

A preliminary comparison of flavoured waterpipe tobacco aerosol with cigarette smoke: Part 1: NFDPM, nicotine and carbon monoxide machine derived yields.

Dr. P. J. WILKINSON (p.wilkinson@alfakher.com)

Al Fakher Tobacco Factory F.Z.E., PO Box 20037, Free Zone Gate No. 4, Ajman, United Arab Emirates.

INTRODUCTION

In 2005 the World Health Organisation (WHO) Study Group on Tobacco Product Regulation (WHO TobReg) published an advisory note entitled 'Waterpipe Tobacco Smoking: Health Effects, Research Needs and Recommendations by Regulators'. One of the conclusions of the report stated "The waterpipe smoker may therefore inhale as much smoke during one session as a cigarette smoker would inhale consuming 100 or more cigarettes". Subsequently, numerous claims appeared in both the published scientific literature and media outlets suggesting that "a one-hour waterpipe session is the same as smoking up to 200 cigarettes" or variations thereof.

Such statements are misleading since they only refer to the volume of aerosol produced, and do not consider the composition of the aerosol relative to cigarette smoke. Cigarette smoke is composed of thousands of chemical substances produced by the combustion of tobacco at temperatures between 400°C and 900°C. In contrast flavoured waterpipe aerosol is produced by heating a mixture (which typically contains around 20% tobacco) at between 120°C to 190°C and therefore might be expected to contain less toxicants.^{1,2,3,4,5}

In addition, studies from around the world show that consumers of waterpipe products use them infrequently.^{6,7,8,9,10} According to Germany's Federal Institute for Risk Assessment (BfR) "Average consumers in Germany smoke between one and two waterpipes a week..." compared to "between 20 and 30 cigarettes a day".¹¹

The aim of the present study was to, in Part 1, assess potential toxicant exposures, based on consumption patterns and a simple evaluation of the machine derived yields of Nicotine-Free Dry Particulate Matter (NFDPM), nicotine, carbon monoxide, water and humectants from a commercially available flavoured waterpipe tobacco product (Al Fakher "Two Apples with Mint"), and the University of Kentucky 3R4F reference cigarette. **In Part 2 (STPOST25) we further characterise the composition of waterpipe NFDPM to that from cigarettes, to assess potential differences in the presence of toxicants.**

MATERIALS & METHODS

Waterpipe Tobacco Sample Preparation

Al Fakher "Two Apples with Mint" was conditioned for 12 hours prior to testing at 22±2°C, at a relative humidity 60±5%.

Cerulean SPS- Shisha Smoking Machine Preparation

A 10g sample of Al Fakher "Two Apples with Mint" was placed into the shisha head. The head was covered in aluminium foil and a puncher used to create uniform perforations. Three Kings™ Quick Light Charcoal was placed centrally on the foil, and lit using a gas lighter. The waterpipe head was connected to the bottle (containing 750ml deionized water) and the head protected from ambient air currents using a glass screen, a setup which is representative of typical use by consumers.

Waterpipe Aerosol and Cigarette Smoke Collection & Analysis

Waterpipe aerosol was collected in a one-hour session according to the International Organisation for Standardisation (ISO) Technical Specification 22486 "Water pipe tobacco smoking machine — Definitions and standard conditions" and analysed at Global Laboratory Service (GLS) Inc., USA. 3R4F mainstream smoke yields were taken from the published scientific literature using the Health Canada Intense (HCI) machine smoking regime (Table 1.0).^{12,13}

Table 1.0: "Puff" parameters of the ISO 22486 and HCI machine smoking regimes.

