Hand blenders available on the Swedish market may contaminate food with chlorinated paraffins.

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Summary

The list of chemicals used as additives or as functional chemicals in products, goods and materials is long. The knowledge about what is used where and why is commonly not available for consumers, authorities or researchers, but regarded as proprietary information by the manufacturers. After we got some indications that chlorinated paraffins (CPs) may be used in hand blenders, sold on the Swedish market, we purchased twelve hand blenders, intended for household use. The blenders were analysed for any potential leakage of CPs into food when used for blending according to the distributor instructions. The results showed that eight out of twelve hand blenders are leaking CPs to the prepared food they were used for, and in our opinion the levels can be regarded as high in five of them. This means that usage of 2/3 of the hand blenders tested will cause human exposure of CPs, i.e. exposure to a group of persistent and bioaccumulative chemicals. The presence of CPs has previously been reported in Swedish mothers' milk. Short chain CPs (SCCPs) have low acute toxicity to mammals but are classified as possible carcinogens.

Introduction

The background to the present investigation is the observation of typical CP patterns in samples from a research project being analysed for their content of halogenated environmental contaminants, in general. Cat food, of different brands and tastes, were blended in-house and cleaned up prior to instrumental analysis. The observation of CPs in these blended cat food samples was not considered reasonable, but rather an artefact, i.e. that the samples had been contaminated during the clean-up procedure. A number of known possible

contamination sources were checked, all with negative results. After re-analysing samples with and without the use of a newly bought hand blender used for preparing homogeneous cat food samples, we concluded that the hand blender caused the contamination. In addition, a small hole was drilled just above the mixer blades and content of the compartment drilled into was analysed and the presence of CPs was confirmed.

The results of this first study indicate a risk for humans to be exposed to CPs from hand blenders, which means that human exposure to persistent, bioaccumulative and toxic compounds, a so called POP, takes place. At this stage the obvious question was to look into how common it is to have CPs in hand blenders, in general. To enable us to further investigate this issue, a total of twelve hand blenders of different brands and/or models were purchased from local retailers in the Stockholm area. One of these was the same model as the one originally used for blending cat food. We were also interested to see if other models from this brand, all gave the same result.

CPs are complex mixtures of straight alkane chains with different degree of chlorination. Depending on chain length they are divided into short chain (C_{10-13}), medium chain (C_{14-17}), and long chain (C_{17-30}) alkanes, commonly referred to as SCCPs, MCCPs and LCCPs, respectively. They have been used for a long time as plasticizers, flame retardants and also in cutting fluids for metals. In 1996 IPCS published a scientific overview of CPs [1] and US EPA another report in 2009 [2]. Based on experimental studies SCCPs cause damage to liver, kidneys and the thyroid, they have also shown carcinogenic properties in rats and mice [2].

The European Union summarize in a report to the United Nations [3] that SCCPs are strongly toxic to numerous aquatic species. They also state that the toxicity of CPs may be of concern also for terrestrial organisms. SCCPs are listed as possible carcinogens [3]. CPs were reported in Swedish mothers' milk in a study published by the Swedish Chemicals Agency, 2012 [4].

No SCCPs are allowed in any products and goods, according to the POP regulation 850/2004. This should therefore apply everywhere in the EU. Whether there are any specific EU regulations regarding CPs in food contact materials is unclear to us.

Experimental

Twelve commercially available hand blenders were purchased from retailers in the Stockholm area, with the intention to screen for their potential to leak CPs into the mixed ingredients. An individual photo of each one of the12 hand blenders tested are presented in Appendix 1. This appendix also includes information regarding brand, model and production country (when available to us).

Prior to analysis, the hand blenders were cleaned according to the written instructions given by the manufacturers. To test any potential leakage of CPs, 1 g of cooking oil was mixed with 100 mL of water, which was applied for mixing under the recommended maximum running time for fluids or soft ingredients (also shown in Appendix 1). In cases where no recommendations regarding mixing time were available from the manufacturer, the hand

blenders were used for 1 min. The oil/water mixture was extracted using isohexane:acetone (3:1), lipids were removed by using concentrated sulfuric acid. The samples were further cleaned up by applying a silica gel column impregnated with sulfuric acid. Each batch of samples included a control solvent blank and a sample of non-blended cooking oil, as controls.

