

A STUDY OF THE AMMONIA CONTENT OF CIGAR SMOKE^{1, 2}

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(WITH ONE FIGURE)

The number of cigars manufactured in the United States for the year 1913 exceeded 8,500,000,000, while in 1928 the number produced was about 7,000,000,000. These figures indicate a noticeable decrease in demand. Probably the chief cause for this is the increasing popularity of cigarettes. However, the quality of the cigars now on the market may be a factor of considerable importance. The curing, fermentation, and aging processes have a great deal to do with the development of a pleasant aroma, lack of harshness, and a mild physiological effect when smoked, but the field treatment of the tobacco itself may be of overshadowing importance.

Pennsylvania ranks high as a producer of cigar-leaf tobacco. The Pennsylvania Agricultural Experiment Station and the United States Department of Agriculture have been interested for a number of years in the factors that affect quality production. Various field treatments have been employed at the Tobacco Experiment Plots at Ephrata. Each year a considerable quantity of the tobacco produced is fermented and made into cigars for testing purposes. As a rule, the cigars are made from tobacco less than a year after the crop is harvested. Because of insufficient aging, these cigars usually produce a harsh unpleasant smoke. The burn, coherence of ash, and other qualities may, however, be studied satisfactorily.

The physiological effect and other undesirable qualities of cigar smoke have been attributed, in large measure, to the nicotine content, although cigar smoke is known to contain ammonia, aldehydes, amines, organic acids, carbon monoxide, hydrocarbons, hydrogen sulphide, hydrogen cyanide, pyridine, and many other substances. From a physiological standpoint, ammonia is an important constituent in that it may interfere with the normal action of the heart and produce other complications if present in the smoke in sufficient concentrations.

Very little has been reported on the ammonia content of cigar smoke, especially for cigars made from tobacco of known history. For this reason it was decided to make a study of this constituent in the smoke of cigars made from the experimental tobaccos.

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² This investigation was conducted in cooperation with Dr. W. W. GARNER, of the U. S. Bureau of Plant Industry, Office of Plant Nutrition and Tobacco Investigations, and Professor F. D. GARDNER, Department of Agronomy of the Pennsylvania State College.

Experimental

The test cigars were made wholly of tobacco grown on 10 separate plots which received fertilizer treatments according to the plan given in a previous paper (5). An intermittent smoking apparatus was used. Somewhat similar methods have been employed by others. JENKINS (6) used an apparatus in which suction was secured by means of an aspirator which filled by a continuous inflow of water and emptied at regular intervals by means of a siphon. GARNER (4) retained the essential features of this apparatus, but modified it so that several cigars could be smoked simultaneously. GARNER's apparatus, however, was devised for work pertaining to the burning qualities of the cigar rather than to the chemistry of the smoke. The duration of each puff was 10 seconds; the interval between puffs was 30 seconds. WILEY (9) describes a similar apparatus. ASHERSON (1) used an aspirator which evidently was turned on and off by hand, so as to simulate the manner of smoking of the average smoker. BOGEN (2) states that he obtained the necessary suction by the use of a water pump which was turned on and off at regular intervals by an electric solenoid valve, operated by a contact on a Harvard kymograph. An automatic siphon arrangement was tried, but was discontinued as unsatisfactory.

Various methods have been employed for collecting the active constituents of smoke. BOGEN (2) reports that he collected the smoke over water, allowed it to condense for one hour and then analyzed the aqueous solution for ammonia. THOMS (7) employed three jars containing various quantities of 10 per cent. H_2SO_4 in order to remove the basic constituents of the smoke.

Methods of analyses employed by other workers in this field were reviewed. VICKERY and PUCHER (8) developed a method for estimating the ammonia in tobacco and tobacco extracts which is entirely satisfactory for work of this kind. It is based on the observation that nicotine is absorbed by permutit (a synthetic aluminosilicate) only to a very small extent, whereas ammonia may be quantitatively removed from a faintly acid solution by permutit, set free by alkali and determined by Nesslerization. The method which is fully described by VICKERY and PUCHER (8) and which is a modification of FOLIN and BELL's method for the determination of ammonia in urine (3), was used by us and found quite satisfactory.

The smoking apparatus

Some of the apparatus previously used by us proved unsatisfactory. It was felt that an intermittent siphon could be made that would give a regular interval in the suction. An apparatus was devised which proved satisfactory (see fig. 1). It was so regulated that each puff lasted about 6.5 seconds with an interval between puffs of 35 seconds.