Parameter	Waterpipe - ISO 22486	Cigarette - Health Canada Intense (HCI)
"Puff" duration	2.6s ± 0.1s	2 s
"Puff" volume	530ml ± 10ml	55 ml
"Puff" frequency	20 s ± 0.5s	30 s
"Puff" number	175 (180 used by GLS)	N/A
Total volume collected	92750 ml (95400 ml at GLS)	500 - 600 ml ^a

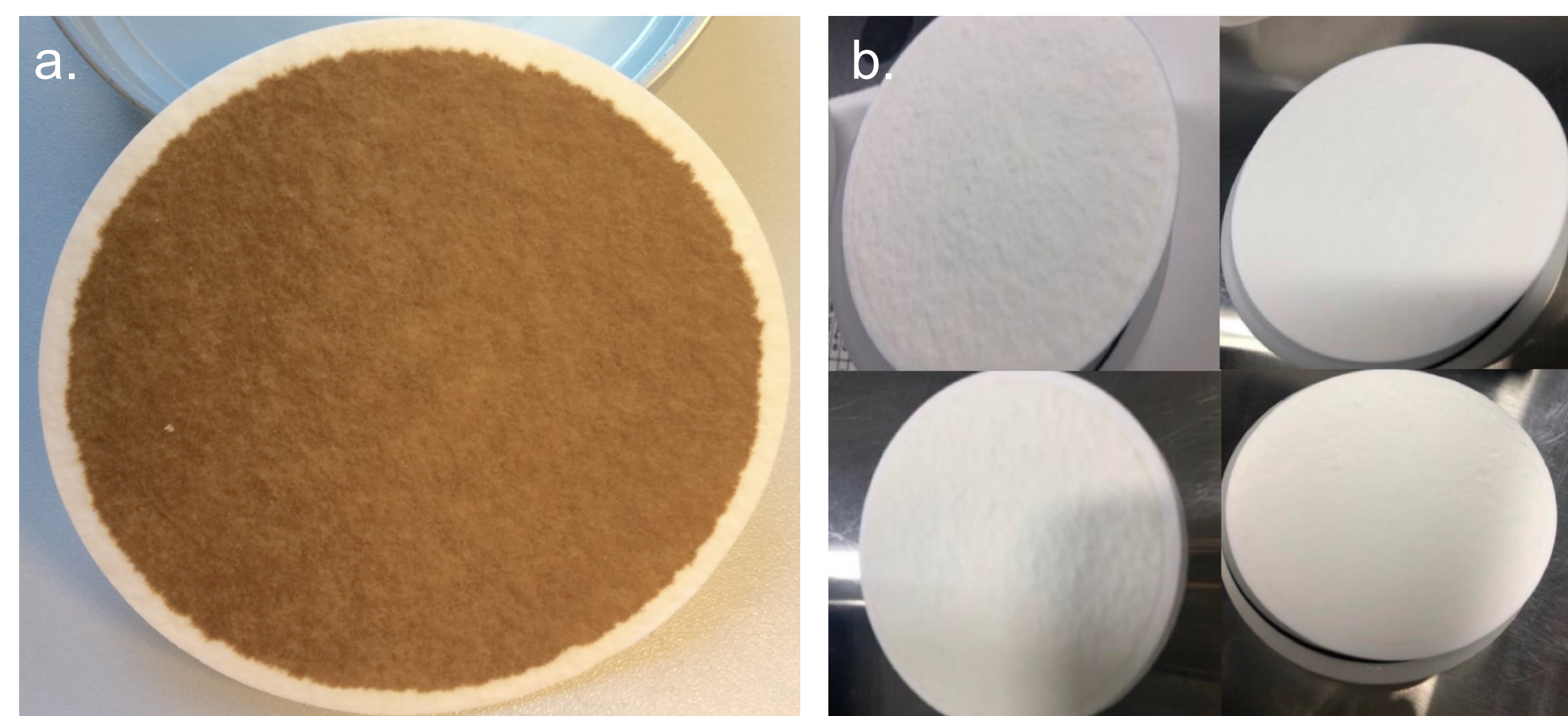
a. Dependent upon "puff" number recorded during analysis.

EMISSIONS ANALYSIS

Figure 1.0 visually demonstrates the significant differences between the composition of 3R4F cigarette smoke, and Al Fakher "Two Apples with Mint" aerosol.

