UREAP Application
Research Proposal

Investigating an analytical method for quantifying tetrahydrozoline found in eye drops using capillary electrophoresis

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Abstract (1500 characters)

The purpose of my study is to develop and optimize an analytical method using capillary electrophoresis (CE) to isolate and determine tetrahydrozoline in commercially available eye drops. Eye drops are most often saline solutions with medications in them to treat various eye diseases. They are used as artificial tears to treat dry eyes or simple irritation such as itching or redness. One of the main components of eye drops is tetrahydrozoline, a decongestant used to relieve redness in the eyes caused by minor eye irritations (ex: smog, swimming, dust, smoke). Unfortunately, recently the oral consumption of eye drops has risen causing poisoning due to the tetrahydrozoline in the eye drops. Capillary electrophoresis, an analytical technique that separates ions based on their electrophoretic mobility by using an applied voltage, has yet to be used to isolate tetrahydrozoline from eye drops. CE provides several advantages, including high separation efficiency, low cost, short analysis times, easy use, and low waste generation. The results of this research will provide insight into the successful detection of tetrahydrozoline from commercially available eye drops to identify which brands of eye drops are potentially the most dangerous. It will also provide companies with a better means to ensure that their products contain the correct amount of tetrahydrozoline. Furthermore, the method will be validated to evaluate its precision, accuracy, and limits of detection and quantification.

Literature Review: (3500 characters)

In recent years, the number of poisonings caused by the ingestion of eye drops has been rising. Eye drops designed to treat redness are not intended to be consumed orally. If swallowed, the medication can cause illness and even death. This is caused by tetrahydrozoline, the main component of eye drops.

Tetrahydrozoline is a derivative of imidazoline that serves to reduce the redness of the eye caused by minor ocular irritants. Tetrahydrozoline works by temporarily narrowing the blood vessels in the eye. Alongside constricting blood vessels, tetrahydrozoline can cause difficulty breathing and a slowed heartbeat (1). However, when consumed orally, tetrahydrozoline passes quickly through the gastrointestinal tract, rapidly reaching the blood and the central nervous system, causing toxic blood levels and the possibility of slipping into a coma when consumed in large quantities (1,2).

Previously, analytical instruments such as liquid chromatography-mass spectrometry (LC-MS) and high-performance liquid chromatography (HPLC) have been used to detect toxins in blood and urine samples of patients suffering from poisoning from eye drop ingestion (3). The isolation and identification of tetrahydrozoline from ophthalmic solutions have also been done using these methods (4). Interestingly, such studies have not been done using capillary electrophoresis (CE). CE as an alternative method will alleviate the number of disadvantages associated with LC-MS and HPLC methods.

HPLC is a type of column chromatography that relies on different polarities of compounds in a solution to separate them. HPLC uses pressure to force the solution through the column more quickly (5). However, the cost and complexity of the HPLC are often a deterrent to its usage. LC-MS is used to isolate the compounds of a sample mixture with the power of mass spectrometry as a detector. The main disadvantages of LC-MS are its cost, complexity, and that it only works with

volatile buffers. The advantages of CE include better sensitivity, low cost, short analysis times, and easy use in comparison to other analytical techniques such as HPLC and LC-MS.
In this study, we propose to isolate and identify tetrahydrozoline from commercially available eye drops through a novel capillary electrophoresis method. Furthermore, the method will be validated to evaluate its precision, accuracy, peak area, and migration time. The proposed investigation will establish CE as a means of a low-cost and efficient method of identifying tetrahydrozoline in patients suffering from eye drop ingestion.

Research Question: (500 characters)

The following research question will be addressed in this project:

> Can tetrahydrozoline from commercially available eye drops be detected and quantified using capillary electrophoresis?

Methodology: (1500 characters)

Tetrahydrozoline in commercially available eye drops will be analyzed by capillary electrophoresis. Capillary electrophoresis (CE) is an analytical technique that separates ions based on their electrophoretic mobility with the use of an applied voltage (6). The electrophoresis mobility depends on both the particle properties (surface charge, density, and size), and solution properties (ionic strength, electric permittivity, and pH) (7). The size and charge of the ion will determine the rate of separation, which is also directly proportional to the applied electric field. Neutral species are not affected; only ions move with the electric field. If two ions are of the same size, the one with a greater charge will move faster. For ions of the same charge, the smaller particle will have less friction and an overall faster migration rate (7).

The ions will be detected by the UV detector, and the results will be processed with the 32 Karat software, which operates the CE instrument. The wavelength of the UV detector, pH and concentration of the buffer, and the voltage and injection time conditions on the CE will be optimized to obtain high resolution and baseline peaks for the analytes. Eye drops will be obtained from several local supermarkets and pharmacies. Prepared eye drops solutions will be run on the CE with the help of my primary supervisor, Dr. Kingsley Donkor. The linear relationship between the concentration of the tetrahydrozoline and their corresponding peak area on the electropherogram will be determined and used to determine the amounts of tetrahydrozoline present in the eye drops. This method will be validated for reproducibility of the peak area and migration times of the analytes, accuracy, limits of detection and quantification, percent recovery, and intraday and interday precision of the analysis.

Impact on field of study: (1500 characters)

The results from this study will provide evidence that for isolating and identifying tetrahydrozoline from eye drops, CE, a more efficient and rapid method than HPLC and LC-MS (methods that have been previously used for such studies), can be used. Major eye drop companies can then use the optimized novel method as a means of tetrahydrozoline detection in their own factories. Alongside this, the results can provide consumers with knowledge about the

tetrahydrozoline levels of the eye drop solutions they are purchasing. The findings can also be potentially used for other medical research purposes.

Dissemination: (500 characters)

To disseminate the results of this research, I will present the results at the annual Canadian Chemistry Conference and Exhibition (CCCE) in June 2023. Additionally, I will present the research results at the TRU Annual Undergraduate Research and Innovative Conference and the Western Canadian Undergraduate Chemistry Conference (WCUCC) in May 2023. Furthermore, I also hope to submit the findings of this research to a science magazine or a peer-reviewed scientific journal for publication.

Academic and Professional Goals: (1000 characters)

I am currently in my third year of my Bachelor of Science degree and am majoring in Cellular, Molecular, and Microbial Biology. I have always been interested in science and particularly the research aspect of it. After completing my first year of university online, due to COVID-19, I had the amazing opportunity to work with Dr. Donkor and become part of his research team.

In the past two years, I had the opportunity to investigate and be exposed to the multiple facets of science, especially analytical chemistry. Conducting research has deepened my appreciation of the hands-on aspect of science. Because of this, after completing my degree, I plan on applying for medical school. My choice is heavily impacted by the amazing experiences I have had researching and the skills and knowledge I have learned thus far. Due to this project's focus on pharmaceutical and medical implications, conducting this study would further enhance my understanding of my future studies and career. Therefore, I would be very grateful to receive this award as it will allow me to gain invaluable research experience that I could use for my future.

References: (3500 characters)

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Timeline:

Period	**Activity**
Jan 10 – Jan 17	Ordering reagents
Jan 18 – Jan 31	Optimization of CE instrumental parameters
Feb 1 – Feb 10	Solution preparations
Feb 11 – Mar 31	Analysis of standard and sample solutions
Apr 1 – Apr 20	Evaluation of analytical data
Apr 21 – Apr 30	Writing of report

Budget:

Item	**Estimated Price ($)**
Tetrahydrozoline standard	370.00
Buffer reagents	120.00
Platinum electrode	300.00
Acetonitrile	80.00
Eye drops	130.00
Total	1000.00