

From Bottom Shelf to Top Shelf: Evaluating the Effect of Brita Filtration on Alcohols, Aldehydes, and Esters by Capillary Electrophoresis

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Goal Statement: This work will aim to determine whether Brita filtration alters the chemical composition of cheap vodka in a way that makes it more similar to premium vodka. Capillary electrophoresis using micellar electrokinetic chromatography (MEKC) will be used to quantify trace alcohols, aldehydes, and esters (known collectively as congeners), that contribute to the flavour and quality of a variety of vodkas.

Project Summary

College students everywhere, and the internet at large, have spread the longstanding myth that cheap vodka can be run through a Brita filter to make the taste resemble premium vodka. Our project aims to assess the validity of this claim by using capillary electrophoresis (CE) to analyze critical components in vodka samples that affect taste and quality. Cheap vodka exhibits a worse taste because of differences in quantities of specific alcohols (methanol, 1-propanol, 2-propanol, isobutyl alcohol (isobutanol), n-butanol, and isoamyl alcohol), aldehydes and ketones, and ester compounds (ethyl acetate and methyl acetate). Our experiment will involve using CE to determine the amounts of these compounds in cheap, medium, and expensive vodkas, as well as a filtered sample of each. Principal component analysis (PCA) will then be used to compress the multiple variables into a few components and examine the points' positions on a graph to determine overall similarity based on chemical composition. In this way, we can compare the vodka samples in depth on a chemical basis and determine whether the filter has made cheap, unfiltered vodka resemble premium alcohol.

Instrument Information and Settings:

Instrumentation: Sciex P/ACE MDQ Plus Capillary Electrophoresis System and 32Karat Software

Separation Method: Micellar electrokinetic chromatography (MEKC)

Table 1. Proposed Sciex P/ACE MDQ Plus Capillary Electrophoresis System Operating Conditions.

Parameter	Value
UV Detector wavelength	214 nm
Data rate	4 Hz
Absorbance signal	Direct
Separation voltage	20.0 kV
Run time	15.00 min
Rinse pressure	20.0 psi
Injection pressure	1.0 psi

32Karat software will be used to create a method with the following rinse sequence:

- Rinse: 0.1M NaOH, 20.0 psi, 4.00 min
- Rinse: 18 MΩ water, 20.0 psi, 1.00 min
- Rinse: SDS-Borate Buffer (pH 9) 20 psi, 4.00 min
- Injection: Sample, 1.0 psi, 5.00 s
- Run time: 15.00 min, 20.0 kV

Separation will be performed using an SDS-borate buffer system that is suitable for MEKC separation of neutral organic compounds.

Unscrambler principal component analysis (PCA) software will be used to assess the efficacy of the Brita filtration while taking into account all the variables of interest.

Materials List:

Vodkas (50 mL)

- RED TASSEL VODKA (\$2.49)
- VINCENT VAN GOGH - ESPRESSO (\$4.89)
- GREY GOOSE - ALUMINUM (\$6.99)
- POLAR ICE (\$7.29)
- CRYSTAL HEAD (\$9.09)

Standards

Alcohols

- Ethanol
- Methanol
- 1-propanol
- 2-propanol
- isobutyl alcohol (isobutanol)
- N-butanol
- isoamyl alcohol

Acetaldehyde

Esters

- ethyl acetate
- methyl acetate

Other Lab Supplies

- 10-mL Volumetric flasks
- Micropipettes and tips
- 3-mL Syringes
- 0.45 μm nylon syringe filter
- CE sample vials
- Brita filter
- Beakers
- Sodium hydroxide (NaOH)
- Sodium dodecyl sulfate (SDS)
- Sodium tetraborate, anhydrous...? ($\text{Na}_2\text{B}_4\text{O}_7$)
- 18 M Ω water
- Hydrochloric acid (for adjusting buffer pH)
- pH meter
- *can also optionally use premade buffer that I prepped (SDS-borate, pH 9.10)*
- Vortex mixer

Information on preparation plans for solutions and samples

Standard curves for the analytes of interest will be made. Standard solutions will be prepared in 18 MΩ water. The standard curves will have the following ranges:

- Ethanol: 0% (v/v) to 50% (v/v)
- Congener alcohols (methanol, 1-propanol, 2-propanol, isobutyl alcohol, N-butanol, isoamyl alcohol): 0% (v/v) to 1% (v/v)
- Acetaldehyde: 0% (v/v) to 0.5% (v/v)
- Esters (ethyl acetate, methyl acetate): 0% (v/v) to 0.1% (v/v)

Vodka samples will be diluted 5-fold with 18 MΩ water to reduce conductivity effects and prevent capillary overloading while still maintaining sufficient concentration of minor congeners for detection. Diluted samples will be filtered with a 0.45 μm nylon filter prior to analysis. Triplicate samples of 1.0 mL each will be run, and the resulting electropherograms will be analyzed by observing the corresponding analyte peaks. The following samples will be analyzed:

- Red Tassel Vodka (“cheap” vodka sample)
- Alberta Pure Vodka (“cheap” vodka sample)
- Vincent Van Gogh Vodka (“midrange” vodka sample)
- Smirnoff Vodka (“midrange” vodka sample)
- Grey Goose Vodka (premium vodka sample)
- Polar Ice Vodka (premium vodka sample)
- Crystal Head Vodka (ultra-premium vodka sample)
- Brita Filtered Red Tassel Vodka
- Brita filtered Alberta Pure Vodka

Timeline

Week 1:

Prelab work

- *Larry makes a method/sequence*
- *Thomas Buys Vodkas*
- *Prep Vodkas (Morning)*

Lab Work

- Prepare the 9 Standards
- Run samples overnight
- Assemble calibration curves

Week 2

- PCA Analysis (never done before, so will need a full lab period)

Standard curves for the analytes of interest will be made. Standard solutions will be prepared in 18 MΩ water. The curve for ethanol will range from % (v/v) to % (v/v).

Vodka samples will be diluted 5-fold with 18 MΩ water to reduce conductivity effects and prevent capillary overloading while still maintaining sufficient concentration of minor congeners for detection. Diluted samples will be filtered with a 0.45 μm nylon filter prior to analysis. Triplicate samples of 1.0 mL each will be run, and the resulting electropherograms will be analyzed by observing the corresponding analyte peaks.