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Cigarette Smoke Formation Studies

V. The Effects of the Cigarette Periphery on Mainstream Smoke Formation*

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axial - along the rod -
radial - distance from the center -

INTRODUCTION

In a recent report, recommendations for the standardized preparation of carbon-14 labelled cigarettes were made (1). It was shown that the error generated in uniformly placing the radioactive label axially within the rod is also the degree of error reflected in the radioactivity recovered from total smoke. Cigarettes with large variations in the axial placement of the label would require the smoking of a large number of such cigarettes to determine the total smoke distribution. The data thus generated are reflective of the average values, but with a large experimental error. The more uniformly labelled the cigarette, the smaller the error in the total smoke distribution.

When the radioactivity is not uniformly distributed radially within the cigarette, the smoking of a large number of cigarettes might not overcome any bias imparted to the data. *Egerton* (2), *Keith* (3), *Wakeham* (4) and *Osdene* (5) have all theorized about the effects of the periphery on mainstream smoke formation. To date, there is very little experimental evidence to support these hypotheses. In order to empirically ascertain the importance of the tobacco periphery to smoke formation, carbon-14 labelled cigarettes have been prepared with uniform and non-uniform radial labelling. Effects of radial positioning on the total smoke distributions were measured.

MATERIALS AND METHODS

Preparation of Labelled Cigarettes

The carbon-14 labelled cigarettes were fabricated by the procedures recommended for the standardized preparation of labelled cigarettes (1). The cigarettes were prepared by three basic incorporation methods:

1. *Syringe-Spiking:* This procedure was used to add the labelled compounds primarily to the central portion of the cigarette rod (1).

2. *Spraying:* This procedure was employed when solubility permitted, and produced cigarette filler uniformly labelled with the carbon-14 compounds. Cigarettes were then handmade as previously described (1).

3. *Sheetcasting-Blending:* This procedure was used when materials were insoluble in desired solvents. The labelled sheet materials were then either uniformly blended into normal University of Kentucky 1R1 reference filler or were added at discrete radial positions within the cigarette rod (1).

Radiochemicals

Dotriacontane-16,17-^{14}C was purchased from Mallinckrodt Nuclear and proline-^{14}C (U) from New England Nuclear. Nicotine-^{14}C (U) and cellulose-^{14}C (U) were obtained from biosynthesized Bright tobacco-^{14}C (U) (6). Invert sugar (U) was prepared by the treatment of glucose-^{14}C (U) (New England Nuclear) with invertase. Radiochemical purities in all cases were better than 98% before application.

Radioactivity Determinations

Appropriate aliquots of the extracted or combusted samples were counted in a Packard Model 3390 scintillation spectrometer (Packard Instrument Company) with optimized gain and window settings. The procedures and cocktails used have been previously described (7).

Cigarette Smoking

The procedures and smoking machine instrumentation were described previously (7) and were used to obtain the ^{14}C-activity distributions in the total cigarette smoke.

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RESULTS AND DISCUSSION

Keith (3), *Wakeham* (4) and *Osdene* (5) have each theorized about the effects of the tobacco cigarette periphery on mainstream smoke formation. They reasoned that the major pathway of air into the cigarette during puffing is between the junction of the paper and the coal, referred to by *Wakeham* as the "bypass zone" (Figure 1). The low air permeability of the paper and the high resistance of the coal combine to bring about a preferential passage of air through the bypass zone. The cigarette during puffing would burn the tobacco more rapidly around the periphery than in the center. Hence, the periphery should play a larger proportionate role in mainstream smoke formation than the center sec-

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