All samples were analysed using gas chromatography with electron capture detection (GC/ECD). The samples showing typical CP patterns with high intensity (i.e. the highest concentrations) were also analysed by mass spectrometry (GC/MS, ECNI, full scan) to confirm the presence of CPs. Samples were compared to technical CP mixtures available in house: C_{10-13} ~60 – 70% Cl, C_{14-17} ~40-52% Cl and C_{22-26} ~42-52% Cl (a total of 20 different products). The identification was based on similarities in peak shapes and comparisons of specific fragments generated by MS between samples and technical mixtures. No quantification has been performed since all samples have been analysed using the same final volume (150 µL) and injection volume (1 µL). Accordingly, the chromatograms shown in Appendix 2 and 3 are fully comparable, showing a range of relative CP concentrations.

Results

GC/ECD chromatograms from all hand blenders as well as from pure cooking oil are presented in Appendix 2. The chromatograms obtained from the samples mixed by the four hand blenders, M3, M4, M7 and M8, did not really differ much from the chromatogram recorded from that obtained from the pure cooking oil. For the other eight hand blenders, typical CP chromatographic patterns were recorded (Appendix 2). For the five samples showing the highest intensity of CP content, i.e. from M5, M9 – M12, it was possible to carry out identification using GC/MS. The chromatograms obtained are shown in Appendix 3. For blended samples from M5, M10 and M12, the patterns and fragments were found to be similar to technical mixtures of SCCPs: Hüls 60 (C_{10-13}, 60% Cl) and Witachlor 55 (C_{10-13}, 49-59% Cl). For the other two hand mixed samples coming from the use of M9 and M11, the CP content was more similar to the pattern of MCCPs (C_{14-17}). The CP retention times were comparable to technical MCCP mixtures available. Still, fragments differed to some extent and our assumption is that this is due to the fact that we only have access to MCCPs with quite low chlorine content (42 – 52%). What we do see in M9 and M11 is probably MCCPs with a higher chlorine content than the technical mixtures available to us, which can explain the differences in retention times and fragmentation of the standard CP we used.

Discussion/ Conclusions

We have in this screening study shown that eight out of the twelve hand blenders tested leak CPs under normal use. The tested hand blenders are a selection of what is available on the Swedish market. Four of the blenders (M3, M4, M7 and M8) did not show any evidence of containing CPs. For the other eight we have concluded that leakage of CPs occurs when used.

Due to the analytical difficulties associated with quantification of CPs no actual amounts or concentrations are presented. Further, the present study does not include any study relating potential decreasing leakage of CP with usage time of the hand blenders. Still, when the above mentioned cat food was prepared no obvious decrease in CP content was observed with usage time. Mixing at increased temperatures was not tested.

The results we are presenting in this screening study are unexpected and serious since humans eating food prepared using the hand blenders leaking CPs will become exposed to CPs. This is of particular concern since these types of household appliances often are used and recommended for preparing food for small children.

Four of the eight CP-leaking hand blenders tested are produced in China, and three of them were among the five showing the highest levels. China is also the major CP producer with an annual production of over 600 000 tonnes in 2007 [5]. Four different models of the brand OBH Nordica were tested, two of them showed high levels of CPs, notably the production country was not available for this brand. For the other two hand blenders showing CP visible patterns, one was produced in Poland and for the other one no information was available to us.

Given the high detection limits we see for these contaminants it is possible that CPs also have been used in the other hand blenders as well. Therefore we also have to consider the risk that these blenders may contaminate the ingredients mixed, even if we did not see any CPs in our test. A possible next step is therefore to open all blenders and analyse for any possible traces of CPs.

The results we are presenting herein are in line with a recent publication from Germany where they analysed fat from kitchen hoods for different types of environmental contaminants. A wide range of contaminants was analysed and CPs were present at the highest levels (140 – 15 000 ng/g fat, n = 15), and the use of CPs in kitchen- and indoor environments was suggested as the source [6].

