

Comparative Assessment of PULZE™ Heated Tobacco and Herbal Aerosols Demonstrates Substantially Lower Toxicant Levels On Average (95%) Than Cigarette Smoke

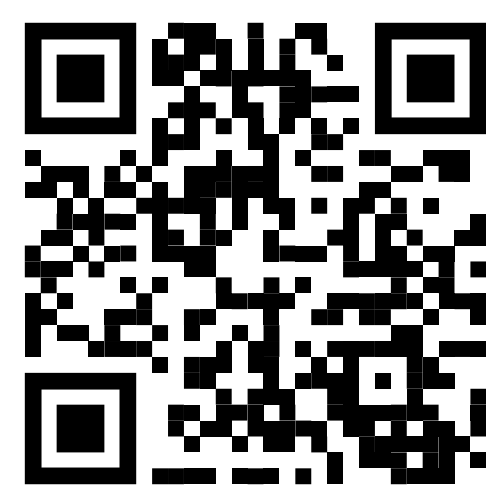
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INTRODUCTION

Smoking is a cause of serious diseases; however, Next Generation Products (NGP), including heated systems, aim to offer potentially reduced harm alternatives for adult smokers who would otherwise continue smoking. Imperial Brands has developed the PULZE™ device, designed to be used with two types of consumables: iD™ (tobacco based Heated Tobacco Product) and iSENZIA™ (tea based Heated Herbal Product). Both formats operate at temperatures below combustion, generating aerosols with substantially fewer harmful and potentially harmful constituents¹. This study forms the

emissions component to complement the biological assessment of the same products addressed by Firth et al., 2026².

This study assessed the aerosol emissions of two commercially marketed and representative consumables—iD™ (tobacco) and iSENZIA™ (tea, fruity flavour)—when used with the latest PULZE™ device. The aim was to characterise their emissions of the WHO 9 priority toxicants and to determine the extent to which consumable type influences toxicant yields. Aerosol was generated following ISO 20778 (55 mL puff volume, 30 s interval, 2 s duration). 1R6F reference cigarette

smoke was included for comparison; HHP consumables were tested without ventilation blocking.

Across all WHO 9 toxicants, both iD™ and iSENZIA™ demonstrated substantial reductions (Up to 99%) versus 1R6F cigarette smoke. Direct comparison between the two heated consumables showed statistical equivalence across all analytes, with only minor differences for CO and formaldehyde, and all values remained far below cigarette (1R6F) emissions for all commercial articles tested.

Test Articles and Methods

1.0 Test Products

iSENZIA™ (Tea based, fruity flavours) PULZE™ 3.0 – Imperial Brands

iD™ (Tobacco) PULZE™ 3.0 - Imperial Brands

1R6F – Kentucky Reference Cigarette (University of Kentucky)

2.0 Methods (All data generated by Imperial brands internal labs except for PAH for iD™, this was provided by Eurofins GfA Lab Service GmbH).

Tob Reg 9 Analytes	Test Method
Carbonyls (Acetaldehyde, Acrolein & Formaldehyde)	Carbonyls in HTP aerosol by LC-UV
Volatiles (1,3-Butadiene & Benzene)	Gas-phase in HTP aerosol by GC-MS
TSNAs (NNK & NNN)	TSNA's in HTP aerosol by LC-MSMS
PAHs (Benzo[a]pyrene)	Polyaromatic hydrocarbons in HTP aerosol by GC-MS
Carbon Monoxide	CO – NDIR
Standard Heating Mode, ISO5501-1 conditioning, 55mL/2s/30s puffing regime, vent blocking, 10 puffs per stick, 3 replicates (ISO20778) ³ applied to all test products	

Results and Discussion

The combustion of tobacco products in its traditional formats (cigarettes, cigars and pipe .etc) occurs within a temperature range of 700°C to 950°C, this produces a complex mixture of gas and particulate matter that contains the established combusted tobacco human health toxicants⁴. Heated tobacco (HT) and heated herbal (HH) products use a lower operating temperature below 400°C to produce an inhalable aerosol via distillation and vaporisation as opposed to combustion⁴. Combustion at elevated temperature has been shown to be a key driver in higher levels of toxicants and many companies are now offering HT/HH products as part of their harm reduction portfolio as less toxicants are being generated in comparison.

Benzo[a]pyrene was below LOQ (limit of quantification) in all iSenzia and iD sticks. However, the LOQ for iD™ was measured externally, with a different method sensitivity and LOQ. As all results were reported below LOQ, an approximation of the geometric mean was calculated using LOQ/V₂, and this result was compared to 1R6F in both cases to calculate % reduction.

For NNN, the percentage reduction for the iD™ sticks compared to iSENZIA™ can be explained by the fact that iD™ has more tobacco present than the iSENZIA™ sticks do. Therefore, TSNAs overall, are likely to be a higher in iD™ vs iSENZIA™, resulting in a lower % reduction vs 1R6F, although both are significant reductions in comparison to 1R6F.

