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Development of multifunctional hydrogels for the delivery of drugs and nutrients for patients with Inflammatory Bowel Disease

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Background

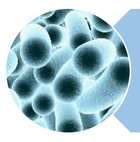
Inflammatory Bowel Disease (IBD) is a group of diseases that affect the gastrointestinal tract (GI) (1). Comprised of Crohn's Disease (CD) and Ulcerative Colitis (UC), it affects 6.8 million people globally.

IBD is characterised by chronic relapsing inflammation in the GI tract. The exact pathogenesis is unknown, but incidence is increasing across westernised areas. Current treatments often don't work or cause side effects. Therefore, more advanced, novel therapeutic treatments are required to help treat IBD patients (2).

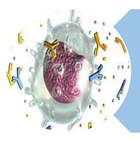
Pathogenesis

Genetics

Environment



Microbial Factors



Immunological factors

5-ASAs

Headache, abdominal pain, nausea, vomiting, rash or fever

Corticosteroids

Osteoporosis, diabetes, weight gain and muscle weakness

Current treatment
Side effects

Immunotherapy

Headache, weight gain, shortness of breath, diarrhoea and edema

Biologic therapies

Infection, headache, bruising, itching, lymphoma

Hydrogel Synthesis

The polymer (PEGDMA -750) investigated was prepared via free-radical polymerisation using ultraviolet (UV) light. 1.0 wt.% Irgacure 2595 (a photoinitiator) was used to initiate the reaction.

The solution was mixed using a magnetic stirrer for 30 minutes until a homogenous mixture was achieved.

The solution was pipetted into silicone moulds. Photopolymerisation was carried out at 15 minute intervals, the samples were turned to ensure the gels got the same level of UV exposure during the polymerisation process.

Characterisation Methods

Gel fraction measurement:

Gel fraction was carried out to measure the efficiency of the network formation.

It was found that the gel fraction was 94.2%±1.510, similar to that of previous studies using PEGDMA – Gel fraction: 96.02%±1.05 (3).

Swelling Studies:

Swelling studies were carried out to investigate the surface properties of the hydrogel, the influence of solute diffusion and the stability of the hydrogel. Figure 1 shows the swelling of the hydrogels overtime. The samples slowly swelled to approx. 75% equilibrium.

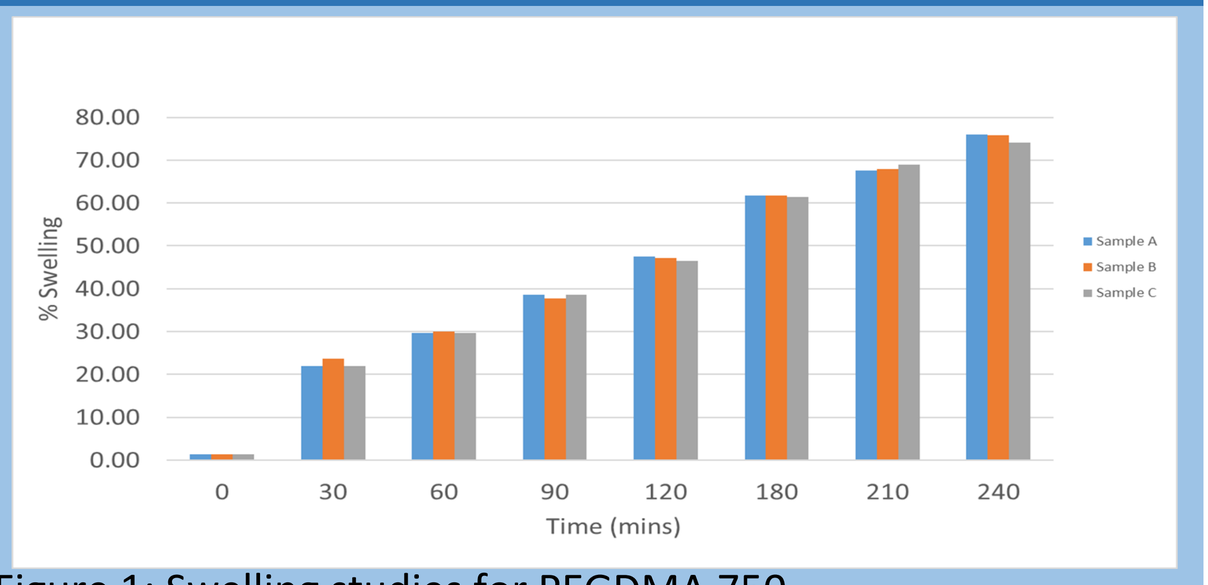


Figure 1: Swelling studies for PEGDMA 750

PEGDMA hydrogels and structure

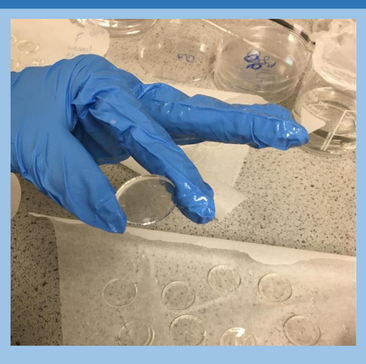


Figure 2: PEGDMA hydrogel

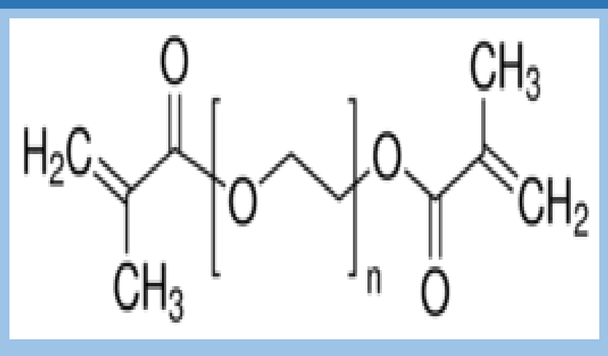


Figure 3: PEGDMA structure

Future Plans

- A drug/nutrient encapsulation method will be developed
- The hydrogel will be modified to appropriately target the inflamed gastrointestinal site
- Further characterisation tests will be carried out
- Drug dissolution studies with a model drug will be carried out
- A blend of probiotics and nutraceuticals will be encapsulated into the hydrogels

Conclusion

A new 'pharmanutraceutical' polymer system may have the potential to improve therapeutic efficacy of IBD. Swelling and gel fraction studies for PEGDMA hydrogels are positive therefore, suggesting that PEGDMA hydrogels are promising polymer delivery systems.

References

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3. Killion, J.A., Geever, L.M., Devine, D.M., Kennedy, J.E. and Higginbotham, C.L. (2011) Mechanical properties and thermal behaviour of PEGDMA hydrogels for potential bone regeneration application. Journal of Mechanical Behaviour of Biomedical Materials, 4, 1210-1227. Available at: Science Direct

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