The presence of CPs in household appliances that contaminate food during preparation is unacceptable and actions have to be taken immediately. This is based on the fact that CPs are persistent organic pollutants characterised by their lipophilicity, bioaccumulativity, potential to undergo long range transport and their toxicity.

References

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6. P. Bendig, F. Hägele, W. Vetter, 2013. Widespread occurrence of polyhalogenated compounds in fat from kitchen hoods, Analytical and Bioanalytical Chemistry. 405, 7485–7496.

Appendix 1.
Information about the hand blenders tested for potential leakage of chlorinated paraffins (CPs) to mixed products. Brand, model, production country and recommended maximum time of usage for mixing of fluids/ soft ingredients are shown.

M1

Brand: Matsui
Model: M24HBW09E
Production country: China
Maximum blending time: 1 min.

M2

Brand: Voltage
Model: HM-918
Production country: Not specified
Maximum blending time : 15 sec.

M3

Brand: Bosch
Model: MSM6B100
Production country: Slovenia
Maximum blending time : Not specified

M4

Brand: OBH Nordica, Chili
Modell: 6707
Production country: Not specified
Maximum blending time : 10 sec. intervals, 1 min.

M5

Brand: OBH Nordica, Kitchen, Quickmix
Model: 6705
Production country: Not specified
Maximum blending time: 10 sec. intervals, 1 min.

M6

Brand: Braun Multiquick 3
Model: 4162
Production country: Poland
Maximum blending time: Not specified

M7

Brand: Philips, ProMix
Model: HR 1607/ 08
Production country: Not specified
Maximum blending time: 1 min.

M8

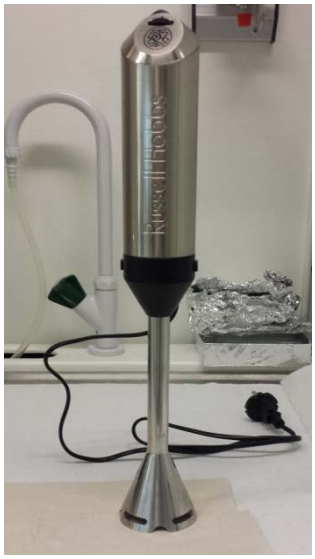
Brand: OBH Nordica, Indigo
Model: 6712
Production country: Not specified
Maximum blending time: 1 min., or
10 sec. intervals for 2 min.

M9

Brand: Electrolux, Ultramix Pro
Model: ESTM 6400
Production country: China
Maximum blending time: 1 min.

M10

Brand: Coline
Model: LW-3318
Production country: China
Maximum blending time : 2 min.



M11

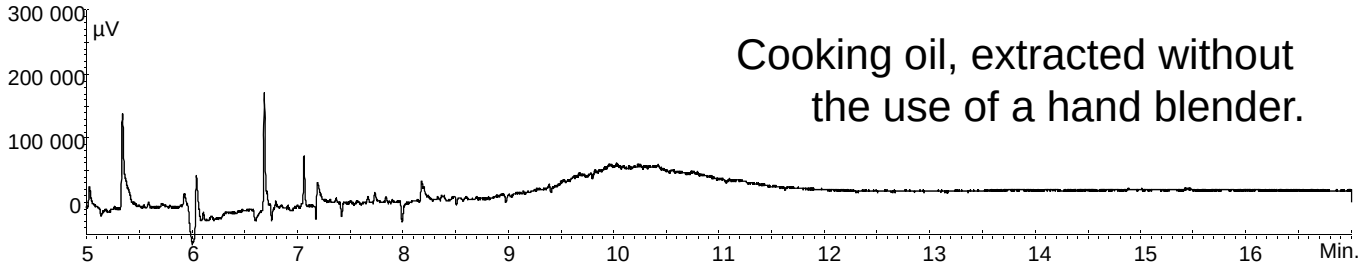
Brand: Russel Hobbs
Model: 18274-56
Production country: China
Maximum blending time: 2 min.

