Eradication of *E. coli* and *S. aureus* by Ciprofloxacin-loaded hydrogel

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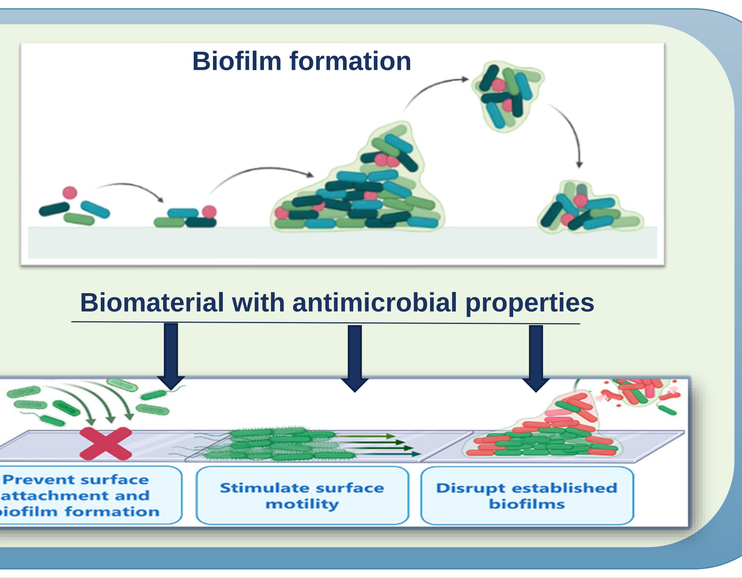
INTRODUCTION

Hospital-acquired infections are one of the major risks to the patient and an economic burden on the healthcare system, the multidrug resistance is considered a problem arising at an alarming rate toward developing new strategies to decrease the infection burden in the healthcare environment. Novel drug delivery systems for antimicrobial agents can act as a solution for infection. In this study, we demonstrate a biomaterial with antimicrobial properties through the incorporation of ciprofloxacin into Poly(HEMA-*co*-MMA) hydrogel.



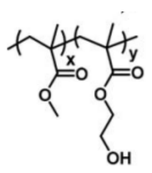
AIM

The main aim is to prevent bacterial adherence on these surfaces which presents a valuable strategy for nosocomial infection control. The adherence percentage of both S. *aureus* and *E. coli* were significantly decreased, this eradication was successfully worked for 24 hr which can contribute to decreasing the biofilm formation.

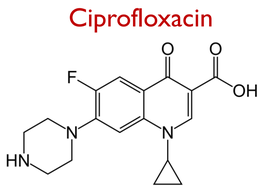
MATERIALS AND METHODS

Materials

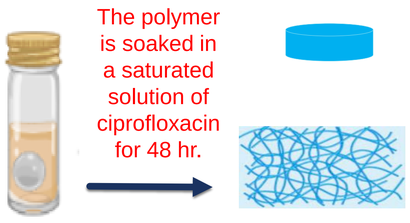
Poly(HEMA-*co*-MMA)



Ciprofloxacin

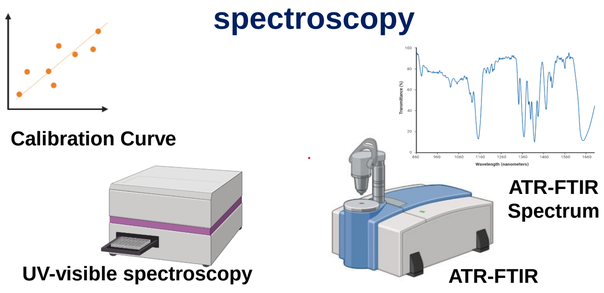


1. Ciprofloxacin Loading



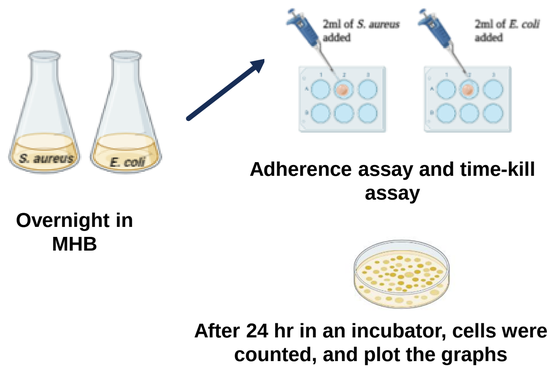
The post polymerisation loading method is used to load ciprofloxacin into the Poly(HEMA-*co*-MMA) hydrogel.

