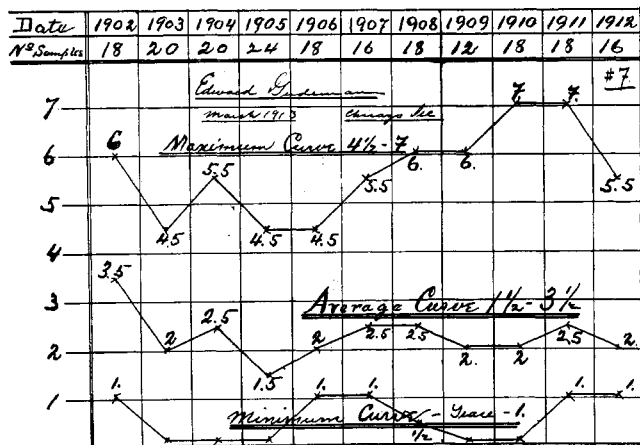


Copper in Glucose (U.S.)  
Parts per Million



POSTAL TELEGRAPH BUILDING  
CHICAGO

### INFLUENCE OF OZONE ON YEAST AND BACTERIA

CARL A. NOWAK

Received May 8, 1913

To test the influence of ozone on yeast, especially as regards fermentative power, the following experiments were made:

Brewers' yeast (bottom fermenting) was freed from excess of moisture by drying on filter paper until it had the consistency of compressed yeast. Five portions of 5 grams each were then carefully weighed out into glass flasks of about 250 cc. capacity and mixed with 125 cc. of distilled water; the resulting mixture was ozonized by passing ozonized air through for periods varying from 5 to 45 minutes. The contents of the flask were then permitted to settle over night and the following morning the supernatant liquids were carefully decanted from the yeast sample, which had settled quite firmly.

To each of the yeast samples 500 cc. of clear hopped brewers' wort (sp. gr. about 1.05) were added and the samples permitted to ferment at a temperature of about 9°. Saccharometer readings were taken every second day for a period of eight days and the percentage of apparent extract (carbonic acid gas removed by shaking) tabulated.

On the eighth day each of the samples was examined microscopically for dead cells and bacteria, and the following observations were made:

The untreated sample contained the largest number of bacteria (13 per 1000 yeast cells), the treated samples (period of treatment varying from 5 to 45 minutes) contained on an average 8 bacteria per 1,000 yeast cells—the longer period of ozonization (45 minutes) showing no apparent advantage over the shorter period. The number of dead or weakened cells in the untreated sample averaged about 75 per 1,000 cells, there being practically no difference in this number in the case of the sample subjected to ozonization for a period of 5 minutes. Further increase in the duration of the treatment had, however, a positively destructive action on the yeast, the number of dead or

weakened cells in the case of 45-minute sample amounting to 200 per 1,000, or about  $\frac{1}{5}$  of the total number of cells present.

From the results in the table given below the following conclusions can be arrived at:

(1) At the outset of the fermentation the non-ozonized yeast ferments more rapidly than any one of the ozonized samples. (2) At the end of the third day the ozonized sample (5 min.) has a somewhat greater fermentative power than the non-ozonized sample, which it retains until the final degree of fermentation has been reached. (3) Inasmuch as on the fifth day and each of the following days the number of yeast cells present in the non-ozonized sample (as judged by the difference in the specific gravity of the sample with yeast and without yeast) is greater than in any of the ozonized samples, it follows that the fermentative power of the ozonized yeast must be greater than that of the non-ozonized yeast. This is most apparent in the case of the 45-minute sample in which the total number of cells had at the outset been reduced to  $\frac{4}{5}$  of the number present in the non-ozonized sample due to the prolonged period of ozonization. (4) In general, the results indicate that prolonged ozonization has an inhibitory action on the multiplication of the yeast by reproduction. (5) The maximum results as regards the destruction of bacteria and beneficial influence on fermentative power are obtained with 5 minutes' ozonization, prolonged treatment having a positively detrimental influence.