M12

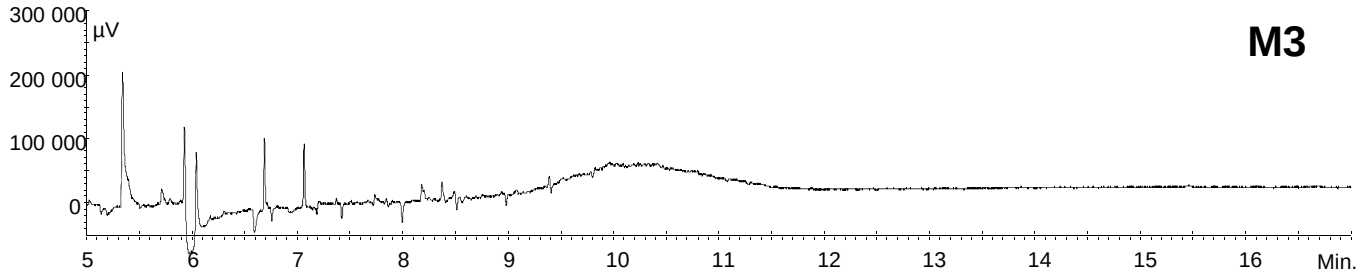
Brand: OBH Nordica Kitchen,
Quickprep 500
Model: 7701
Production country: Not specified
Maximum blending time: 1 min.

Appendix 2.

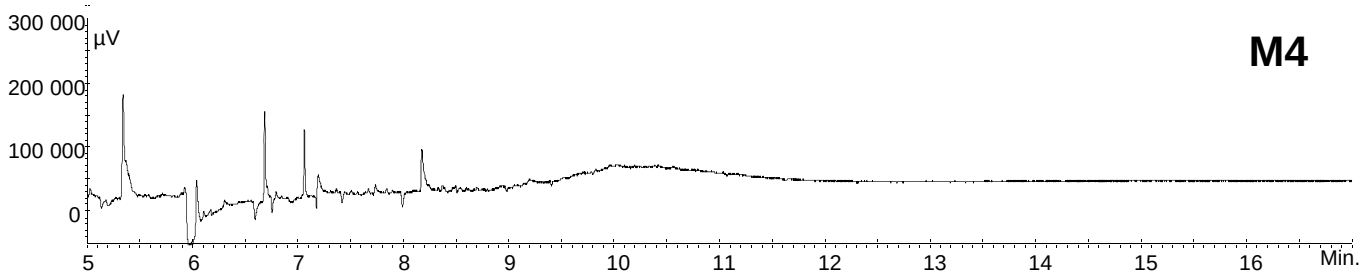
GC/ECD chromatograms from all hand blenders tested (M1 – M12) and also from cooking oil extracted without the use of any hand blender. The samples are arranged according to increasing amount of chlorinated paraffin content.



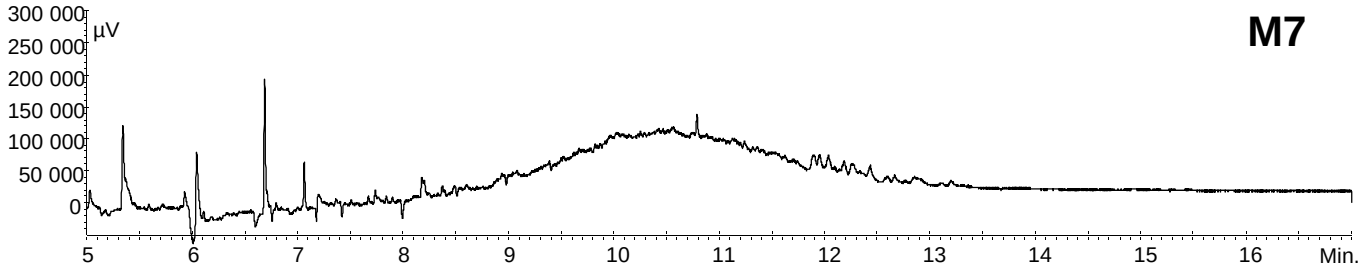
Cooking oil, extracted without the use of a hand blender.



