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TECHNICAL NOTE

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Analysis of Artificial Fireplace Logs By High Temperature Gas Chromatography

ABSTRACT: High temperature gas chromatography is used to analyze the wax of artificial fireplace logs (firelogs). Firelogs from several different manufacturers are studied and compared. This study shows that the wax within a single firelog is homogeneous and that the wax is also uniform throughout a multi-firelog package. Different brands are shown to have different wax compositions. Firelogs of the same brand, but purchased in different locations, also have different wax compositions. With this information it may be possible to associate an unknown firelog sample to a known sample, but a definitive statement of the origin cannot be made.

KEYWORDS: forensic science, gas chromatography, firelog, fireplace log, wax

Artificial fireplace logs have become a popular alternative to natural firewood due to their convenience, ease of use, and lower emissions. These synthetic firelogs are composed of a cellulosic material and a binder. The cellulose material is typically wood shavings, chips, or saw dust. The binder is usually an oil refinery wax. These materials are mixed and extruded into the desired log shape.

Recently, portions of these artificial firelogs were submitted to the laboratory for identification and comparison purposes. Due to their unique texture and composition, and the fact that firelogs retain their shape after burning, they are quite easily recognized. Since the cellulose material can be a variety of materials, it was deemed that the analysis of the wax would be the most beneficial approach to potentially identify the source of the log.

Gas chromatography has been used to analyze wax and wax-based products for many years (1,2). The ability to detect and identify small amounts of waxes was enhanced through the use of capillary gas chromatography (3). Additionally, the use of a Programmable Temperature Vaporizing (PTV) system can reduce, if not eliminate, the mass discrimination observed with traditional injection systems (4). This work shows the utility of capillary gas chromatography equipped with a PTV injection system in analyzing the wax component of several different commercially available firelogs.

Methods and Materials

Materials

Commercially available firelogs were purchased from local stores in the Washington, DC and San Francisco metropolitan areas. The manufacturers included Duraflame, Incorporated (Stockton, CA), Conros Corporation (Toronto, Canada) and Forest Technology Corporation (Akron, OH). Approximately 0.04-gram samples of material were removed from each firelog and extracted with 1 mL of stabilized trichloroethylene (ACS grade, J.T. Baker).

Gas Chromatography Conditions

All samples were run on a Perkin Elmer Model 8500 gas chromatograph equipped with a Programmable Temperature Vaporizer (PTV) and a Flame Ionization Detector (FID). The column was a 30 m $\times$ 0.25 mm ID Supelco DB-1 with a 0.1 μm film thickness. The carrier gas was hydrogen with a head pressure of 20 PSI. One-μL samples were injected with a 30:1 split ratio. The PTV was heated ballistically to 440°C and held at that temperature for four min. The initial column temperature was 100°C with a one-min. hold time, then ramped at 20°C/min to 330°C and held at that temperature for five min. The FID temperature was 350°C. The retention times and the column resolution were checked using a 125 μg/mL solution containing C_{20}, C_{24}, C_{28}, C_{32}, C_{36} and C_{44} normal paraffins.

Results and Discussion

The first phase of the study examined the homogeneity of the wax within a single firelog. Eight different samples were removed from each firelog. These samples were from the outer surface, the ends and the inside of a firelog. Each sample was injected three times to ensure the consistency of the chromatographic pattern. Figure 1 shows representative chromatograms of the surface wax of a Duraflame® log. The observed patterns extend from approximately C_{21} to C_{46} and are consistent with each other. In Fig. 2, the chromatograms of core samples taken from the right side, left side and the center of the same log are displayed. These three patterns are not only consistent with each other but with the surface wax as