Overall, this set of emissions data demonstrates that heated tobacco and heated herbal products offer reduced levels toxicants for TobReg 9 analytes adding further evidence that they have a role to play in tobacco harm reduction.

Results and Discussion contd.

Table 1 – Emissions data and corresponding % reductions.

TobReg9 Analyte (units)	iD™ (tobacco)	iSENZIA™ (tea based)	1R6F results	% Reduction iSENZIA™ vs 1R6F	% Reduction iD™ (tobacco) vs 1R6F
CO (mg/puff)	0.029	0.038	3.161	98.797	99.097
NNN (ng/puff)	2.416	0.354	24.970	98.584	90.326
NNK (ng/puff)	0.836	0.354	20.197	98.249	95.861
Benzo[a]pyrene (ng/puff)	0.354*	0.141	1.606	91.193	77.983
Formaldehyde (ug/puff)	0.642	0.863	10.436	91.730	93.851
Acetaldehyde (ug/puff)	12.722	6.284	114.843	94.528	88.923
Acrolein (ug/puff)	0.584	0.564	13.320	95.763	95.618
1,3-Butadiene (ug/puff)	0.043	0.043	12.502	99.659	99.659
Benzene (ug/puff)	0.032	0.019	9.264	99.793	99.656

*Data for PAH Benzo[a]pyrene was generated by an external lab partner, Eurofins GfA Lab Service GmbH).

Figure 1 - % Reduction of both iD™ and iSENZIA™ in comparison to 1R6F.

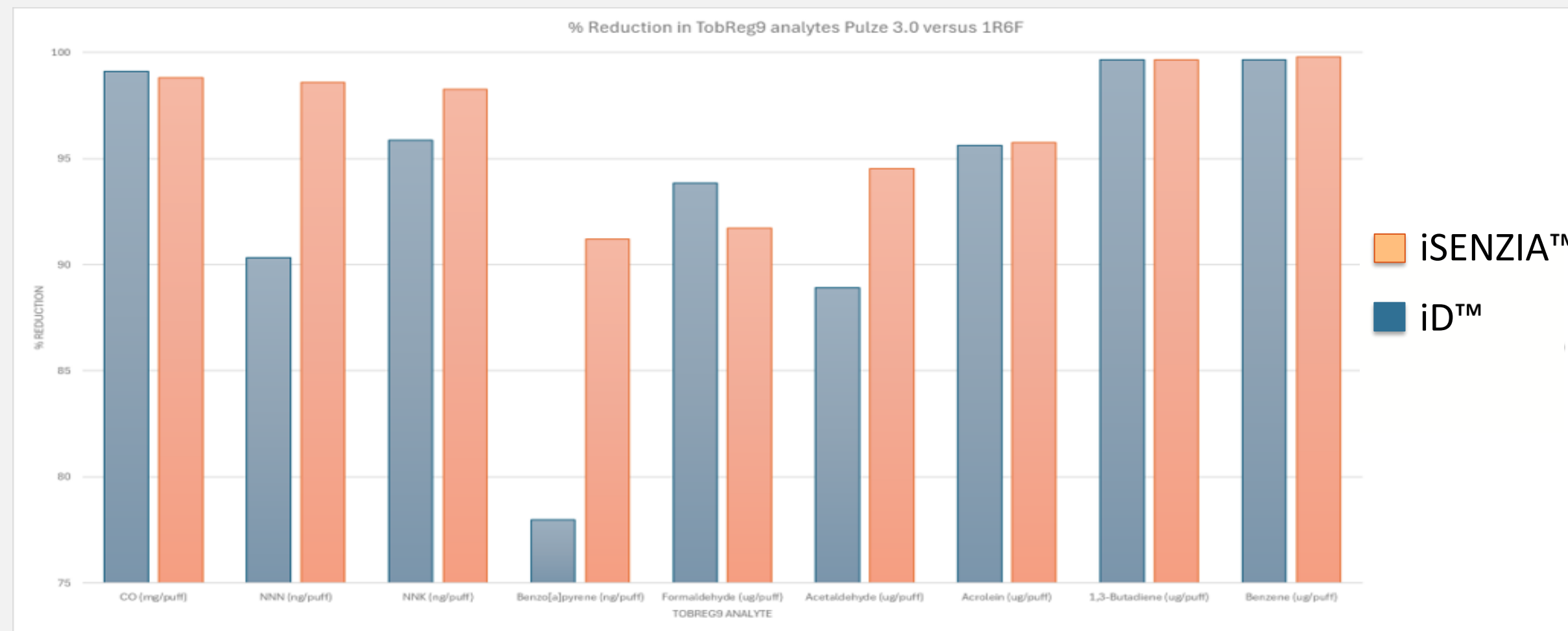
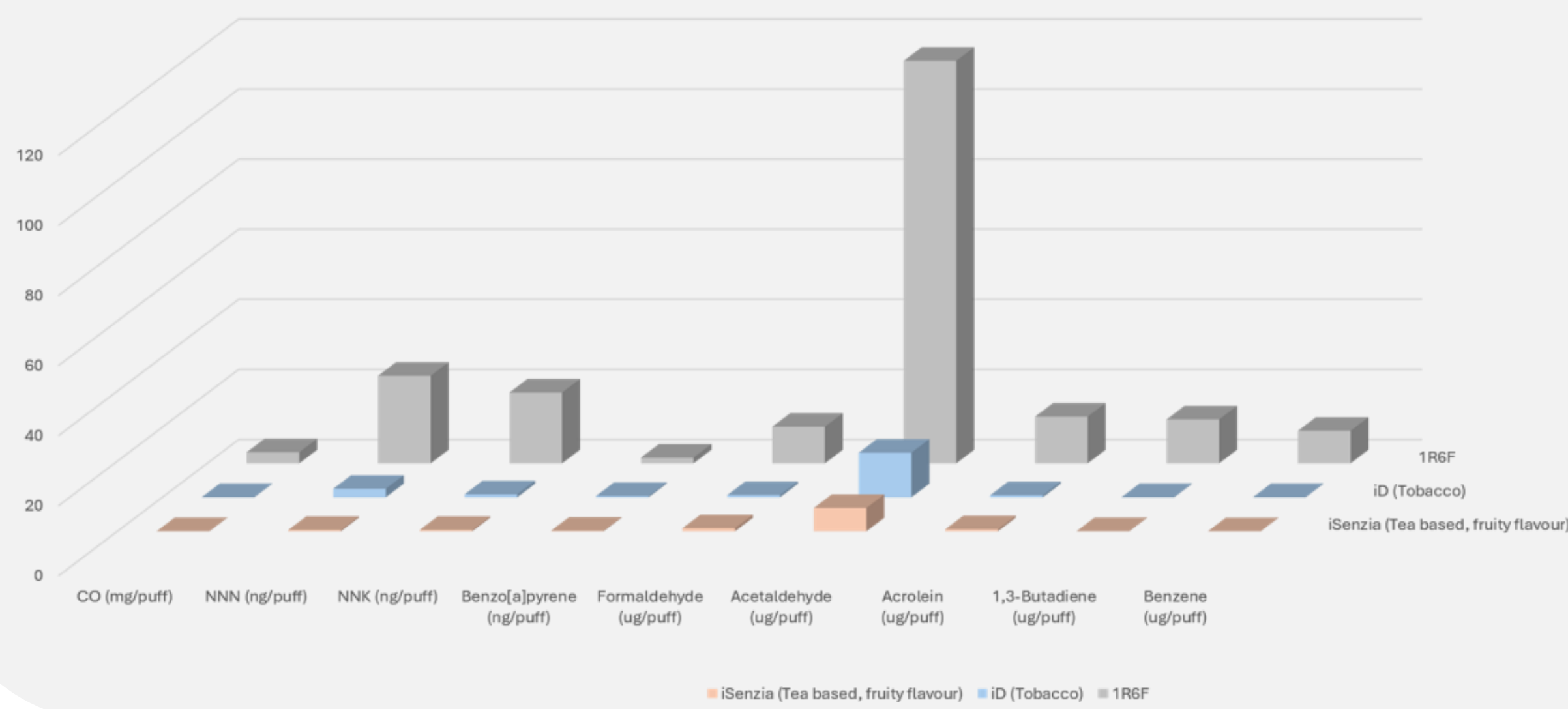


