Effect of Next Generation Tobacco Products on Teeth Colouration

#1568

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Introduction

- Cigarette smoking is associated with changes in the oral cavity including tooth discolouration [1]
- Next generation tobacco and nicotine products (NGPs) such as e-cigarettes (e-cig) and tobacco heating products (THP) have rapidly increased in popularity over the last decade
- There is also a growing consensus that NGPs hold great potential for reducing the risk associated with cigarette smoking [2-3]
- However, the effects of e-cig and THP aerosols on the oral cavity or tooth discolouration are unknown

Products

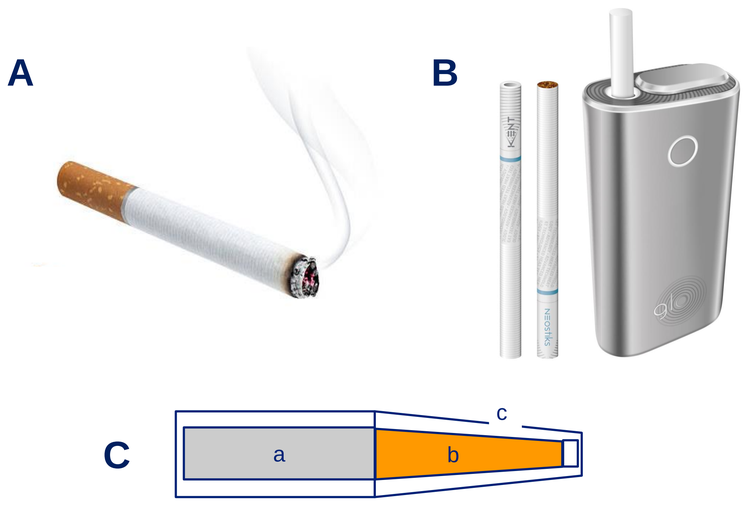

Figure 1: Products assessed for enamel discolouration *in vitro.* A) 3R4F Kentucky scientific reference cigarette (https://ctrp.uky.edu/), B) Glo™ commercial THP with Bright Tobacco Neostick™, C) Schematic of BAT Prototype e-cig, a: battery, b: consumable (containing e-liquid with 5 mg/mL nicotine and flavours), c: device body.

Methods

Total particulate matter (TPM) generation

- Products were attached to a linear smoke machine and smoke/aerosol captured on Cambridge filter pads (CFP)
- The puffing regimes used were:
  - 3R4F cigarette and Glo™: Health Canada Intense [4] - 55 mL puff volume, 2 sec puff duration, 30 sec puff interval. Filter ventilation was blocked on 3R4F products
  - Prototype e-cig: CORESTA recommended method No. 81 [5] - 55 mL puff volume, 3 sec puff duration, 30 sec puff interval
- Figure 2A details representative Cambridge filter pads with collected aerosol
- The smoke/aerosol captured on CFPs were eluted using DMSO (Figure 2B)

Figure 2. A) Representative CFP from 3R4F (10 puffs), Glo™ (48 puffs), e-cig (500 puffs) and blank. B) 3R4F TPM eluted in DMSO.

Enamel block preparation

- Enamel blocks (6.5 x6.5 mm) were cut from bovine incisors and polished using 400-grit silicon carbide paper to produce a surface finish similar to human enamel (Ra=~0.5µm)
- Blocks were sonicated in deionised water for 2 minutes and then stored in phosphate-buffered saline (PBS)
- Blocks were incubated with sterile human saliva for 3 hours at 35°C to form a pellicle layer

Enamel block exposure to TPM

- 10 enamel blocks were prepared per TPM and DMSO control
- Samples were incubated at 35°C for 14 days

Colour measurement

- Blocks were periodically removed from the test article and hydrated in PBS for 60 minutes
- Colour readings (L*, a*, b*) were measured using a Konica Minolta CM-700d at 0, 1, 2, 3, 4, 7, 8, 9, 10, 11 and 14 days
- Discolouration was determined as change in colour (ΔE) between baseline and exposure day ($\Delta E = \sqrt{((\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2)}$)
- A one-way ANOVA test was used to test for a difference in ΔE means at Day 14 between the four test articles. The Tukey procedure was used for pairwise comparisons

Results

- Discolouration was apparent in as little as 1 day exposure to 3R4F TPM and continued to increase until day 14 (Figures 3 and 4)
- The mean colour change induced by 3R4F TPM at Day 14 was statistically significantly ($p<0.0001$) higher than other treatments
- Mean ΔE values were 29.39 ± 3.57, 10.67 ± 2.64,10.46 ± 2.30 and 12.57 ± 1.97 for 3R4F, e-cig, THP and DMSO respectively