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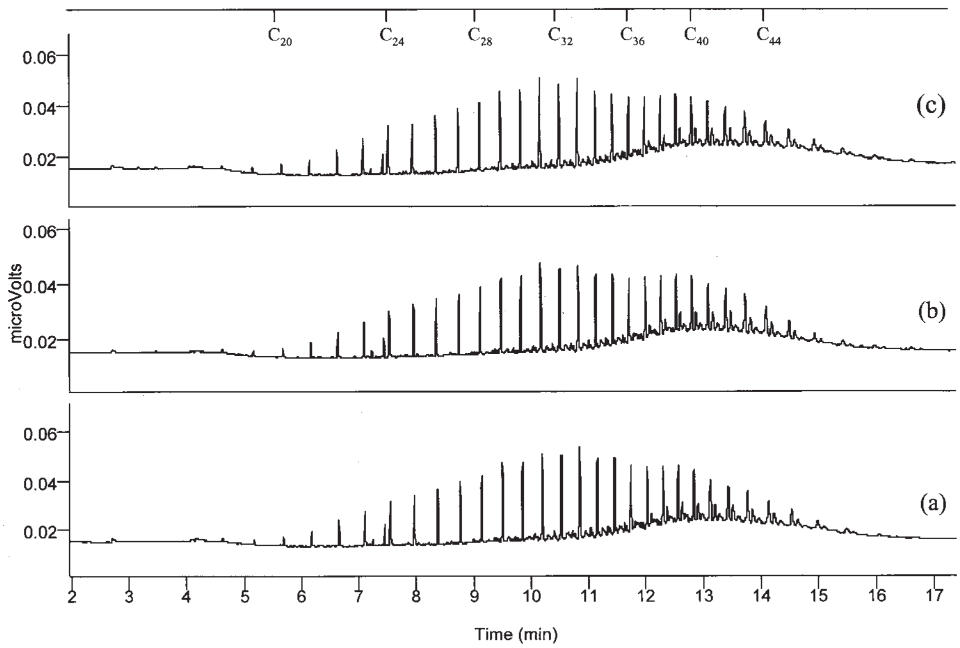

FIG. 1—*Gas chromatograms of surface wax samples from a single Duraflame® brand firelog:* (a) *left end,* (b) *right end,* (c) *center.*

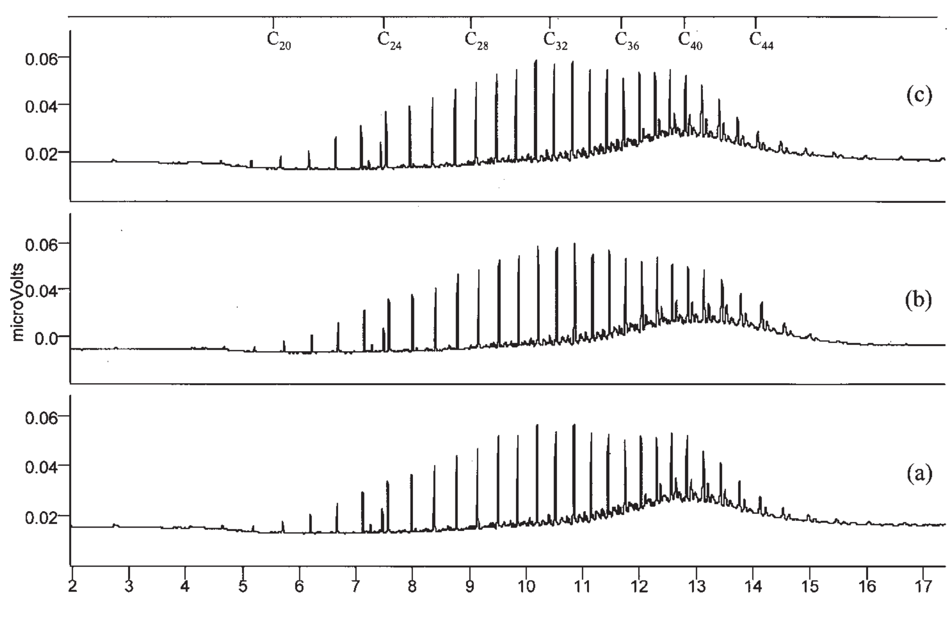

FIG. 2—*Gas chromatograms of core wax samples from a single Duraflame® brand firelog: (a) right,* (b) *center,* (c) *left.*

well. This clearly demonstrates that the wax is uniform throughout this firelog. Several samples from a single Pine Mountain® firelog, manufactured by Conros, were also analyzed. Figure 3 shows the chromatograms from the right end of the log, the surface of the log on the left side and the center core. These patterns are representative of all the samples removed from the Pine Mountain® log. The overall pattern extends from C_{20} to C_{43}. Again, the uniformity of the wax throughout a manufactured firelog is apparent.

