

Tobacco Specific Nitrosamines in Mainstream Smoke of Commercial Little Cigars



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BACKGROUND

- Little cigars (small sheet-wrapped cigars, weight $\leq 1.36g$) are among a broad category of FDA regulated tobacco products that experienced rapid growth in sales after the Tobacco Control Act (TCA) banned “characterizing flavors”, except tobacco and menthol, from cigarettes¹.
- Little cigars have nearly similar sizes and dimensions as cigarettes, however, some dimensions vary due to among-brand differences².
- Unlike cigarettes, the mainstream smoke delivery of harmful and potentially harmful constituents (PHCs) like tobacco-specific nitrosamines (NNN and NNK) generated by little cigars are not extensively investigated. Both NNN and NNK are upper respiratory tract and lung carcinogens.
- In this study 60 brands of commercial little cigars sold in the US were characterized for mainstream smoke NNN and NNK yields.
- Mainstream smoke for product characterization was generated by the International Organization for Standardization (ISO) and the Health Canada Intense (HCI) smoking regimens and the smoke yields of NNN and NNK were compared to 50 commercial American Blend cigarettes.

METHODS

- ISO Smoking Regimen:** 35-ml puff volume, 60-second puff interval, 2-second puff duration and no blocking of the filter ventilation holes
- HCI Smoking Regimens:** 55-ml puff volume, 30-second puff interval, 2-second puff duration and 100% blocking of the filter ventilation holes
- Validated LC-MS/MS Method:** Extraction of Cambridge filter pads spiked with 100 μL of isotopically-labeled NNN-¹³C₆ and NNK-¹³C₆ with 10 mL of 100-mM aqueous ammonium acetate solution followed by HPLC/MS/MS. 1R5F reference cigarette used for validation and quality control.

Table 1. Physical attributes of the 60 little cigars² and 50 commercial cigarettes³

Product Attributes	Little Cigar	Cigarettes
	Median (Range)	Median (Range)
Tobacco Rod Length (mm)	99 (73.9 – 100)	84 (79.6 – 99.2)
Filter Length (mm)	27 (8.11 – 31.8)	27 (15 – 31.9)
Rod Diameter	7.9 (6.84 – 8.36)	NA
Filter Ventilation (%)	0.9 (0.13 – 53.9)	26.1 (0.13 – 66.6)
Paper/Wrapper Porosity (CU)^a	83 (24.16 – 131)	48.1 (17.3 – 72.1)
Tobacco Weight (mg)	1089 (767 – 1367)	661 (401 – 880.7)
Draw Resistance (open)(mmWG)^b	173 (85.6 – 254)	111 (7.7 – 136.2)
Draw Resistance (closed)(mmWG)^c	195 (100 – 297)	138 (10.1 – 194)
Tobacco pH	6.2 (5.4 – 6.6)	5.4 (5.29 – 5.61)

^a CORESTA Units (CU) – measure of air flow (cc/min) passing through a 1cm² test paper at 1.0 kPa pressure; ^b Draw Resistance-Pressure drop determined under ISO machine-smoking conditions (mmWG, millimeter of water gauge); ^c Draw Resistance-Pressure drop determined under CI smoking conditions; NA – Not Available.

- Little cigars have longer rod length; lower filter ventilation; higher wrapper porosity; higher tobacco weights, and draw resistance compared to cigarettes that affects the mainstream smoke NNN and NNK yields.
- Little cigars have higher median pH that can affect nicotine chemistry.

RESULTS

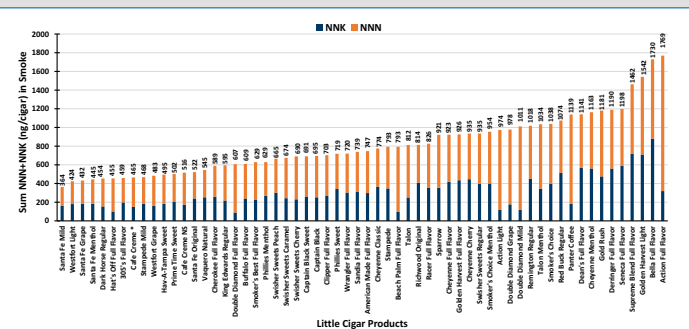
Table 2: Testing variability of cigars, commercial cigarettes and 1R5F

Testing Variability	Mean % RSD	
	ISO	HCI
Little cigars	12.4	12
Commercial Cigarettes	8.4	9.3
1R5F	8	8

- Little cigar testing has higher analytical variability among the products compared to commercial and reference cigarettes.
- Both smoking regimens optimized for cigarettes are suitable for little cigar analysis⁴

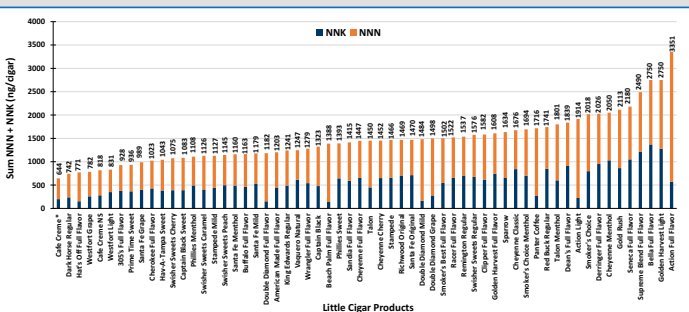
LITTLE CIGAR DATA

Figure 1. Median NNN and NNK in mainstream smoke of commercial little cigars listed in ascending order of the sum of NNN and NNK: ISO smoking regimen



