Fluorescent Boronic Acid Derivatives for Glucose Biosensing

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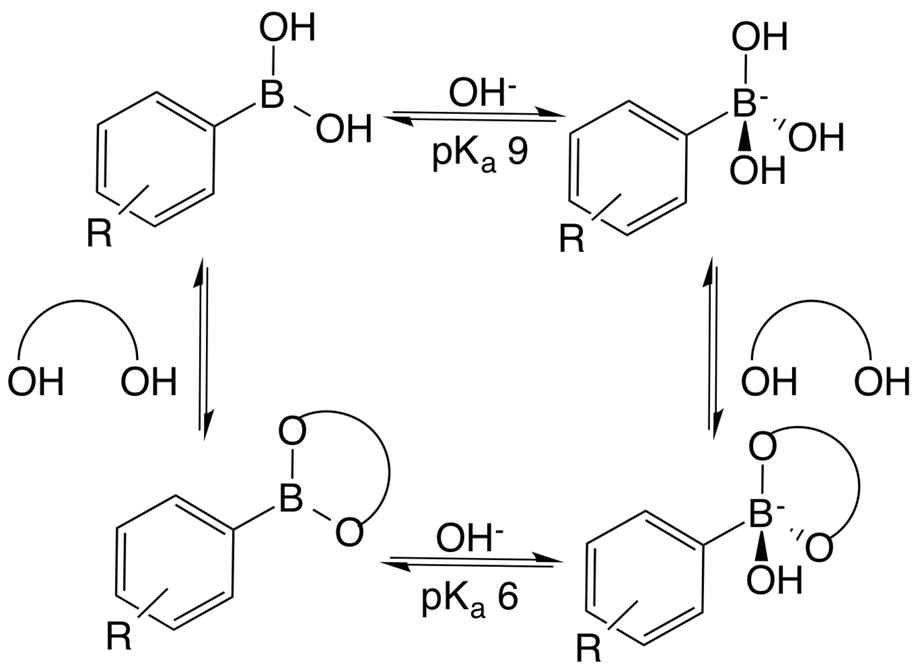
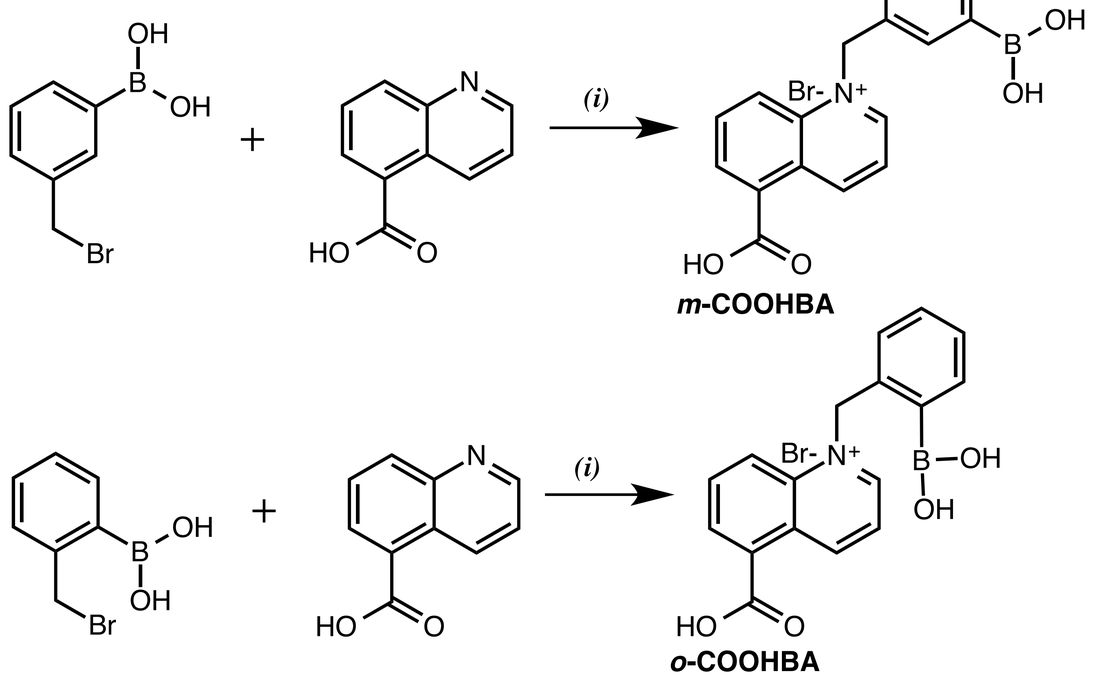
Introduction