The next phase of the study compared the wax of all the firelogs within a multiple log package. Communication with a manufacturer indicated that multiple log packages consist of logs from a single batch. To confirm this information, all six logs in a Duraflame® package were examined. Figure 4 shows representative chromatograms from three of the logs. The observed patterns are consistent with each other. This demonstrates the consistency in the manufacturing process and verifies information provided by the manufacturer. As a result of this intra-package consistency, it is not possible to differentiate individual logs within the same package. However, this fact may be helpful in associating a log recovered from a fire scene to unburned logs from the same package.

Firelogs manufactured by the same company and sold in separate locations were also examined. Figure 5 shows representative

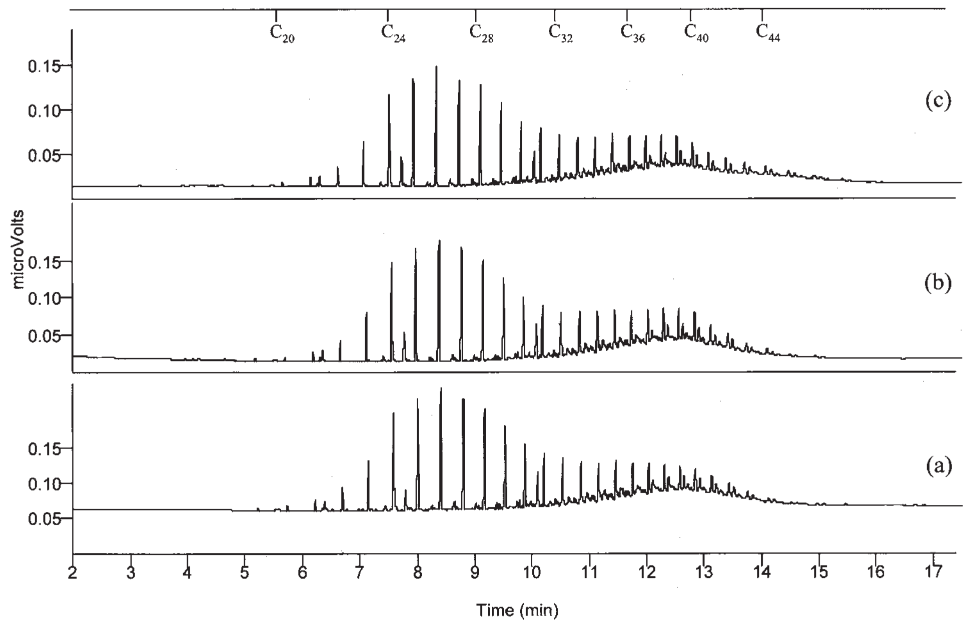

FIG. 3—*Gas chromatograms of wax samples from a single Pine Mountain® brand firelog:* (a) *right end surface,* (b) *center core,* (c) *left side surface.*