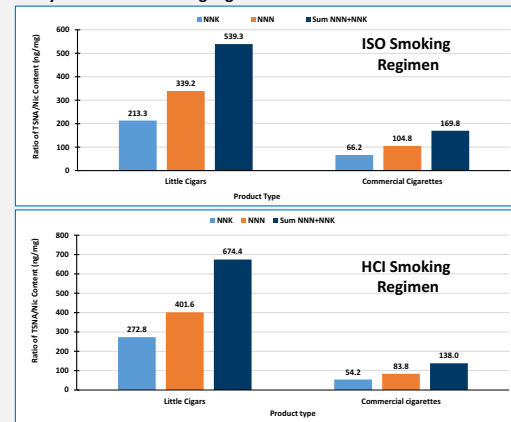
- The median (range) smoke yield of NNN was 446 (201 – 1450) ng/cigar; NNK was 261 (89.3 – 879) ng/cigar, and (NNN + NNK) was 747 (364 – 1769) ng/cigar.
- Action Full Flavor (A&T Tobacco Imports) had the highest NNN and sum NNN + NNK yields, while Santa Fe Mild (Swisher International Inc.) had the lowest sum NNN + NNK yields.
- Bella Full Flavor (Sunshine Tobacco) had the highest NNK (879 ng/cigar) yield while Double Diamond Full Flavor (A&T Tobacco Imports) had the lowest NNK (89.3 ng/cigar) yield.
- Dark Horse Regular (A&T Tobacco Imports) had the lowest tobacco filler sum NNN + NNK quantity (not shown) and is ranked 5th lowest sum NNN + NNK by the ISO smoking regimen.

Figure 2. Median NNN and NNK in mainstream smoke of commercial little cigars listed in ascending order of the sum of NNN and NNK: Canadian Intense smoking regimen



- The median (range) smoke yield of NNN was 818 (445 – 2780) ng/cigar; NNK was 535 (138 – 571) ng/cigar, and (NNN + NNK) was 1449 (644 – 3351) ng/cigar.
- Action Full Flavor (A&T Tobacco Imports) had the highest NNN and sum NNN + NNK yields while Café Crème* (Scandinavian Tobacco Group Ltd) had the lowest NNN and sum NNN + NNK yields.
- Bella Full Flavor (Sunshine Tobacco) had the highest NNK and Beach Palm Full Flavor (A&T Tobacco Imports) had the lowest NNK yields. Dark Horse Regular (A&T Tobacco Imports) had the lowest tobacco filler sum NNN + NNK and is ranked the 2nd lowest sum NNN + NNK yields by the HCI smoking regimen.

Figure 3: Comparison of little cigar and cigarette TSNA content normalized per milligram of nicotine by ISO and HCI smoking regimens



Compared to cigarettes:

- Little cigar NNN/Nic and NNK/Nic smoke yields are 3.5-fold higher compared to commercial cigarette tobacco products by the ISO smoking regimen. Little cigars deliver more TSNA than cigarettes with similar ventilation (%).
- Little cigar NNN/Nic and NNK/Nic smoke yields are 4.5-fold higher by the Canadian Intense smoking regimen.

Table 3: Average transfer (%) of TSNA from tobacco filler to mainstream smoke of little cigars compared to cigarettes

Smoking Regimen	TSNA	Observed Transfer (%)	
		Cigar Average (Range)	Cigarette Average (Range)
ISO	NNK	37 (11 – 305)	16 (4 – 31)
	NNN	10 (5 – 16)	7 (2 – 12)
Canadian Intense (HCI)	NNK	51 (25 – 462)	36 (17 – 58)
	NNN	18 (12 – 30)	15 (7 – 24)

- Transfer (%) (100* Amt in smoke/Amt in tobacco filler) of NNN and NNK from tobacco to smoke of the little cigars are higher compared to cigarettes regardless of smoking regimen.
- ISO Smoking Regimen:** Hat’s Off Full Flavor (A&T Tobacco Imports) (304%) and Santa Fe Mild (Swisher) (11%) have the highest and lowest NNK transfer (%) to smoke, respectively. Panter Coffee (Royal Agio Cigars) (17%) and Santa Fe Original (Swisher) (5%) have the highest and lowest NNN transfer (%), respectively.
- HCI Smoking Regimen:** Hat’s Off Full Flavor (A&T Tobacco Imports) (462%) and Hav-a-Tampa Sweet (Altadis) (25%) have the highest and lowest NNK transfer (%) from tobacco to smoke, respectively. Cherokee Full Flavor (Cherokee Tob Company) (30%) and Swisher Sweets Caramel (Swisher) (12%) have the highest and lowest NNN transfer (%), respectively.

CONCLUSION

The study demonstrates that little cigars on the US market have a wide variation in the amounts of carcinogenic NNN and NNK and potentially can deliver higher smoke yields compared to typical American blend cigarettes regardless of filter length and tip ventilation (%) or smoking regimen used.

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