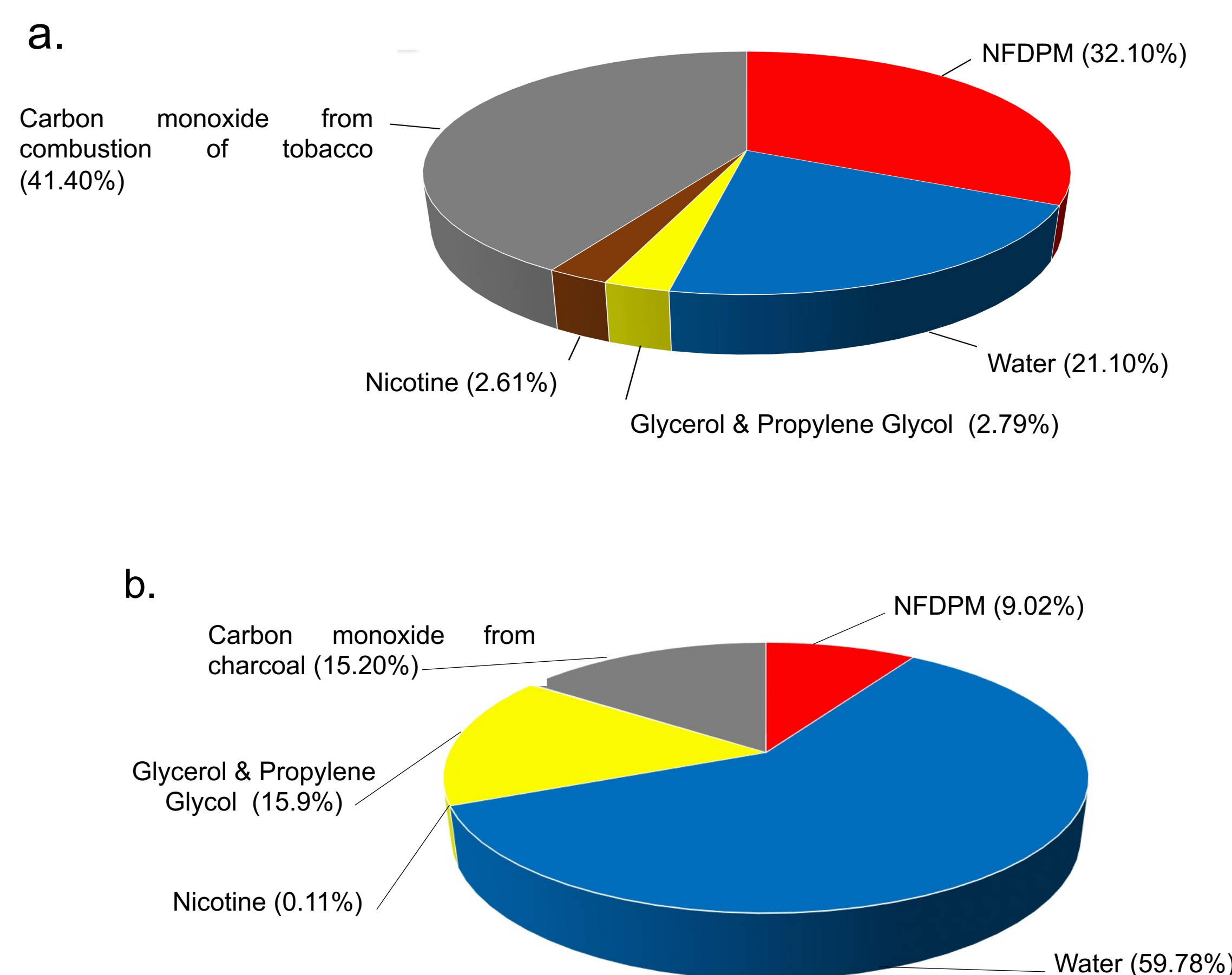
The 3R4F Cambridge Filter Pad (CFP) (Figure 1.0a) was completely discoloured by the extensive deposition of combustion by-products, unlike those used for the collection of waterpipe aerosol (Figure 1.0b).

Figure 1.0: TPM collected on CFPs during machine smoking of (a) 3R4F reference cigarette showing extensive deposition of by-products of combustion, and (b) Al Fakher "Two Apples with Mint".



