Toxicant Evaluation of Commercial Oral Tobacco Products

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Introduction

Oral tobacco products (OTPs) have been used globally for several centuries and are classified by the International Agency for Research on Cancer as carcinogenic.[1] However, as noted by the UK Royal College of Physicians,[2] different types of OTPs are associated with different health risks, depending on their toxicant contents. In Sweden, epidemiological and long-term population studies have shown that use of snus products which meet particular standards such as Gothiatek®, offer lower health risks than cigarette smoking.[3,4]

Given the links between OTP toxicant contents and their reported health risks, understanding the chemical composition of different OTP types is important. Such data may also support bridging epidemiological data on studied products to the potential health risks of oral nicotine pouches that do not contain tobacco.

Methodology

Products

83 commercial OTPs from Sweden and the United States were evaluated.

Products were obtained in 2008 - 2010 and were selected to cover all the major manufacturers representing ~90% market share of the major OTP categories.

Analytes

Contents of 114 toxicants, and 17 additional measurands, were chosen for their reported historic presence in tobacco or cigarette smoke, including recognised lists (IARC, WHO, FDA)[1,5,6] and established toxicological data (Table 1).

Table 1: Toxicants included in OTP survey

Category	#	Sub-category	#	Individual toxicants
Nitrosamine species	30	TSNAs*	7	NAB, NAT, NNA, NNAL, iso-NNAL, NNK, NNN
		Volatile & involatile nitrosamines*	12	NDMA, NEMA, NDEA, NDiPA, NDPA, NDBA, NDBzA, NDELA, NDiPLA, NPYR, NPIP, NMOR
		Nitrosacids*	11	NSAR, MNPA, MNBA, MNTCA, NPRO, iso-NNAC, NMPhA, NPic + (NTCA, NHPRO, NAzCA)
Radionuclides[7]	28			^{228}Ac, ^{241}Am, ^{212}Bi, ^{214}Bi, ^{14}C, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{3}H, ^{131}I, ^{40}K, ^{234m}Pa, ^{210}Pb, ^{212}Pb, ^{214}Pb, ^{210}Po, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{226}Ra, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}Th, ^{208}Tl, ^{234}U, ^{235}U, ^{238}U
Hydrocarbons	26	Polycyclic aromatic hydrocarbons[8]	21	naphthalene, 1-methyl naphthalene, 2-methyl naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, B[a]A, chrysene, B[b]F, B[k]F, B[j]F, B[e]P, B[a]P, perylene, DB[ah]A, I[cd]P, B[ghi]P
		Other hydrocarbons*	5	1,3-butadiene, benzene, isoprene, styrene, toluene
Metals*	8			As, Be, Cd, Cr, Hg, Ni, Pb, Se
Carbonyls*	4			acetaldehyde, acrolein, crotonaldehyde, formaldehyde
Aromatic amines*	4			1-aminonaphthalene, 2-aminonaphthalene, 3-aminobiphenyl, 4-aminobiphenyl
Aflatoxins*	4			aflatoxin B1, aflatoxin B2, aflatoxin G1, aflatoxin G2.
Microbiological measurands*	3			aerobic colonies, aerobic spores, bacillus cereus
Oxygenated or nitrogenous organic compounds	7	Oxygenated[9]	3	α-angelica lactone, β-angelica lactone, coumarin
		Both[10,11]	2	acrylamide, ethyl carbamate
		Nitrogenous*,[12]	2	acrylonitrile, hydrazine
Total toxicants	**114**			

Note: The 17 additional measurands were: Ammonium N, ash, Cl^-, fleece mass, glycerol, mass, moisture, nicotine, total nicotine alkaloids, nitrate, propylene glycol, pH, total sugars, reducing sugars, Na^+, water and water activity.[13,*]
* Manuscripts not yet published

New methods were developed for the determination of α- and β-angelica lactone,[9] hydrazine,[12] volatile and involatile nitrosamines,* nitrosacids* and NNA* in OTPs.

Results

An overview of the maximum results for each toxicant by product style is shown using a heatmap (Figure 1). 45 out of 114 toxicants were not quantifiable across all products (grey cells), indicating that without improvements in current levels of analytical sensitivity, there is minimal value in assessing these toxicants in future surveys of OTPs.

Toxicant levels were compared on an as-received basis, and per-gram of OTP. Moist snuff and dry snuff samples had higher levels of TSNAs (NAT, NNN, NNK, iso-NNAL), volatile and involatile nitrosamines (NPYR, NDMA and nitrosacids (NSAR, NPRO, MNPA). Moist snuff, dry snuff and soft pellet samples had higher levels of polyaromatic hydrocarbons (pyrene, phenanthrene, perylene, I[cd]P).

Boxplots of selected compounds of interest (Figure 2) indicate differences in toxicant levels across styles.