2. In vitro drug release & FTIR spectroscopy



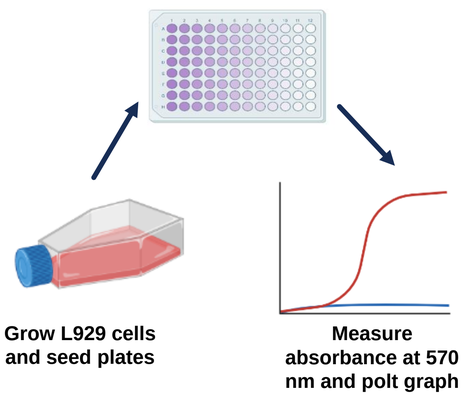
- The amount of drug released was analyzed at 270 nm, using a UV-visible spectroscopy method. A calibration curve was freshly constructed.
- Attenuated total reflection- fourier infrared (ATR-FTIR) spectroscopy to detect the ciprofloxacin loading

3. Microbiological Assessment



S.aureus and *E.coli* were grown overnight in Mueller-Hinton broth (MHB) in an orbital incubator at 37°C. Then the adherence test and time-kill assay were carried out

4. Cell Viability Assessment



RESULTS

In vitro drug release & FTIR spectroscopy

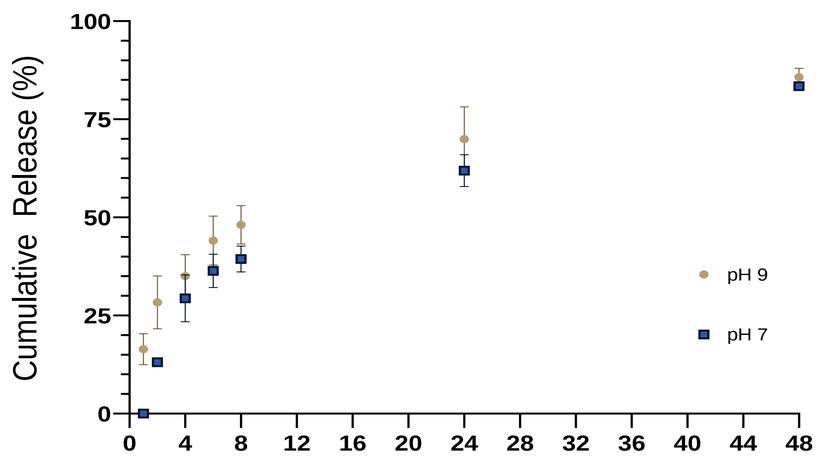
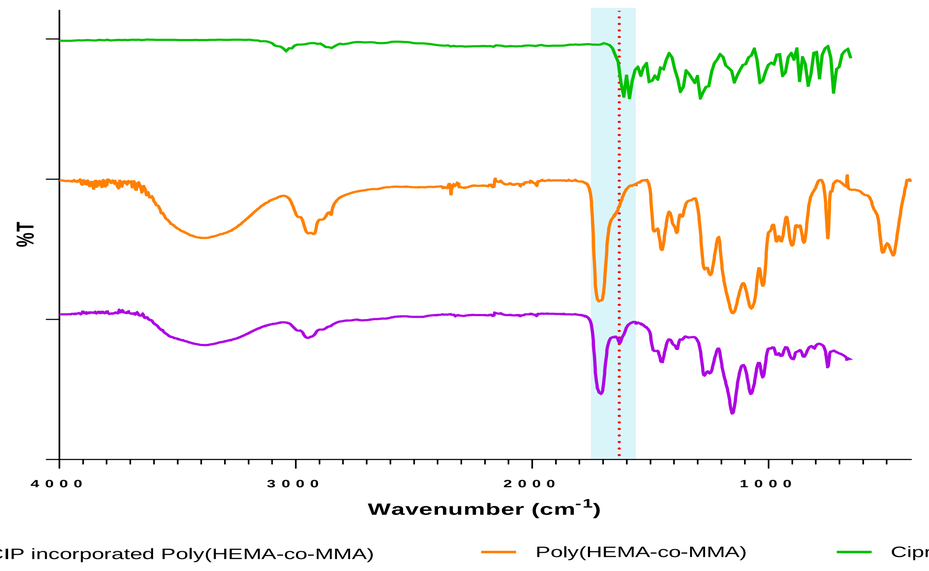


