Boronic Acid Derivatives for Sugar Sensing

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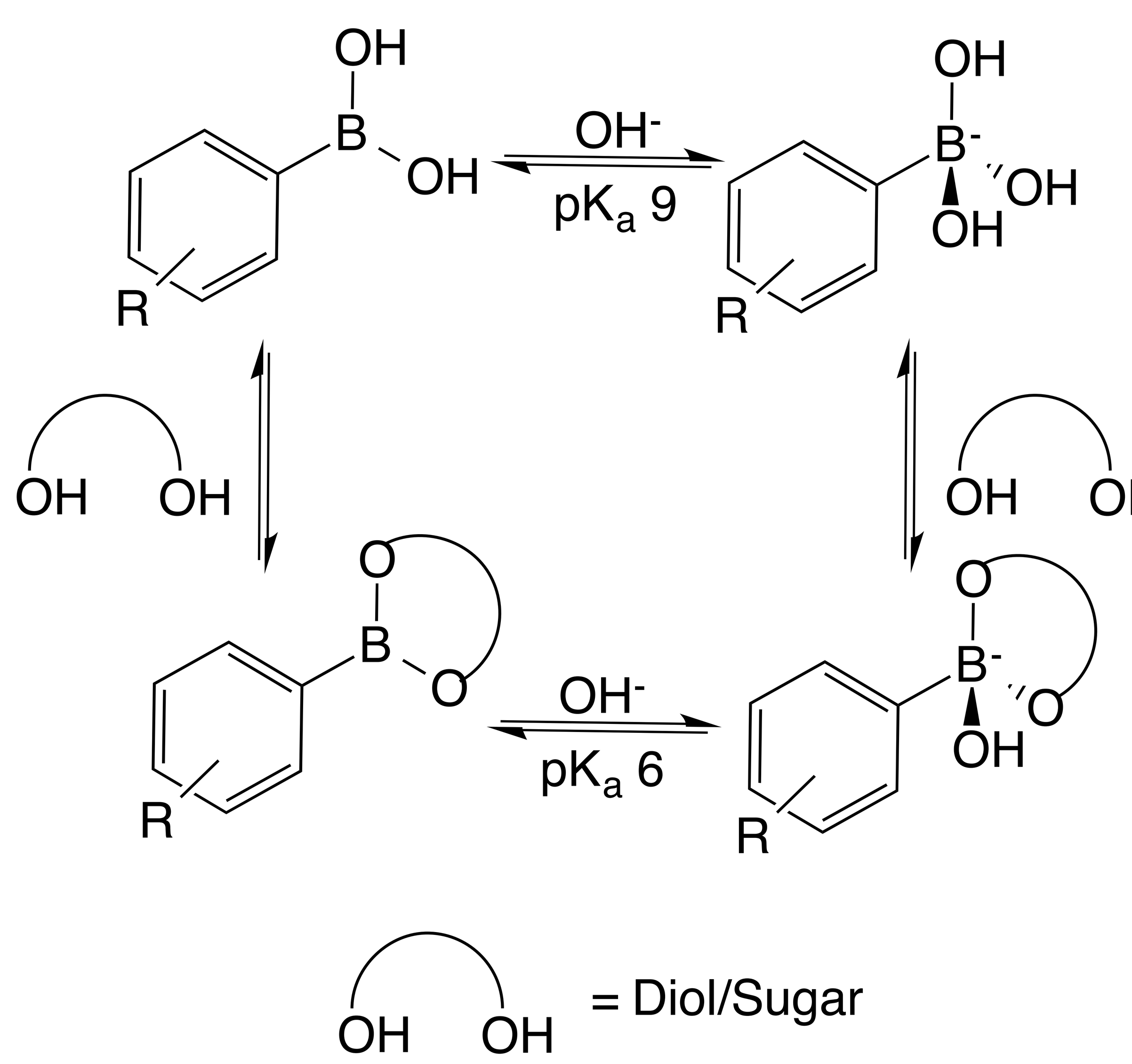
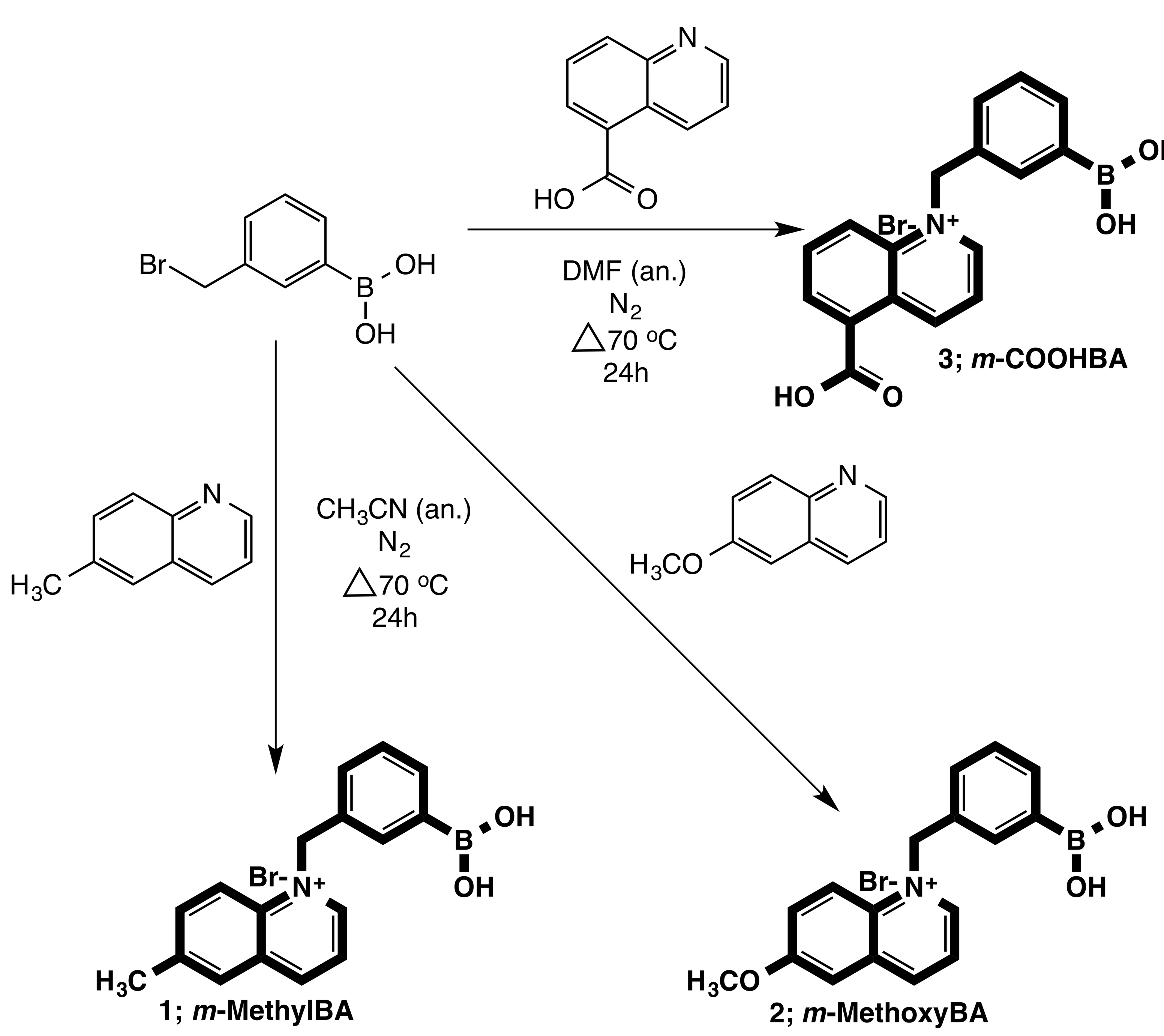
Introduction

