ABSTRACT
Aromatic amines are a class of carcinogenic compounds in tobacco smoke that are listed on the FDA list of harmful and potentially harmful constituents (HPHCs) in tobacco products and tobacco smoke. Six aromatic amines yield (1-aminonaphthalene (1-AN), 2-aminonaphthalene (2-AN), 3-aminobiphenyl (3-ABP), 4-aminobiphenyl (4-ABP), ortho-toluidine (o-TOL), o-anisidine (o-AN)) in the mainstream smoke (MSS) from 23 commercial filtered cigars, 16 cigarillos, and 11 large cigars were determined with solid-phase microextraction coupled to gas chromatography triple quadrupole mass spectrometry (SPME headspace GC–MS/MS) method. The commercial cigars were smoked under CORESTA Recommended Method 64 (CRM 64) using a linear cigar smoking machine. The aromatic amines yield in the mainstream smoke from 50 commercial cigars show high variation within and between products. The means of each aromatic amine yield in the filtered cigars, cigarillos, and large cigars were 121, 307, and 562 ng/cigar for o-TOL; 6, 14, and 22 ng/cigar for o-AN; 65, 114, and 174 ng/cigar for 1-AN; 25, 59, and 87 ng/cigar for 2-AN; 6, 14, and 22 ng/cigar for 3-ABP; 6, 11, and 17 ng/cigar for 4-ABP, respectively. The relationship between aromatic amines and total particulate matter (TPM) was evaluated. On a per cigar basis, the aromatic amines have a good linear relationship with TPM.

INTRODUCTION
Tobacco smoke is a complex mixture that contains thousands of compounds; more than 60 carcinogens were identified by the year 2000.1 Cigar smoking has been linked to a range of cancers that include oral, esophageal, laryngeal, bladder, and lung cancers, as well as other harmful health effects.2Aromatic amines are a class of carcinogenic compounds in tobacco smoke that are listed on the FDA HPHCs list in tobacco products and tobacco smoke. However, there is limited literature reporting aromatic amine yields in cigar smoke. Our objective was to determine the aromatic amine content in the mainstream smoke of various types of commercial cigars.

MATERIALS AND METHODS
Cigars:
A total of 50 brands of cigars (Figure 1) sold in the US market were purchased from different cigar websites between February and November 2020. All cigars were machine-made and included cigars with natural wrappers and wrappers made from homogenized tobacco leaf (HTL). CRM 64 smoke regime: Puff duration = 1.5 sec; puff period = 40 sec; puff volume = 20 mL (diameter <12.0 mm) or 0.139d2 mL (diameter >12.0 mm) using a linear cigar smoking machine (Borgwaldt).

Aromatic amine analysis:
The aromatic amines in the mainstream smoke were collected on 55 mm SPME disks with a fiber length of 30 mm and made from Divinylbenzene/carboxylic acid copolymer (DVB/CAR/PDMS) (Supelco). The mainstream smoke was collected in the upper phase of the smoke using multimodal SPME fiber. After a specific smoking regime, the sampling fiber was extracted with 1 mL of methanol. The aromatic amines were derivatized with N-Methyl-bis(trifluoroacetamide). Six aromatic amines were determined by SPME headspace GC-MS/MS.

RESULTS
There was a wide range of aromatic amine levels in the MSS of the 50 commercial cigars that were tested. (Figures 2, 3 and 4). The means and concentration ranges of six aromatic amines levels in the three cigar types are shown in Figure 5. On a per cigar basis, the large cigars generated the highest aromatic amines in the MSS while the filtered cigars contained the lowest aromatic amines in three categories of cigars. The aromatic amine yields in the mainstream smoke increased with the TPM increase on a per cigar basis (Figure 6).

CONCLUSIONS
The yields of six aromatic amines (o-TOL, o-AN, 1-AN, 2-AN, 3-ABP, and 4-ABP) in the mainstream smoke from 23 commercial filtered cigars, 16 cigarillos, and 11 large cigars were determined in this study. The aromatic amine yields in the mainstream smoke showed high levels of variation within and between products. The aromatic amines showed a good linear response with TPM on a per cigar basis.

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REFERENCES

Figure 1: Different brands of filtered cigars, cigarillos, and large cigars

Figure 2: Six aromatic amine levels in the filtered cigars’ MSS

Figure 3: Six aromatic amine levels in the cigarillos’ MSS

Figure 4: Six aromatic amine levels in the large cigars’ MSS

Figure 5: The means and concentration ranges of each aromatic amine yield in the filtered cigars, cigarillos, and large cigars’ MSS

Figure 6: The relationship of aromatic amine yield (ng/cigar) in the MSS and TPM (mg/cigar)