The Effect of Organic Acids on the Stability of Nicotine: A Study on the Liqueur

Introduction

Nicotine in e-liquids is the key component which fulfills the vapers’ physiological craving. It is found that high levels of nicotine will cause throat irritation with unpleasant taste when vaped. In real e-liquid blending, some certain-organic acids are used as flavor additives to replace such kind of unpleasant irritation as well as modify the profile. It has been believed that nicotine will be degraded when exposed to light, so nicotine should be controlled around 3% (w/w) in e-liquids since nicotine is alkaline. However, as organic acids with different chemical structure can result in variability of the degree of reaction with nicotine, whether this kind of “rare” is applicable for all organic acids used in e-liquids needs to be investigated. In this study, five commonly used organic acids were chosen based on the carbonyl group differences to study their effect on nicotine stability and irritate taste. The acids are two monooxidic (benzoic acid and 2-methyl butyric acid), two diacids (maleic acid and tartaric acid) and one teritary acid (citric acid).

Study design

For both of the two flavors, the pH value of a liquid decreased with the addition of selected organic acids as expected and such decline presented a dose-dependent manner. The most drastic decrease in pH value was observed with the addition of citric acid, maleic acid and tartaric acid.

Table 1: Effects of organic acids on nicotine in e-liquids

<table>
<thead>
<tr>
<th>Acids</th>
<th>Percentage of nicotine in e-liquids</th>
<th>Titratable acidity (2010) (mL)</th>
<th>Minimum (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citric acid</td>
<td>0.1, 1.1, 2.1, 3.1, 4.1</td>
<td>1.4</td>
<td>1.2, 3.4, 5.5</td>
</tr>
<tr>
<td>Maleic acid</td>
<td>0.1, 1.1, 2.1, 3.1, 4.1</td>
<td>1.2</td>
<td>1.1, 1.1, 2.1</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>0.1, 1.1, 2.1, 3.1, 4.1</td>
<td>1.1</td>
<td>1.1, 2.1, 1.2</td>
</tr>
<tr>
<td>Benzoic acid</td>
<td>0.1, 1.1, 2.1, 3.1, 4.1</td>
<td>1.0</td>
<td>1.0, 1.1, 1.2</td>
</tr>
</tbody>
</table>

As shown in table 2, even with the highest ratio of acid to nicotine (12:1, w/w), the nicotine was generally stable in e-liquids containing 2-methyl butyric acid and benzoic acid or other acids with similar chemical properties but without organic acids. The nicotine was much less stable in other three organic acids containing six rings, especially when the highest ratio of tartaric acid was applied, the nicotine content was reduced by over 47%.

Conclusions and inspirations in real practice

Acid use and nicotine stability:

The application of organic acids, even within the normal dosage range (~3% by weight), in real e-liquid blending process may significantly improve the stability of nicotine, while application of maleic acid, citric acid and tartaric acid reduced nicotine to a similar extent. This might result from either a degradation or formation of new compounds of nicotine with other constituents.

Acids behaved differently in interaction with different flavors. Especially for tartaric acid, it unexpectedly that with more addition of tartaric acid in mixed flavor, it actually caused less nicotine loss (tartaric acid 1.3× and two times of tartaric content in 2-methyl butyric acid and tartaric acid, however caused 30% and 10.9% nicotine loss respectively). It is indicative that different acid blending when organic acids are added, we may not be able to use the theory to evaluate the nicotine stability simply by calculating the amount of acids used or by direct measurement of pH, since it is a complex and dynamic process to how nicotine is degraded (Tables 1-2).

Organic acids “reduce” irritation effectively

It is clearly stated that application of the chosen five organic acids effectively eased the irritation feeling due to the high dose of nicotine (20 mg/L) and such effect relied on the different irritation intensity of the five acids. As the irritation intensity is the most potent among the five, it is interesting to note that the citric acid as the second most potent irritation acid (Figure 2) while provide the lowest irritation relief.

Futhermore, investigation needed to study on the impact of organic acids on degradation or formation of new compounds of nicotine with other compounds, as well as the mechanism of free nicotine converting to nicotine salt by reacting with nicotine by organic acids.

Reference