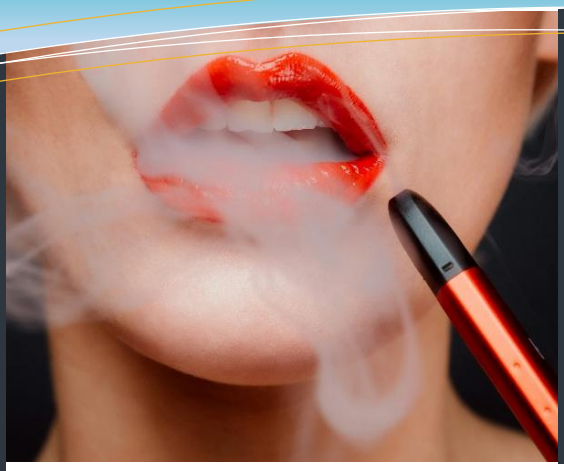
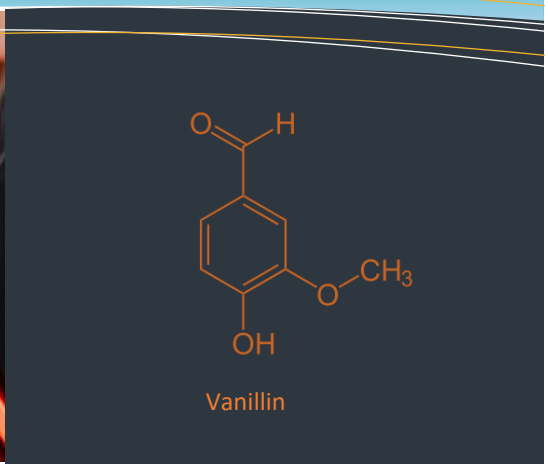
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Poison of the month





Vanillin

The proposal to select Vapes as the Poison of the Month came from the Working Group on Mixture Toxicology

…because they illustrate how chemical interactions, the formation of new toxicants during heating, and potential combined effects of different substances complicate the toxicological risk assessment of complex mixtures.

Cooling Agents – A Cooling Sensation with Potential Health Risks

Modern vapes frequently contain synthetic cooling agents such as WS-23, WS-3 and WS-5. These substances activate the cold-sensitive receptor TRPM8, producing a cooling sensation without actually lowering the temperature.
This sensory effect may mask irritation caused by nicotine and other aerosol constituents, potentially facilitating inhalation and increasing nicotine uptake, which could promote dependence, particularly among adolescents.
From a toxicological perspective, these cooling can't be considered harmless as animal studies have demonstrated adverse effects on the liver and kidneys, while cell-based studies with WS-23 have also shown damage to bronchial epithelial cells. However, robust inhalation toxicity studies remain largely unavailable.
In a recent scientific opinion, the German Federal Institute for Risk Assessment (BfR) concluded that health risks cannot be ruled out even at low levels of e-cigarette consumption. Potential combined effects of multiple cooling agents and flavouring substances were not considered in this assessment.

Vapes – Harmless Vapour or a Toxic Cocktail?

E-liquids consist mainly of propylene glycol and glycerol and frequently contain nicotine, flavourings and colourants. Nicotine is addictive, increases heart rate and blood pressure, and may impair brain development in adolescents. Heating can generate formaldehyde, acetaldehyde and acrolein. Formaldehyde is classified by the International Agency for Research on Cancer (IARC) as carcinogenic to humans (Group 1). Acrolein damages cellular proteins, impairs mucociliary clearance and promotes inflammation, potentially contributing to the development of chronic bronchitis or chronic obstructive pulmonary disease (COPD) over time.

Most flavouring substances used in e-liquids are approved for use in food. Common examples include vanillin, ethyl maltol and ethyl butyrate. According to a Dutch study, e-liquids contain an average of ten different flavouring substances. However, approval for use in food does not establish their safety when inhaled. Vanillin can react with propylene glycol within the liquid to form acetals that may subsequently enter the aerosol. In human bronchial and pulmonary cell lines, these reaction products reduced mitochondrial energy production more strongly than vanillin itself and caused cellular damage at high concentrations. Cinnamaldehyde and cinnamon-flavoured vape aerosol reduced ciliary beat frequency in primary human bronchial epithelial cultures, potentially compromising the clearance of inhaled pathogens. At high concentrations, ethyl maltol induced oxidative stress in bronchial epithelial and macrophage-like cell lines. In the latter, it also increased the release of pro-inflammatory mediators. Whether these experimental findings translate into adverse effects under real-world vaping conditions remains uncertain. For colourants detected in e-liquids, data on inhalation toxicity and their transfer into the aerosol are also largely lacking.

