A portable device to measure puffing behaviour and tobacco smoke exposure

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Standardised machine methods to measure cigarettes have been developed to routinely measure cigarette smoke yields (ISO 3308:2000). While this methodology allows products to be compared it is not indicative of how smokers use a product. Therefore, to provide more accurate measurements of the levels of smoke to which smokers are exposed, it is necessary to measure their puffing behaviour (topography). Since 2002, British American Tobacco (BAT) has used the Smoking Analyser 7 (SA7, BAT/C-Matic Systems) to measure a smoker's puffing topography and optical tar in real time. Optical tar is an estimate of Nicotine Free Dry Particulate Matter (NFDPM) or tar, based on light obscuration from the smoke aerosol.

The SA7 can only be used in a central location, due to its need for a trained operator. Under these conditions smokers' behaviour may be altered. We have therefore developed a portable, handheld version named the Portable Smoking Analyser (PSA). This records puffing behaviour (flow, volume, duration and interval), by measuring the pressure drop across the device, and optical tar per puff, again by light obscuration, against a gravimetric calibration.

The PSA was tested using a two stage approach; the first stage evaluated the accuracy and precision of the PSA in recording machine-generated flow rates and volumes, while the second stage used pre-recorded human puffing profiles.

During stage one, a series of flow rates were drawn through the PSA using a Smoking Cycle Simulator (Cambustion, Cambridge UK) with a mass flow meter (TSI, High Wycombe UK) in-line to record the flow rate generated. Figure 1 shows a comparison of the flow rates recorded by the PSA compared to the mass flow meter.

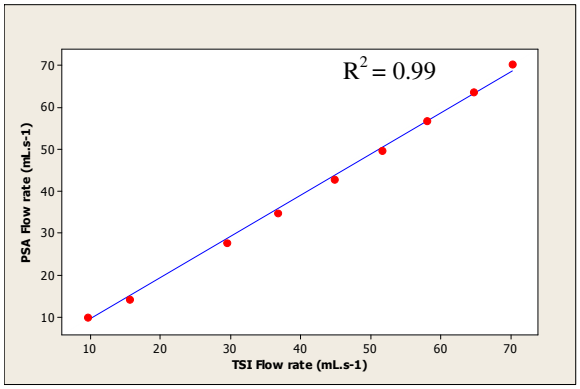

Figure 1 - PSA recorded flow rate against TSI mass flow meter flow rate

There was no significant difference between the flow rates recorded by the PSA and those recorded by the TSI flow meter (p=0.909, range 10 - 70 mLs^{-1}, RSD ± 1.5%).

The accuracy and precision of volumes was also assessed using a glass syringe to draw air through the PSA. A calibrated soap bubble flow meter was placed in-line to record the volumes drawn. There was no significant difference between the measured volumes (p=0.922, range 20 -100 mL, RSD ± 1.3%).

In stage 2, a prototype smoke machine, LM4X (Borgwaldt, Hamburg Germany) was used to replicate human puffing profiles, previously collected using the SA7, with the PSA re-recording the profiles. The PSA recorded volumes were then evaluated against the volumes from the SA7. The PSA volumes were not statistically different to the SA7 volumes (p=0.910, range 14 - 121 mL, RSD ± 2.3%).

During stage 2 Cambridge Filter Pads (CFP) were place behind the PSA to collect the smoke particulate matter from the cigarette. These CFPs were then analysed for nicotine and water by gas chromatography, allowing calculation of NFDPM. The correlation between the optical tar estimate from the PSA and NFDPM is shown in Figure 2. There was no significant difference between the optical tar estimate and the NFDPM (p=0.535, range 0.3 – 38.8mg).

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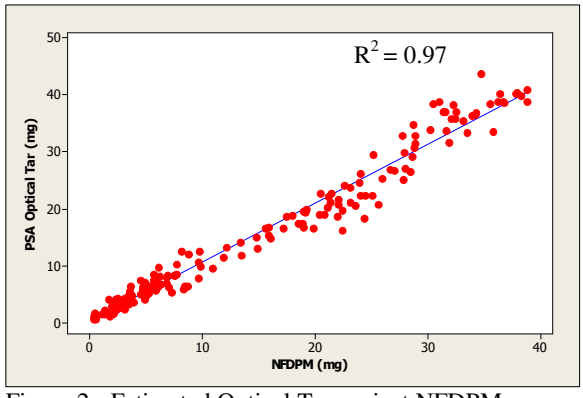

Figure 2 - Estimated Optical Tar against NFDPM

Based on these data, the PSA has been shown to be an accurate and precise device for measuring puffing topography and estimating NFDPM.