#### FERMENTATION TESTS

Time Min.	Original Sp. gr.	Original Balling per cent	2nd day with yeast	3rd day		5th day		7th day	
				With-out yeast	With yeast	With-out yeast	With yeast	With-out yeast	With yeast
0	1.0524	12.86	8.35	6.20	6.45	4.65	5.15	4.05	4.75
5	1.0528	12.95	8.46	6.05	6.38	4.45	5.05	4.00	4.55
10	1.0528	12.95	8.73	6.32	6.63	4.48	4.81	4.00	4.45
20	1.0528	12.95	9.27	7.00	7.22	4.60	4.95	4.15	4.60
45	1.0525	12.88	10.86	8.85	9.00	5.58	6.12	4.25	4.75

From this it appears that the ozonization of yeast is of value, not only in freeing the yeast of objectionable organisms which are susceptible to the destructive action of ozone to a larger degree than the yeast itself, but also in eliminating the weakened cells and stimulating the fermentative power of the surviving ones. In the brewing industry the overproduction of yeast is a great source of loss, which possibly could be minimized by ozonization.

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### DETERMINATION OF SMALL AMOUNTS OF CAFFEINE A COMPARISON OF METHODS

By B. L. MURRAY

Received April 21, 1913

The object of this paper is merely to present certain interesting data that are at hand, with the thought that possibly the figures in the succeeding tables may prove useful to others having small amounts of caffeine to determine. Emphasis is placed on the fact that the comparison of methods here brought out shows that the determination of small amounts of caffeine presents a problem quite unusual, and much more

susceptible to gross errors than the determination of large amounts.

Coffees, coffee preparations, coffee extracts, coffees that have been freed from practically all of their caffeine, make up the samples used in the analyses. Wherever it was a coffee in bean or in ground condition, roasting on large scale has preceded the analysis.

The methods of analysis are those of Görter and of Lendrich and Nottbohm. Both methods as used are given below, but it should be noted that all results here tabulated were obtained from the determinations of nitrogen in the caffeine separated from the samples, instead of by weighing the caffeine itself. No results here recorded were obtained by the alternative process of shaking out with chloroform. The work has been performed by two different analysts, thus showing the value of the methods in different hands.

TABLE I—PERCENTAGES CAFFEINE,  $C_8H_{10}N_4O_2$ 

Sam- ple	L. & N.	Görter	Sam- ple	L. & N.	Görter	Sam- ple	L. & N.	Görter
1	0.075 0.080	0.152 0.136	8	0.153 0.148	0.199 0.195	16	0.100 0.095	0.141 0.146
2	0.063 0.063	0.107 0.117	9	0.099 0.105	0.121 0.126	17	0.107 0.102	0.156 0.151
3	0.084 0.092	0.169 0.172	10	0.126 0.126	0.160 0.165	18	1.211 1.213	1.226 1.230
4	0.061 0.045	0.133 0.136	11	0.102 0.105	0.146 0.141	19	1.170 1.165	1.192 1.196
5	0.073 0.073	0.141 0.136	12	0.129 0.124	0.180 0.175	20	1.189 1.194	1.235 1.235
6	0.078 0.083	0.126 0.117	13	0.119 0.117	0.169 0.165	21	0.049 0.044	0.083 0.078
7	0.598 0.596	0.627 0.618	14	0.124 0.119	0.151 0.141	22	0.105 0.100	0.122 0.122
			15	0.121 0.118	0.184 0.184			

It is evident from Table I that the Görter method gives results greatly at variance with and higher than those of Lendrich and Nottbohm. This variation, as will be seen, becomes pronounced when, as a rule, less than 0.5 per cent of caffeine is at hand. One must, therefore, select his method of analysis

TABLE II—PERCENTAGES CAFFEINE

Sample	L. & N. method		Sample	L. & N. method		Sample	L. & N. method	
	Complete	Without $KMnO_4$		Complete	Without $KMnO_4$		Complete	Without $KMnO_4$
23	0.185 0.178	0.189	26	0.143 0.146	0.168	30	0.143 0.138	0.175
24	0.129 0.119	0.175	27	0.131 0.127	0.153	31	0.112 0.112	0.158
25	0.148 0.146	0.156	28	0.126 0.122	0.141	32	0.168 0.178	0.197
			29	0.212 0.211	0.216	33	0.143	0.204

with care because differences of fifty and one hundred per cent are not uncommon.

Some experiments have been made with the idea

of ascertaining the value of the purification of the crude caffeine by means of potassium permanganate as used by Lendrich and Nottbohm. The few results in Table II show the effect of the purification.

From Table II the necessity of the permanganate purification as described by the authors of the method is confirmed, and in addition the effect and extent of the purification is brought out.

Table III is presented merely to show the nature of results obtained by the Lendrich and Nottbohm method, that is, mainly, how duplicate analyses agree.