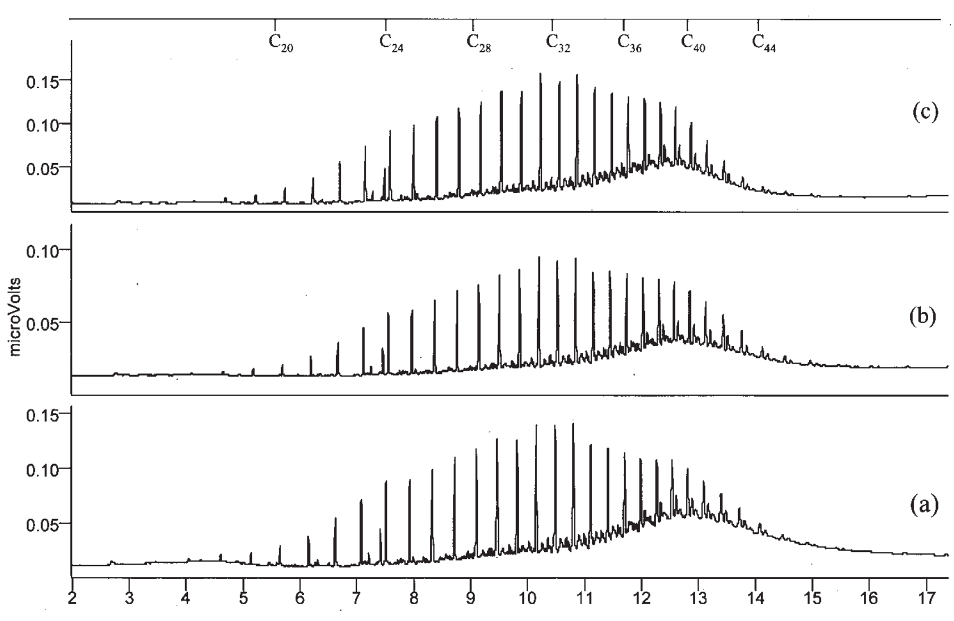

FIG. 4—*Gas chromatograms of representative wax samples from three Duraflame® brand firelogs in a six log package:* (a) *log 4,* (b) *log 2,* (c) *log 3.*

chromatograms of Duraflame® brand logs purchased in Virginia, California and Maryland. The Virginia and the Maryland logs have a similar overall pattern, but the pattern of the California log is distinctly different. There are some slight differences in the Virginia and the Maryland patterns, however, these differences are not enough to clearly differentiate the two logs. Figures 6 and 7 show the comparisons between California-purchased and Maryland-purchased logs for Pine Mountain® brand and Safeway brand firelogs, respectively. Again, significant pattern differences between the logs purchased in different locations are readily observed. These differences are most likely due to lot variations and from where the manufacturer purchased the wax.

Figure 8 shows the representative chromatograms of firelogs sold by different manufacturers or distributors in Maryland. Each chromatographic pattern is distinctly different from the others based upon the distribution of the normal paraffins. This difference allows the examiner to discriminate between various firelogs.

This study shows that it may be possible to differentiate between firelogs based on variations in the wax used to manufacture the logs. This variation in the wax also makes it difficult to brand iden-

