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Design of a Drug Delivery System through the Gastrointestinal Tract

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BIOMEDICAL

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CAPSTONE DESIGN EXPO 2016

INTRODUCTION

Alzheimer's disease (AD) drugs are commonly administered orally, requiring passage through the gastrointestinal (GI) tract before entering the bloodstream. While in the GI tract, much of the drug is broken down by catalytic enzymes before being reabsorbed by the small intestines or denatured due to the varying levels of pH. Orally ingested drugs are predominantly excreted from the body, making the design of a high efficacy delivery system a priority.

OBJECTIVE

Enhance the delivery of Memantine through the GI tract to increase drug bioavailability

DESIGN

A PEGDA (polyethylene glycol diacrylate) hydrogel coating containing PMMAcoMA [poly(methyl methacrylate-co-methacrylic acid)] will be used for the delivery of Memantine. This drug delivery system will be used to enhance pH reactivity and prolong digestion. pH sensitivity will prevent the drug from releasing within the stomach where minimal absorption occurs.

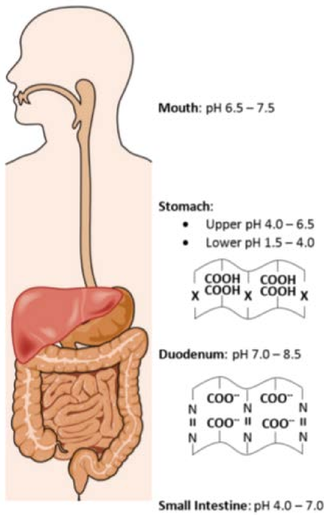

Figure 1: pH levels in the GI Tract

Once entering the duodenum of the small intestine, the rise in pH will cause the hydrogel to swell and release the drug. This will lead to subsequent digestion and absorption in the small intestine.

FITC, a fluorescent dye, was used to mimic Memantine in the PEGDA hydrogels and were placed in separate vials containing different pH levels found in the GI Tract. NanoDrop Spectrophotometry was used to determine the amount of fluorescence in each vial after varying time points.

Figure 2: PEGDA hydrogel prior to UV catalysis *(Left)*. PEGDA hydrogel during UV catalysis (*Middle)*. PEGDA hydrogel after 30 minutes of UV catalysis *(Right)*

RESULTS

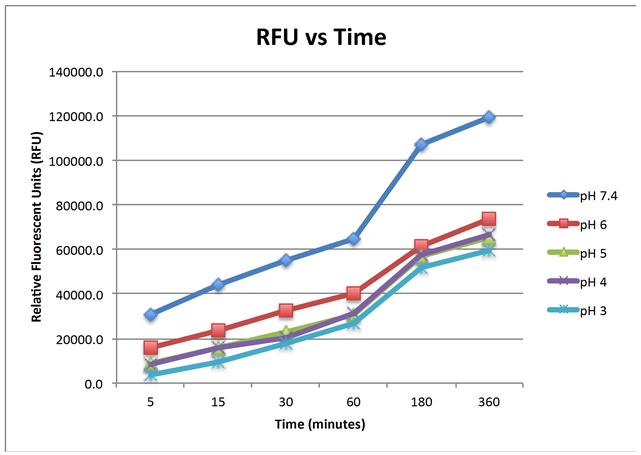

Figure 3: Average relative fluorescence over time at various pH levels

Fluorescent release was found to be maximum at a pH of 7.4 followed by a pH of 6, 5, 4, and 3 respectively.

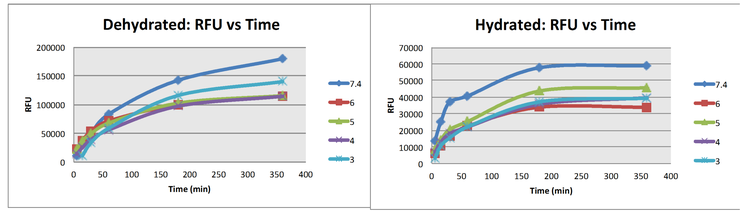

Figure 4: The dehydrated hydrogel displayed RFU values well below the respective values for the hydrated hydrogel. The overall relationship; however, remains the same in both sets of data.

CONCLUSION

In all of the trials testing the PEGDA/PMMA-co-MA hydrogel, the drug delivery system demonstrated the desired decrease in swelling with decrease in solution pH, assessed using fluorescent FITC as the model for the drug. The design allows for the desired drug, memantine, to be carried through the acidic environment of the stomach to be released ultimately in the small intestine where the pH increases. This expected change in swelling due to changes in pH is due to PMMA-co-MA's anionic nature that carries a charge in less acidic environments to allow swelling and release of its contents.

Although the desired correlation was observed between swelling and pH, the design can be improved by adjusting the polymer ratios to minimize swelling at more acidic pHs. Further experimentation could also include replacing the FITC in the design with the actual drug of choice.

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VCU School of Engineering

Make it real.

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