Diabetes is a worldwide incurable disease known to have acute and chronic health effects, such as blindness, heart or kidney failure. Monitoring physiological blood-glucose concentrations is a means of managing diabetes, however no continuous noninvasive monitoring method currently exists. The use of boronic acids (BAs) for sensing sugars is well-known, as these Lewis acids have a high affinity for diol-containing compounds. By attaching a fluorophore to a BA derivative, an optical response for continuous-glucose monitoring can be created. Hence, these BA sensors have been investigated for glucose sensing with the aim of developing an optical method through which people suffering from diabetes can track their condition.

Sensing Mechanism



Synthesis

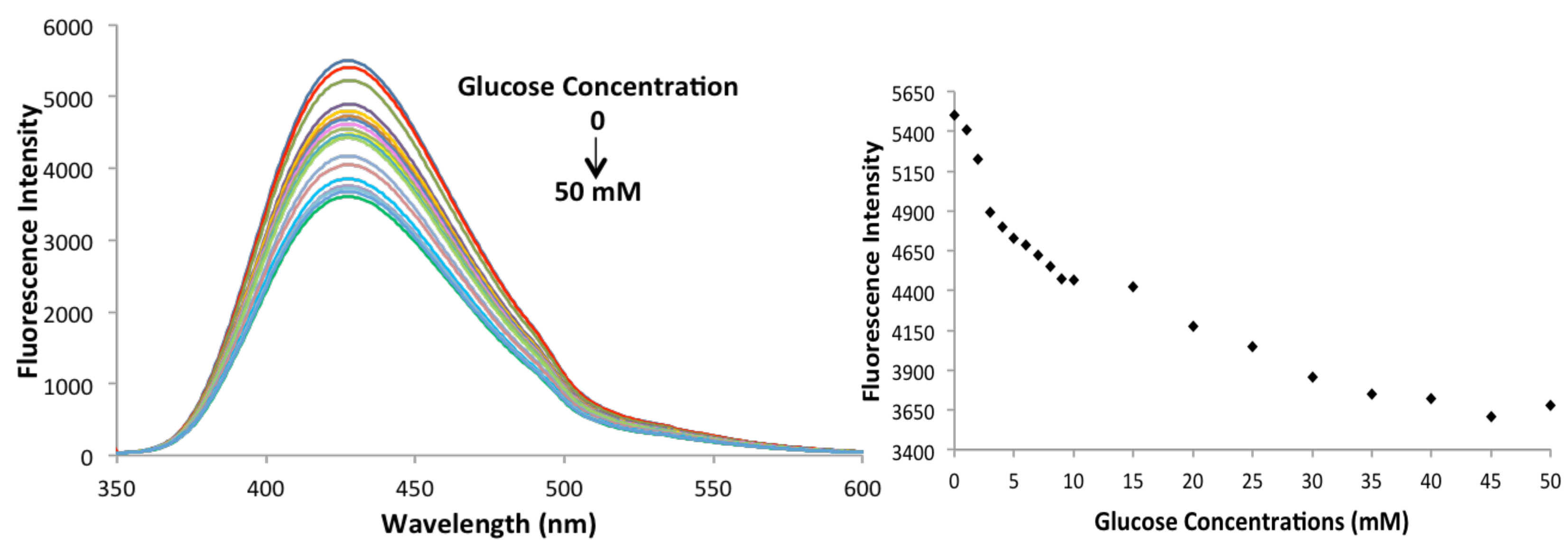


The formation of all three BA sensors was confirmed by ^{1}H NMR.

1. Badugu, et al., *Journal of Fluorescence*, **2004**, *14*, 617-633.

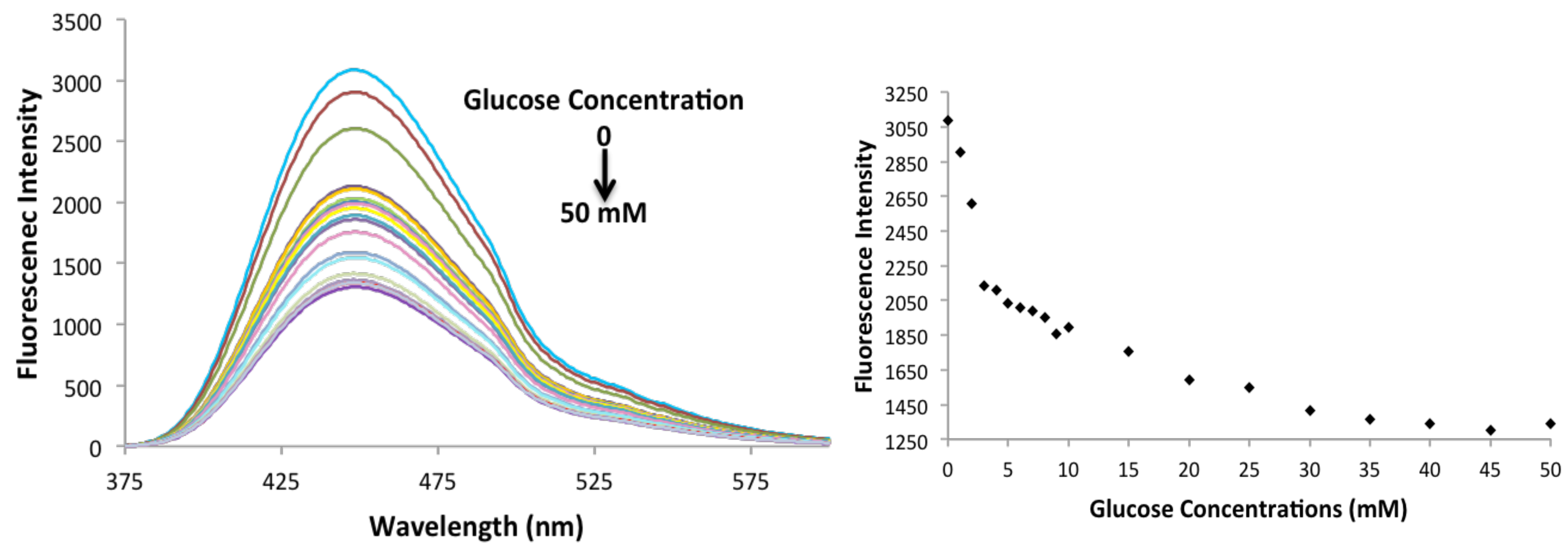
Fluorescence Studies

The fluorescence of compound **3**, a novel BA sensor synthesized by us, has been compared with BA sensors **1** and **2**, that have been previously reported in the literature [1] and shown to respond to glucose in the dynamic range 0-100 mM. The glucose ranges presented below are between 0-50 mM, as this covers the blood-glucose ranges for a healthy person (3-8 mM) and diabetics (up to 40 mM).



