Temperature Profiles Throughout Cigarettes, Cigars, and Pipes

The recent interest in a correlation between cigarette smoking and cancer, such as the isolation of carcinogens from cigarette paper, prompts me to offer some evidence I obtained on this subject. During a lull in some work I was doing at the Whiting Laboratories of Standard Oil (Indiana), I had a high-speed, high-temperature Micromax recorder at my disposal, which I used to measure the temperature profiles throughout cigarettes, cigars, and pipes. Since I have never found any mention of these temperatures, I believe that other readers may be interested in them. I found as much as a 300°C difference between the "hot spots" in a cigarette and those in a pipe. Most moderately priced cigars had "hot spots" approaching that of cigarettes.

The temperature profile throughout the burning tobacco was measured by the insertion of six glass-coated 28-gage chromel-alumel thermocouples throughout the tobacco bed. The temperature-time curves were then recorded on the Micromax recorder as the tobacco was smoked. In this way, as the "hot spot" approached a given thermocouple its temperature rapidly rose and then dropped as the "hot spot" passed. The over-all burning temperature was then considered to be the average of the maximum temperature reached by all six thermocouples. The six maximum temperatures so measured were all within 10°C of one another.

The popular brands of cigarettes had "hot spots" that varied between 610°C and 740°C, depending on the brand. The temperature of the gases entering the mouth varied from 50°C to 70°C, also depending on the brand of cigarette. The temperature-time curves were smooth curves showing no discontinuity.

Repetition of this same procedure with low-priced cigars showed the same maximum temperature range of the "hot spot," from 600°C to 660°C, with the gases entering the mouth at 40°C to 60°C. More expensive cigars showed maximum temperatures from 580° to 610°C.

Highly aromatic pipe tobacco showed a maximum temperature of 540°C to 590°C, while untreated, nonaromatic tobaccos showed a "hot spot" in the pipe of only 420°C to 450°C. The temperature of the gases at the bottom of the pipe bowl at the entrance to the stem was as low as 30°C with some tobaccos and ranged up to 50°C. However, in all tobaccos examined, the temperature of the gases from pipe tobacco was lower than that of the gases from a cigarette. I believe that the wide difference in aromatic and nonaromatic pipe tobacco and the wide temperature difference between cigarettes and pipes must be due, in part, to the potassium chlorate used to treat cigarette tobacco in order to insure even and continued burning. The aromatic odorant used to treat aromatic pipe tobacco may be responsible for the increased temperature of the "hot spot" found in aromatic pipe tobaccos.

Having thus established the temperature range in the "reaction zone" in tobacco, one might conclude that the carcinogenicity of cigarettes over pipe tobacco is due to the 300°C higher temperature found in cigarettes. However, most cigars also show the 600°C "hot spot," and recent evidence would tend to indicate that cigars are not carcinogenic. Since the 600°C temperature range in cigarettes is more than sufficient to decarboxylate or decarbonylate pyridine or pyran carboxylic acids or aldehydes, it would seem possible, from a chemical viewpoint, that the carcinogenic pyrans and pyridines arise from the cigarette paper. Furthermore, in view of the extreme high temperatures in cigarettes, thermal cracking to yield free radicals which could subsequently dehydrocyclize to yield condensed ring carcinogens is not an unreasonable postulate.

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31 December 1954

Aureomycin in the Saliva of Dairy Calves after Intramuscular Injection of the Antibiotic

In a preceding study, Radisson (*1*) showed that during continuous feeding of terramycin to dairy calves, high concentration of the antibiotic could be detected in both feces and urine. Rusoff *et al.* (*2*) reported that Aureomycin (*3*), following either oral administration or intramuscular injection, also could be detected in both of these forms of excreta. Since growth stimulation was obtained whether Aureomycin was given orally or intramuscularly, the latter authors assumed that injected Aureomycin "by-passed" the rumen and concluded: "The mode of action of Aureomycin in stimulating growth in the young calf is not due to its action in the rumen." In view of the evidence presented by Bender *et al.* (*4*) that saliva from human beings who had been injected intravenously with Aureomycin contained significant quantities of this antibiotic, an attempt was made to determine whether the same might occur in the young calf (*5*).

In preliminary work attempts were made to detect Aureomycin in the saliva of several calves after intramuscular injection of the antibiotic. The standard paper-disk method for assay of antibiotics was used, with spores of *B. subtilis* (ATCC No. 6633, DIFCO) as the test organism; considerable difficulty was experienced in consistently detecting small quantities of Aureomycin in the saliva. But, when the cup-plate method was used, with spores of *B. mycoides* (*6*) as the test organism, and when the saliva sample was adjusted to *p*H 6.5, it was possible to detect Aureomycin concentrations as low as 0.05 μg/ml.

The results reported here (Table 1) involved four ruminating calves, 7 to 9 weeks of age, that consumed 2 to 5 lb of a grain mixture, plus hay, daily. A single dose of 2 g of Aureomycin HCl in sesame oil was injected intramuscularly (in the semitendinosus of the hind leg) into each calf immediately after the morning feeding. Samples of saliva, approximately 15 ml each, were collected at intervals of 0.5, 1, 2, 3, 5, 8, 12, and 24 hours after injection of the antibiotic. The samples were stored immediately in a freezer and kept frozen until completion of all the collections from each calf. Standard curves were prepared by plotting the size of the zones of inhibition produced by known quantities of Aureomycin added to saliva, which had been obtained from calves receiving no Aureomycin, and which also had been adjusted to *p*H 6.5.

As early as ½ hour after intramuscular injection of Aureomycin, the antibiotic was detected in the saliva of three of the four calves (Table 1). From 2 to 8 hours after injection, with one exception, Aureomycin was present in the saliva of all four calves at all collections. At 12 hours, the antibiotic was still detected in

Table 1. Concentration of Aureomycin found in the saliva of dairy calves following intramuscular injection of the antibiotic

Calf No.	Breed	Weight (lb.)	Concentration of Aureomycin in saliva (μg/ml)							
			Hours after injection							
			0.5	1	2	3	5	8	12	24
1	Jersey	90	0.25	0.35	0.15	0.00	0.05	0.10	0.10	0.00
2	Jersey	101	0.00	0.00	0.10	0.20	0.15	0.20	0.00	0.00
3	Guernsey	130	0.05	0.05	0.10	0.25	0.05	0.05	0.00	0.00
4	Ayrshire	115	0.10	0.20	0.25	0.20	0.10	0.10	0.10	0.00