CYANIDE, SMOKING, AND TOBACCO AMBLYOPIA*† OBSERVATIONS ON THE CYANIDE CONTENT OF TOBACCO SMOKE

BY

P. W. DARBY¹ AND J. WILSON²

From the Research Laboratory¹, Gallaher Ltd., Belfast, N. Ireland, and the M.R.C. Clinical Genetics Research Unit², Institute of Child Health, Guilford Street, London

RECENTLY it has been suggested that in so-called tobacco amblyopia, an uncommon condition characterized by centro-caecal scotomata which develops usually in males over 40 years of age, the visual deterioration is due to a failure to detoxicate normally the cyanide present in tobacco-smoke (Wokes and Picard, 1955; Wokes, 1958; Smith, 1961). This may be due to a relative or absolute deficiency of vitamin B₁₂ (Heaton, McCormick, and Freeman, 1958; Smith, 1961).

Certain strong brands of pipe-tobacco are said to be particularly liable to precipitate the condition, and in view of the hypothetical role of cyanide, it was decided to compare the cyanide content of smoke from various brands of tobacco.

Methods

Several consultant ophthalmologists and neurologists were asked to name the brands which in their experience were associated with tobacco amblyopia.

Three of the brands most frequently nominated, and seven other commonly smoked brands representative of a wide range of types of pipe-tobacco, were selected for comparison of the cyanide content of their smoke.

One pound samples of each pipe-tobacco were purchased from a large retail supplier, and combustion data were also obtained from a non-branded plain cigarette, "T", composed of tobacco used in major selling, "regular size", plain brands.

The experimental pipe-smoking technique was adapted from the Tobacco Research Council standard procedure (Bentley and Burgan, 1961). Whereas for standard cigarette-smoking experiments smoking conditions based on observations of human smoking behaviour have been adopted, comparable information on pipe-smoking is not available. In these experiments the standard conditions were determined mainly by the problem of keeping pipes alight throughout smoking, and to do this, it was necessary to increase the puff volume used in the standard cigarette-smoking procedures from 25 ml. to 35 ml. and to increase the frequency of puffing from one to ten per minute. It is recognized that the conditions used were somewhat unrealistic, and resulted in more rapid consumption of the tobacco than would normally occur during human smoking, but this should not invalidate comparisons between different brands.

In each test, smoke from four pipes, each loaded with 1 g. tobacco (moisture content as supplied), was collected in alkali traps. Cigarettes were smoked under identical conditions, leaving a butt length of 20 mm.

The contents of the four traps were combined and hydrogen cyanide was recovered quantitatively by steam distillation after acidification, and estimated titrimetrically by the method of Ryan and Culshaw (1944). Determinations were carried out on aliquots in duplicate, or until results showed agreement to within 20 µg.

* Received for publication December 22, 1965.

† Address for reprints: Institute of Child Health, 30 Guilford St., London, W.C.1.

Results

The brands nominated for their association with tobacco amblyopia were identified by letters A, B, and C, and the other brands examined by the letters D to J. Their trade descriptions are shown in Table I.

The amounts of hydrocyanic acid produced from the various brands are shown in Table II. Repeated determinations on brand "F" established the reproducibility of the technique on one batch (mean 0.29 mg./g. smoked; SEM $\pm$ 0.008; $n = 16$); a minimum of two charges to each of the pipes was considered to give adequate data from the other brands. These studies did not include any systematic measurement of batch to batch variation in HCN yield from a given brand.

TABLE I
TRADE DESCRIPTION OF BRANDS OF TOBACCO

Brand	Description
A	Strong (pipe)
B	Strong (pipe)
C	Medium (pipe)
D	Strong (pipe)
E	Medium (pipe)
F	Light medium (pipe)
G	Medium (pipe)
H	Light medium (pipe)
I	Light (pipe)
J	Light medium (pipe)

TABLE II
HCN CONTENT OF SMOKE FROM VARIOUS PIPE TOBACCOS

Brand	Per cent. Moisture	Per cent. Nicotine	No. of Puffs per Pipe	No. of Smoking Tests (each for four pipesful of 1 g.)	Mean Quantity of HCN Produced (mg./g. smoked) and S.E. of Mean		Concentration of HCN (μ g./ml. smoke)
					Mean	SEM	
A	24	3.7	71	4	0.32	0.010	0.13
B	26	3.7	70	6	0.40	0.017	0.16
C	21	2.4	89	2	0.34	—	0.11
D	26	3.4	78	2	0.31	—	0.11
E	23	2.7	68	4	0.30	0.025	0.13
F	26	2.5	75	16	0.29	0.008	0.11
G	24	2.5	81	2	0.30	—	0.11
H	19	1.4	91	2	0.31	—	0.10
I	20	0.9	79	2	0.27	—	0.10
J	19	2.4	72	4	0.34	0.014	0.14
T (cigarette)	13	1.8	26†	2*	0.55	—	0.48

