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Eugenol, menthol and other flavour chemicals in kreteks and 'white' cigarettes purchased in Indonesia

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ABSTRACT

Background Flavoured tobacco products are not restricted in Indonesia, a country with about 68 million adults who smoke. Most use clove-mixed tobacco cigarettes ('kreteks'); non-clove ('white') cigarettes are also available. Although the use of flavour chemicals has been identified by WHO as promoting tobacco use, little has been reported for Indonesia about the levels of flavourants in either kreteks or 'white cigarettes'.

Methods 22 kretek brand variants and nine 'white' cigarette brand variants were purchased in Indonesia during 2021/2022; one of the kretek packs contained three colour-coded variants, giving a total sample number of 24 for the kreteks. Chemical analyses gave the mg/stick (=mg/(filter+rod)) values for 180 individual flavour chemicals that included eugenol (a clove-flavoured compound), four other clove-related compounds and menthol.

Results Eugenol was present at significant levels in all 24 kreteks (2.8–33.8 mg/stick), but was essentially absent in all of the cigarettes. Menthol was present in 14 of 24 kreteks, with levels ranging from 2.8 to 12.9 mg/stick, and in five of the nine cigarettes, with levels ranging from 3.6 to 10.8 mg/stick. Other flavour chemicals were also found in many of the kretek and cigarette samples.

Conclusions In this small sample, we found numerous variations of flavoured tobacco products offered by multinational and national companies in Indonesia. Given the body of evidence that flavours make tobacco products more appealing, regulation of clove-related compounds, menthol and other flavour chemicals should be considered in Indonesia.

INTRODUCTION

A key aim of WHO Framework Convention on Tobacco Control is to reduce the appeal of tobacco products¹: Article 9 states: 'From the perspective of public health, there is no justification for permitting the use of ingredients, such as flavouring agents, which help make tobacco products attractive.'² As of September 2022, twenty-three countries plus the European Union (EU) have implemented policies restricting flavour chemicals in tobacco products.^{3,4}

Indonesia is a country with one of the largest numbers of people who smoke, with 34% of Indonesians aged 15+ using tobacco in 2018.⁵ About 73% of people who smoked tobacco in Indonesia in 2014 smoked clove-mixed tobacco cigarettes known as 'kreteks'.⁶ In Indonesia, non-clove cigarettes are referred to as 'white' cigarettes (henceforth herein simply 'cigarettes').⁷ Kreteks have been found to result in higher exposures to particulate

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Despite the high societal costs of tobacco use, flavour chemicals are being used worldwide to increase the appeal of tobacco products.
- ⇒ Little is known about the flavour ingredients in tobacco products sold in most countries.

WHAT THIS STUDY ADDS

- ⇒ Consumers in Indonesia are offered a range of flavour chemical profiles that include clove-related compounds (eg, eugenol), menthol and other added flavour chemicals.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ The variety of flavour profiles in kreteks/cigarettes may encourage use and expand the user base.
- ⇒ Regulation of clove and other flavour chemicals should be considered in Indonesia.

matter, nicotine, tar and carbon monoxide per stick than cigarettes.^{8,9} Inhaling eugenol—the primary flavouring chemical in kreteks—has been linked to a number of animal and human toxicity endpoints¹⁰ including haemorrhagic pulmonary oedema, respiratory infection and severe inflammation.

Flavoured tobacco products are not restricted in Indonesia,¹¹ and flavour chemical levels in Indonesian kreteks and cigarettes have been scarcely studied to date. This is despite the nexus that exists between the use of flavouring agents in tobacco products in Indonesia and the associated healthcare and human and costs (~US\$1.6 billion in 2019¹² and ~225 000 tobacco-related deaths per year¹³). Two studies assessing Indonesian kreteks found the clove-related compounds eugenol, anethole and coumarin.^{14,15} Eugenol was consistently present at high levels in clove cigarettes purchased in the EU, and in the USA when clove cigarettes were available there.^{16,17} Three of the four aforementioned studies^{14,16,17} evaluated compounds in cigarettes purchased in the USA and Europe, not in Indonesia. The one study on kreteks and cigarettes purchased in Indonesia only examined a few flavour chemicals.¹⁵

Here, we determine and compare the identities and levels of 180 flavour chemicals in kretek and cigarette brand variants purchased in Indonesia. The findings may inform product regulation that has the potential to reduce tobacco-caused death and disease in Indonesia.



