

Poster 5-11, Society for Research on Nicotine
and Tobacco (SRNT) Dublin, April 30, 2009

Ruyan® E-cigarette Bench-top tests continued

Murray Laugesen QSO MBChB FNZCPHM
Health New Zealand Ltd, Christchurch NZ.

www.healthnz.co.nz laugesen@healthnz.co.nz



Results

THE MIST

Particle size distribution. Particle size was approximately 0.04 microns (count median diameter or CMD).¹ A second laboratory confirmed that CMD was below their cutoff of 0.1 micron.⁷ CMD of tobacco smoke was much greater, at 0.15 to 0.25 microns, though measured on a different instrument.¹

Chemical composition. The Ruyan V8 yielded >300 (35 mL) puffs of mist: 82% PG, 15% water, 1% free-based nicotine, 2% particulates and flavours.¹ Mean puff weight was 0.88 mg.¹

Toxicology and safety of mist. Of 50+ priority-listed toxicants tested and found present in cigarette smoke, none was found in Ruyan V8 e-cigarette mist.^{1 12 17}

Toxicants tested for in Ruyan e-cigarette mist

Not detectable (52)

Aldehydes Acrolein was tested and found absent.¹⁷ Acetaldehyde was found to be present, but with the method used (thermal desorption tubes) could be artefact from ethanol.

Volatiles: Acrylonitrile, Ammonia, Benzene, Carbon monoxide, Isoprene, 1,3-butadiene, toluene, vinyl choride;

Metals: Arsenic, beryllium, cadmium, chromium, lead, nickel, selenium.

Miscellaneous. Acetamide, benzalphapyrene, hydrogen cyanide, pyridine, quinoline, styrene

PAHs and azarenes. Benzo(a)anthracene, Chrysene, Benzo(k)fluoranthene, Benzo(a)pyreneIndeno(1,2,3,-cd)pyrene, 5-methylchrysene, Benzo(b)fluoranthene, Benzo(j)fluoranthene, Dibenz(a,h)acridine, Dibenz(a,j)acridine, 7H-Dibenzo(c,g)carbozole, Dibenz(a,h)anthracene, Dibenz(a,i)pyrene.

Phenols: Catechol, hydroquinone, phenol, resorcinol, m-,o- and p-cresols.

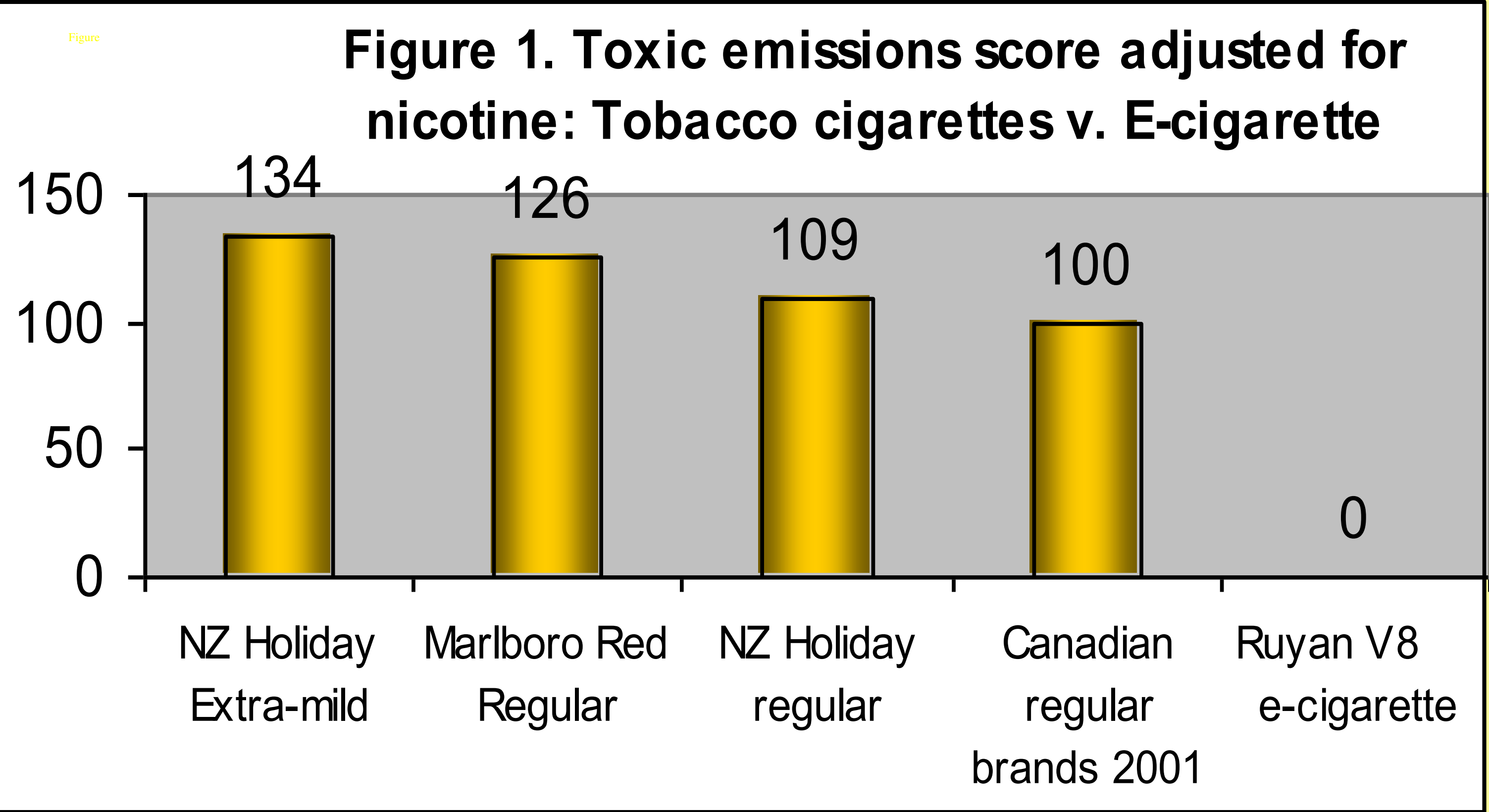
TSNAs: NAB, NAT, NNK, NNN, NDMA, NPYR, NEMA, NDEA, NDPA, NDBA, NPIP.