Unverified, inexpensive products purchased through online retailers may pose additional risks through exposure to prohibited or undeclared

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Sucralose – When a Sweetener Generates New Toxicants

Sucralose is a chlorinated sweetener that is also added to e-liquids. At temperatures above approximately 120 °C, it can decompose to form various chloropropanols, particularly 3-chloropropane-1,2-diol (3-MCPD), as demonstrated by gas chromatographic analysis of aerosol condensates from experimentally heated e-liquids.

The International Agency for Research on Cancer (IARC) classifies 3-MCPD as possibly carcinogenic to humans (Group 2B). In animal studies, oral exposure caused kidney and testicular damage. The aerosol condensates examined also reduced the metabolic activity of human vascular endothelial cells in vitro. The health risks associated with inhalation exposure remain unclear.

Sucralose also influences the thermal degradation of other e-liquid constituents. One study demonstrated that sucralose concentrations as low as 0.24% by weight enhanced the formation of acrolein, acetaldehyde and formaldehyde-releasing hemiacetals from propylene glycol and glycerol. This may increase exposure to respiratory toxicants and carcinogenic substances.

Accordingly, the revised October 2026 draft amendment to the German Tobacco Products Ordinance (Tabakerzeugnisverordnung) proposes a ban on sucralose in e-cigarettes. However, this ban has not yet entered into force.

colourants and flavourings with potentially harmful effects.

Additional toxicants may originate from the devices themselves. A study of disposable vapes found substantial concentrations of lead, nickel and antimony in the aerosols of some products. Lead can damage the nervous system and kidneys, while nickel can cause respiratory sensitisation. IARC classifies nickel compounds as carcinogenic to humans (Group 1) and metallic nickel as possibly carcinogenic to humans (Group 2B). The chemical species of nickel present in the aerosols were not determined. Trivalent antimony, classified as probably carcinogenic to humans (Group 2A), was also detected. In some devices, metal emissions increased markedly over their operational lifetime.

Although e-cigarettes generally emit many harmful substances at lower levels than conventional cigarettes, epidemiological studies have nevertheless reported associations between vaping and respiratory diseases, including asthma and COPD, without conclusively establishing causality. Moreover, critical studies investigating potential additive or synergistic effects of aerosol constituents are still lacking, preventing a comprehensive risk assessment. Nevertheless, the available evidence continues to raise substantial toxicological concerns.

By Ute Haßmann

Literature and links:

- Beyond Nicotine: Toxicological Insights Into Metals, Nanoparticles, and Flavoring Agents in E-Cigarette Aerosols - Beigh - Journal of Applied Toxicology - Wiley Online Library
- E-Cigarette Toxicology | Annual Reviews
- E-Zigaretten: Alles andere als harmlos
- Aromastoffe in E-Zigaretten: aktualisierte Bewertung von Safrol, Sucralose und Menthol - BfR
- Comprehensive overview of common e-liquid ingredients and how they can be used to predict an e-liquid's flavour category | Tobacco Control
- Kühlstoffe in E-Zigaretten sind schlecht erforscht – Gesundheitsschäden möglich
- 6-Methylnikotin in E-Zigaretten: Unzureichende Datenlage – BfR beteiligt sich an Untersuchung des Suchtpotenzials - BfR
- Elevated Toxic Element Emissions from Popular Disposable E-Cigarettes: Sources, Life Cycle, and Health Risks | ACS Central Science | ACS Publications
- Evidence update on the respiratory health effects of vaping e-cigarettes: A systematic review and meta-analysis
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- Evidence update on the respiratory health effects of vaping e-cigarettes: A systematic review and meta-analysis
- 3-MONOCHLORO-1,2-PROPANEDIOL - Some Chemicals Present in Industrial and Consumer Products, Food and Drinking-Water - NCBI Bookshelf
- Foto by Chiara Summer on Unsplash

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