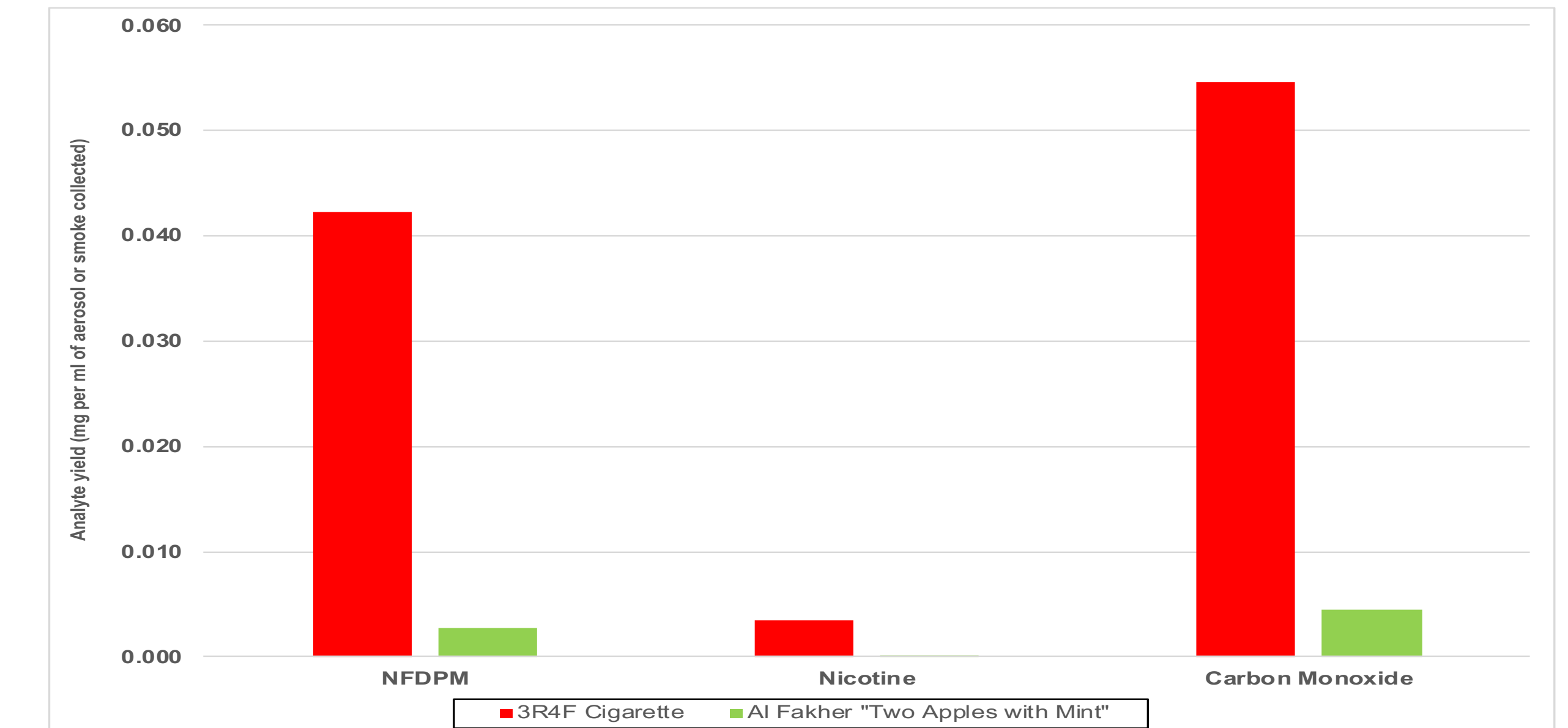
Subsequent analysis revealed that Al Fakher "Two Apple with Mint" aerosol was primarily composed of glycerol, propylene glycol and water (Figure 2.0).

Figure 2.0: Relative composition of machine derived (a) 3R4F cigarette smoke, and (b) Al Fakher "Two Apples with Mint" aerosol.



On a per ml basis, machine derived aerosol from a one hour session of the Al Fakher "Two Apples with Mint" product produced significantly reduced concentrations of NFDPM, nicotine and carbon monoxide (93%, 99% and 92% respectively compared to the smoke generated from a single 3R4F reference cigarette (Figure 3.0).