Detected: (1)

Mercury was detected in trace quantity of 0.17 ng per e-cigarette, which was just above the reporting limit of 0.13 ng, and within the reported 38% coefficient of variation.¹

Not tested: (14)

Acetaldehyde, formaldehyde, 3 aldehydes + Me Et Ketone: delayed by world shortage of acetonitrile reagent; 1- and 2- amino-naphthalenes, and 3, and 4-aminobiphenyls; chlorinated dioxins and furans; hydrazine; nitrous oxide and other oxides of nitrogen; and urethane.

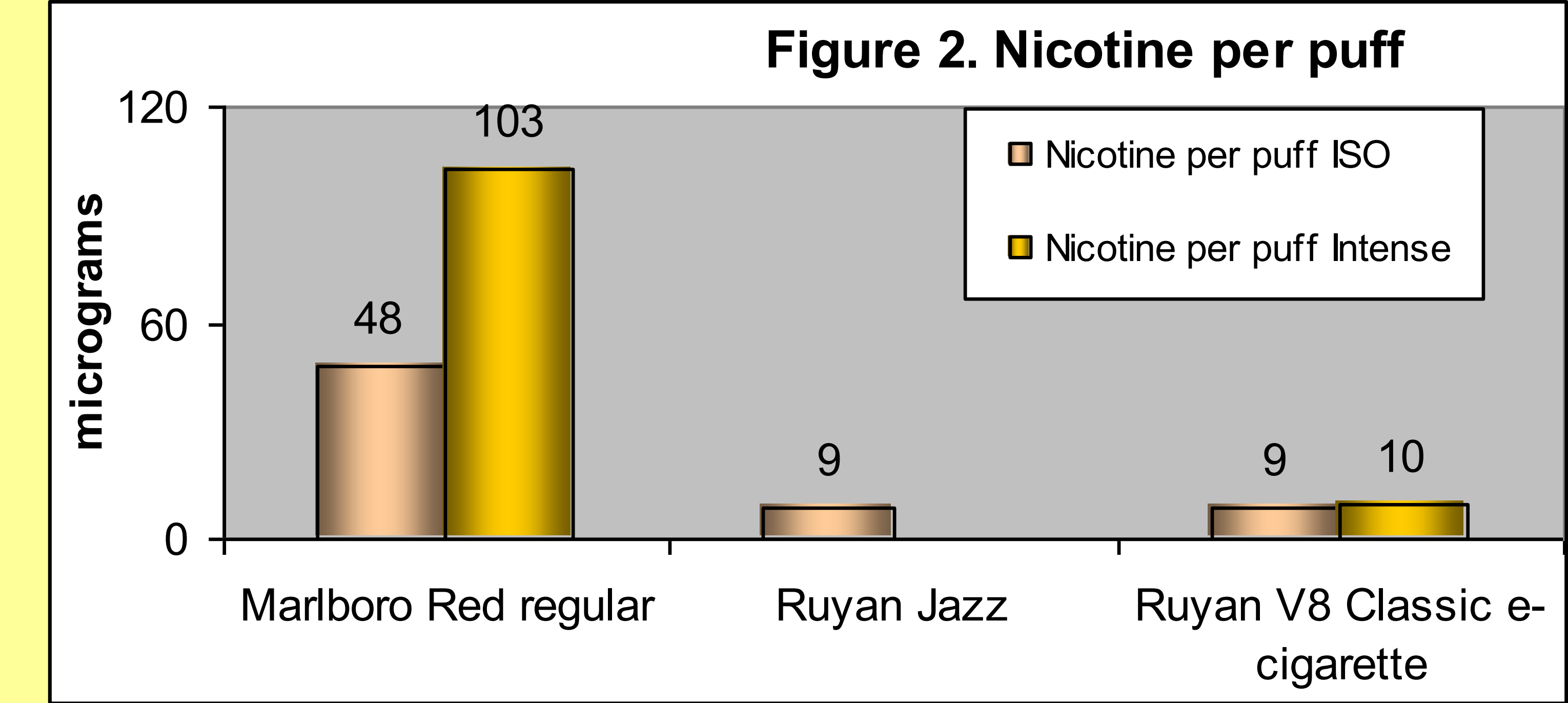


In figure 1, the toxicant emissions score adjusted for nicotine is a relative score comparing different cigarette brands, with Canadian brands scored at 100.¹⁷

NICOTINE CHEMISTRY

Free base nicotine The nicotine in the V8 inhaler condensate was checked against the UK governmental standard for nicotine. It is in the form of the S-stereo-isomer, and is free-base nicotine.¹⁵ Loss of nicotine dissolved in PG from oxidation by ambient air reaching the cartridge liquid after the cartridge is opened and assembled into the e-cigarette is a theoretical possibility, which we have not studied. Visible mist is a pre-condition for adequate vaporisation of nicotine, but visible mist, as in the 0 mg nicotine cigarette, does not imply nicotine is present.

Nicotine delivery per puff A 35 mL puff from the Ruyan® V8 delivers only 10% of the nicotine obtained from a similar puff of a Marlboro regular cigarette. Deeper 50 mL puffs from the Ruyan V8 delivers only slightly more nicotine.¹



Note: In Figure 2, a human-smoked Marlboro cigarette is estimated to produce 15 puffs.
Source: BAT Group R&D, November 2007.² BAT Group R&D, 15 April, 2009.¹

Site of nicotine absorption No deposition of aerosol nicotine occurred on pulling mist through six levels of the diminishing apertures of a cascade impactor, indicating very small particle size and little or no absorption from lung.⁷

Discussion

Main finding Testing for over 50 cigarette key smoke toxicants found none in any but trace quantity, in Ruyan V8 mist.

Safety of e-cigarettes as a product class Safety results refer to the Ruyan® V8 Classic. However the low operating temperature (54°C) of the atomiser, that is 5 to 10% of the temperature of a burning cigarette, suggests e-cigarettes as a class are unlikely to emit cigarette toxicants in their mist.

