Comparison of Juul from the United States and the United Kingdom through an investigation into chemical composition and nicotine concentration

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Background/Aim

- The e-cigarette Juul was invented in 2015.
- The use of Juul in the US has increased dramatically in recent years, with Juul controlling the majority of the e-cigarette market share and teenagers sixteen times more likely to use these products than adults.
- In 2018, Juul spread its advertising and product distribution to the United Kingdom.
- In the United States, Juul is advertised as 5.0% (59 mg/mL) nicotine strength, however in the United Kingdom, as a result of 2016 tobacco and drug regulations, Juul is advertised as only 1.7% (20 mg/mL) nicotine strength.
- The aim of this study is to compare Juul across these two countries through an investigation of chemical composition and nicotine concentration.
- US Flavors: Virginia Tobacco, Cool Mint, Crème Brulee, Mango
- UK Flavors: Golden Tobacco, Glacier Mint, Royal Crème, Mango Nectar

Nicotine Concentration Results

Figure 1: Nicotine in Pod Eliquid

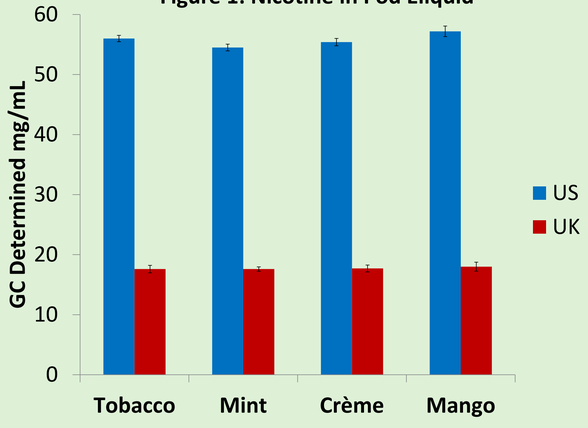


Figure 2: Average Nicotine in Aerosol per Puff

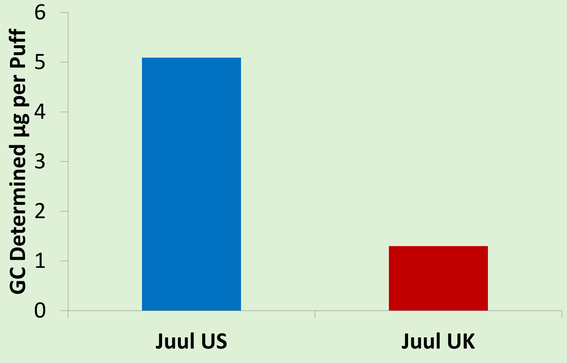
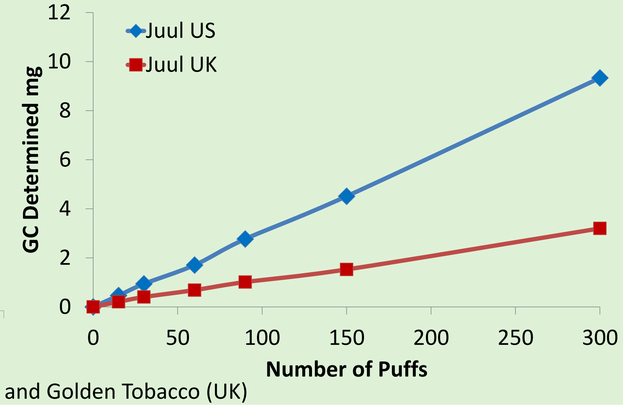


Figure 3: Nicotine in Aerosol per Puff



Juul Pod: Virginia Tobacco (US) and Golden Tobacco (UK)

Methods

Qual + Quant Scan

30ul sample

1mL dichloromethane

GC/MS + QTOF

Nicotine Concentration

30ul sample

3ml methanol and 100ul quinoline

GC/NPD

500ul sample of aerosol diffused in 200mL methanol and quinoline

- Qualitative Scan, analyzed via Agilent 7890A/5977B GC/MS, and Nicotine Concentration, analyzed via Agilent 7890A GC/NPD, were tested using in-lab developed methods.
- Aerosol was generated with Borgwaldt smoking machine, following the modified HCI puff protocol (55mL, 3sec, 30sec)

Chemical Composition Results

Figure 4: Solvent, Salt and Flavoring Compounds

	US	UK	US	UK	US	UK	US	UK
	Virginia Tobacco	Golden Tobacco	Cool Mint	Glacier Mint	Crème Brulee	Royal Crème	Mango	Mango Nectar
PG:VG	40:60	40:60	40:60	40:60	40:60	40:60	40:60	40:60
Salt	All Products Contained Nicotine Benzoate							
Total Flavorings	10	32	47	39	20	36	34	28
Flavorings Found in the US/UK (µg/mL)	Trimethyl pyrazine (39.6)	Trimethyl pyrazine (26.1)	Eucalyptol (105.0)	Eucalyptol (59.7)	Trimethyl Pyrazine (<19.5)	Trimethyl Pyrazine (<19.5)	Benzyl Alcohol (27.0)	Benzyl Alcohol (1050.0)
	Acetyl Pyridine	Acetyl Pyridine	L-Menthol (9789.9)	L-Menthol (7124.1)	Vanillin (6457.4)	Vanillin (<625.0)	Styralyl Acetate	Styralyl Acetate
Differing Flavorings (µg/mL)	2-Pentenal (E)	Ethyl Maltol (770.5)	Benzyl Alcohol (694.9)	Pyrrolidine	Ethyl Maltol (<625.0)	Benzyl Alcohol (41.0)	Ethyl Maltol (1168.9)	2-Pentenal

Conclusions

1. The nicotine concentration in both the eliquid and the aerosol emitted by Juul from the United States is about three times higher than that from the United Kingdom, proportional to the difference in advertised strengths, 5.0% (59 mg/mL) to 1.7% (20 mg/mL).
2. The rate of at which nicotine is emitted into the aerosol is similarly linear with Juul from both the United States and the United Kingdom.
3. The prevalent flavoring compounds in the corresponding Juul products from the United States and the United Kingdom are very similar.
4. Juul from the United Kingdom is in accordance with all of the provisions of the 2016 tobacco and drug regulations, including an incredibly standardized nicotine concentration below 20 mg/mL, as well as a standardized rate of nicotine delivery into the aerosol.

Funding/Conflict of Interest

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