Fig. 1. The release profiles of ciprofloxacin at pH 7.4 and pH 9 from the prepared hydrogel Poly(HEMA-co-MMA). Error bars represent ± S.D., n = 5.

The release at pH 9 was > 70% after 24 hours. The drug responds to release at two different pH levels and the bioavailability of the drug can be responsive to conditions elevated pH such as the onset of urinary catheter infections



The drug into the Poly(HEMA-*co*-MMA) was confirmed by FTIR spectra. The figure is showing a different adsorption band amine group at 1488 cm^{-1} which is a small peak because of the lower quantity of drug in it.

Antimicrobial Assessment

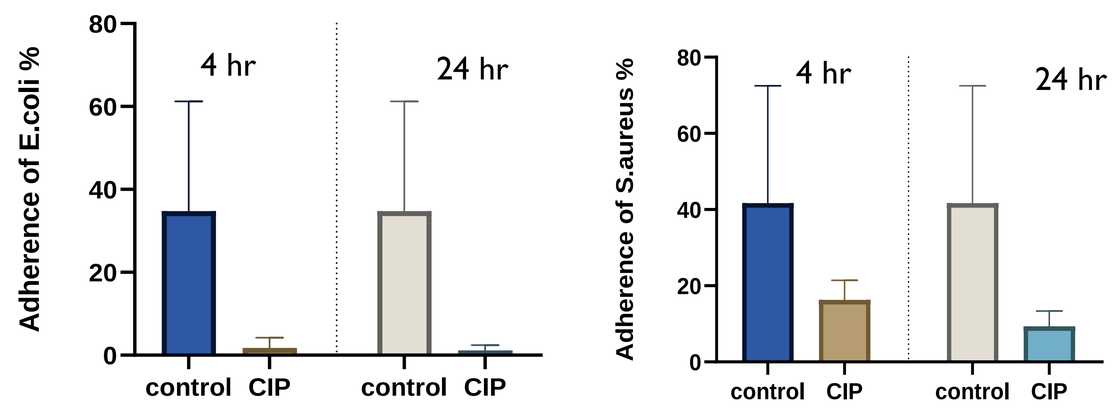
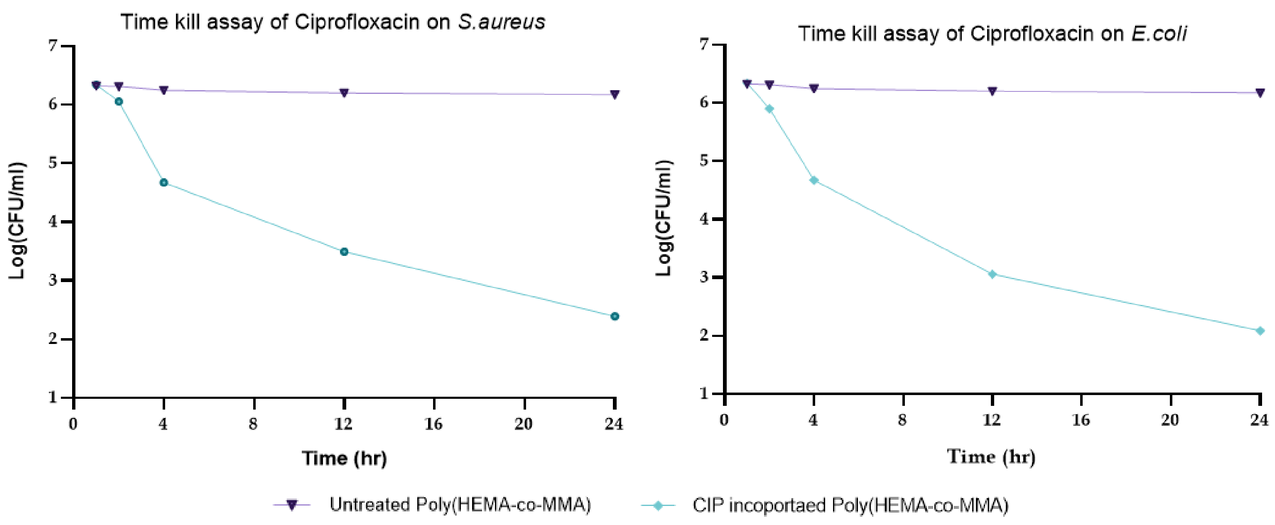


