

DGF/PB/46D

19th December, 1958.

C.H. James, Esq.,
Tobacco Manufacturers' Standing Committee,
6-10 Bruton Street,
LONDON, W.1.

Dear Mr. James,

I hope that the following will assist you, should the T.M.S.C. decide to reply to Mr. McCarty's questions.

To answer these questions we must start with definitions. For example, while nicotine is a single chemical entity of fixed composition and chemical structure and therefore may be defined exactly, "tar" is a vague term which has come into common usage based on the hypothesis that any dark-brown semi-solid mass is a "tar". If tar is defined as the product of the destructive distillation of materials in the absence of air, e.g. coal tar, then the material from a cigarette is not tar. A much better term is "smoke condensables" or "smoke solids". Tobacco smoke is an aerosol, consisting of very small particles of solids and liquids or, more probably, liquid-sheathed solids, suspended in a gaseous mixture of air, excess carbon dioxide and small amounts of other permanent gases arising in the combustion process. The smoke solids are entrained in the tobacco butt while the gaseous phase passes through. Some workers measure smoke condensables in terms of the weight of total smoke solids collected; others make allowance for the quite considerable quantities of water which are produced during combustion of tobacco and report weights of "dry smoke". Yet again, others collect the total smoke solids in a mixture of dilute acid and chloroform and report "chloroform soluble smoke solids" from which have been removed the nicotine and other bases, and the water-soluble components of smoke.

So you will appreciate how vague such a term as "tar" can be. For the present, we can only say that the chemistry of the smoke particles is not easy, owing to their very complex nature.

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19.12.58

Dealing with the questions in greater detail, we would remark how difficult it is to define the length of an "average stub". We believe the Medical Research Council have embarked on a Survey of this factor, which may produce some sort of answer. For the purpose of answering your questions we will assume the average length to be $\frac{3}{4}$ -1". Then we come to further problems. As you will no doubt be aware, cigarettes may be made from a blend of as many as 20-30 different grades of tobacco leaf, and it is highly improbable that two brands will be made from the same blend. Each grade of tobacco will make its own contribution to the smoke, both in terms of total smoke solids and nicotine content. Some grades may be low in nicotine, others high.

Clearly the retention of smoke solids and nicotine by the "average butt" will depend upon the amounts of these materials presented to the butt and these, you will appreciate, will differ from blend to blend. Other factors which are involved are the moisture content of the cigarettes and the fineness of shredding of the tobacco. We imagine your interests are confined to this country, however, and in these respects these factors and others are less likely to be of importance.

It is therefore impossible to answer your questions by giving weights of materials, since these would have relevance only to particular cases. We can say that 15-20% of the smoke presented to an average stub, during smoking of an English cigarette, will be entrained by the tobacco in the stub and therefore will not reach the consumer. This percentage will be independent of the method of estimation, as long as this is consistently used, and will apply equally to total smoke solids and to nicotine. In the case of nicotine, the range of amounts passing the stub and reaching the smoker may vary from 1.5-3.5 mg. per cigarette. We would remark in passing that the determination of these percentages is full of experimental difficulties, and we would not advise people, unused to these, to attempt the task.

Turning to your pharmacological queries concerning the absorption and toxicity of nicotine, we understand there is evidence that 90% or so of the nicotine present in tobacco smoke is absorbed by those smokers who inhale. Non-inhalers absorb considerably less, perhaps as low as 10-20% of the amount present. In the body, nicotine is rapidly metabolised and excreted. The course of the

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19.12.58

metabolic pathway is largely unknown. Some nicotine is excreted unchanged and the urinary output of nicotine by non-inhalers is some 10% of that by smokers who inhale, which is roughly in line with the figures for absorption.

The toxicology of nicotine is complex. There is naturally a difference in the figures due to the mode of administration and there is an individual variation. Possibly as little as 1 mg. of nicotine per kg. body weight when taken orally may be fatal for some individuals. Probably, the fatal dose for man is of the order of 60 mg. However, the rapidity with which nicotine is excreted means that a greater than fatal dose may be administered if it is spread over a period of hours. In the cat, for example, the single acute median lethal dose may be increased elevenfold by infusing nicotine over an 8 hour period. Moreover, if nicotine is administered repeatedly at sub-lethal doses, a tolerance develops and larger doses may then be administered without noticeable effect.

Your last question is extraordinarily difficult to answer. Assuming you wish to know whether the smoke which is inhaled is exhaled unaltered in composition, then clearly the answer is no, since there is good evidence that nicotine is absorbed, and undoubtedly the same is true of some of the other constituents. There is an alternative meaning to be attached to your question, however. The smoke aerosol is by no means a stable one. Coalescence and aggregation of droplets occur from the moment of its formation and chemical reactions take place as the reactants come into contact. The chemistry of the ageing of smoke has barely been touched upon because of the very great experimental complications which are encountered and we can offer you no guidance upon this aspect.

You will now, we hope, see why your apparently simple questions raise such problems in the answering of them, and we trust that the answers we have given will be helpful to you.

I shall be pleased to learn whether the above reply is satisfactory for T.M.S.C. purposes.

Yours sincerely,

D.G.F.

D.G. Felton - Laboratory.
RESEARCH & DEVELOPMENT ESTABLISHMENT.

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