* Four cigarettes per test

† Number of puffs per cigarette

Discussion

It has been established that the proportions of various constituents of tobacco-smoke can be affected by changes in physical characteristics and in conditions of combustion of cigarette tobacco (*e.g.* Bentley and Berry, 1959, 1960; Berry, 1963; Wynder and Hoffmann, 1964) and there is evidence that there is a similar variation in the hydrogen cyanide content of pipe-tobacco smoke (Darby—unpublished observations). Since in smokers these factors are subject to great personal variation, they are likely to influence considerably the amount of cyanide to which a person is exposed.

Although the amount of hydrogen cyanide formed was greatest in brand "B", one of those associated with tobacco amblyopia, the difference in smoke cyanide content between this and other brands, expressed both as cyanide produced per unit weight and as a concentration, is considered to be less than the differences due to variation in the physical conditions of combustion. Moreover, the quantity of cyanide produced from tobacco "A", which had been named most frequently for its association with tobacco amblyopia, did not differ significantly from the other brands tested. It is also noteworthy that the cyanide content of cigarette-smoke was considerably higher than that of pipe-tobacco under those conditions. If, therefore, cyanide is responsible for precipitating visual failure in susceptible subjects, it is improbable that the reported association between this condition and certain brands of tobacco is due to intrinsic differences in the cyanide content of their smoke.

Most of the clinicians whose views were sought agreed that tobacco amblyopia occurs less commonly now than in the earlier years of the century. The condition tended to be associated with poverty and malnutrition among older men (Heaton and others, 1958) and it is possible that these factors not only contributed to a state of incipient vitamin B₁₂ deficiency, but also enforced the choice of cheaper brands of tobacco, both for pipe-smoking and for rolling cigarettes (Table I).

The frequency with which two or three "strong" tobaccos seem to have been associated with the ophthalmic condition may be a reflection more of their popularity and cheapness than of intrinsic differences in neurotoxicity.

Summary

The yield and concentrations of cyanide in smoke from various brands of tobacco burned under standard conditions have been compared.

The alleged association between certain brands of tobacco and tobacco amblyopia may be a reflection of the popularity of those brands in a susceptible population and not due to intrinsic differences in composition of the smoke.

We gratefully acknowledge the help and comments of the following neurologists and ophthalmologists: Dr. C. J. Earl, Mr. J. R. Hudson, Dr. R. E. Kelly, Mr. H. V. Ingram, Mr. T. Keith Lyle, Dr. I. Mackenzie, Mr. S. J. H. Miller, Mr. J. G. Milner, Prof. E. S. Perkins, Mr. L. H. Savin, Prof. A. Sorsby, and Mr. T. M. Tyrrell, and helpful discussions with representatives of U.K. Tobacco Manufacturers, held under the auspices of the Tobacco Research Council.

REFERENCES

- BENTLEY, H. R., and BERRY, E. G. N. (1959). "Constituents of Tobacco Smoke", Tobacco Manufacturers' Standing Committee Research Paper No. 3. Supplements (1960, ed. Bentley and Berry; 1963, ed. Berry).
- and BURGAN, J. G. (1961). "Cigarette Smoke Condensate", Tobacco Manufacturers' Standing Committee Research Paper No. 4, 2nd ed.
- HEATON, J. M., MCCORMICK, A. J. A., and FREEMAN, A. G. (1958). *Lancet*, **2**, 286.
- RYAN, J. A., and CULSHAW, G. W. (1944). *Analyst*, **69**, 370.
- SMITH, A. D. M. (1961). *Lancet*, **1**, 1001.
- WOKES, F. (1958). *Ibid.*, **2**, 526.
- and PICARD, C. W. (1955). *Amer. J. clin. Nutr.*, **3**, 383.
- WYNDER, E. L., and HOFFMANN, D. (1964). *Adv. Canc. Res.*, **8**, 308, ed. A. Haddow and S. Weinhouse. Academic Press, New York.