Boronic acids (BA) are well-known for their interactions with diol-containing compounds like saccharides, making these compounds attractive for physiological glucose sensing. Fluorescent moieties are commonly incorporated into a BA derivative's framework to monitor the effect of varied sugar concentrations on the sensor fluorescence in a given environment. In this study, novel carboxylic acid BA derivatives, *m*-COOHBA and *o*-COOHBA, have been synthesized and investigated for glucose sensing in solution. Our goal is to create personal and continuous glucose monitoring devices, whereby diabetics can monitor their ocular-glucose levels noninvasively *via* a functionalised sensing contact lens.

Sensing Mechanism



Synthesis

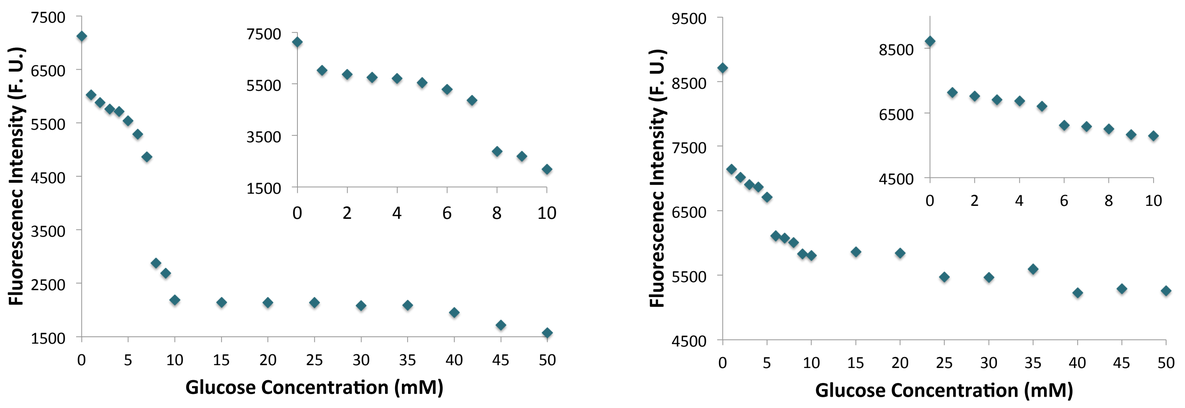


(i) Anhydrous dimethylsulfoxide, N_2, 80 ^{0}C for 48h.

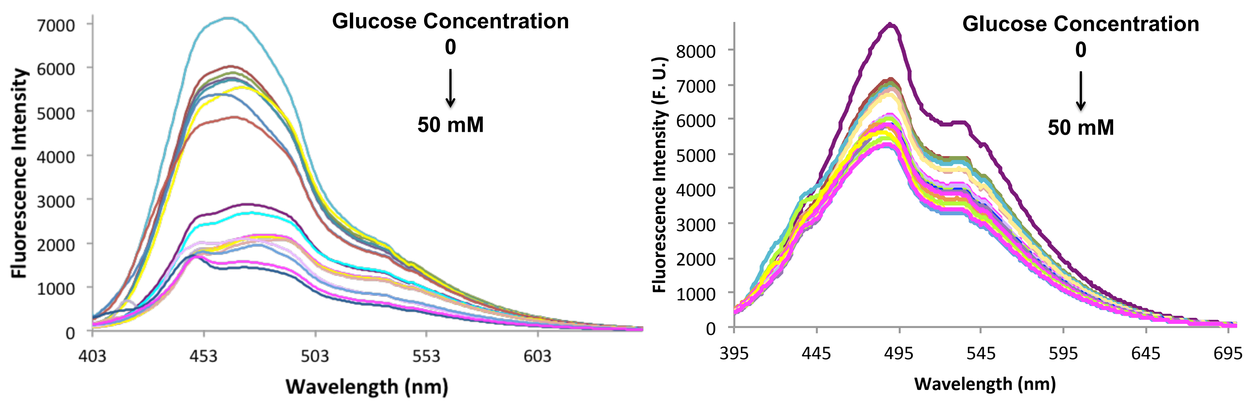
Successful synthesis of novel BA sensors were confirmed by ^{1}H NMR.

