

## THE AMOUNT OF NICOTINE ABSORBED IN SMOKING

BY

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(Received September 23, 1948)

The work which has been carried out in this laboratory on the effect of smoking during diuresis (Burn, Truelove, and Burn, 1945; Walker, 1949) has made it necessary to determine the amount of nicotine absorbed in smoking cigarettes. A few estimates have been published by different workers. These estimates have been made by chemical methods, and the figures vary. Bogen (1929) stated that the amount was between 0.2 mg. and 6.5 mg. per cigarette, according to the rate at which the cigarette was smoked. Schnedorf and Ivy (1939) also give the figure 0.2 mg., but Sollmann (1948) states that under average conditions the amount of nicotine entering the mouth from a cigarette ranges from 1.8 to 8.5 mg., and the amount absorbed ranges from 1.4 mg. to 3.3 mg.

Storm van Leeuwen (1918) estimated the amount of nicotine in cigar smoke, using the blood pressure of the spinal cat. He obtained figures from 1.6 to 4.25 mg. per g. of cigar or 8.0 to 20 mg. for an average cigar.

It is true that cigarettes can be smoked at very different rates, and it is likely that the amount of nicotine entering the mouth will vary considerably according to the rate. In practice, however, cigarettes are smoked at a rate which is about the same for the majority of individuals, and it should be possible to determine the nicotine within narrower limits than those just given.

The work described in this paper consists of two independent investigations, one carried out by H. W. L. in 1935, and the other by C. B. W. P. in 1948, each using the same general method. Since the results of the two investigations are very similar, they are probably a better guide to the amount of nicotine entering the mouth in smoking than are the results given in earlier work. The nicotine was estimated biologically on the blood pressure of the spinal cat.

Ordinary brands of cigarettes were used in both investigations, and a few estimations of cigar and pipe tobacco were also made by C. B. W. P.

### METHOD

The cigarettes, cigars, or pipe were fixed in a holder attached to one side of a long glass U-tube, each arm of which was 50 cm. long and of internal diameter 1 cm. The tube was immersed in a large jar of cold running water, and the other arm was attached to a 500 c.c. filter flask, which in turn was attached to a weak suction pump. A T-piece was inserted between the flask and the pump, and when the arm of the T-piece was open, the pump sucked air in through this open arm; when the arm of the T-piece was closed, air was sucked in through the U-tube. A weighed cigarette was inserted in the holder, and when the arm of the T-piece was closed it was easy to light the cigarette. When the U-tube was full of smoke the side arm was opened and suction ceased. The cigarette continued to burn gently in the air as it would if a person were holding it. Aspirations were then continued to simulate as nearly as possible the smoking of a cigarette, that is to say taking about 10 minutes to smoke the cigarette, so as to leave a stub of about 1 cm. The smoke condensed for the most part in the U-tube, any small excess being trapped in the filter flask.

To prepare each extract of cigarette smoke, 5 cigarettes (about 5 g. of tobacco) were smoked in succession in the apparatus. An extract of cigar smoke was obtained from one cigar (average weight 5–6 g.), and pipe tobacco smoke from 6 g. tobacco. The time taken for the smoking was suitably adjusted.

The U-tube and flask were washed out with *N/10* hydrochloric acid to dissolve the deposit, and the extract was filtered. It was then made alkaline with KOH and extracted with ether. The ether extract was poured into an evaporating basin and left overnight. The solid deposit was dissolved in 1 per cent tartaric acid (a few drops of alcohol assisted the process). It was then filtered and estimated. The estimations were made by comparing the rise of blood pressure of the spinal cat obtained after injecting doses of the extract with the rise obtained after injecting known doses of nicotine acid tartrate. The dose required and the time interval between injections varied in different cats. A dose of nicotine acid tartrate between 0.5–1.0 mg. was usually suitable, and a time interval of 5–7 min. was usually sufficient to avoid a decrease in sensitivity.

This was the method used by H. W. L., and the method of C. B. W. P. was essentially the same. There were two modifications in the later work. Firstly, a set number of aspirations, namely 12, were made in ten minutes for each cigarette, and, secondly, the extract after being made alkaline was extracted five times with ether. It is possible that a more thorough extraction with ether accounts for the slightly higher figures obtained by C. B. W. P.

### RESULTS

#### 1. Obtained by H. W. L. in 1935:

##### A. Cigarettes

Each cigarette weighed approx. 1 g.

Brand	Number of cigarettes used to prepare extract	Amount of nicotine (base) per cigarette
Players .. ..	5	0.66 mg.
Wills Gold Flake..	10	0.75 mg.
" " " "	10	0.7 mg.

##### B. Cigarette tobacco

Wills Gold Flake, 0.6 mg. per g. tobacco.

##### C. Cigars

2 Marcella cigars, 3.8 mg. per cigar (each approx. 5 g.).

#### 2. Obtained by C. B. W. P. in 1948:

##### A. Cigarettes

Brand	Number of cigarettes used to prepare extract	Amount of nicotine (base) mg. per cigarette
Players .. ..	5	0.83
" " " "	5	0.8
" " " "	5	0.94
" " " "	5	1.00
" " " "	5	0.8
State Express 555	5	0.72
" " " "	5	1.00
" " " "	5	0.98
" " " "	5	1.20
	Mean	0.92

##### B. Cigars

- (a) 3.6 mg. per cigar (weight about 5 g.).
- (b) 6.26 mg. per cigar.
- (c) 5.0 mg. per cigar.
- (d) 7.9 mg. per cigar.
- (e) 5.0 mg. per cigar.

##### C. Pipe tobacco

Four extracts of 6 g. each pipe tobacco were estimated. The results were:

- (a) 2 mg. nicotine per g. tobacco.
- (b) 2.75 mg. " " " "
- (c) 3.0 mg. " " " "
- (d) 3.0 mg. " " " "

Mean = 2.69 mg. " " " "

### DISCUSSION AND SUMMARY

The results show that in two independent investigations made at a time interval of 13 years the amount of nicotine found to be deposited in the smoke from well-known brands of cigarettes was of the same order. The war period has certainly not led to any diminution in the nicotine content. If all the results are considered, a figure between 0.6 mg. and 1.0 mg. per cigarette or per gramme tobacco is obtained. The cigars yielded between 3.6 mg. and 7.9 mg. per cigar, or 0.7 mg.-1.6 mg. per g. tobacco. The pipe tobacco yielded between 2 and 3 mg. nicotine per g. tobacco. This figure for pipe tobacco is higher than the figures for either cigarettes or cigars.

These figures give the amount of nicotine entering the mouth of the smoker. The proportion of nicotine absorbed into the circulation depends on the extent to which the smoker inhales, for nicotine in the smoke entering the alveoli is mostly absorbed. Absorption must also occur to some extent in the mucous membranes of the mouth, nose, and throat, for smoking without conscious inhaling raises the pulse rate and the blood pressure. Burn, Truelove, and Burn (1945) describe an experiment in which the same individual drank 1 litre of water on two occasions. The diuresis was then recorded by collecting urine at 15 min. intervals. The anti-diuretic effect of smoking 1 cigarette was of shorter duration than that produced by the intravenous injection of 0.5 mg. nicotine (base). Thus, although the smoker inhaled, less than 0.5 mg. nicotine (base) was absorbed into the circulation from one cigarette.

It can, therefore, be concluded that, while the amount of nicotine from one cigarette entering the mouth is about 0.9 mg., the amount absorbed is about 0.4 mg. or less.

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