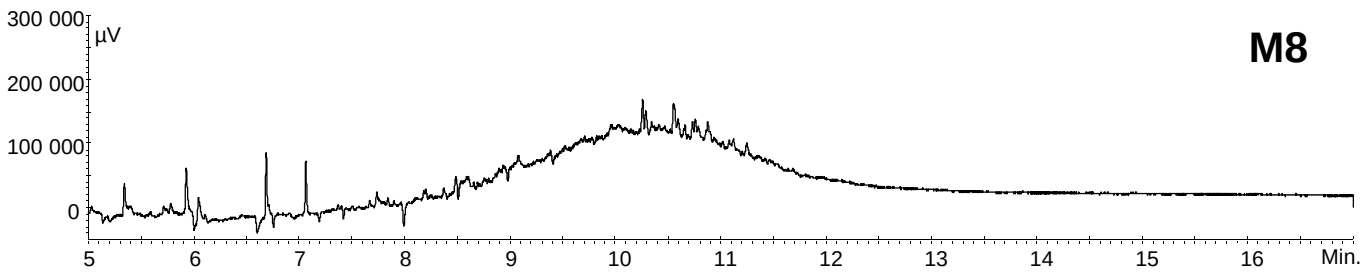
M3



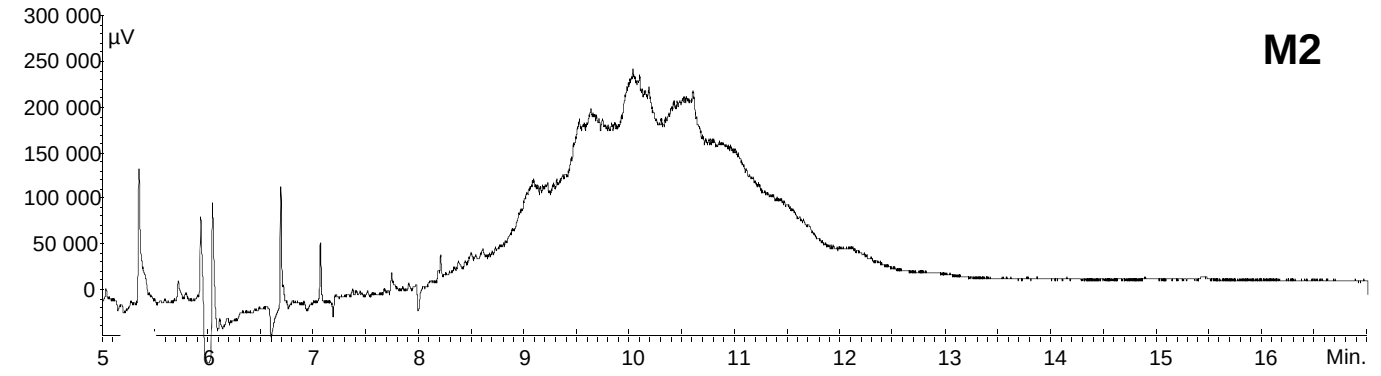
M4

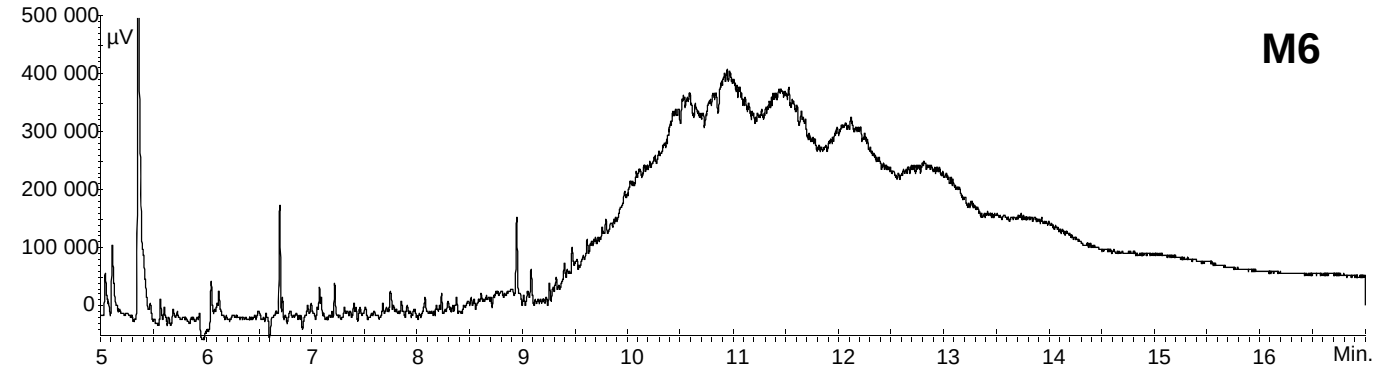