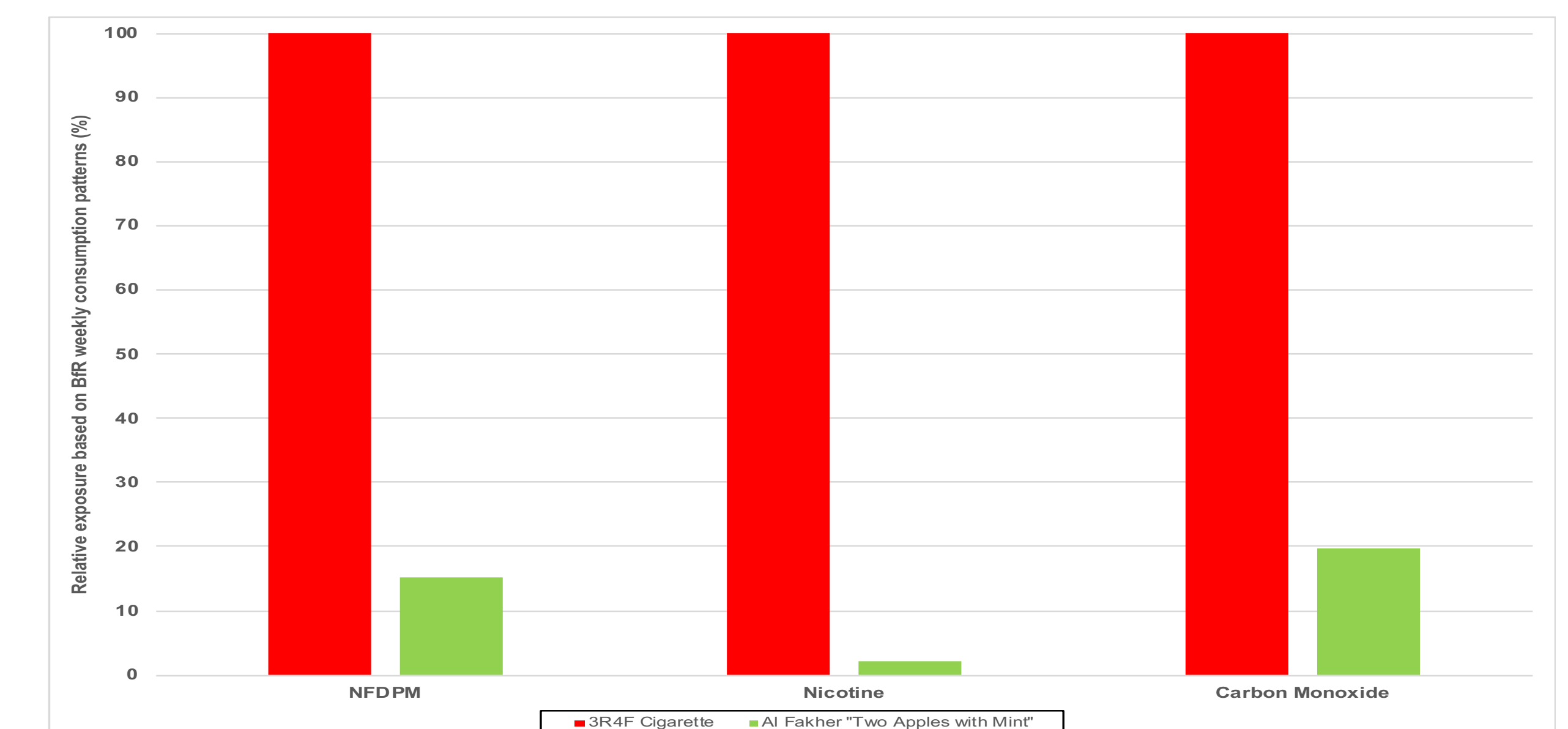
Figure 3.0: Machine derived analyte yields expressed on a per ml basis from Al Fakher "Two Apples with Mint" aerosol and 3R4F cigarette smoke.



It is necessary to assess the number of millilitres of aerosol consumed by a waterpipe user versus a cigarette smoker to understand the real world relevance of the emissions analysis. Predictably, the one hour waterpipe session delivered more aerosol than one cigarette, but waterpipe use is characteristically occasional and shared while cigarette consumption is compulsive, daily and solitary. BfR referenced consumption patterns (two waterpipe sessions per week vs 140 cigarettes per week) were used in conjunction with ISO 224866 and HCI machine smoking regimes to estimate exposure.

