

# **Development and Characterization of Minoxidil Nanosuspension-loaded Dissolved Microneedles for Hair Regrowth**

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## **Abstract**

Minoxidil (MIN) is used topically to treat alopecia, however its low absorption limits its use, warranting a new strategy that can enhance its delivery into skin layers. The objective of this study was to evaluate the dermal delivery of MIN utilizing dissolved microneedles (MNs) loaded with MIN nanosuspension (MIN-NS) for hair regrowth. MIN-NS was prepared by solvent-antisolvent precipitation method. The particle size of MIN-NS was  $226.7 \pm 9.3\text{nm}$  with a polydispersity index of  $0.29 \pm 0.17$  and a zeta potential of  $-29.97 \pm 1.23\text{mV}$ . Then MIN-NS was loaded into MNs fabricated with sodium carboxymethyl cellulose (Na CMC) matrix (MIN-NS loaded MNs). The MIN-NS loaded MNs, prepared with 14% Na CMC, were able to withstand a compression force of 32N for 30s, penetrate Parafilm M® sheet at a depth of 374-504 $\mu\text{m}$ , dissolved completely in the skin within 30min, and MIN recovery of  $95.07 \pm 6.45\%$ . The release of MIN from MIN-NS loaded MNs was  $99.71 \pm 2.16\%$ , higher than MIN-NS film ( $76.92 \pm 7.17\%$ ). Finally, MIN-NS loaded MNs maintained their stability for 4 weeks, when kept at room temperature and in chambers with silica. These results showed that MIN-NS loaded MNs could potentially improve the dermal delivery of MIN through the skin.

**Keywords:** Dissolving microneedles, minoxidil, nanosuspension, dermally delivery