ABSTRACT BOOK

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Development of Ciprofloxacin-loaded PCL-PEG Hydrogel

Siti Hajar Ahmad Shariff[1], Mohamad Wafiuddin Ismail[1*], Muhammad Salahuddin Haris @ Harith[2,3]

1Department of Chemistry, Kulliyyah of Science, International Islamic University Malaysia, 25200 Kuantan, Pahang Darul Makmur, Malaysia.
2Department of Pharmaceutical Technology, Kulliyyah of Pharmacy, International Islamic University Malaysia, 25200, Kuantan, Pahang Darul Makmur, Malaysia
3IKOP Pharma Sdn Bhd, Jalan Sultan Ahmad Shah, 25200 Kuantan, Pahang, Malaysia
*Corresponding author: wafisnj@iium.edu.my

Abstract - The incorporation of polymer blending into hydrogel formulation is expected to improve the drug loading and encapsulation efficiency of the hydrogel for skin application. Star-shaped polymer made up of poly(caprolactone)-b-poly(ethylene glycol) (PCL-b-PEG) has a great potential to be used as polymer blending in the hydrogel formulation as the PCL region can increase drug encapsulation through hydrophobic-hydrophobic interaction with the hydrophobic drug, and the PEG region can increase the solubility of the polymer to be used as a drug cargo in human body. In this study, two hydrogel formulations will be incorporated with different amount of 4-arm star-shaped PCL-b-PEG (4s PCL-b-PEG) to demonstrate drug loading percentage and drug encapsulation efficiency between the two formulations. The key ingredient of the hydrogel consists of the synthesized star-shaped PCL-b-PEG polymers as the drug cargo, along with Carbopol 940 as the gelling agent, ciprofloxacin as the hydrophobic drug model, methyl and propyl paraben as the preservatives, trifluoroethanol, triethylamine, and water. The drug loading and encapsulation efficiency of both formulations were found to be more than 99%, indicating high capability of the formulations as hydrophobic drug cargo.

Keywords: Star polymer, PCL-PEG, Hydrogel formulation, Drug loading, Encapsulation Efficiency

Introduction - Hydrogel is a water-based formulation and therefore limiting the drug loading and encapsulation efficiency towards hydrophobic drugs. Since most wound healing drugs are hydrophobic in nature, a modification of the hydrogel is necessary to improve its ability to heal wounds. Hydrogel also has low mechanical stability, which required modification to be applied (Blumlein & McManus, 2015). Hence, hydrogel blending with star-shaped amphiphilic polymers is an alternative to overcome this issue. One of the best candidates to be combined with hydrogel-based dressing is star-shaped PCL-PEG polymers. The advantage of this form of amphiphilic polymer is the increase in hydrophobic drug encapsulation through hydrophobic-hydrophobic interaction with PCL, while PEG, as hydrophilic part will increase the solubility of the drug cargo for human use (Dragojevic et al., 2015; Hussein & Youssry, 2018). Therefore, in this study, two hydrogel formulations will be designed and incorporated with different amount of 4s PCL-PEG polymers (0.25 and 0.5 % w/w), to study the capability of the two formulations in terms of drug loading and encapsulation efficiency towards hydrophobic drug model, ciprofloxacin. The results of this work are expected to resolve the constraint of commercialized hydrogel in terms of hydrophobic drug loading and encapsulation efficiency.

Methodology – Preparation of hydrogel: Two 4s PCL-PEG copolymers of different amount (0.25 and 0.5 % w/w) were first diluted in trifluoroethanol before ciprofloxacin was added. The solution was stirred for 12 hours to make sure the mixture was homogeneous. Meanwhile, Carbopol was dispersed in deionized water for 12 hours to ensure complete dispersion. Then the two solutions were mixed and stirred for 24 hours. Triethylamine was added by drop-wise addition to neutralize the mixture and to adjust the hydrogel with desired pH. Drug loading and encapsulation efficiency: Direct method was used to calculate the drug loading and entrapment efficiency of ciprofloxacin in the formulations. A quantity hydrogel was taken and dissolved in phosphate buffer of pH 7.4. The sample was analysed using UV-Vis spectrophotometer. The base solution without drug was used as a blank and the absorbance was noted. The concentration of the drug loaded was determined from the standard curve, and the percentage was calculated using drug loading and entrapment efficiency equation.

Results and Discussion –

Table 1. Results of the characterization of the hydrogel formulations.

Characteristics	Formulation 1	Formulation 2
pH	7.32 ± 0.02	7.28 ± 0.02
Homogeneity	Good	Good
Appearance	Opaque	Opaque
Drug loading %	99.9999	99.9999
Entrapment efficiency %	99.9964	99.9963

Both hydrogels were homogeneous without any aggregation or rough particles, which were the characteristics of the ideal topical gel. The pH of both hydrogel formulation lies between the normal pH range of the skin (pH 7.2-7.4), which was important to avoid the risk of skin irritation for skin application. The percentage of the drug found in both formulations were higher than 99%, which is in accordance with the United States Pharmacopoeia (Amaral et al., 2013). The enhancement in the encapsulation of the hydrophobic drugs were similar to previous study in the presence of amphiphilic copolymers (Shin et al., 2009). Additionally, star-shaped polymers can improve the performance of drug trapping, as it provides additional drug-conjugated sites and looser space for drug loading (Wu, Wang, & Li, 2015).

Conclusion - In conclusion, hydrogels with desired pH and good homogeneity were successfully prepared in this study. The drug loading and entrapment efficiency of both formulations were high, with more than 99.99%, indicating the capabilities of both hydrogels to act as hydrophobic drug cargo intended for human use.

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