Glucose Sensing

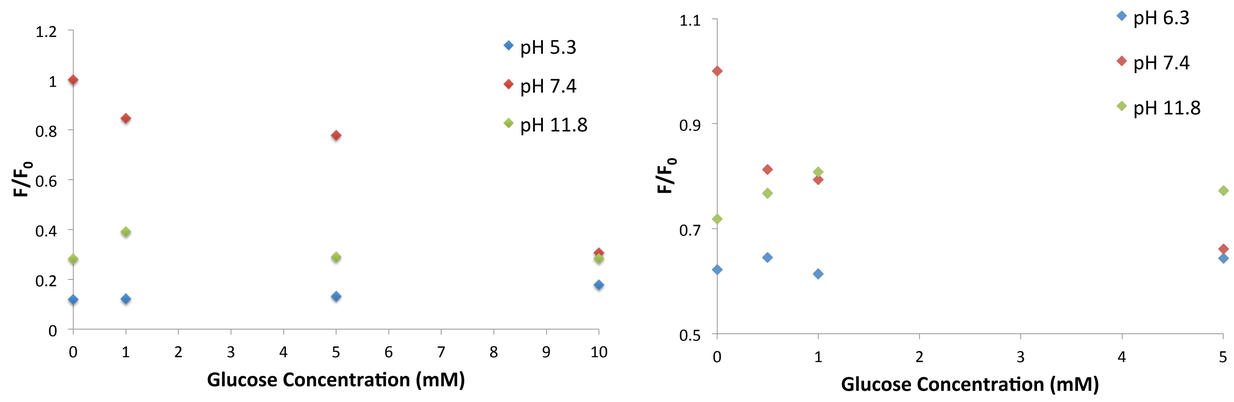
The fluorescence of *o*-COOHBA and *m*-COOHBA, when studied in a pH buffer solution at physiological pH 7.4, demonstrated a response to glucose by a decrease in fluorescence intensity on increased glucose concentration. This decrease in fluorescence was observed in the dynamic range of 0-10mM, which corresponds to the ocular glucose concentration range in diabetics (~500µM – 5mM).



Calibration curve for *m*-COOHBA and *o*-COOHBA (0.5 mM), in pH 7.4 phosphate buffer with increasing glucose concentrations.



Emission spectra for *m*-COOHBA and *o*-COOHBA (0.5 mM) in pH 7.4 phosphate buffer; *Excitation wavelength 390 and 380 nm, respectively.*



Glucose response for m-COOHBA and o-COOHBA (0.5 mM) in different pH buffer solutions ranging from pH 5-11. The results confirm that the pH sensing range for the two BA sensors lies between the pKa of the BA (~9) and that of the BA sugar bound form (~6).

Conclusions

A significant decrease in fluorescence of *m*-COOHBA and *o*-COOHBA occurred with increasing glucose concentrations at the typical physiological pH 7.4. The sensors showed maximum sensitivity for glucose between 0-10mM, making them ideal for ocular glucose concentration monitoring in diabetics (~500µM – 5mM). The dynamic sensing range was also confirmed to be between pH 6-9, by investigating the sensors in various pH buffers in the presence of relevant glucose concentrations.

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