Nicotine dose (Figure 2) An e-cigarette user will need to take more puffs more often, and deeper puffs confer little advantage for V8 users. Six puffs every 5 minutes would deliver the same dose of nicotine delivered by shallow inhaling of 10 (35 mL) puffs) from one tobacco cigarette every hour. This however will not achieve the high immediate nicotine boost which many smokers crave.

Nicotine overdose is unlikely, even though nicotine delivery may vary considerably between brands.

Nicotine absorption site The nicotine dose and particle size are too small to ensure either deposition in the alveoli or bronchioles or rapid nicotine absorption as in cigarette smoking.

Limitations of study The results apply only for the products tested. Extrapolation to all product sold assumes production only from internationally-certified good manufacturing sites, and trademark enforcement.

Conclusion

The Ruyan® V8 nicotine e-cigarette does not deliver smoke or smoke toxicants. Consequently, the modest reductions recommended in 2008 by WHO’s Tobacco Regulation committee for 9 major toxicants in cigarette smoke (in line with Articles 9 and 10 of the WHO FCTC World Health Organization Framework Convention Tobacco Control treaty), are already far exceeded and obtainable now by smokers switching to the Ruyan® e-cigarette.

Absolute safety does not exist for any drug, but e-cigarette emissions, relative to tobacco smoke, are likely to be 100 to 1000 times safer. On the evidence to date, the e-cigarette appears to be akin to a medicinal nicotine inhalator in the safety of its emissions, and nicotine dose.

E-cigarettes are cigarette substitutes. If they can wrest market share from cigarettes, they can improve smoker and population health. They may also have a more up-market role as medicinal nicotine inhaler to aid quitting. Further trials of acceptability, addiction potential, clinical safety, and quitting efficacy are needed.

Funding and acknowledgements

Hon Lik, of Ruyan Group is the inventor of this product, and Ruyan Group (Holdings) Ltd Beijing funded Health NZ to carry out initial tests. Duke University, (NC, USA) and British American Tobacco, Group R&D (UK), kindly supplied further results at no cost.

Competing interests

Neither the author, or his company, has any financial interest in Ruyan or any other manufacturer.