Nearly 20 000 e-liquids and 250 unique flavour descriptions: an overview of the Dutch market based on information from manufacturers

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METHODS

Flavour classification

E-liquids were classified in a consistent manner according to our recently developed e-liquid flavour wheel [1]. The flavour wheel consists of an inner wheel with 16 main categories: *tobacco*, *menthol/mint*, *nuts*, *spices*, *coffee/tea*, *alcohol*, *other beverages*, *fruit-berries*, *fruit-citrus*, *fruit-tropical*, *fruit-other*, *dessert*, *candy*, *other sweets*, *other flavours*, and *unflavoured*. In the outer wheel, the main categories are further specified using subcategories. Because the subcategories of the published flavour wheel are not all-encompassing, flavour descriptions that did not match the existing subcategories were regarded new subcategories.

Following the approach described in the flavour wheel publication [1], primary and secondary e-liquid flavour descriptors were distinguished. An e-liquid's primary flavour descriptor was defined as the flavour descriptor associated with a particular (food or other) product as a whole (e.g., 'piña colada' or 'bubble gum'). Primary flavour descriptors were classified into one of the 16 main categories (inner wheel) and in one of the subcategories (outer wheel). Thus, e-liquids with piña colada as primary flavour descriptor would be classified in the main *alcohol* category and in the piña colada subcategory.

If the flavour description does not relate to one product as a whole, but contains several separate attributes (e.g., 'strawberry with a hint of menthol and kiwi'), the e-liquid contains secondary flavour descriptors. In such case, the first flavour mentioned was considered the primary flavour descriptor (strawberry) and any other attributes were secondary flavour descriptors (menthol and kiwi). Secondary descriptors, if present, were classified into a subcategory only (outer wheel).

Subcategories were not allowed to encompass brand names (e.g. 'skittles' or 'red bull'), tastes (sweet, sour, bitter, salt, umami), or colors. Information regarding a specific country or area was not used for classification, unless it represented a well-known product type such as American tobacco. Along the classification process, the terms 'ice' ore 'iced' in a brand name appeared to be used to describe a fresh, menthol flavour. Therefore, e-liquids referred to with these terms were consistently classified as having a secondary menthol flavour.

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RESULTS

Table S1: The number of e-liquids within each of the 245 defined subcategories within the 16 main flavour categories.

The main flavour categories were based on our previously published e-liquid flavour wheel [1].

Main Flavour Category	Subcategory	Number of e-liquids
Tobacco (n=2667)	tobacco	1624
	american blend	347
	virginia	175
	cigar	119
	oriental	109
	roll-your-own	44
	pipe	38
	cigarette	36
	burley	27
	shisha	26
	black tobacco	23
	flue-cured	23
	cavendish	20
	kentucky	19
	latakia	11
	kretek	10
	cigarillo	8
	arabian blend	7
	snuff	1
Menthol/mint (n=1240)	menthol	601
	mint	415
	spearmint	103
	peppermint	84
	eucalyptus	19
	wintergreen	12
	horehound	6
Nuts (n=179)	hazelnut	74
	peanut butter	35
	pistachio	23
	peanut	19
	almond	14
	nut	8
	chestnut	3

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	hazelnut spread	3
Spices (n=176)	anise	67
	cinnamon	51
	licorice	46
	ginger	12
Coffee/tea (n=467)	coffee	206
	cappuccino	99
	espresso	34
	black tea	31
	caffè latte	27
	tea	14
	green tea	13
	mint tea	11
	chai	10
	jasmine tea	10
	caffè mocha	5
	earl grey tea	4
	medina tea	3
Alcohol (n=386)	pina colada	82
	rum	57
	mojito	52
	bourbon	25
	amaretto	24
	irish cream	24
	champagne	18
	cocktail	15
	crème de menthe	15
	whisky	15
	absinthe	11
	cider	9
	gin	5
	wine	5
	egg liqueur	4
	gluhwein	4
	ouzo	4
	sex on the beach	4
	blue curacao	3
	eggnog	3
	malibu	3
	crème de cassis	2
	gin tonic	2
Other beverages (n=915)	cola	204
	energy drink	157
	lemonade	152
	milk	89
	milkshake	71
	soda	37
	cassis	35
	smoothie	34
	slush	27

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	apple juice	17
	punch	15
	grenadine	14
	buttermilk	11
	grape juice	11
	iced tea	11
	tropical juice	6
	chocolate milk	5
	fruit drink	5
	watermelon juice	4
	orange juice	3
	tonic	3
	cactus juice	2
	root beer	2
Fruit – Berries (n=2164)	strawberry	795
	blueberry	448
	raspberry	383
	berry	141
	blackcurrant	94
	blackberry	87
	forest fruit	69
	mixed berries	58
	red currant	44
	cranberry	15
	waterberry	8
	boysenberry	7
	loganberry	7
	dewberry	4
	gooseberry	4
Fruit – Citrus (n=743)	lemon	259
	orange	209
	lime	111
	citrus fruit	71
	grapefruit	58
	tangerine	25
	blood orange	10
Fruit – Tropical (n=1173)	mango	229
	banana	222
	pineapple	198
	coconut	116
	kiwi	108
	passion fruit	88
	mixed tropical fruit	61
	guava	36
	lychee	35
	tropical fruit	29
	dragon fruit	25
	papaya	16
	pawpaw	10
Fruit – Other	apple	597