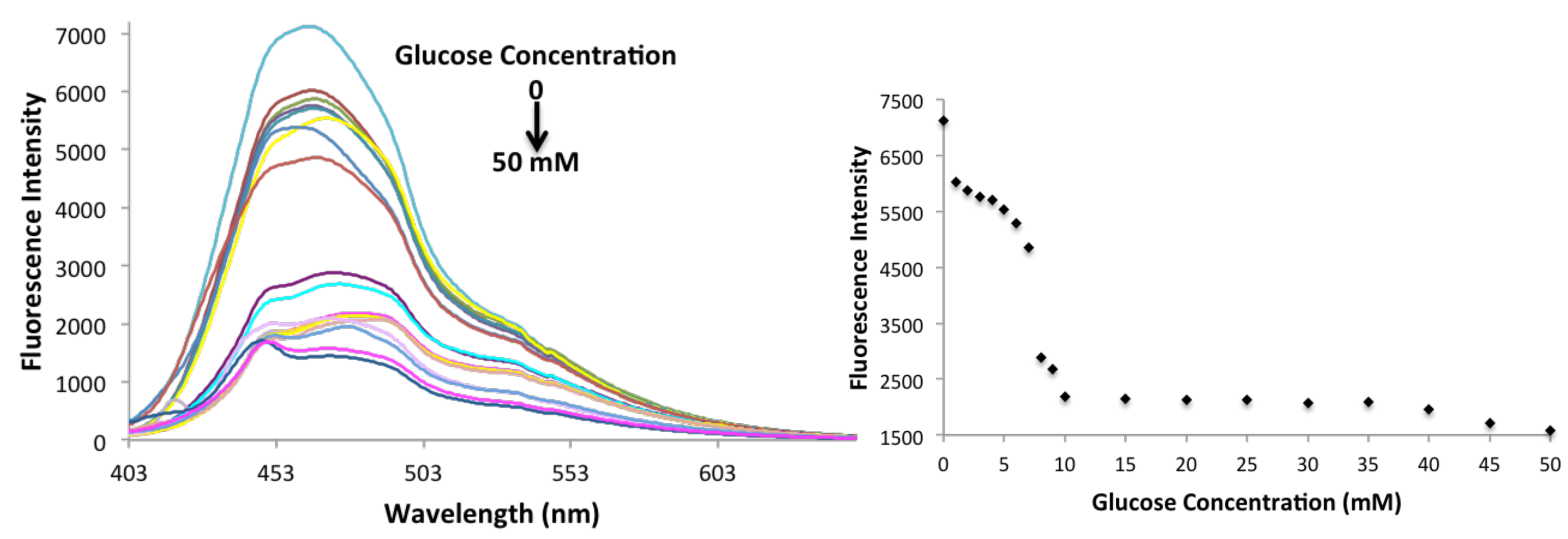
***m*-MethylBA**; 0.25 mM in pH 7.4 phosphate buffer

Excitation wavelength: 341 nm; Emission wavelength: 427 nm



***m*-MethoxyBA**; 0.25 mM in pH 7.4 phosphate buffer and methanol (1:1)

Excitation wavelength: 365 nm; Emission wavelength: 448 nm



***m*-COOHBA**; 0.5 mM in pH 7.4 phosphate buffer

Excitation wavelength 390 nm; Emission wavelength: 475 nm

Conclusions

All BA sensors presented here have demonstrated a decrease in fluorescence intensity on increased glucose concentrations. Although *m*-MethoxyBA has shown the highest fluorescence intensity of the three, *m*-COOHBA could potentially be more suited for glucose sensing applications due to a larger decrease in fluorescence intensity on increasing glucose concentrations. The higher excitation wavelength of 390 nm is also advantageous, as it lies closer towards the visible-region of the electromagnetic spectrum, which allows for the use of cheap, readily available LEDs as excitation sources. The carboxylic acid substituent of *m*-COOHBA is also desirable for covalently anchoring the BA sensor on to an alcohol-terminated polymer substrate.

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