

A Novel Hybrid Hydrogel Cross-linked by Electron Beam for Controlled Release of 5-FU

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INTRODUCTION & AIM

Multifunctional drug delivery systems incorporating 5-fluorouracil (5-FU) represent a novel therapeutic approach for targeted cancer treatment, allowing for controlled drug release while minimizing cytotoxic effects on healthy tissues. Among these systems, hydrogels stand out due to their high biocompatibility, flexibility, and water retention, enabling their use as smart wound dressings and drug carriers.

Electron-beam (e-beam) irradiation offers a clean and efficient technique for simultaneous hydrogel crosslinking and sterilization, without the use of chemical initiators.

AIM: To develop and evaluate new e-beam crosslinked hydrogels based on poly(vinylpyrrolidone) (PVP), carboxymethylcellulose (CMC), poly(ethylene glycol) (PEG), and agar, synthesized and sterilized using a 30 kGy dose, intended for advanced wound dressings and controlled 5-FU release.

METHOD

Formulation

- H1: 5% PVP, 1% CMC, 1% PEG, 1% Agar
- H2: 7% PVP, 0.5% CMC, 1.2% PEG, 1% Agar
- H5: 4% PVP, 0.5% CMC, 1.2% PEG, 0.5% GG

Pre-hydrogel preparation

- Magnetic stirring (800 rpm, 23 °C)
- Heating at 80–90 °C (agar/gellan solubilization)
- Ultrasonication (degassing, 37 Hz)
- Casting into cylindrical moulds

E-beam Irradiation

- Accelerator ALID-7, 6 MeV,
- Dose: 30 kGy, rate 3.3 kGy/min
- Dosimetry: graphite calorimeters & B3 films (alanine reference)

Post-processing

- Freeze-drying (−90 °C, 36 h)
- Drug loading: 5-Fluorouracil (5-FU)

