Nanocomposite preparation with analgesic effect based on highly dispersed silicon dioxide

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The relevance of treating infected and chronic wounds highlights the need for the development of multifunctional pharmaceutical formulations capable of providing both antimicrobial and analgesic effects. The use of nanomaterials, particularly highly dispersed silica (nano-SiO_2), opens new possibilities for creating effective topical agents. Such systems allow not only for the deposition of the active substance but also for regulating its release in the damaged area.

The aim of this work was to study the release kinetics of lidocaine hydrochloride from a nanocomposite system based on nano-SiO_2 and to evaluate the influence of different conditions on the release efficiency of the active component.

The nanocomposite preparation was made by immobilizing lidocaine hydrochloride on the surface of highly dispersed silicon dioxide through impregnation with a solution of anesthetic agent followed by lyophilic drying.

The release kinetics were studied using two methods:

• Classical diffusion method (Ph. Eur. 2.9.3): 1000 ml buffer (pH 4.5 or 6.8), temperatures 25°C and 35°C.

• Franz cell method (USP <1724>): vertical diffusion system with membrane (1.77 cm^2), buffer pH 4.5 or 6.8, temperatures 25°C and 35°C.

In all cases, 12 parallel systems were used. Samples were analyzed by UV spectrophotometry at 262 nm.

The Franz method provided gradual and stable release of lidocaine hydrochloride, approximating the conditions of penetration through the skin, while the classical method indicated rapid initial release (up to 78% in the first 5 minutes). The difference between the methods was particularly noticeable with temperature change: increasing the temperature accelerated the release process, indicating thermosensitive behavior of the system. Studies in a medium with pH 4.5 revealed better solubility and availability of lidocaine, which is significant in wounds with acidosis.

The nanocomposite preparation based on nano-SiO_2 with lidocaine hydrochloride demonstrated promising characteristics for both open and transdermal applications. The combination of the sorption properties of the nanocarrier and controlled release allows for the creation of effective forms with prolonged analgesic action. Further research should be directed toward biocompatibility and optimization of the composition for clinical use.