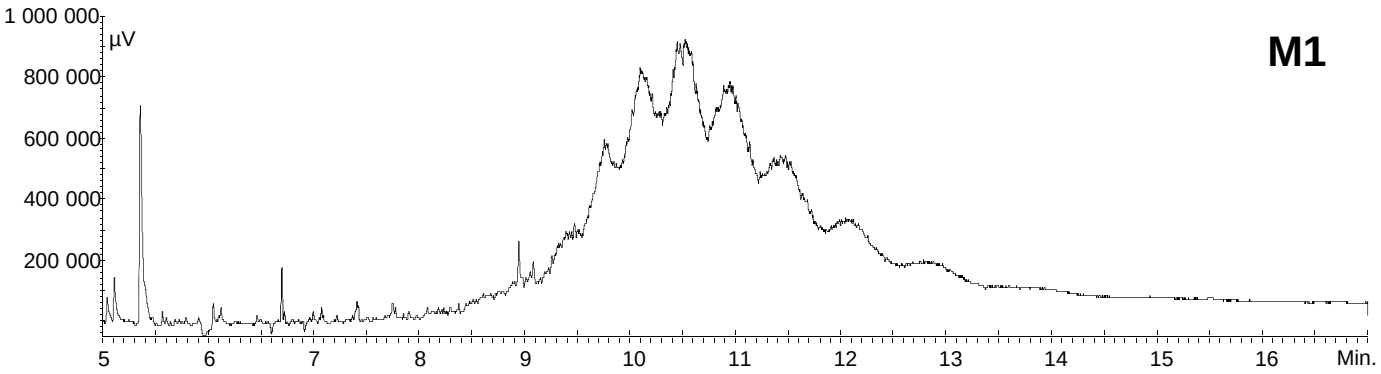
M7

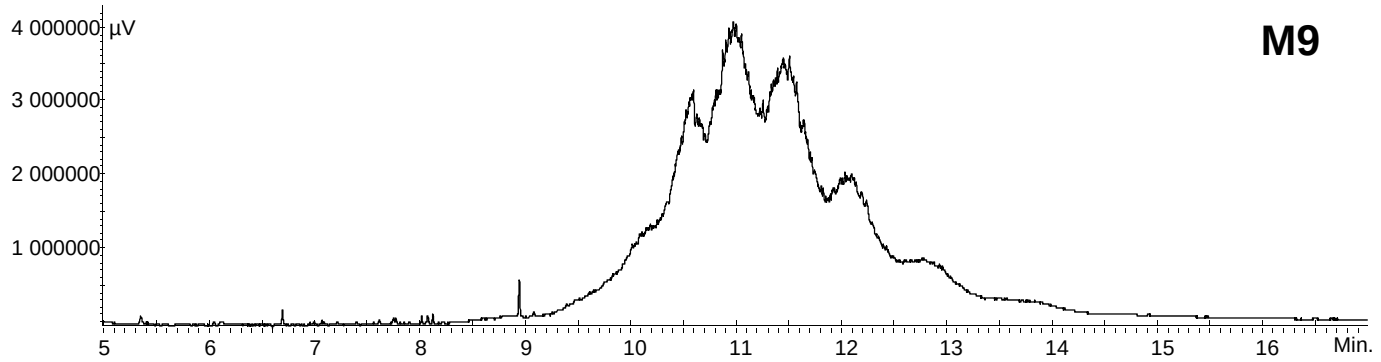


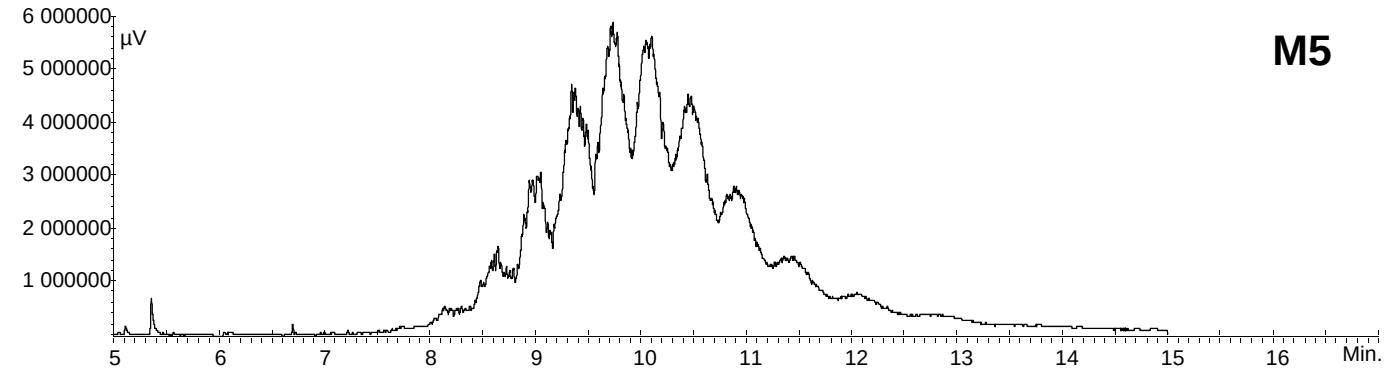
M8