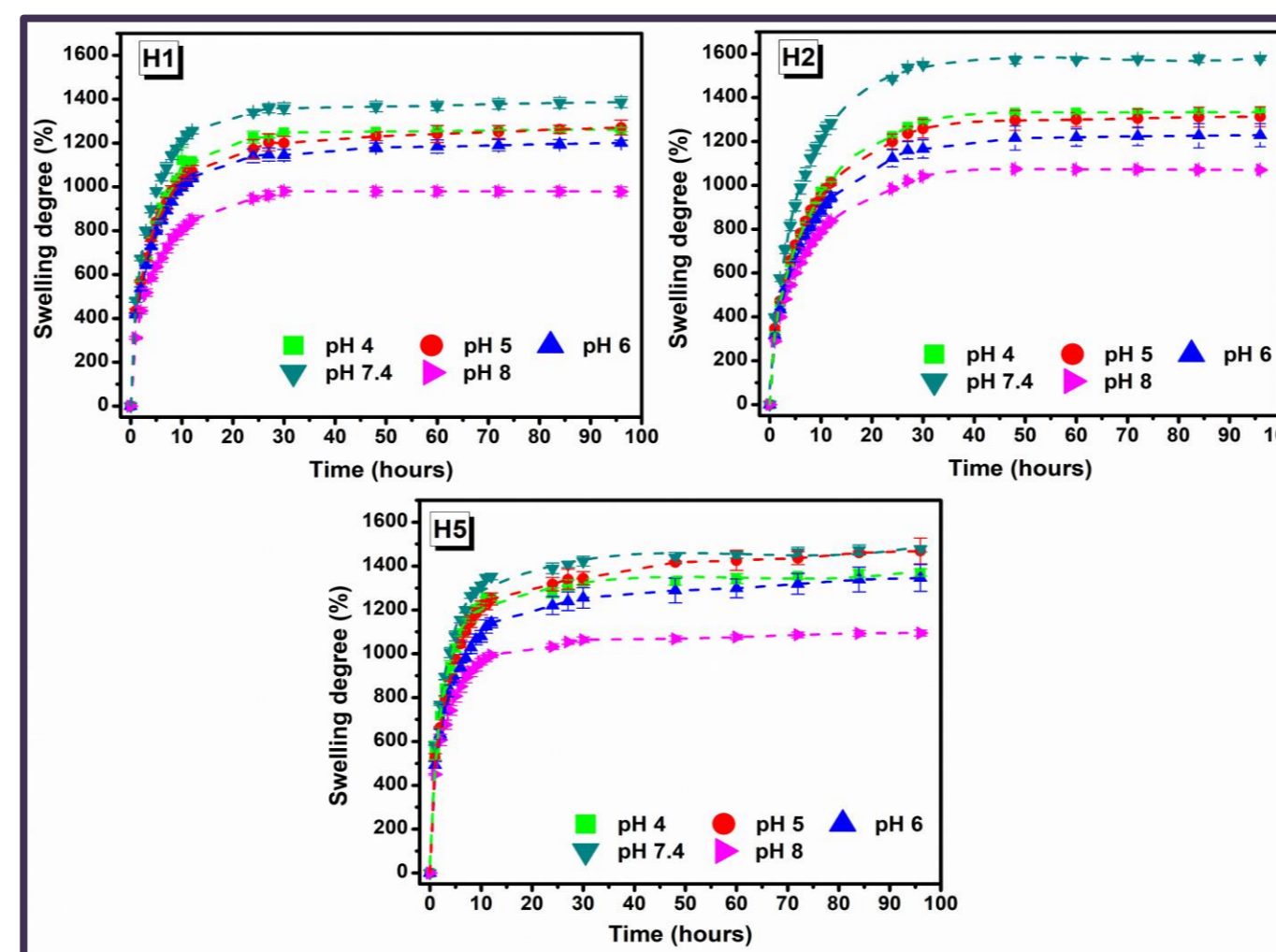


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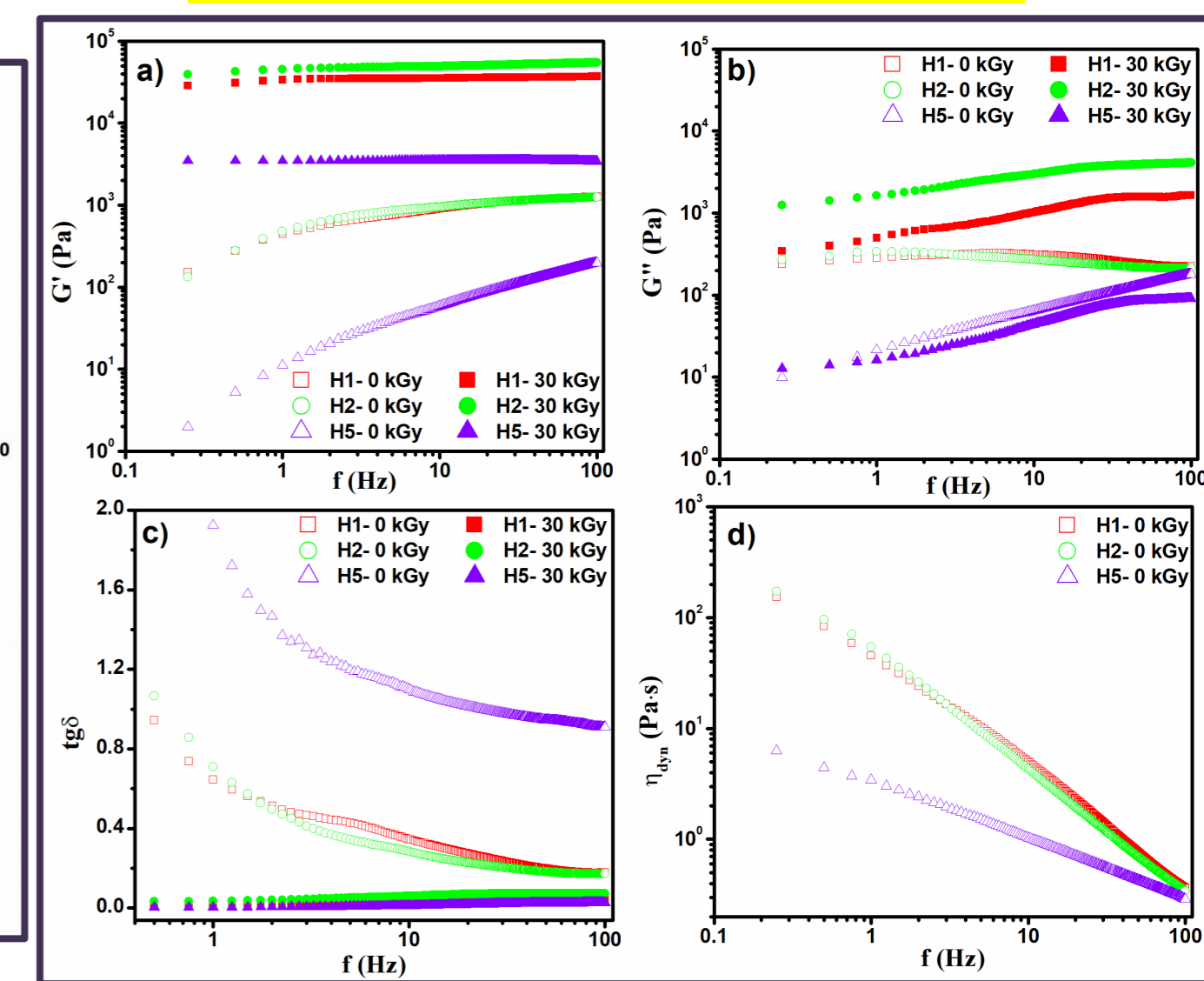
This research was supported by the Romanian Ministry of Education and Research under the National Nucleus Program LAPLAS VII under Contract No. 30N/2023.

