

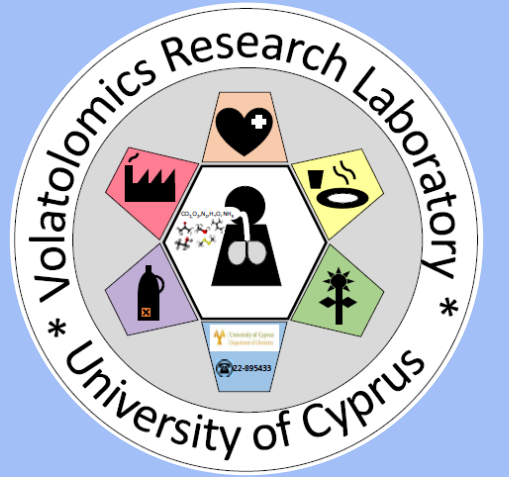
Determination of VOCs and PMs in the indoor air of hair saloons

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Introduction:

- Volatile Organic Compounds (VOCs) are gases that are emitted into the air from products or processes; some of them are considered hazardous and harmful to both environment and individual health ¹.
- Particulate Matter (PM), also known as particle pollution, is the sum of all solid and liquid particles suspended in air many of which are hazardous. Both organic and inorganic particles such as dust, pollen, soot, smoke, and liquid droplets are included. The particles vary greatly in size, composition, and origin ².
- Humans are occupationally exposed to these air pollutants almost every day in their houses and workplaces.
- Specifically, in workplaces like the hair saloons, in which the employee performs different actions e.g., haircutting, haircoloring, hair-drying, hair-washing, the ambient air contains high levels of these pollutants originated from the personal care products (Figure 1) ³.
- Due to this constant exposure of the employees, there is a necessity to identify and control the respective indoor air quality by monitoring the emitted VOCs, as well as the PMs.



Figure 1. Inside picture of a hair saloon.

Experimental setup:

- Sampling of air pollutants was performed inside the hair saloon environment by measuring the respective pollutants.
- Particularly, the indoor VOCs were collected using:
 - a) one coating porous material tube, named Tenax TA (Figure 2)
 - b) an ACTI-VOC low-flow pump (Figure 3).
- The samples were analysed by a thermal desorption unit coupled to a gas chromatography/mass spectrometry (TD-GC/MS) system (Figure 4), and the emitted VOCs were identified.
- PMs of 10 µm aerodynamic diameter (PM₁₀) were measured using the DustTrack 11 Aerosol Monitor (Figure 5) ⁴.
- The measuring devices were placed at the height of the working area of the employees.



Figure 2. Tenax TA tubes sampling.



Figure 3. Low-flow pump during on-site sampling.



Figure 4. TD-GC/MS system for VOCs analysis.



Figure 5. DustTrack for PMs measurements and their impactors.

Results:

Table 1. Hazardous VOCs detected in a hair saloon's indoor air.

RT (min.)	Toxic VOCs
8.615	Formaldehyde
9.647	Isopropyl alcohol
16.359	Benzene
18.937	Hydrazine
19.102	1,4-Dioxane
21.724	Toluene
26.208	Ethylbenzene
26.566	Xylenes
27.877	Styrene
32.017	Mesitylene
32.203	Benzaldehyde
32.841	D-Limonene
34.388	Naphthalene
34.775	Phenol
35.556	Cyclopentasiloxane
39.017	Diethyl Phthalate