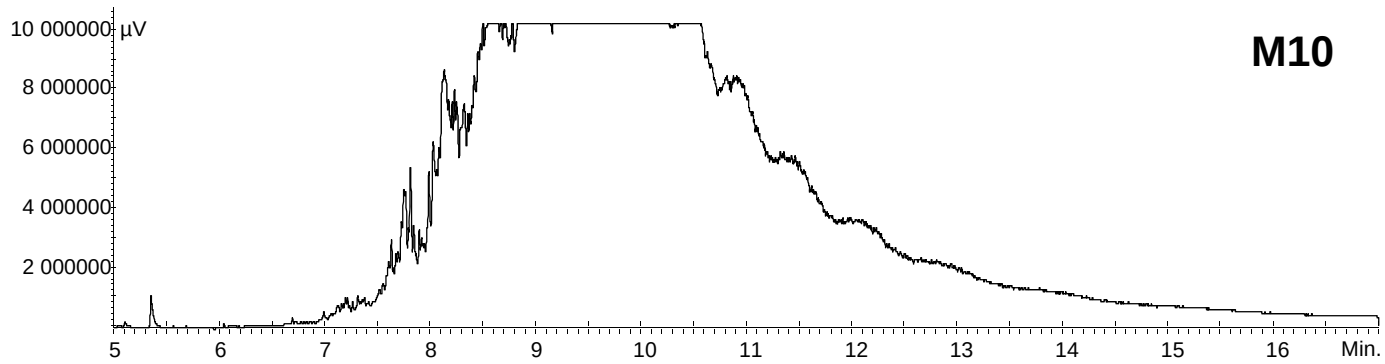

300 000
250 000
200 000
150 000
100 000
50 000
0
µV
M2
5
6
7
8
9
10
11
12
13
14
15
16
Min.

