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## Analysis of E-cigarette Liquids

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### 1. Introduction

'Electronic cigarette' is a battery-powered device that works by heating liquid into an aerosol, which can be inhaled into the lungs. E-liquids usually contains nicotine, flavorings and other chemicals that help to make the vapor (propylene glycol, glycerol and mixtures thereof).

E-cigarette usage is very popular, but in addition to its already known harmful effects, it carries numerous unknown health risks. There is no well-established practice for quality control of e-cigarette liquids across Europe. Further problem with this product group is its illegal, thriving online market.

Therefore, our goal at NIPN's OMCL was to obtain the widest possible information about the quality and actual composition of e-cigarette liquids from internet commerce.

### 2. Materials and methods

Our experiments were performed with 34 different e-cigarette liquid products, most of them were bought from Internet sources (32 pieces) and two pieces from tobacco shops. The purchased products were nicotine-containing and nicotine-free, flavored and unflavored ones.

The most informative technique for the analytical study of e-cigarette liquids is gas chromatography. For the determination of nicotine, propylene glycol and glycerol content, we used the available ISO 20714:2019 method, which is based on flame ionization detection of the products comparing with internal standards. Another goal was to adopt the ISO method for a gas chromatography-coupled mass spectrometry system, so we could also perform qualitative analysis on the same system.

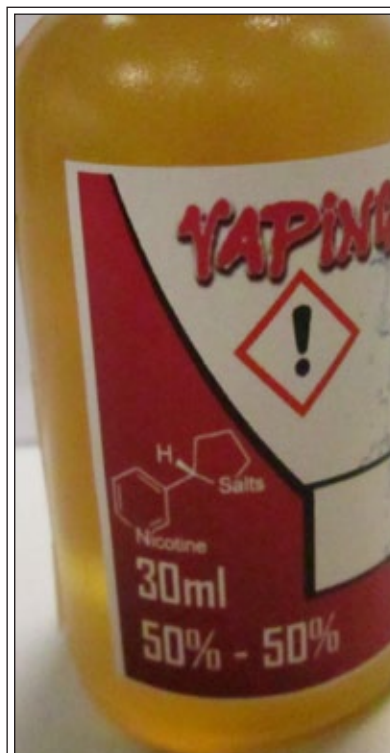
During the validation of our method, we examined selectivity, accuracy, linearity, limit of detec-

tion and determination, carry-over, as well as inter-day repeatability and stability of calibration solutions as performance characteristics.

### 3. Results

According to some international directives, products may not differ more than 10% from the labeled and actual nicotine content. In comparison, based on our study, the measured value for all nicotine-containing products were lower in all cases than indicated on the label. Differences between the measured and nominal nicotine base content were observed by 8.5–34%, which is illustrated in **Figure 2**. There may be several factors behind the lower nicotine content. One reason for the difference is possibly

the fact that the packaging of certain e-cigarette liquids does not refer to the nicotine content as a nicotine base but as a so-called nicotine salt. None of the labels provided accurate information on the actual chemical composition of the mentioned "salt" (**Figure 1**). Furthermore, in 45% of nicotine-free samples were found nicotine contamination / presence in low concentration. In



**Figure 1** Labeled chemical information of nicotine salt

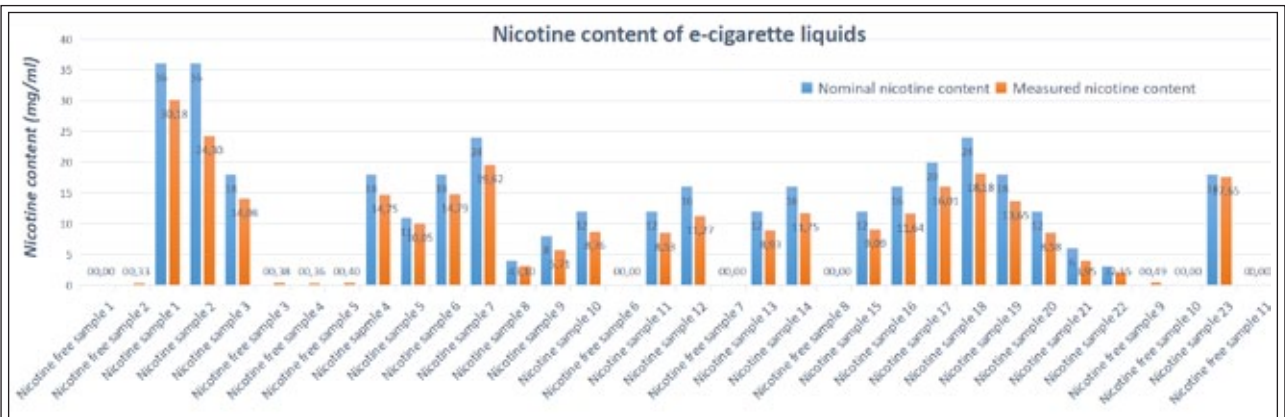


Figure 2 Differences of nominal and measured nicotine content of the 34 e-cigarette liquids

each case exceeding the 0.1 mg / ml concentration specified in the international guidelines.

The contents of propylene glycol and glycerol were significantly less than the approximate value according to the label in each case. The nominal and measured propylene glycol content of the products varied between 7-44% and the glycerol content between 4-31%.

During the quality measurements of 12 products, nearly 50 components were identified. In general, based on mass spectrometric analyses, most of the volatile components identified are indeed widely used flavorings. However, as these substances are not listed exactly anywhere on the labels. In some cases the name of the product is not informative either to the flavoring components present (for example Mystic Juice Essence Arrakis on Figure 3).

4. Conclusions

To summarize our work, the developed and validated GC-MS qualitative and quantitative methods are suitable for the analysis of e-cigarette liquids.

After examining the 34 e-cigarette liquids, the products purchased from the Internet have questionable quality. It can be concluded that these products are likely to mislead consumers, as the nicotine, propylene glycol and glycerol contents on the labels do not correspond to reality either. Furthermore, even less information are available on flavorings.

Based on our experiences, we have addressed questions to other official testing laboratories through the international network. By using the

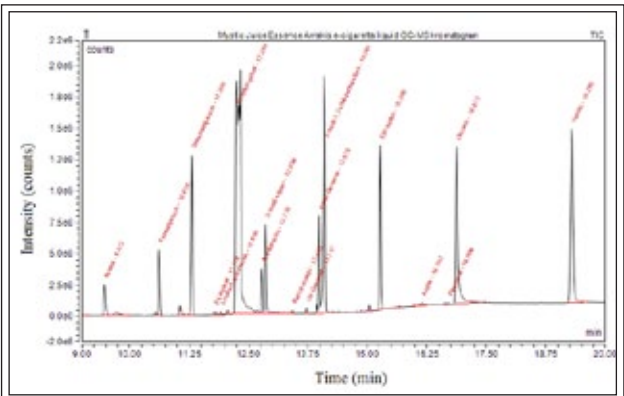


Figure 3 Detail of the total ion chromatogram of Mystic Juice Essence Arrakis e-cigarette liquid

newly obtained information, we would like to make the use of e-cigarette liquids safer in Hungary with a possible proposal to amend the legislation.

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