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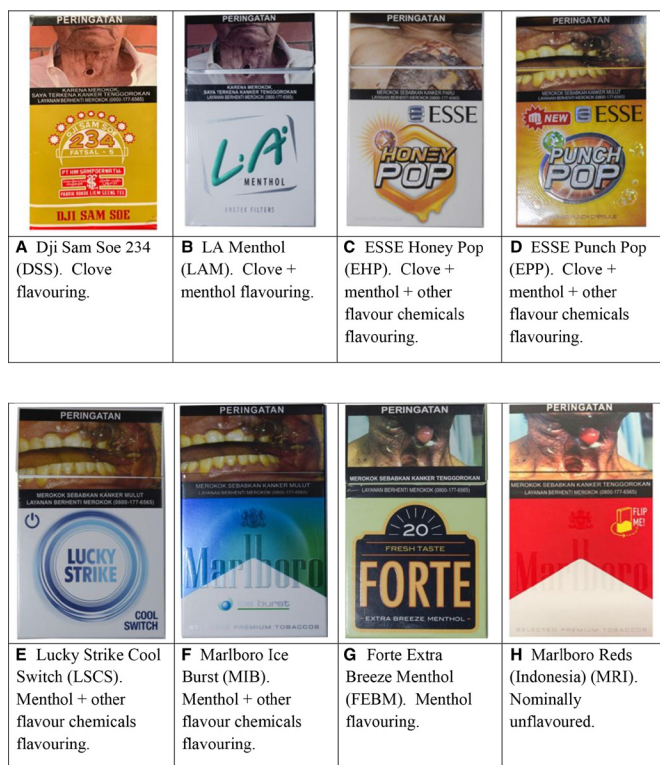


Figure 1 Pack photos of four of the kreteks (A–D) and four of the cigarettes (E–H) examined in this work. (Photos of all the kretek packs are provided in online online supplemental figures S1.a–S24.a and photos of all the cigarette packs are provided in online supplemental figures S25.a–S33.a.

METHODS

Sample: kreteks and cigarettes

Convenience samples of 10 packs of cigarettes and 22 packs of kreteks were purchased in four Indonesian cities at different convenience stores and a small independent grocer in March 2021 and in January 2022. Additional packs were purchased in 2022 to supplement the kretek sample. Packs were chosen to include possibly unflavoured products (based on their packaging), as well as products with ‘menthol’ and concept descriptors as part of their brand variant names or packaging. A product was identified here as a ‘kretek’ if its pack was marked with either ‘SKM’ (machine-rolled kretek) or ‘SKT’ (hand-rolled kretek), the two main types of kreteks sold in Indonesia.¹⁸ One of the kretek packs was a sampler pack containing three colour-coded variants, resulting in 24 unique kreteks. On purchase, packs were put into ‘barrier foil’ Ziplock pouches and shipped by courier to Portland State University for analysis. For every sample, the presence/absence of a filter was noted as was the number of flavour capsules in the filter (if present). On receipt, the samples were stored at 4°C until analysed. Products were extracted and analysed within 1 week of receipt.

Analytical methods

Following our prior work,¹⁹ for each analysis of a brand variant, two sticks were separated into the filter (if present) and rod sections; analysis in duplicate required four sticks. Flavour capsule(s) (if present) were crushed and extracted with the filters using isopropanol; the rod sections were extracted separately. Each extract was analysed for 180 target flavour compounds by

gas chromatography/mass spectrometry (GC/MS). Standard runs and blank runs were used extensively for quality control.

Of the 180 target analytes, five were clove related: eugenol, eugenol methyl ether (also known as methyl eugenol), β -caryophyllene, α -caryophyllene and acetyl eugenol. Eugenol was the predominant clove-related flavour chemical in this sample of kreteks, averaging 87% of the total mass for the five clove compounds (SD=4%). Menthol was also determined, as were 172 ‘other flavor chemicals’. We grouped 105 of the other flavour chemicals as ‘fruit flavour’ chemicals based on information in the Good Scents Company Information System.²⁰

Reported values

Reported data values were calculated as averages for the duplicate extractions. Each value is a confirmed GC/MS result based on authentic standards (ie, matches between sample and standard runs for GC retention time and MS fragmentation pattern), with the final internal standard-corrected quantitation value based on calibration standards. Values for nicotine are not reported because the extraction method was not optimised for alkaloids. Flavour chemical values near 0.001 mg/stick should be viewed as estimated as they were generally below the analytical calibration range. The reporting limit for this work was set at 0.001 mg/stick; lesser values are given as ‘not determined’.

RESULTS

Sample characteristics

Eleven of the 24 kretek variants had one or more flavour capsules; three of the nine cigarette variants had one capsule. One of the kretek packs (ESSE Shuffle Pop) was a ‘sampler’ pack that indicated the presence of five different colour-coded variants; opening each filter revealed a single flavour capsule but only green, orange and brown capsules were found. The filter, rod and stick (=filter+rod) weight values for each product are available from the authors.