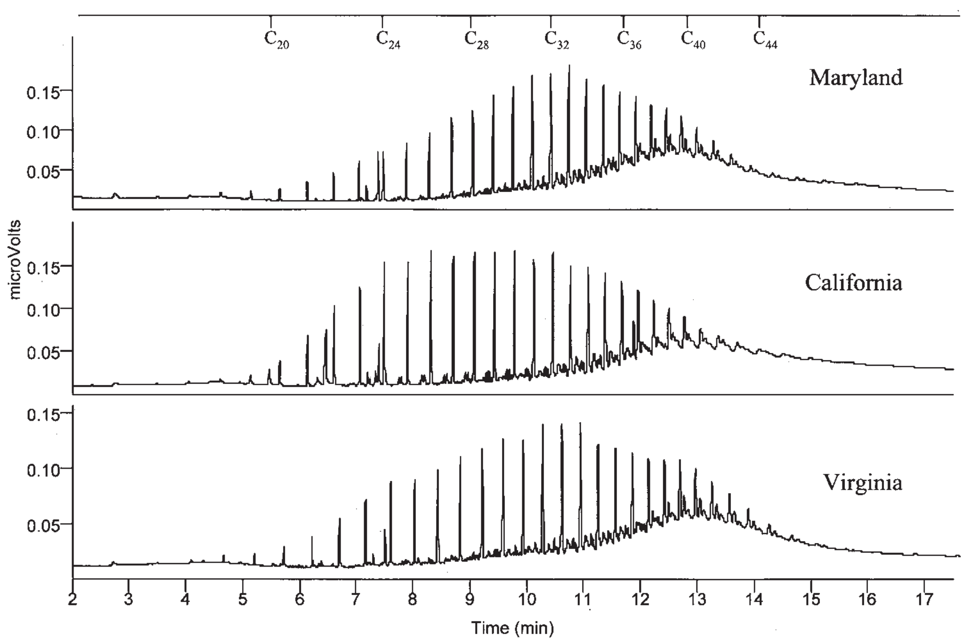

FIG. 5—*Gas chromatograms of representative wax samples from Duraflame® brand firelogs purchased in Virginia, California and Maryland.*

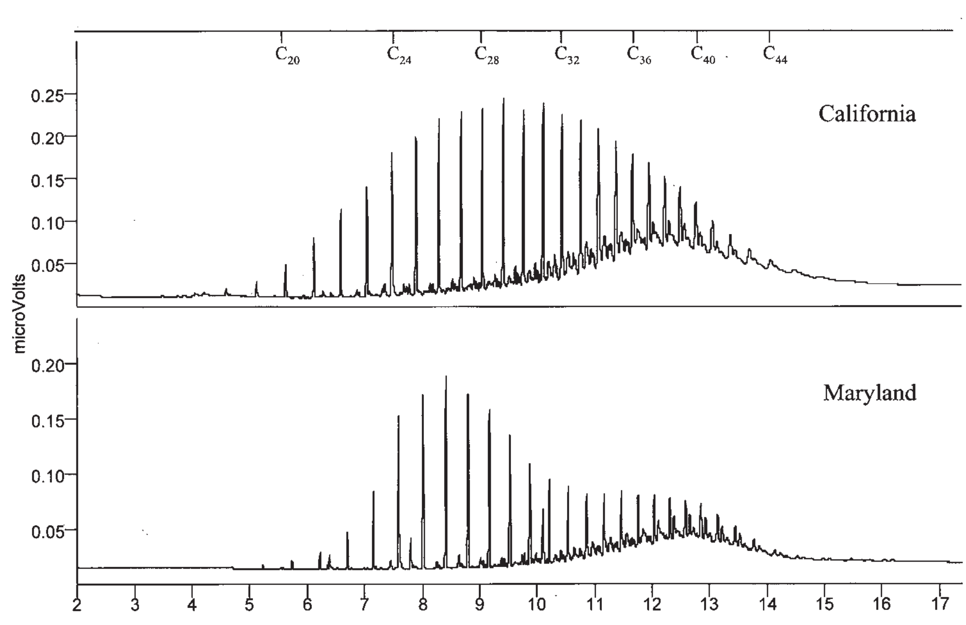

FIG. 6—*Gas chromatograms of representative wax samples from Pine Mountain® brand firelogs purchased in Maryland and California.*

