

# Analysis of minoxidil in tea extracts by LC-FAIMS-MS/MS

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## Overview

**Purpose:** To improve the selectivity of an LC – MS/MS method for minoxidil in tea samples using FAIMS in combination with electve Reaction Monitoring (SRM).

**Methods:** LC – SRM and LC – FAIMS – SRM analyses of minoxidil in tea extracts were performed.

## Results:

- LC – SRM of tea extract samples containing minoxidil had an elevated background and multiple interferences from co-eluting endogenous compounds.
- Precision and accuracy of standards and quality control samples were too variable to consider method validation by LC – MS/MS.
- LC – FAIMS – MS/MS chromatograms showed significantly reduced baseline and no interferences.

## Introduction

Environmental contamination with pharmaceutical compounds is a significant worldwide problem. Minoxidil is a pharmaceutical used for hair regeneration. After use, excess substance is typically washed down the drain, entering the environment. While minoxidil may not be expected to be found in tea leaves, it has been found as an aqueous environmental contaminant. The contamination may enter the tea beverage via the low level residue in drinking water.

The complexity of environmental samples presents some of the most challenging matrix interferences. LC-MS/MS analysis of minoxidil presents the additional challenge of mobile phase interferences. FAIMS (high-Field Asymmetric waveform Ion Mobility Spectrometry) increases the selectivity of an assay by removing interferences. FAIMS selectivity is due to ion mobility at high electric fields post LC analysis and prior to mass analysis. In this study, FAIMS was used in combination with LC and tandem MS to demonstrate clean chromatograms for the analysis of minoxidil in tea extracts.

## Methods

### Sample Preparation

10mL aliquot of tea were acidified with glacial acetic acid 100µl and 2 mL of heptane added to partition. The supernatant was retained and dried under a gentle stream of nitrogen gas. The residue was reconstituted in 1 mL MeOH/Water 1:1 v/v.

### LC-MS-MS Analysis

Tea extracts (10 µL) were injected onto a Biobasic™ C18 column (50 x 2.1 mm, 3 µm). Gradient elution was accomplished using a Surveyor™ MS Pump Plus, and eluents water + 0.1% formic acid (v/v) and methanol + 0.1% formic acid (v/v).

The MS detector was a triple quadrupole MS (TSQ Quantum Ultra™). Ionization was performed by heated electrospray ionisation (HESI) in positive ionization mode.

The source parameters were the following:

Spray Voltage: 3500 V, Vaporizer Temperature: 300 C, Sheath Gas Pressure: 50, AuxGas Pressure: 40, Capillary Temperature 270°C

The scan parameters were:

Q1 m/z = 210.088, Q3 m/z = 109.942, Scan Time 100 ms, Collision Energy 25 eV, Tube Lens Offset 122 V

Standard FAIMS conditions were used including: -5000 V dispersion voltage, a carrier gas stream of 4.5 L/min (nitrogen + helium, 1+1), inner and outer electrode temperatures were set to 70 °C and 90 °C. The compensation voltage was determined at -11.2V.

### Pump gradient table:

No.	Time	H2O%	MeOH%	Flow Rate (µL/min)
0	0.00	90.0	10.0	200.0
1	1.00	90.0	10.0	200.0
2	2.00	5.0	95.0	200.0
3	7.00	5.0	95.0	200.0
4	7.10	90.0	10.0	200.0
5	10.0	90.0	10.0	200.0

FIGURE 1. A schematic of the FAIMS electrodes used in this study. The endcap in the front has been removed for illustrative purposes. After passing through a desolvation region, gas carries ions around both sides of the inner electrode. Voltages are applied to allow only a subset of ions to successfully pass through the device and into the mass spectrometer. Other ions will collide with one of the electrode walls and will not pass.

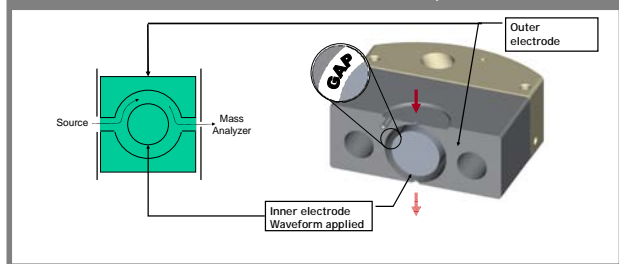
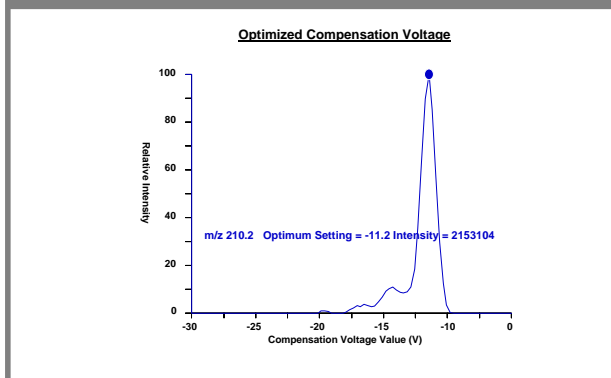
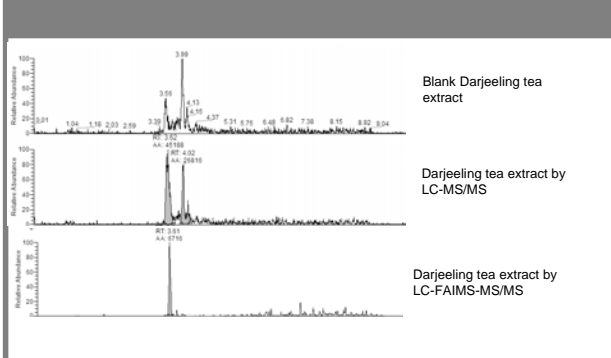


FIGURE 2. Optimisation of the compensation voltage obtained during the infusion of minoxidil reference standard.



**Results :** A standard solution of minoxidil was infused at different FAIMS conditions (inner and outer electrodes temperatures, proportion of He in the carrier gas, dispersion voltage) in order to obtain the best ion transmission and selectivity through the electrodes. For each set of conditions, a CV ramp was performed and the optimal corresponding CV tested by LC-FAIMS-MS/MS analysis. The intention was to check for the selectivity of FAIMS towards the analyte and against the matrix contaminations while using chromatographic separation. Figure 2 illustrates a CV optimisation corresponding to the parameters described in the method section.

FIGURE 3. Comparison of LC-MS/MS and LC-FAIMS-MS/MS analyses in tea extracts



**Results :** LC-MS/MS analysis resulted in chromatograms with numerous background peaks at and near the retention time of minoxidil. These interferences reduce the precision of the assay because the start and stop points of the chromatographic peak integration become highly variable from sample to sample. Interferences prevented reproducible determination of the concentration of minoxidil in the samples. LC-FAIMS-MS/MS analysis of the water and tea extracts resulted in chromatograms displaying significantly fewer interfering peaks. The absolute signal intensity was reduced by 3-fold but the signal-to-noise ratio was improved by 30-fold. By using FAIMS the interferences were removed, allowing more accurate and precise measurement.

## Conclusion

FAIMS provided excellent selectivity for the analysis of minoxidil in tea, allowing a strong improvement in assay sensitivity in matrices representative for food and environmental sample analyses.

## References

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