Photographs of four examples each of the kretek and cigarette packs are provided in [figure 1](#). Photographs of all packs with opened filters, showing the crushable capsules if present, are provided in online supplemental figures S1.a–S24.a for the kreteks and in online supplemental figures S25.a–S33.a for the cigarettes.

Chemical analytes

[Table 1](#) summarises the concentrations of selected flavour chemicals and chemical groups in the samples, with the kreteks and cigarettes categorised by the presence/absence of menthol and the presence/absence of at least one flavour capsule. The detailed analytical results for the 180 compounds for all of the samples are available from the authors.

[Figure 2](#) is a stacked bar graph giving the mg/stick values for the sum of five clove compounds, menthol and other flavour chemicals for all of the samples. A flavour chemical ‘heat map’ for the kreteks for the 130 compounds detected at least once at 0.001 μ g/stick is provided in online supplemental figure S34. With the variants ranked in decreasing eugenol level, the eugenol pixels become less bright (ie, less red and more green) going from left to right. A corresponding heat map for the cigarettes is provided in online supplemental figure S35. Eugenol and menthol had a high presence in most of the kretek variants. In cigarettes, menthol was largely found at higher levels compared with other compounds. For the kreteks, the levels of eugenol methyl ether (133), β -caryophyllene (138), α -caryophyllene (α -humulene, 148) and acetyl eugenol (eugenol acetate,

Table 1 Median concentrations (mg/stick) of flavour chemicals in kreteks (n=24) and cigarettes (n=9) purchased in Indonesia between March 2021 and January 2022

| | n | Eugenol Median (min, max) | Five clove compounds* Median (min, max) | Menthol Median (min, max) | Other flavour chemical† Median (min, max) | Fruit flavour chemical‡ Median (min, max) |
|---------------------------|----|---------------------------|---|---------------------------|---|---|
| Kreteks | | | | | | |
| Total | 24 | 13.1 (2.5, 31.0) | 15.0 (2.8, 33.8) | 3.6 (0.0, 12.9) | 0.9 (0.0, 7.2) | 0.5 (0.0, 7.0) |
| Menthol | | | | | | |
| Yes | 14 | 12.1 (6.7, 14.9) | 14.3 (7.9, 17.1) | 4.3 (2.8, 12.9) | 1.3 (0.1, 7.2) | 0.8 (0.0, 7.0) |
| No | 10 | 15.1 (2.5, 31.0) | 18.4 (2.8, 33.8) | 0.0 (0.0, 0.0) | 0.3 (0.0, 1.9) | 0.2 (0.0, 1.1) |
| Flavour capsule(s) | | | | | | |
| Yes§ | 11 | 11.3 (6.7, 14.2) | 13.8 (7.9, 16.1) | 4.5 (3.4, 7.0) | 1.4 (0.4, 7.2) | 1.3 (0.2, 7.0) |
| No | 13 | 13.8 (2.5, 31.0) | 17.1 (2.8, 33.8) | 0.0 (0.0, 12.9) | 0.3 (0.0, 1.9) | 0.2 (0.0, 1.1) |
| Cigarettes | | | | | | |
| Total | 9 | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.1) | 3.6 (0.0, 10.8) | 0.0 (0.0, 2.2) | 0.0 (0.0, 6.7) |
| Menthol | | | | | | |
| Yes | 5 | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.1) | 6.4 (3.6, 10.8) | 0.9 (0.0, 2.2) | 0.0 (0.0, 1.0) |
| No | 4 | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.0) | 0.0 (0.0, 6.7) |
| Flavour capsule | | | | | | |
| Yes¶ | 3 | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.0) | 9.5 (6.4, 10.8) | 1.1 (1.0, 2.2) | 0.2 (0.0, 1.0) |
| No | 6 | 0.0 (0.0, 0.0) | 0.0 (0.0, 0.0) | 0.0 (0.0, 4.0) | 0.0 (0.0, 0.1) | 0.0 (0.0, 6.7) |

*Sum for five clove-related compounds: eugenol, eugenol methyl ether, β -caryophyllene, α -caryophyllene (α -humulene) and acetyl eugenol (eugenol acetate).

†Sum for 172 flavour chemicals that do not include the five clove-related compounds, menthol, triacetin and triethyl citrate.

‡The 105 'fruit flavour' chemicals were identified based on information in the Good Scents Company Information System.²⁰

§One variant had two capsules and 10 variants had one capsule each.

¶All variants contained one capsule each.