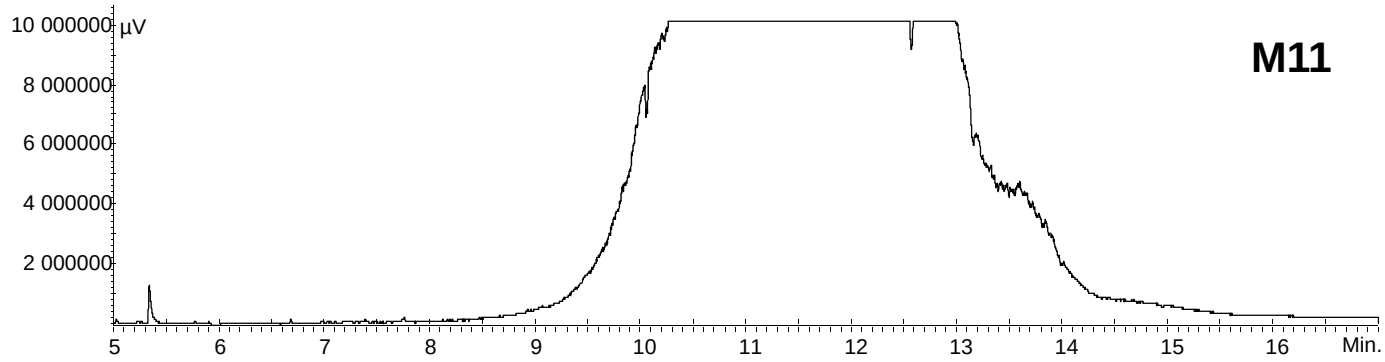

500 000
400 000
300 000
200 000
100 000
0
µV
M6
5
6
7
8
9
10
11
12
13
14
15
16
Min.

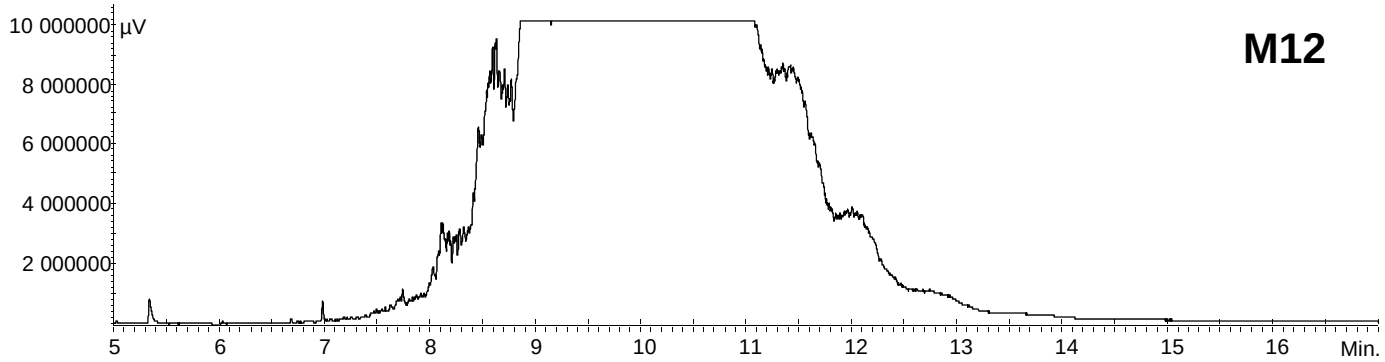

1 000 000
800 000
600 000
400 000
200 000
µV
M1
5
6
7
8
9
10
11
12
13
14
15
16
Min.


4 000000
3 000000
2 000000
1 000000
µV
M9
5
6
7
8
9
10
11
12
13
14
15
16
Min.


M5
µV
6 000000
5 000000
4 000000
3 000000
2 000000
1 000000
5 6 7 8 9 10 11 12 13 14 15 16 Min.


M10
µV
10 000000
8 000000
6 000000
4 000000
2 000000
5 6 7 8 9 10 11 12 13 14 15 16 Min.


M11
µV
10 000000
8 000000
6 000000
4 000000
2 000000
5 6 7 8 9 10 11 12 13 14 15 16 Min.


M12
µV
10 000000
8 000000
6 000000
4 000000
2 000000
5 6 7 8 9 10 11 12 13 14 15 16 Min.

Appendix 3

GC/MS chromatograms of hand blender samples M5, M9 and M10 – M12.