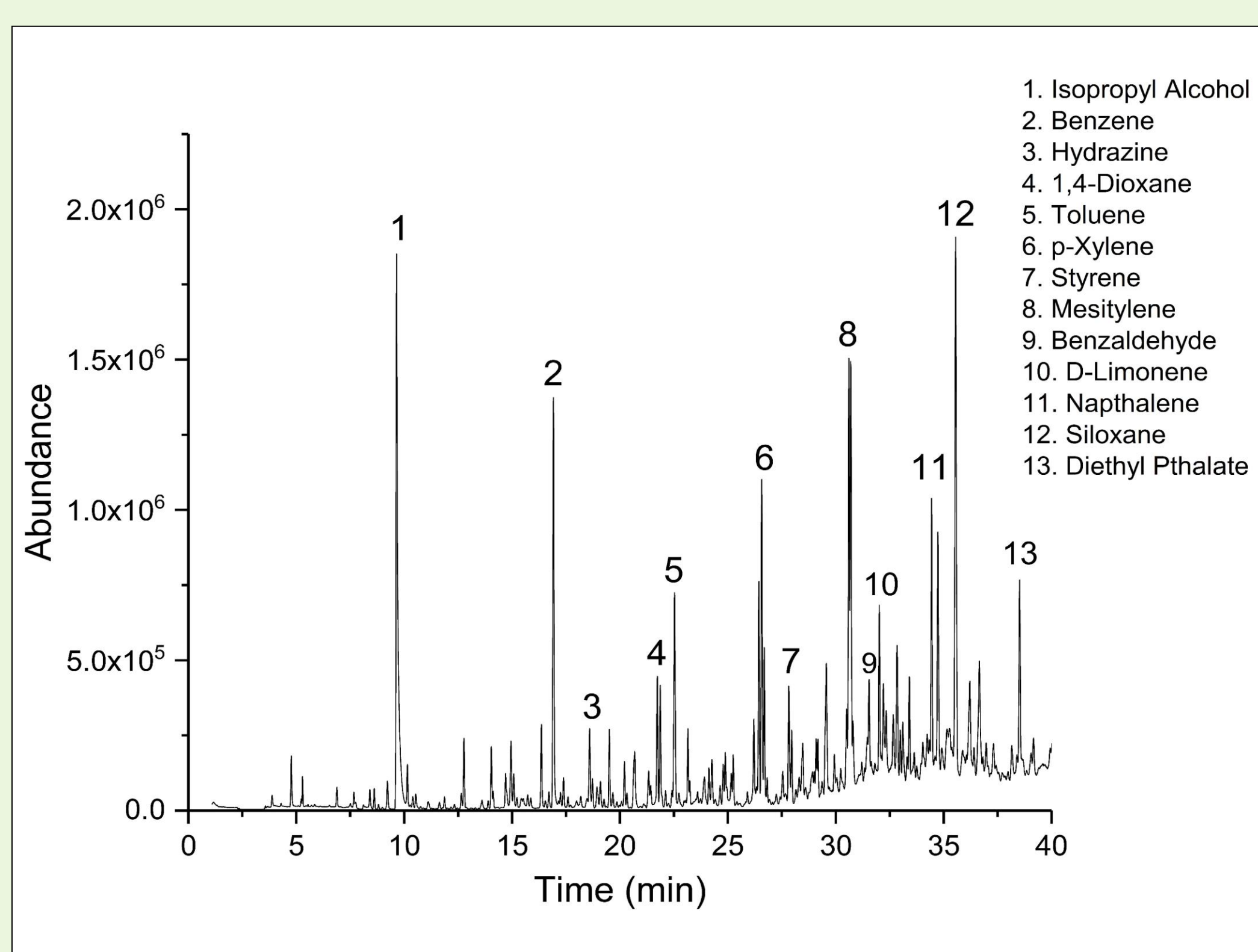


Fig. 6. TD-GC/MS chromatogram of a hair saloon's indoor air.