RESULTS & DISCUSSION

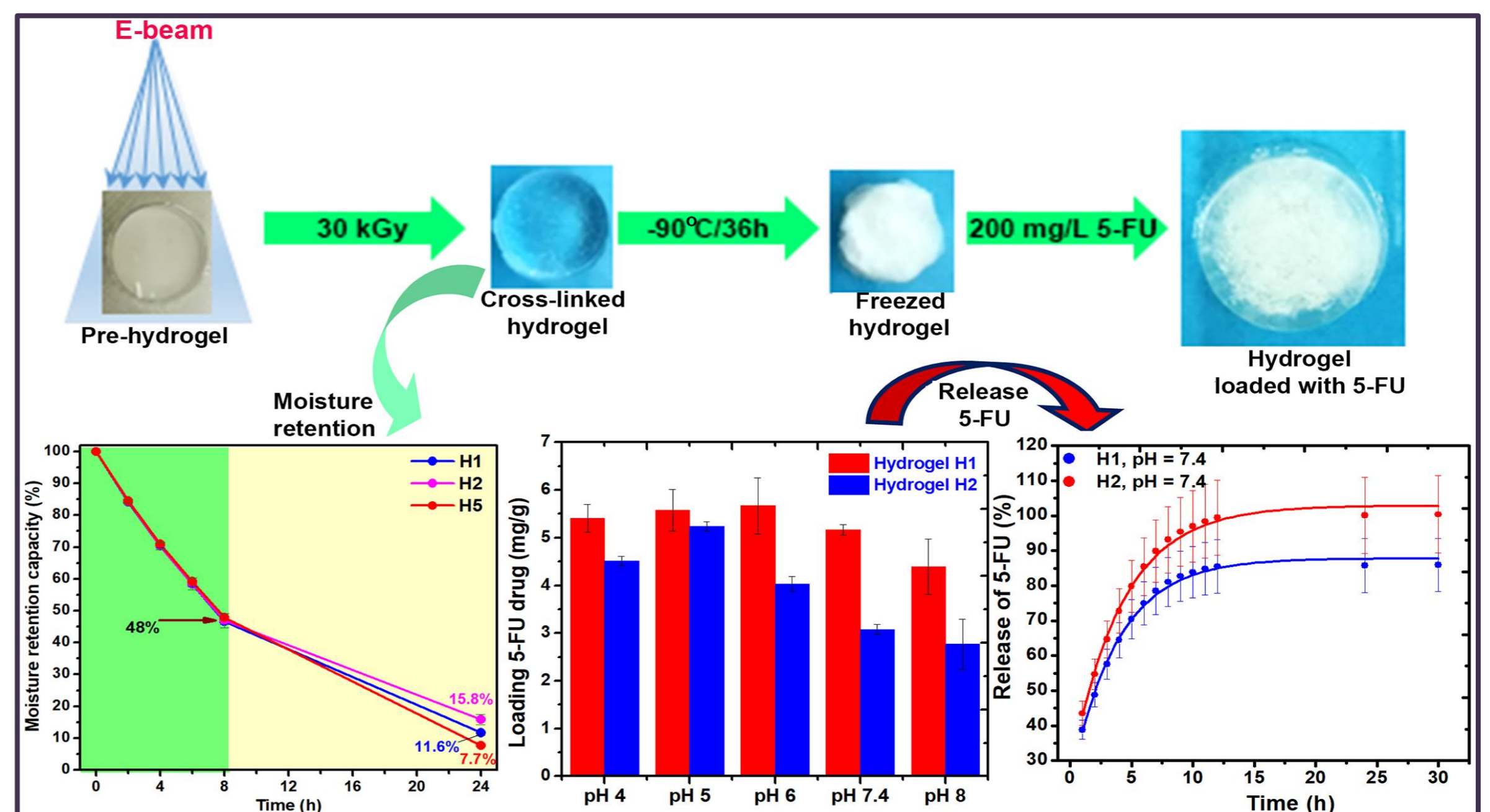
Swelling Capacity



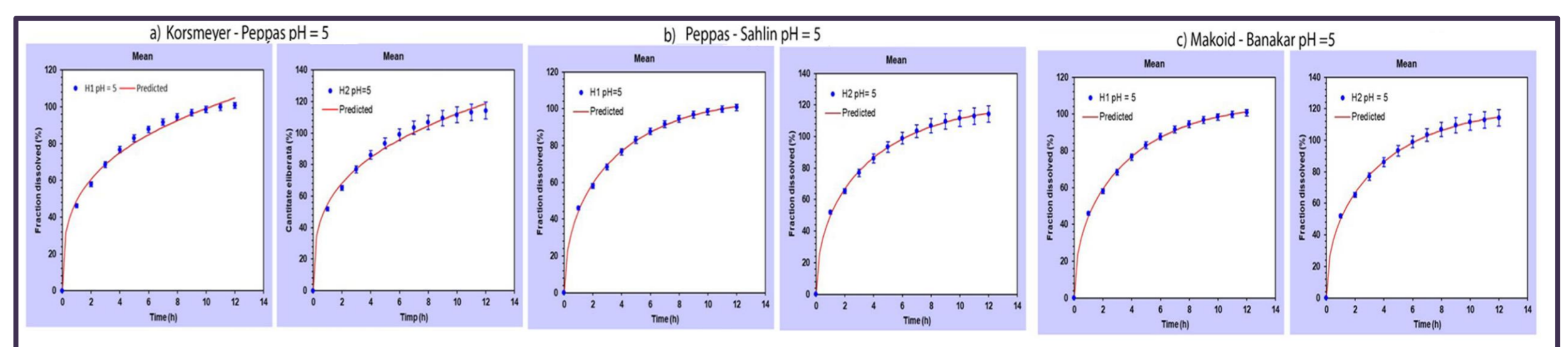
Rheological properties



Retention capacity, Drug Loading & Release Profile



5-FU Release Kinetics



CONCLUSION

- The e-beam crosslinked PVP/CMC/PEG/agar hydrogel showed excellent swelling behavior, high elasticity, and a stable macromolecular network.
- The system exhibited a high 5-FU loading capacity of 5.5 mg/g at pH 6, with a cumulative release of 96 % (pH 5) and 80 % (pH 7.4) within 30 h.
- The release kinetics fitted the Korsmeyer–Peppas, Peppas–Sahlin, and Makoid–Banakar models ($r^2 > 0.99$), indicating a Fickian diffusion mechanism.
- These results confirm the potential of the hydrogel as an intelligent wound dressing for localized 5-FU cancer therapy.