscopic images showed that the drug can diffuse into the depth of 300-500 μm, which is similar to the depth of skin dermis layer. The *in vitro* drug permeation profiles revealed different release behavior of AA2G-loaded UMN, 0.5% AA2G-loaded UMN showed a burst release in the first 30 min, while 1.0% and 2.0% AA2G-loaded UMN showed a sustained release. The cumulative release amount of AA2G after 3 h was about 80-90%, which was higher than the solution group (40%). Briefly, this study demonstrated that UMN can enhance the transdermal delivery efficiency of AA2G and have the potential to be used in pharmaceutical or cosmeceutical fields.

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