OVERVIEW

INTRODUCTION

Adsorption by Ion Exchange Mechanism

Overcoming Glass Vial Adsorption Effects for Trace Analysis of Basic Compounds by LC/MS/MS

Most glass vials are made of type I borosilicate glass typically comprised of approximately 4% Na2O. The residual sodium ions on the glass surface can be dissociated from the glass surface by hydroxyl groups in the aqueous solutions. This leads to negatively charged sites on the silica surface that behave as cation exchange sites for protonated basic compounds (Figure 1). The level and the rate of the adsorption effect is primarily dependent on the amount of sodium available on the surface and the surface area in contact with the sample solution. Due to the small surface area of vials, the adsorption is more noticeable at concentrations of parts per billion (ng/mL) or lower, which are the typical concentration ranges for MS/MS or other highly sensitive MS techniques. An UPLC system interfaced with a tandem quadrupole MS system was used for the analysis of nortriptyline. The adsorption of nortriptyline was calculated by comparing the areas obtained from standard solutions stored in glass vials to the standard solution areas obtained from polypropylene vials, which were used as control.

RESULTS

The percentage loss at 1 ng/mL ranged from less than 10% up to 62.4% for all of the glass vials tested. If the vial is left undisturbed without vortexing, there is continuous adsorptive loss with time, but most of the loss takes place in the first 20 minutes (Figure 2). In typical lab workflows, the sample solution has been in contact with the glass surface for a few hours before the assay. Analyte adsorption to glass vials may be completed.

The chromatograms above, on the left, vendor A’s vials showed significant loss compared to the QC controlled standard. The overlay chromatograms on the right, Waters prototype vials showed no loss compared to the QC controlled standard.

- A simple, quick and sensitive isocratic LC/MS/MS method was developed to quantify the loss of nortriptyline due to the adsorption to the surface of glass vials.
- Compared to other vendor’s vials, Waters prototype vials demonstrated consistent and low adsorption loss of nortriptyline.
- The tight control of the manufacturing process for the Waters prototype vials ensures consistent performance in LC/MS/MS for low level concentrations of analytes.

Table 1: Comparison of Average Loss of Nortriptyline

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Method</th>
<th>Avg Loss%</th>
<th>%Loss Range</th>
<th>Waters Prototype Clear vial (n=3)</th>
<th>Waters Prototype Clear vial (n=10)</th>
<th>Waters Prototype Clear vial (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waters Prototype Clear vial (n=3)</td>
<td>1.00</td>
<td>0.00-10.00</td>
<td>3.62</td>
<td>11.34</td>
<td>11.34</td>
<td></td>
</tr>
<tr>
<td>Waters Prototype Clear vial (n=10)</td>
<td>4.38</td>
<td>0.00-10.00</td>
<td>11.34</td>
<td>11.34</td>
<td>11.34</td>
<td></td>
</tr>
</tbody>
</table>

- As shown in Table 2, vendor A’s vials showed a larger average loss (n=10) of 25.32%. The data also indicated a wider range of adsorption loss of 30% (from 7.57% to 37.61%) between the vials with the highest and lowest losses. Waters prototype vials not only showed a smaller average loss of 4% (n=5), but the range of loss was also less than 13%. The differences among individual vials were reduced when the adsorption loss is minimized.

- In the overlaid chromatograms above, on the left, vendor A’s vials showed significant loss compared to the QC controlled standard. On the right, Waters prototype vials showed no loss compared to the QC controlled standard.

- Waters Prototype Clear vial (n=5) | 0.16 | 0.00-10.00 | 0.16 | 0.16 |
- Waters Prototype Clear vial (n=10) | 4.38 | 0.00-10.00 | 0.16 | 0.16 |

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