Figure 4.0 highlights the significant reductions in exposure to NFDPM, nicotine and carbon monoxide from Al Fakher "Two Apples with Mint" compared to 3R4F cigarette when consumption patterns described by the BfR are taken into account.

Figure 4.0: Weekly exposures to NFDPM, nicotine and carbon monoxide when BfR consumption patterns are applied to machine derived yields.



CONCLUSION

These data disprove claims that "a one-hour waterpipe session is the same as smoking up to 200 cigarettes" and demonstrates that a typical 2 sessions per week waterpipe user is substantially less exposed to NFDPM, nicotine and carbon monoxide compared to a 20 a day cigarette smoker. The study indicates that shisha NFDPM should be further examined to better assess toxicant intake relative to cigarette smokers (this was the focus of Part 2 of the study).

REFERENCES

- Maziak, W., Ben Taleb, Z., Jawad, M., Afifi, R., Nakkash, R., Akl, E., Ward, K., Salloum, R., Barnett, T., Primack, B., Sherman, S., Cobb, C., Sufin, E., Eissenberg, T. (2017). Expert Panel on Waterpipe Assessment in Epidemiological Studies. Consensus statement on assessment of waterpipe smoking in epidemiological studies. *Tobacco Control*, 33(3):338-343.
- Shahadeh A. (2003). Investigation of mainstream smoke aerosol of the argileh water pipe. *Food and Chemical Toxicology*, 41(1):143-52.
- WHO study Group on Tobacco Product Regulation (TobReg). Waterpipe tobacco smoking: health (First and Second Editions).
- International Standards Organisation (ISO) (2019) 22486 - Water pipe tobacco smoking machine - Definitions and standard conditions. Switzerland.
- Schubert, J., Heinke, V., Bewersdorff, J., Luch, A., Schulz T. (2012). Waterpipe smoking the role of humectants in the release of toxic carbonyls. *Arch Toxicol*, 86:1309-1316.
- Tamim, H., Terro, A., Kasseh, H., Ghazi, A., Khamis, T., Hay, M., Musharrafieh, U. (2003). Tobacco use by university students, Lebanon, 2001. *Addiction*, 98:933-9.
- Asler, T., Ward, K., Eissenberg, T., Maziak, W. (2005). Comparison of patterns of use, beliefs, and attitudes related to waterpipe between beginning and established smokers. *BMC Public Health*, 5:19.
- Dar-Odeh, N., Bakri, F., Al-Omri, M., Al-Mashni, H., Eimar, H., Khraisat, A., bu-Hammad, Abdul-Aziz, S., Duden, F., Abdallah, M., Zied Alkilani, S., Al-Shami, L., Abu-Hammad, O. (2010). Narghile (water pipe) smoking among university students in Jordan: prevalence, pattern and beliefs. *Harm Reduction Journal*, 7:10.
- Awan, K. H., Alrashedan, A., Kahtani, M., Patil, S. (2016). Waterpipe smoking among health sciences university students: knowledge, attitude and patterns of use. *The Saudi Dental Journal*, 28:189-193.
- Nuzzo E, Shensa A, Kim KH. (2012). Associations between hookah tobacco smoking knowledge and hookah smoking behaviour among US college students. *Health Educ Res*, 2013; 28:92-100.
- Deutsche Bundesinstitut für Risikobewertung (German Federal Institute for Risk Assessment) (2018). Frequently asked questions about waterpipes. http://www.bfr.bund.de/en/frequently_asked_questions_about_water_pipes_520538.html. Last accessed 29th August 2019.
- St Helen, G., Jacob III, P., Nardone, N., Benowitz, N. (2018). IQOS: examination of Philip Morris International's claim of reduced exposure. *Tob Control*, 27:s30-s36.
- Eldridge, A. Boston, T.R., Vinicius Gama, M., McAdam, K. (2015). Variation in tobacco and mainstream smoke toxicant yields from selected commercial cigarette products. *Regulatory Toxicology and Pharmacology*, 71:409-427.