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Studies of Environmental Tobacco Smoke Generated by Different Cigarettes

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ABSTRACT

A method was developed to reproducibly measure environmental tobacco smoke (ETS) components generated by different cigarettes. Measurements were carried out in an unventilated, controlled environment chamber. True ETS (the aged and diluted combination of exhaled mainstream plus sidestream smoke) was generated by human smokers. To reliably quantitate components normally present at trace levels, the comparisons were carried out at elevated ETS concentrations—greater than 40 times those typically encountered in "real-world" settings.

The method was applied to four commercially available cigarettes and a cigarette prototype that primarily heats tobacco. Forty-three properties and components of the gas and particulate phases of ETS generated by the different cigarettes were measured. Good precision of measurement was obtained both within and between tests. Statistically significant differences in the concentration of ETS components were observed among the different commercial cigarettes and between the commercial and prototype cigarettes. Most ETS components from the prototype cigarette were reduced by >90% when compared to the commercial cigarettes. The method was used to determine the effect of cigarette design changes on the generation of ETS.

IMPLICATIONS

Concentrations of environmental tobacco smoke (ETS) constituents are often inferred from sidestream smoke measurements or from ratios of components in sidestream and mainstream smoke. Determination of the ETS contribution to contaminants measured in the field is difficult because of myriad other sources for most components of ETS. The environmental chamber method described here allows direct measurement of components present in real ETS. Direct comparisons of different cigarette types can be performed, and quantitative differences among cigarettes can be determined. The method could be easily modified to make other comparisons involving ETS or its surrogates.

INTRODUCTION

Environmental tobacco smoke (ETS) has been defined as the aged and diluted mixture of sidestream smoke (the smoke from the lit end of a cigarette) and exhaled mainstream smoke (the smoke a smoker exhales).[1] A wide range of testing methods have been used to characterize the composition of ETS.[2-6] Typically, investigators target a limited number of specific components in the ETS from one or a few cigarettes. It is unusual to find reports that offer a relatively complete picture of ETS composition for one or more cigarettes. Often, rather than sampling a range of different cigarette brands and styles (e.g., soft pack or box, king size or 100s, full flavor or lights), it has been assumed that the ETS generated by different cigarettes within a brand family is qualitatively and quantitatively the same.[7,8] Alternatively, the results of non-standardized comparisons of mainstream and sidestream smoke composition have been used to predict ETS composition—a problematic process.[1]

The ideal situation for characterizing ETS would be determination of its composition in "real-world" settings under actual use conditions. Unfortunately, this is not possible. Many of the compounds present in ETS have other environmental sources,[9] and an exact determination of the fraction of an analyte that comes from ETS is not practical. Even when smoking takes place, many ETS constituents are present at levels too low to reliably measure in indoor air. It is often impossible to determine concentrations of such ETS components without long-term sampling of large volumes of air. The problems of ETS characterization in the field are further compounded when analysis of a "reduced ETS" cigarette is desired.

The analysis of ETS is frequently carried out in environmental chambers.[4,5,9-12] The chambers provide a number of advantages for determining contributions of tobacco smoke to indoor air. Smoke generation can be controlled in a reproducible manner in a closely controlled and monitored environment. To ensure reliable quantitation of trace ETS components, ETS levels in the chamber can be increased to levels that cannot practically be obtained in the field. Background concentrations of components