

Supplemental information

Flavors and flavorings in waterpipe products: a comparison between tobacco, herbal molasses and steam stones

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249 waterpipe tobacco products were registered in EU-CEG in The Netherlands in March 2019. These products contain a total of 378 unique ingredients. The 25 most frequently added ingredients of waterpipe tobacco, as registered in the EU-CEG database, are listed below (Table S1).

Table S1. The 25 most frequently added ingredients in EU-CEG registered waterpipe tobacco products (March 2019, The Netherlands). Shown in this table are ingredient names, prevalence, median concentration per product (mg/g) flavor descriptions (from the Leffingwell database) and additive functions. N/A = not applicable.

| Ingredient name | Prevalence | Median conc. (mg/g) | Flavor description | Function |
|--------------------------|------------|---------------------|--|-----------------------------------|
| Glycerol | 100% | 434 | N/A | Solvent, humectant, bodying agent |
| Propylene glycol | 62% | 17.0 | N/A | Solvent, humectant, bodying agent |
| Water | 63% | 1.27 | N/A | Solvent, humectant |
| Vanillin | 59% | 0.31 | Sweet, powerful, creamy, vanilla-like | Flavoring |
| Ethyl alcohol | 49% | 0.01 | N/A | Solvent |
| Ethyl vanillin | 47% | 0.02 | Intense, sweet, vanilla-like odor; creamy, vanilla taste | Flavoring |
| High fructose corn syrup | 44% | 357 | Sweet | Bodying agent, flavoring (sugar) |
| Caramel | 44% | 0.006 | Primarily used for coloring purposes; little taste as used | Flavoring (sugar), color |
| Potassium sorbate | 44% | 0.003 | N/A | Preservative |

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|---|-----|-------|--|------------------------------|
| Synthetic amorphous silica | 44% | 4.00 | N/A | Anticaking agent |
| FD&C red | 43% | 0.25 | N/A | Dye |
| Dihydrocoumarin | 41% | 0.001 | Very, sweet, nut-like, hay-like, coumarin-tobacco like odor | Flavoring |
| Ethyl butyrate | 40% | 1.24 | Ethereal, fruity with buttery-pineapple-banana, ripe fruit and juicy notes | Flavoring |
| Ethyl acetate | 34% | 0.49 | Ethereal, sharp, wine-brandy-like | Flavoring |
| Unspecified flavors | 31% | 50.0 | N/A | Mixture, various ingredients |
| Ethyl-2-methylbutyrate | 31% | 0.54 | Strong, green, fruity, apple with strawberry notes | Flavoring |
| Maltol | 27% | 0.22 | Sweet, fruity, berry, strawberry, caramellic | Flavoring |
| Isoamyl acetate | 25% | 1.10 | Sweet, fruity, banana, pear odor & taste | Flavoring |
| Menthol | 25% | 0.76 | String trigeminal cooling sensation with a slight mint note | Flavoring |
| Benzyl alcohol | 24% | 1.26 | Faint, sweet, almond fruity, somewhat chemical | Flavoring |
| Benzaldehyde | 23% | 0.07 | Floral, hay-like odor; sweet anisic-vanilla-fruity herbaceous | Flavoring |
| Sucrose | 23% | 280 | Sweet | Flavoring (sugar) |
| Citric acid | 23% | 0.72 | N/A | Preservative |
| Sodium benzoate | 23% | 0.70 | N/A | Preservative |
| 4-(4-Hydroxyphenyl)-2-Butanone (raspberry ketone) | 20% | 0.61 | Very sweet, fruity odor and taste reminiscent of raspberry | Flavoring |

Next, ingredients from EU-CEG were sorted from highest to lowest median concentration (mg/g). After exclusion of the following ingredients (non-flavorings and sugars): glycerol, high fructose corn syrup, glucose, molasses, sucrose, fructose, 1,2-propylene glycol, triethyl citrate, alpha-tocopherol, synthetic amorphous silica, sunflower oil, acetic acid, malt extract, carmoisine and water only flavorings (including mixtures such as oils and extracts) were left and a top 25 is depicted in Table S2.

Table S2. This table shows 25 flavorings sorted on their median concentrations (from high to low) for EU-CEG registered waterpipe tobacco products (March 2019, The Netherlands). Listed in this table are ingredient names, median concentration per product (mg/g), prevalence and flavor descriptions (from the Leffingwell database).

N/A = not applicable, ^a = not found in Leffingwell database, but flavor/taste descriptions obtained from thegoodscentscompany.com

| Ingredient name | Median conc. (mg/g) | Prevalence | Flavor description |
|-----------------------------|---------------------|------------|---|
| Unspecified flavors | 50.0 | 30.9% | N/A |
| Pineapple essence | 20.0 | 0.8% | Sweet pineapple |
| Allyl cyclohexyl propionate | 19.6 | 0.8% | Sweet-fruity pineapple-like odor and taste |
| Dodecanal | 12.0 | 2.4% | Sweet, clean floral waxy odor; somewhat fatty-citrus woody flavor |
| Terpineol | 12.0 | 2.4% | Sweet, floral (lilac), lime odor; very sweet taste in dilution |
| Citronellal | 10.0 | 3.6% | Fresh, green, citrus-lemon, woody; citronella oil-like |
| Banana distillates | 10.0 | 0.4% | Taste: Estery banana character. Full ripe banana flavor.banana ^a |
| Licorice | 10.0 | 0.4% | Sweet, caramel, spicy, "root-like" odor; very sweet flavor |
| Orange oil | 8.2 | 16.5% | Fresh, sweet, terpeny citrus |
| Triacetin | 3.8 | 16.9% | Very weak ethereal-fruity odor; a mild sweet taste; normal use as solvent |
| Turpentine oil | 3.4 | 1.6% | Peculiar, pine solvent, warm-balsamic, refreshing odor |
| Hexyl acetate | 2.8 | 0.4% | Sweet, fruity, pear-apple like odor; green, banana, apple-pear like taste |
| Commint oil | 2.5 | 11.2% | Peppermint-like odor & flavor |
| Estragol | 2.5 | 0.8% | Odor: sweet sassafrass anise spicy green herbal fennel; flavor: sweet licorice phenolic weedy spicy celery ^a |
| Cis-3-hexenyl propionate | 2.3 | 0.8% | Sweet green, waxy, vegetable character, apple, pear, citrus notes |
| Anethole | 2.2 | 11.2% | Sweet, herbaceous, anise (artificial Licorice) odor & taste |
| L-Carvone | 2.1 | 5.2% | Spearmint odor & taste |
| Spearmint oil | 1.9 | 5.2% | Warm characteristic spearmint herbaceous odor with a sharp taste |
| Mint oil | 1.8 | 2.8% | Odor: cornmint ^a |
| Cocoa extract | 1.5 | 0.8% | Cocoa/chocolate aroma and flavor |
| Peppermint oil | 1.5 | 5.2% | Sweet, fresh, peppermint (minty) aroma and cooling taste |
| Cinnamyl acetate | 1.4 | 0.4% | Sweet, balsamic, floral-fruity odor; slightly cinnamic spicy |
| Amyl butyrate | 1.4 | 2.8% | Strong, fruity, apple, banana, apricot, mixed fruit flavor |
| Methyl 2-methylbutyrate | 1.3 | 0.8% | Fruity, sweet, apple, berry, ripe tropical notes |
| Citral | 1.3 | 15.3% | Strong, lemon-like aroma and taste |