A is a suction flask to which continuous suction is applied by means of a laboratory vacuum pump. The amount of suction is regulated by means of a valve. *B*, *C*, and *D* are absorption tubes, each of which holds 25 cc. of 20 per cent. H_2SO_4 . *E* is a glass cigar holder. *F* is a tube admitting air to the suction flask *A*, when the water level in the intermittent siphon *G* is below the level of the inverted tube *F*. When the water rises to the level of the inverted funnel, the air supply is cut off and the vacuum created in *A* draws air through the cigar. When the water reaches the top of the curved tube in *G*, it siphons out and the tube *F* is again open, air enters the suction flask *A* and no air is drawn through the cigar. *I* is a bottle holding water at a constant level, and fed from the supply bottle *J*. The rate of flow of water from *I* is regulated by means of the clamp *H*.

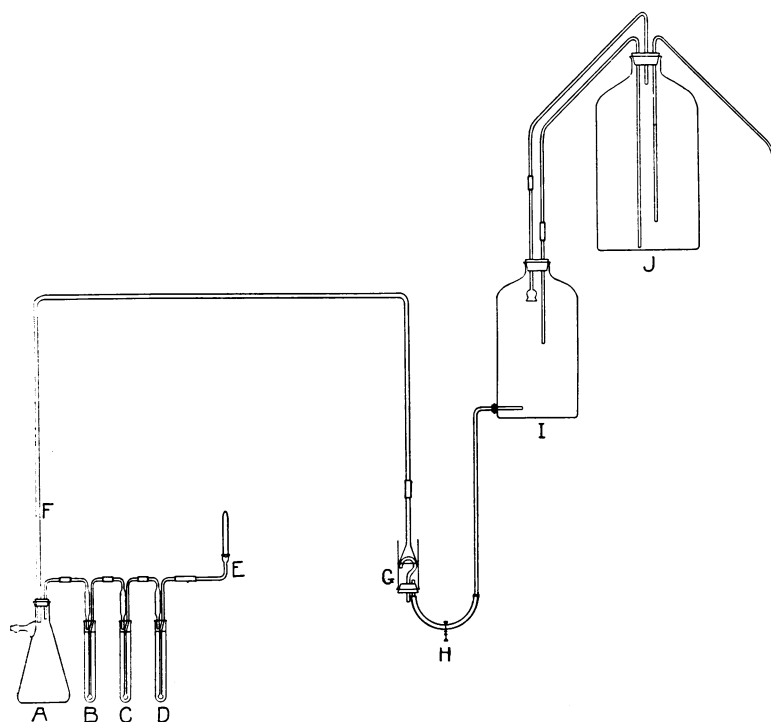


FIG. 1. Intermittent smoking apparatus.

Before smoking, the cigars were kept in a desiccator containing 43 per cent. H_2SO_4 . At 25°C ., according to WILSON (10), this should give an atmosphere having a relative humidity of 50 per cent. The ends of the cigars were cut so that all had the same circumference. Each cigar then was weighed and smoked. The small quantity of tobacco remaining at the

end of the experiment was weighed and subtracted from the original weight. In this way the weight of tobacco smoked was ascertained.

In the preliminary work it was found that 25 cc. of normal H_2SO_4 in the first tube absorbed practically all of the ammonia. Since we desired to determine nicotine, however, we used 20 per cent. H_2SO_4 instead.

Three cigars were smoked before the acid was removed. The total amount of ammonia and its relation to the total nitrogen content of the tobacco then was determined. The results are given in table I.

TABLE I

QUANTITY OF AMMONIA IN SMOKE AS RELATED TO THE TOTAL NITROGEN CONTENT OF THE ORIGINAL TOBACCO FROM WHICH THE CIGARS WERE MADE

CONSTITUENTS	SAMPLES									
	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
Total nitrogen	<i>mg.</i> 51.7	<i>mg.</i> 50.0	<i>mg.</i> 48.1	<i>mg.</i> 47.1	<i>mg.</i> 49.5	<i>mg.</i> 49.3	<i>mg.</i> 51.4	<i>mg.</i>	<i>mg.</i> 51.8	<i>mg.</i> 44.5
Ammonia in smoke.....	4.7	5.4	5.5	5.6	5.4	5.4	6.0	4.8	3.5	3.6

The results show that apparently there is no relation between the ammonia content of cigar smoke and the fertilizer treatment received by the tobacco. This is not strange since the fertilizer treatment did not materially affect the nitrogen content of the tobacco. The first seven samples show a close correlation between the total nitrogen content of the tobacco and the quantity of ammonia in the smoke. Representative samples of several commercial cigars made almost wholly of well fermented tobacco showed a smoke of much lower ammonia content.

Summary

1. An apparatus was devised which proved satisfactory for the intermittent smoking of cigars.
2. There was no correlation between the fertilizer treatment of the tobacco and the ammonia content of the smoke. This may not hold true for cigars made of thoroughly fermented tobacco.

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