Figure 2 – TobReg 9 analyte representation of iD™, iSENZIA™ and 1R6F.

iSenzia (tea based, fruity flavour) PULZE 3.0 vs iD (tobacco) PULZE 3.0 vs 1R6F - TobReg9 Analytes



CONCLUSIONS

Across all WHO 9 priority toxicants analytes, both products demonstrated substantial reductions (up to 99%) compared to 1R6F emissions. Direct comparison of both the HT and HH products showed that their emissions were statistically equivalent across all analytes even with minor increases observed for both CO and formaldehyde. For both the iD™ and iSENZIA™ products, the results for the targeted analytes remained far below cigarette emissions. Additional analyses

demonstrated that activating the flavour capsule had no significant impact on toxicant emissions, with percentage reductions versus 1R6F remaining highly consistent across all analytes.

As a responsible manufacturer, Imperial Brands is committed to offering adult smokers potentially less harmful alternatives. These findings reinforce the significantly reduced toxicant emissions are achievable with both heated tobacco and heated herbal formats, such as PULZE™ using iD™ or

iSENZIA™ when compared with cigarettes. Under these test conditions, these results suggest that PULZE™ with iD™ & iSENZIA™ have the potential to offer a harm reduced alternative to smoking cigarettes and the potential to make a meaningful contribution to tobacco harm reduction.

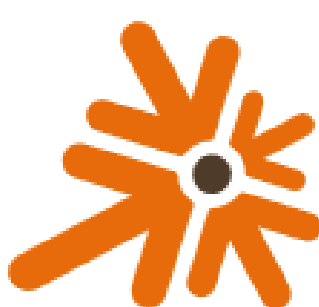
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