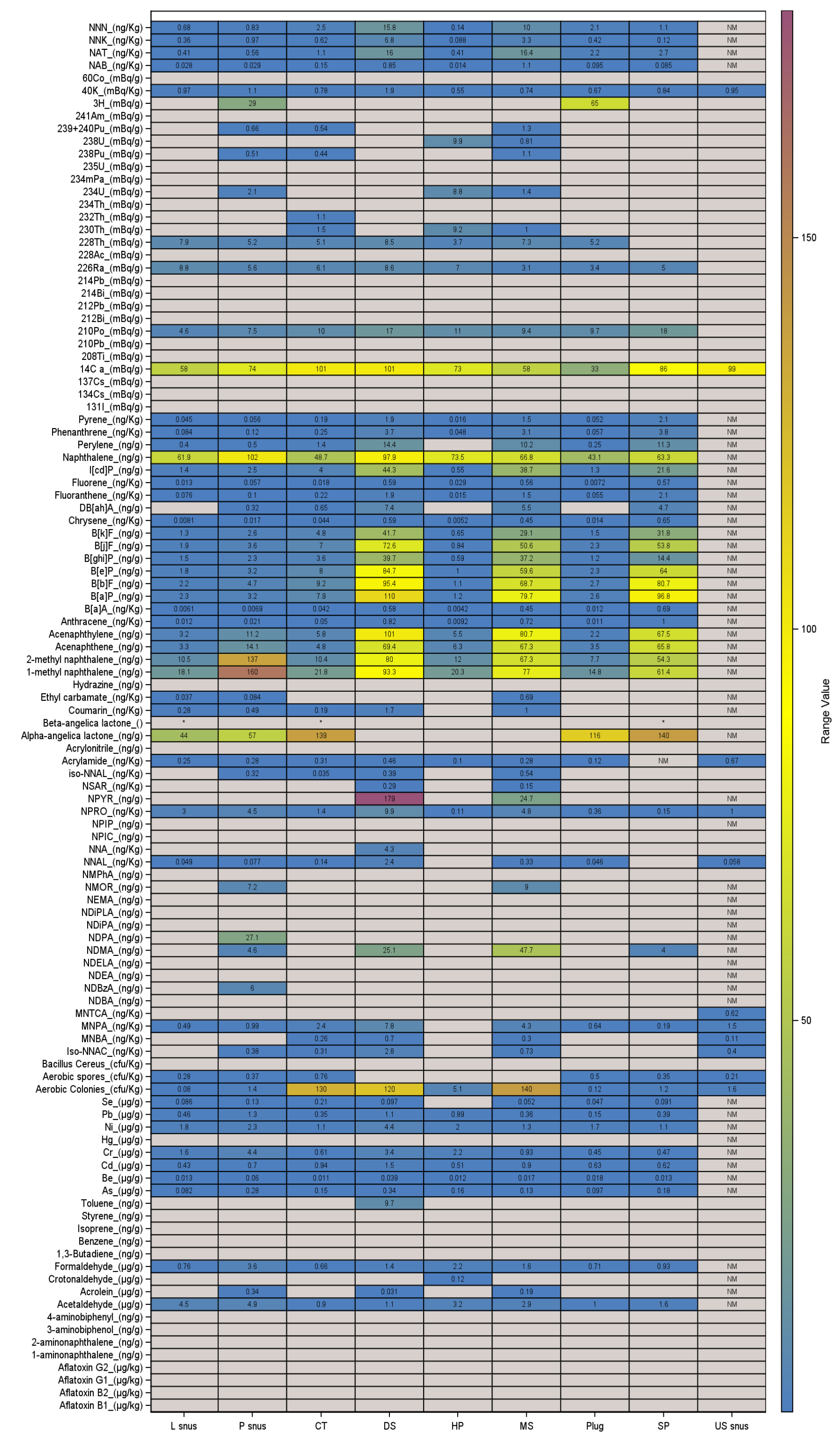

Figure 1: (Left) Heatmap of maximum value of toxicant per style.

All values >LOD or >LOQ

NM = Analyte not measured

* Detected but not quantified

Note: US snus products were not assessed for compounds marked as NM as these products did not exist at the time of testing

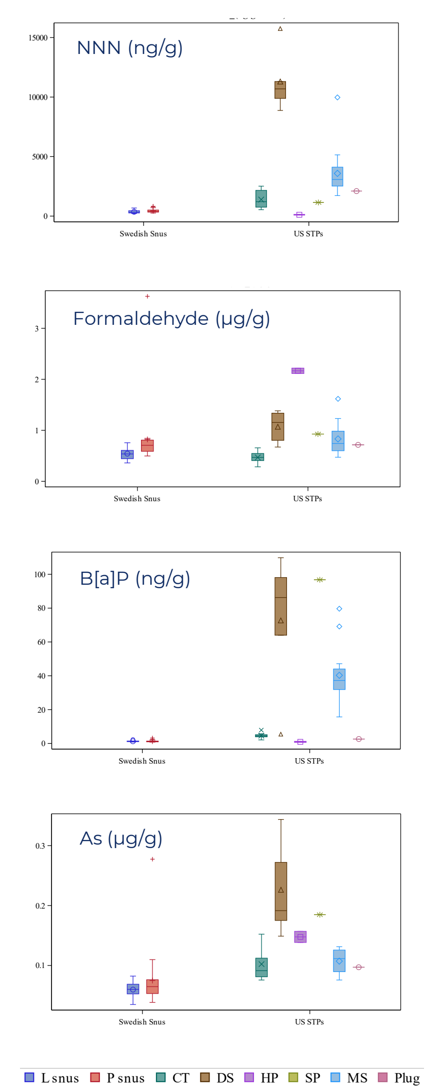

Figure 2: (Above) Boxplot of selected compounds of interest

Conclusion

The results showed significant differences in the toxicant contents across OTP types, largely related to differences in tobacco content type, tobacco curing and product manufacturing. Together with dosimetry estimates for snus and moist snuff, these data also suggest potential differences in health risks associated with the respective products' use. Furthermore, the study data enable direct comparisons to be made with toxicant content data on oral nicotine products.

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