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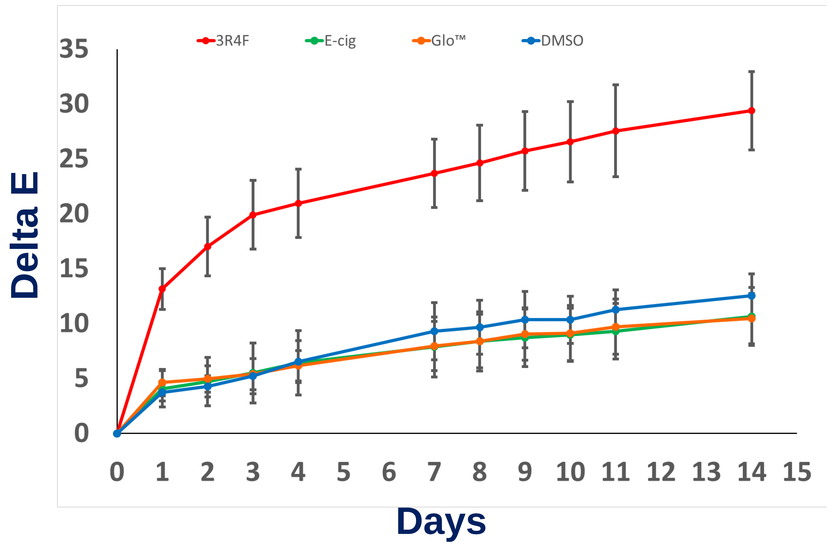

Figure 3. Mean ΔE values of enamel blocks at days 0-14 for 3R4F cigarette, BAT prototype e-cig and Glo™ TPM or DMSO control.

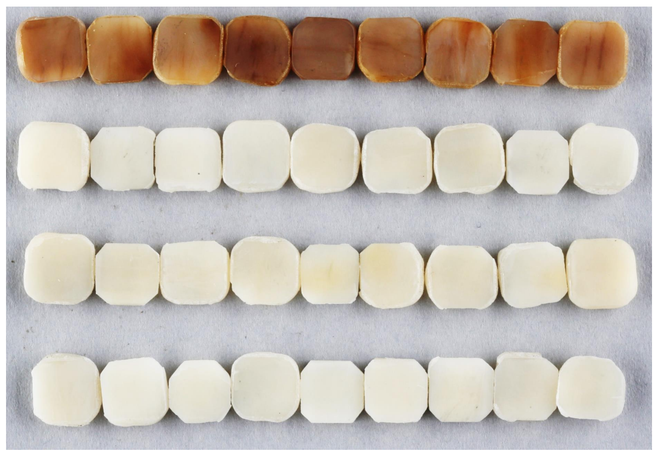

Figure 4. Enamel block discolouration after 14 days exposure to TPM generated from 3R4F cigarettes, Glo™ or BAT prototype e-cig and also DMSO control.

Conclusions

- **Cigarette smoke (3R4F) significantly increased the level of discolouration on bovine enamel teeth samples**
- **E-cig and THP exposure produced little discolouration and were comparable to the 'untreated' DMSO control group**
- **Further studies are required to assess the longer-term impact of e-cig and THP aerosols on tooth discolouration**

References

1. M.N. Alkhatib, R.D. Holt, R. Bedi. Smoking and tooth discolouration: findings from a national cross-sectional study. BMC Public Health. 2005 Mar 24;5:27
2. A. McNeill, L.S. Brose, R. Calder, S.C. Hitchman, P. Hajek, H. McRobbie, E-cigarettes: an evidence update. A report commissioned by Public Health England. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/457102/Ecigarettes_an_evidence_update_A_report_commissioned_by_Public_Health_England_FINAL.pdf, 2015 (accessed 18.07.17).
3. Royal College of Physicians, Nicotine without smoke: tobacco harm reduction. https://www.rcplondon.ac.uk/projects/outputs/nicotine-without-smoke-tobacco-harm-reduction-0, 2016 (accessed 18.07.17).
4. Health Canada Official Method T-115. Determination of "Tar", Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke. Prepared by the Department of Health, Dec. 31, 1999.
5. CORESTA, No. 81 - routine analytical machine for e-cigarette aerosol generation and collection - Definitions and standard conditions. https://www.coresta.org/sites/default/files/technical_documents/main/CRM_81.pdf, 2015 (accessed 18.07.17)

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