Note

Odor Analysis of Cigarette Butts
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Received July 30, 1984

The odor of cigarette butts is rather more unpleasant than that of the cigarette smoke. A study of the odor of cigar butts has been done by Peck,¹⁾ but no reports on the odor of cigarette butts have been found. In this paper, "the tar-like odor of cigarette butts" was studied by an analysis of the headspace volatiles from cigarette butts with Tenax GC.²⁾

Unblended cigarette samples, namely flue-cured, Burley and Turkish, were smoked under standard conditions. Five mm lengths of the charred side of butts were cut off leaving 25 mm pieces. Two butts were placed in a vessel (80 mm × 30 mm i.d.). A Tenax GC (30 mg) trap was connected to the vessel and helium gas (20 ml/min) was passed through it for five minutes. The headspace volatiles of the butts collected on the Tenax GC were analysed by gas chromatography according to a method previously reported.²⁾

The method for analysing the semivolatile compounds of the smoke was the same as that reported by Ishiguro *et al.*³⁾

A sensory evaluation of the headspace volatiles collected on the Tenax GC was performed by desorbing into a 30 ml syringe and sniffing them. Sensory evaluation by sniffing of each peak eluted from a gas chromatograph was also carried out.

Although all the butts of the three varieties gave a tar-like odor, there were some differences in quality between them. The butt of the flue-cured cigarette gave a tar-like odor with a sweet note, that of the Burley cigarette gave one with an amine note, and that of the Turkish cigarette gave one with a sweaty note. The butt of the Burley cigarette was used for the following study, because it had the strongest and most characteristic tar-like odor among the three varieties. When the two odors of the butt itself and the headspace volatiles were compared in quality and quantity by sniffing after smoking (0, 30 and 60 min), their two odors were similar and showed the same changes with the progress of time. That is, immediately after smoking, they gave a strong amine note, and then gradually

changed to a characteristic butt tar-like odor with a slight amine note. Even after 60 min, they were similar in quality to those after 30 min, but had diminished in quantity. Consequently, the butts of Burley cigarettes obtained 30 min after smoking were used for an analysis of the headspace volatiles. Coefficients of variation calculated from the areas of 20 major peaks were from 10.0 to 35.7%.

Figure 1A shows a typical gas-chromatogram of the headspace volatiles from the butts of Burley cigarettes. The compounds listed in Fig. 1 have already been reported as present in cigarette smoke.³⁾ Many amine notes, burning notes, and greenish aldehydic notes were found in the first half of the chromatogram by a sniff evaluation. Although the tar-like odors eluted around peaks for 2,3-pentanedione (No. 10), *N*-methylpyrrole (No. 18), No. 37, No. 80 and 3-methylpyrrole (No. 110), their odors were relatively weak and slightly different from the tar-like odor of the butts themselves. Alkaline notes, originating from tobacco alkaloids, eluted around peaks for isocaproitrile (No. 38), No. 57 and No. 72, and pungent aldehydic notes eluted around the peaks for pyrrole (No. 93), 2-methylpyrrole (No. 109) and No. 48. When the chromatogram of volatiles from the butts (A) is compared with that of the semivolatiles (B), the compounds on A are different in quantitative balance from those on B. Notably, the peaks which eluted after 2-furfuryl alcohol (No. 140) are very small on A. The peak for acetic acid (No. 74), which is relatively large on B, can not be found on A. The odor of the headspace volatiles collected from two Burley cigarettes (25 mm) which had not been smoked was very weak, so that the volatiles of the tobacco seem to be hardly related to the odor of the butts.

As the odors of the three kinds of cigarette butt differed in quality, the areas of major peaks of the headspace volatiles were compared between the three varieties, these varieties showing differences in the quantitative balance of some peaks, although acetol and pyrrole were major compounds in all of the three varieties. In the flue-cured cigarette, 2-furaldehyde was higher in concentration than in the other varieties. 3-Methyl-2-cyclopentenone was more abundant and cyanobenzene was less abundant in Burley samples.

The results of this study lead to the following conclusion. The headspace volatiles of butts have no components other than those in the cigarette smoke. It is estimated that the tar-like odor is composed of the mixed-odor in the headspace volatiles from butts. The weak tar-like odors of 2,3-pentanedione, *N*-methyl pyrrole and 3-methyl pyrrole, the alkaline note of isocaproitrile, and the pungent aldehydic notes of pyrrole and 2-methyl pyrrole seem to contribute largely to the tar-like odor of a butt. Such acidic components as acetic acid and phenolic compounds contained abundantly in the smoke, however, seem to make little contribution to the tar-like odor,

[†] This study was presented at the Annual Meeting of Agricultural Chemical Society of Japan, Tokyo, April, 1984.

FIG. 1. Gas Chromatograms of the Headspace Volatiles of the Butts (A) and the Semivolatiles in the Smoke (B) from Burley Tobacco.

Apparatus, Shimadzu GC-9A; column, glass capillary column (60 m $\times$ 0.28 mm i.d.) coated with Reoplex 400; temp., 30 $\rightarrow$ 180°C (2°C/min); carrier, He (1.0 ml/min); detector, FID.

Compounds: (3) 2-pentanone; (7) toluene; (10) 2,3-pentanedione; (16) ethyl benzene; (17) 3,3-dimethyl-1-butene*; (18) *N*-methylpyrrole; (19) xylene*; (26) pyridine; (27) cyclopentanone; (28) limonene; (29) pyrazine; (38) isocaproitrile; (39) cyclooctatetraene*; (44) 2-methylpyrazine; (45) acetol; (65) 2-cyclopentenone; (71) 2-methylcyclopentenone; (74) acetic acid; (82) 3-furaldehyde; (92) 2-furaldehyde; (93) pyrrole; (96) acetol formate; (108) 3-methyl-2-cyclopentenone; (109) 3-methylpyrrole; (110) 2-methylpyrrole; (120) proto-anemonin; (126) cyanobenzene; (140) 2-furfuryl alcohol; (186) guaiacol; (198) nicotine; (204) phenol; (218) cresol*.

* Tentatively identified.

because they are hardly present in the headspace volatiles. There are recognizable differences in the odors and gas chromatographic profiles of the headspace volatiles of the three varieties of butts.

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