Detection and Quantification of Magnesium in Biological Samples

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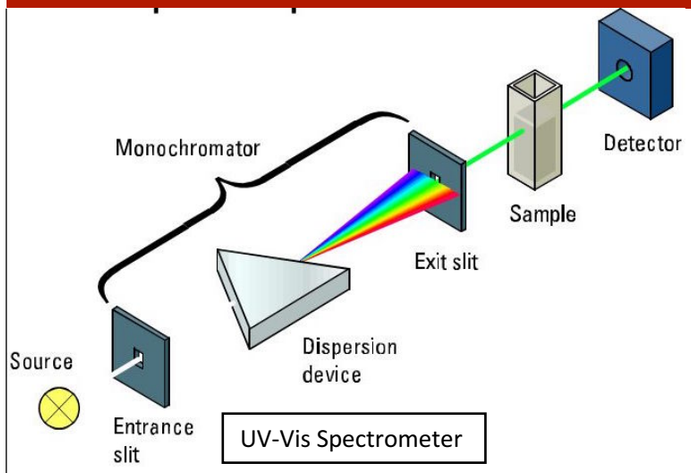
Abstract

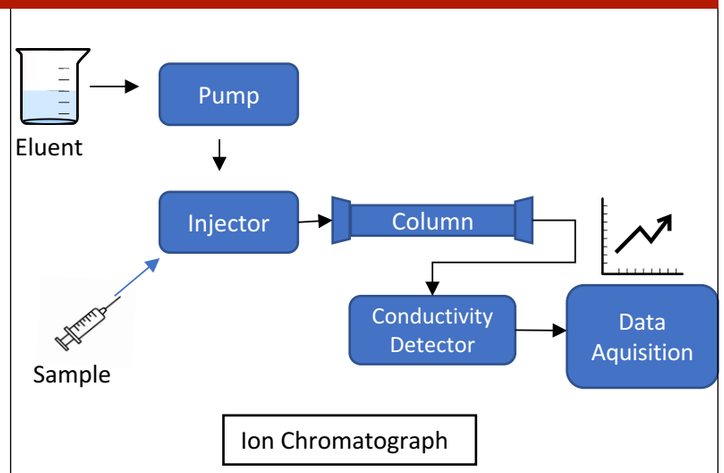
Metal ions such as magnesium play a key role in a countless number of biological processes. Previous studies show that reduced intracellular magnesium concentrations in the eye contributes to the progression of cataracts disease, the leading cause of blindness in the world.[1] This study aims to further investigate the concentrations of magnesium ions in cataracts samples. This may be accomplished through testing methods such as ion chromatography (IC) and UV-Vis spectroscopy, which can be used with biological samples to detect metal ion concentrations. Elevated or lowered concentrations of magnesium in cataracts samples would be significant at both the biological and environmental level. These findings would help to further clarify the relationship between magnesium levels and the formation of cataracts, as well shed light on environmental factors such as diet and other life factors of the patient with cataracts.

Introduction

- As the second most common intracellular cation, magnesium plays a critical biological function as the cofactor for over 300 enzymatic reactions in the body.[2]
- Magnesium deficiency leads to ATP depletion and the dysfunction of membrane associated transporters and other ionic imbalances. It also causes increased oxidative stress, leading to lens fiber apoptosis, further contributing to cataractogenesis.[1]
- Due to the limited availability of cataracts samples, a testing method for the concentration of magnesium will first be developed and optimized using *E.Coli* cultures to mimic the biological matrix of cataracts samples for testing.
- The testing of these samples will require sample preparation, such as acid treatments in order to break down metal containing biological compounds.

Instrumentation





- These instruments work well when used in succession because the UV-Vis spectrometer would not consume the sample, allowing for ion chromatography to be completed after UV-Vis analysis on the same sample.
- The IC would allow for the quantification of magnesium using a calibration curve of standard magnesium solutions.
- It was determined that oxalic acid at a concentration of 3 mM would be a suitable eluent for magnesium quantification.
- Concentration of magnesium ions would be determined based on the calibration curve using the conductivity measurement of the ions and their retention time in the IC column.
- Both instruments would allow for quantification in a biological matrix.[3,4]

Experimental Design

- In order to optimize experiment parameters, *E. Coli* samples would first be used to mimic the cataract sample matrix.
- These samples would be tested by adding magnesium and running them through both the spectrometer and the IC in order to determine the percent recovery.
- Pre-treatment with acid in order to breakdown biological materials containing magnesium will likely be necessary so that the magnesium present in the sample can be analyzed.
- Dual-analysis with UV-Vis spectrometry and ion-chromatography will allow for further confirmation of the concentration level of magnesium.

Potential Problems

- IC detection limits for magnesium may be higher than the level found in the cataracts samples. A possible solution for this would be utilizing a standard addition method.
- Optimizing the conditions of these experiments to improve the percent recovery will require changes in sample preparation and tweaks in the experimental method to ensure the highest possible percent recovery with cataracts samples.
- IC analysis will consume the sample, which limits the amount of testing that can be done with the cataracts samples.

References

1) Agarwal, Renu, Igor N. Iezhitsa, Puneet Agarwal, and Alexander A. Spasov. “Mechanisms of Cataractogenesis in the Presence of Magnesium Deficiency.” *Magnesium Research* 26, no. 1 (2013): 2–8.
2) Feyzahan, Ekici, Safak Korkmaz, Emine Karaca, Sabahattin Sul, Hasan Tufan, Bahri Aydin, and Ergin Dilekoz. “The Role of Magnesium in the Pathogenesis and Treatment of Glaucoma.” *Int Sch Res Notices*, October 13, 2014.
3) Singh, Raj P, Sally Ann Smesko, and Nureddin M Abbas. “Ion Chromatographic Characterization of Toxic Solutions: Analysis and Ion Chemistry of Biological Liquids.” *Journal of Chromatography A* 774, no. 1-2 (1997): 21–35.
4) Roberts, Jessica, Aowife Power, James Chapman, Shaneel Chandra, and Daniel Cozzolino. “The Use of UV-Vis Spectroscopy in Bioprocess and Fermentation Monitoring.” *Fermentation* 4, no. 1 (2018): 18.

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