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(n=2506)	cherry	415
	peach	327
	watermelon	299
	mixed fruit	195
	grape	154
	melon	151
	pear	108
	red fruit	82
	pomegranate	40
	apricot	36
	honeydew melon	34
	fruit	17
	raisin	13
	fig	10
	plum	10
	nectarine	8
	cactus	7
	star fruit	3
Dessert	cream	251
(n=1710)	cake	198
	custard	183
	cookie	166
	cereal	107
	cheesecake	101
	donut	80
	pie	64
	yoghurt	53
	ice cream	46
	apple pie	44
	sorbet	44
	cinnamon roll	38
	bonbon	25
	pudding	21
	biscuit	20
	pastry	20
	waffle	19
	strudel	17
	dough	16
	pancake	15
	merengue	14
	cupcake	13
	churros	12
	muffin	12
	rice crisps	12
	bavarian cream	11
	crème brûlée	11
	nougat	11
	baked apple	9
	smore	9
	cannoli	8

	rice pudding	8
	crêpe	7
	red velvet cake	7
	cereal bar	5
	dulce de leche	5
	gingerbread	5
	crème anglais	4
	croissant	4
	macaron	3
	scone	3
	tiramisu	3
	tompouce	3
	praline	2
	galaktoboureko	1
Candy (n=771)	bubble gum	163
	fruit candy	90
	tutti frutti	62
	licorice candy	61
	hard candy	53
	cotton candy	51
	chewing gum	45
	toffee	39
	gummy bear	38
	marshmallow	27
	butterscotch	20
	mint candy	19
	popcorn	18
	candy	16
	candy cane	14
	chew candy	13
	peanut butter cup	12
	lollipop	9
	wine gum	8
	marzipan	5
	turkish delight	5
	jawbreaker	3
Other sweets (n=768)	vanilla	364
	chocolate	170
	caramel	115
	honey	73
	cocoa	15
	sugar	15
	white chocolate	11
	mocha	5
Other flavours (n=169)	woodruff	39
	jam	21
	rhubarb	21
	cannabis	20
	cucumber	16
	flowers	7

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	violet	7
	bread	5
	sandwich	5
	aloë vera	4
	cherry blossom	4
	fennel	4
	lavender	4
	hibiscus	3
	honeysuckle	3
	roses	3
	verbena	3
Unflavoured (n=266)	pg/vg base	266

DISCUSSION

Strengths and limitations of the data source and approach to flavour classification

The EU-CEG system provides access to an extensive collection of information regarding all tobacco products and e-cigarettes that have been marketed in each European Member State. Such information provides a unique opportunity to obtain insight in various aspects of the European e-cigarette and tobacco product market. For instance, it allows analyses on branding, ingredients, and emissions of products that are currently on the market as well as of products that have been removed from the market. In this way, trends in tobacco products and e-cigarettes can be monitored, such as the emergence of new products or changes in composition as a consequence of new regulations. Therefore, the EU-CEG system can be a highly valuable tool in monitoring the market, provided that manufacturers consistently and regularly update the data on their products. This is especially important in a constantly changing and expanding market, as the one for e-cigarettes.

It should be noted that marketing-related information that could be used to determine an e-liquid's primary flavour descriptor may differ between the EU-CEG system and web shops, and between web shops. E-liquids currently classified using information from the EU-CEG system may therefore have been classified in a different main flavour category if they were to be searched for online. In addition, the primary flavour descriptor that was used for classification may not be a complete representation of an e-liquid's flavour. This is due to fact that only the first flavour descriptor mentioned was selected for classification of e-liquids containing multiple flavour descriptors, because e-liquids can be classified in only one main category. Thus, for a careful interpretation of results, it should be taken into account that classification of e-liquids by marketed flavour descriptions depends on the source of information.

Moreover, as flavour-related information from the EU-CEG system is limited, the number of secondary flavour descriptors may have been underestimated. Information about e-liquids that were described with at least one secondary flavour descriptor (approximately 30%), was mostly obtained using the Internet search. If flavour descriptions of more e-liquids were to be searched

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for online or if the EU-CEG system would contain more extensive flavour-related information, we expect the number of secondary flavour descriptors to be higher.

In this study, the e-liquid flavour wheel was used and proved to be a useful tool for classification of e-liquids by flavour description. Future research using e-liquid flavour categories may consider to more precisely structure the *dessert* category, as it contained many different flavour descriptions, varying from pastries (e.g., cinnamon roll, croissant, doughnut), cakes, and pies to dairy flavours (e.g., yoghurt, (ice) cream, pudding) and treats (e.g., praline, cookies, nougat). For example, a sub-classification by type of dessert could be included (similar to the division of the fruit category into berries, citrus, tropical, and other types of fruits), or separate main categories representing these different types of flavours could be created. Furthermore, some dessert-related flavour descriptions could be classified in new main categories that could also be used to classify certain flavours that were part of the *other flavours* category in this study. For instance, flavour descriptions such as sandwich and bread could be combined with cereal from the *dessert* category into a new main *grains-related* category. Additional main categories related to *plants*, *flowers*, and/or *vegetables* could be considered as well.

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References

[1]   Krusemann EJZ, Boesveldt S, de Graaf K*, et al.* An E-liquid Flavor Wheel: A Shared Vocabulary based on Systematically Reviewing E-liquid Flavor Classifications in Literature. *Nicotine Tob Res* 2018.