The Fluorescence of Aqueous Sycamore Extracts

Andrea Bootsma with Professor Mark Muyskens

Fluorescent characteristics of wood extracts into water have not been extensively studied. There is evidence for fluorescence from a large variety of tree extractives, coming from many species across the globe. One species that has been found previously by the Muyskens lab to have strong fluorescent properties is the American Sycamore. For this reason the sycamore tree was the focus of our work this summer.

The primary goal of our research is to determine the exact compound which is the cause of the observed fluorescent behaviour. This primary goal was supplemented by two secondary goals. These goals were to find a way to obtain pure fluorescent compound, as opposed to a mixture of the fluorescent and non-fluorescent compounds, and to investigate the further properties of the fluorescent compound.

We began the summer by preparing sycamore extracts to work with. We did this by combining wood shavings, which were obtained through engineering projects, with water at a ratio of 5 g of wood for every 100 mL of water. We then boiled this mixture with constant stirring for 20 min. At this point we had a fairly concentrated solution of fluorescent compound, along with the other water-soluble molecules in the wood. We used vacuum filtration to eliminate any wood shavings or other solid particles. The solution was further concentration through a freeze-drying process.

To purify this solution we used a technique called semi-preparative high pressure liquid chromatography (HPLC) which involves a column that allows different molecules to move through it at different rates based on their structure. Using an absorbance detector and a handheld fluorescence detector (called the picofluor) we were able to isolate the fluorescent fraction, though this often required the solution to go through the semi-preparative HPLC multiple times. We determined the purity of our fraction through the use of analytical HPLC. At the end of work this summer 0.9 mg of material had been purified.

Previous work had shown a molecular formula of C13H20O4. However the structure is not yet known. We hope to determine the structure through the use of NMR. NMR uses a magnetic field to determine the location of atoms in a molecule. At this time the NMR results are still inconclusive. Two properties have also been thoroughly investigated. The molecule was found to have a quantum yield of 0.312 in its acidic form. The quantum yield represent how much of the absorbed light is emitted at the different wavelength rather than being released as heat. PH dependence was also investigated. It was found that our molecule of interest has two form, on in acidic conditions and one in basic conditions. These two forms had different excitation wavelengths.

I am very grateful to have been able to work in this research position, and I feel that this hands-on experience will help me to succeed in future chemistry education. It has also given me knowledge of the research process that will be very valuable to me as I continue in my learning and in my future career. I have learned many specific laboratory techniques but have also learned the attitude work ethic and patience required to successfully do research in chemistry.