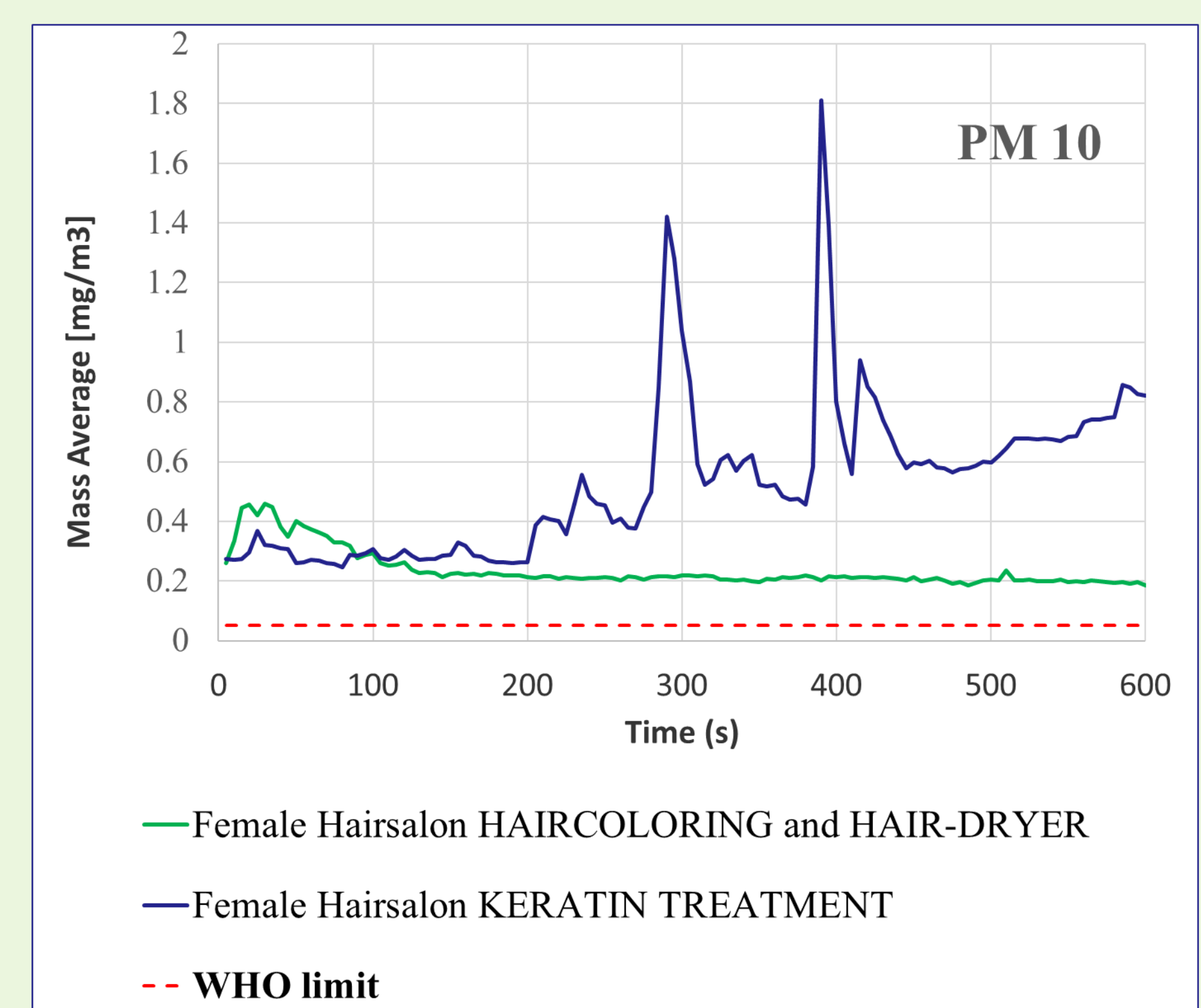


Fig. 7. PMs in a hair saloon's air during 2 actions; haircoloring and hair-dryer, as well as keratin treatment.

Conclusions:

- ❑ Tenax TA was proved a suitable sorbent material for the sampling of VOCs and semi-VOCs (SVOCs).
- ❑ A variety of VOCs was detected in the indoor air of hair saloons during the different procedures: benzene, toluene, naphthalene, siloxanes, hydrazine, 1,4-dioxane, diethyl phthalate, etc. Some of these VOCs are considered toxic with harmful effects.
- ❑ For the PMs, the measuring levels revealed violations of the international standards set by WHO related to the permissible limit concentrations of PM₁₀ in all procedures, but mostly during keratin treatment.
- ❑ TD-GC/MS chromatograms are characterized by high resolution of peaks and the identification of various compounds.
- ❑ TD advantages include off-field sampling without major sample losses or errors, simplicity of sampling preparation process, no involve of solvents and efficient monitoring of indoor air quality.
- ❑ There's a need to protect the breathing zones of hairstylists and prevent overexposure to excessive levels of harmful VOCs and PMs.

References:

- 1) EPA (2018) <https://www.epa.gov/indoor-air-quality-iaq/what-are-volatile-organic-compounds-vocs>.
- 2) Rivas I, Fussell JC, Kelly FJ, Querol X. Indoor Sources of Air Pollutants (2019). *Issues in Environmental Science and Technology* 83:119–126.
- 3) Baghani AN, Rostami R, Arfaeinia H, et al (2018) BTEX in indoor air of beauty salons: Risk assessment, levels and factors influencing their concentrations. *Ecotoxicol Environ Saf* 159:102–108.
- 4) Petasas C, Stylianou M, Zorpas A, Agapiou A (2021) Measurements of local sources of particulates with a portable monitor along the coast of an Insular city. *Sustain* 13:1–17.