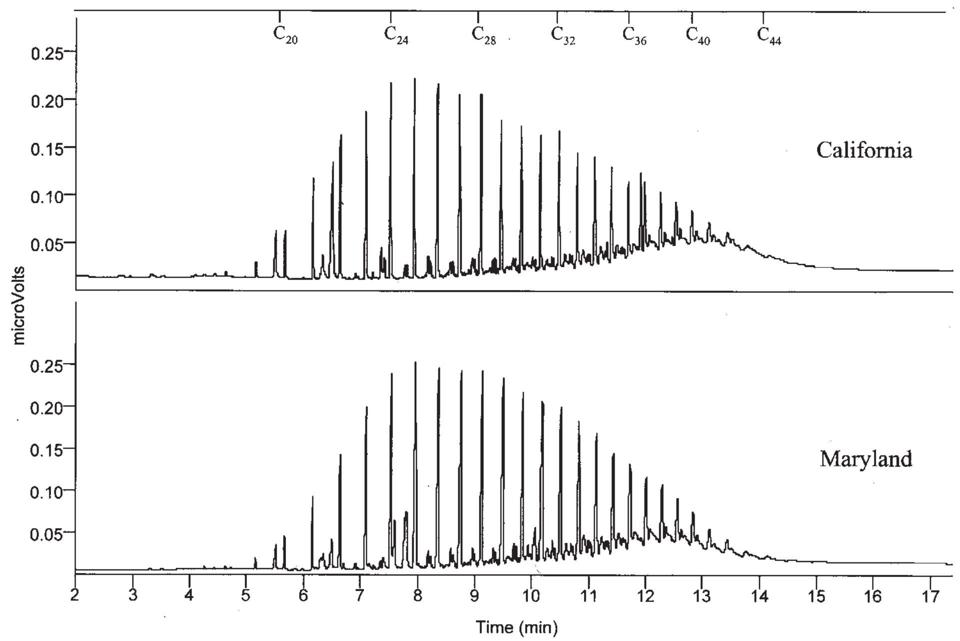

FIG. 7—*Gas chromatograms of representative wax samples from Safeway store brand firelogs purchased in Maryland and California.*

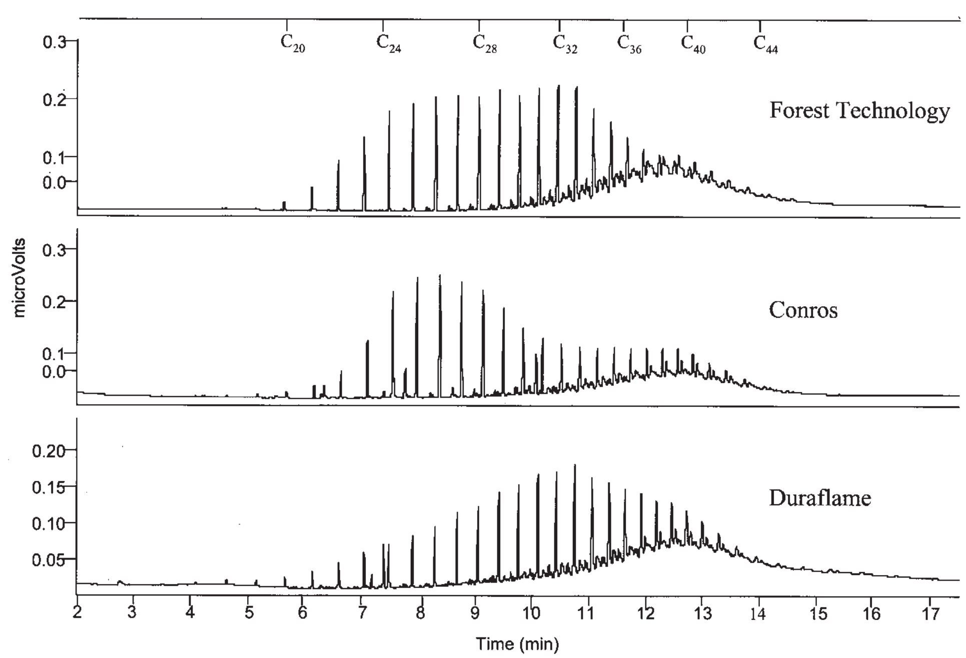

FIG. 8—*Gas chromatograms of representative firelog wax samples sold in Maryland by different manufactures or distributors: (*a*) Duraflame, Incorporated, (*b*) Conros Corporation, (*c*) Forest Technology Corporation.*

tify a firelog. As shown in this study, a single manufacturer may use different wax formulations for different site locations or batches. The results of this study also demonstrate that it is possible to associate an unknown firelog sample with a known source. Care must be taken, however, if an association is to be made. Even though the wax is homogenous throughout a log, several different firelogs will have been produced using the same batch of wax. Therefore, a definitive statement of the exact origin of the unknown sample cannot be made.

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