159) were all generally correlated with that of eugenol (online supplemental figure S36). None of the cigarette variants were found to contain any of the five clove compounds at levels above the reporting limit (0.001 mg/stick).

For the ESSE Shuffle Pop kretek sampler pack, the three versions (green, orange and brown) had similar levels of eugenol. The menthol levels were more variable at 6.8, 4.5 and 5.1 mg/stick, respectively. For the other flavour chemicals at 1.4, 3.2

and 1.3 mg/stick, respectively, the flavour chemical profiles were indeed distinctly different indicating an effort to offer the consumer customised flavour options.

DISCUSSION

This study found that, even in a small convenience sample, a wide range of flavoured kreteks and cigarettes are being sold in Indonesia, marketed by both multinational and national tobacco companies. Menthol and other flavour chemicals were found in the clove-flavoured kreteks, potentially increasing appeal among some users. Of the convenience sample of 24 kretek variants, we identified 4 that were just clove flavoured, 2 were clove plus menthol (both of these included 'menthol' in their brand variant name), 6 were clove plus other flavour chemicals and 12 were clove plus menthol plus other flavour chemicals, with all but one of these 12 containing flavour capsules. Of the nine cigarettes, none had clove flavourings, two contained menthol (both with 'menthol' in their brand variant name), three contained menthol plus other flavour chemicals (all three contained flavour capsules) and four were nominally unflavoured (including Marlboro Reds).

The results describe the flavour profiles of a convenience sample of kreteks and cigarettes recently available for sale in Indonesia but cannot be generalised to all kreteks and cigarettes sold in Indonesia. Nonetheless, the findings demonstrate that an extensive variety of flavoured smoked products are available for sale. Further, we have shown that flavour profiles can vary even within a pack (ie, the pack that included kreteks with three different colours of capsules).

Overall, our findings are consistent with previous studies which demonstrate high levels of eugenol in kreteks.^{14–16} The major difference between our sample here as compared with a previously studied sample of Mexican cigarettes¹⁹ is the wide availability of kreteks with their generally heavy clove flavouring. Even so, as with the Mexican samples, here we found that it has

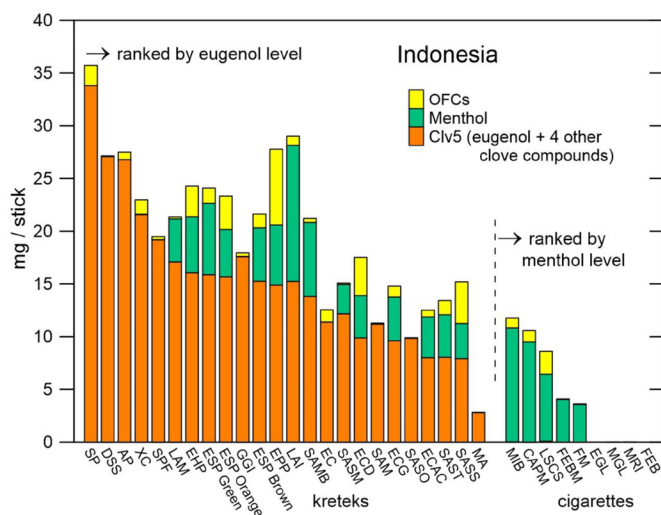


Figure 2 Stacked bar graph for kreteks and cigarettes giving mg/stick values for Clv5 (eugenol plus four other clove-related compounds), menthol and other flavour chemicals (OFCs—the 180 target analyte flavour chemicals minus the five clove-related chemicals+menthol+triacetin+triethyl citrate). The x-axis labels represent the abbreviated names of the unique brand variants analysed; the full brand names and their respective abbreviations can be found in the online supplemental figures.

been considered attractive to add other flavour chemicals with fruity, vanilla and other characteristics.

It is important for Indonesian regulators to address the appeal of kreteks and other tobacco products by banning the use of flavour chemicals, given their connection to increased tobacco consumption and associated societal costs. Research has shown that banning flavoured tobacco products, including menthol, can reduce their use and increase quit attempts; public support for this type of policy intervention has been found in at least two countries.^{21–23}

In addition to the actual flavours in tobacco products, research has found that consumer appeal is influenced by the presence of flavour descriptors, imagery and colours on the product packaging.^{24–25} In this sample of kreteks and cigarettes from Indonesia, we observed that many of the packs of flavoured products had bright colours and designs similar to those that have been found to be appealing to youth.^{26–28} Thus, restrictions on the use of imagery, descriptors and colours that may connote flavours, including those with concept descriptors, could be a valuable complement to tobacco flavour bans.

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