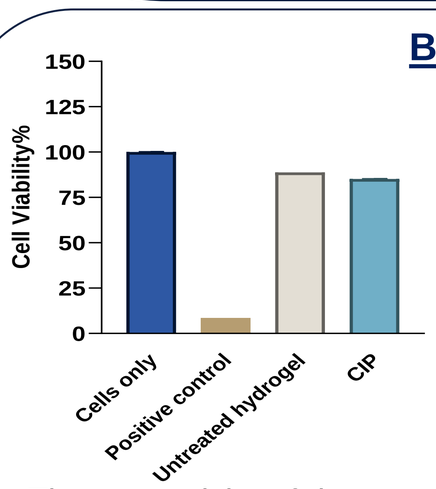
Fig. 2. The adherence percentage of E .coli and S. aureus on the surface of Poly(HEMA co MMA) hydrogel (control) and ciprofloxacin-loaded Poly(HEMA-co-MMA) hydrogel (CIP). Error bars represent ± S.D.. n = 5.



Group	Log_{10} S. aureus (CFU/ml) after 24 hr	Log_{10} E. coli (CFU/ml) after 24 hr
Ciprofloxacin incorporated Poly(HEMA-co-MMA)	2.45±0.1	2.06±0.1
Untreated Poly(HEMA-co-MMA)	6.11±0.0	6.35±0.0

- Based on the antibacterial efficacy of the hydrogel loaded with ciprofloxacin, the adherence percentage of *E .coli* and *S. aureus* to the surface of polymers loaded with ciprofloxacin were analyzed at time periods of 4 h and 24 h incubation **(Figure 2)**
- Less than 20% of adherence was shown after 24 hrs for hydrogel loaded with ciprofloxacin for both gram-positive and gram-negative bacteria.
- Time-kill assay results have demonstrated that hydrogel loaded with ciprofloxacin had a significant long-term eradication of gram-positive and gram-negative bacteria for up to 24 hr results compared to untreated hydrogel (P-value<0.0001)

Biocompatibility



The cytotoxicity of the materials examined using the MTT assay was found to exhibit the lowest cytotoxicity of hydrogel after direct contact with L929 cells. 70%, the level required to indicate no cytotoxicity. Based on the findings all the samples have survival (%) > 70%.

CONCLUSION

- This study describes the rational development of drug-loaded hydrogel and microbiological properties of an infection-responsive drug delivery system.
- The findings represented that drug-loaded hydrogel provided infection resistance for 24 hours and the adherence percentage for gram-positive and gram-negative were significantly decreased compared to the untreated hydrogel.

REFERENCES

Irwin, N. J., C. P. McCoy, D. S. Jones and S. P. Gorman (2013). "Infection-responsive drug delivery from urinary biomaterials controlled by a novel kinetic and thermodynamic approach." Pharmaceutical research **30**(3): 857-865.

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