TABLE III—PERCENTAGES CAFFEINE—DUPLICATES BY L. &amp; N. METHOD

Sample	Sample	Sample	Sample
34 0.165 0.162	40 0.131 0.126	45 0.131 0.136	50 0.151 0.151
35 0.199 0.210	41 0.159 0.172	46 0.132 0.134	51 0.097 0.102
36 0.612 0.626	42 0.137 0.148	47 0.160 0.155	52 0.131 0.114
37 0.124 0.124	43 0.155 0.151	48 0.155 0.160	53 0.055 0.068 0.058
38 0.180 0.206	44 0.151 0.151	49 0.117 0.112	54 0.136 0.138
39 0.130 0.140			

## GÖRTER METHOD

Moisten 11 grams of the finely powdered coffee with 3 cc. of water, allow to stand for half an hour, and extract for three hours in a Soxhlet extractor with chloroform. Evaporate the extract, treat the residue of fat and caffeine with hot water, filter through a cotton plug and a moistened filter paper, and wash with hot water. Make up the filtrate and washings to 55 cc., pipette off 50 cc., and extract four times with chloroform. This chloroform extract is evaporated in a tared flask and the caffeine dried at 100° and weighed.

Calculate the caffeine from the nitrogen content also.

## LENDRICH AND NOTTBOHM METHOD

Twenty grams of green or roasted coffee ground to pieces about 1 millimeter in size are moistened with 10 cc. of distilled water, thoroughly mixed, and allowed to stand 2 hours with occasional stirring. The whole is then transferred without loss into an extraction thimble and extracted with carbon tetrachloride five to eight hours in a Soxhlet apparatus. To the extracted matter about 1 gram of solid paraffin is added, then the carbon tetrachloride is completely distilled off and the remaining residue extracted four times with boiling water, consisting of one portion of 50 cc. and three portions of 25 cc. each. The cooled aqueous extract is filtered upon a moistened paper and finally washed with boiling water. The filtrate cooled to room temperature is treated with from 10 to 30 cc. of a 1 per cent solution of potassium permanganate. After the permanganate has acted for fifteen minutes the excess of manganese is reduced to peroxide by the addition of a 3 per cent solution of hydrogen peroxide, containing 1 cc. of 96 per cent acetic acid in each 100 cc. The hydrogen peroxide is to be added by drops. The solution is now heated upon the water bath fifteen minutes, filtered hot, and the residue upon

the filter paper is washed with boiling water. The filtrate is evaporated to dryness in a glass evaporating dish upon the water bath, the residue dried at 100° C. for fifteen minutes, and then at once taken up with warm chloroform and filtered. The chloroformic extract is freed from chloroform and the caffeine so obtained, after drying thirty minutes at 100° C., may be

weighed. The caffeine is to be checked by determination of nitrogen.

In place of the evaporation of the aqueous caffeine solution which has been purified by permanganate, shaking out with chloroform directly may be used.

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## LABORATORY AND PLANT

### THE DISTRIBUTION OF HEAT IN THE OPERATION OF STEAM BOILERS<sup>1</sup>

By PERRY BARKER<sup>2</sup>

In the process of combustion of coal in boiler furnaces a comparatively large percentage of the heat in the fuel is not usefully employed for the generation of steam. The extent of the losses which ultimately affect the boiler efficiency is governed by (a) the design and physical condition of the plant, (b) the personal element in the operation of the boilers and furnaces, (c) the character and adaptability of the fuel for the plant in question, and (d) the rate of steam generation or capacity at which the boiler is operated. The efficiency with which fuel is burned is controlled by these factors, and excessive losses may be due to one or a combination of the contributing causes.

In accordance with the recent recommendations of the Power Tests Committee of the American Society of Mechanical Engineers, a balance accounting for the distribution of heat in a pound of dry coal fired consists of the following items:

I. Heat absorbed by the boiler.

II. Loss due to evaporating and superheating moisture in coal.

III. Loss due to evaporating and superheating moisture formed by the combustion of hydrogen and distillation of oxygen-hydrogen compounds in the coal.

IV. Loss due to heat carried away by dry flue gases leaving the boiler.

V. Loss due to heat escaping through the formation of carbon monoxide (CO).

VI. Loss due to combustible removed from ash pits and from grates during cleaning.

VII. Loss due to superheating moisture in the air used for combustion.

VIII. Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for.

Of the items enumerated above, (IV), (V) and (VI) generally constitute about 75 per cent of the total heat which is lost in the operation of steam boilers and are the variable factors which have a direct effect on the percentage of heat imparted to the water in the generation of steam. In presenting certain data on these losses, illustrations of the origin, extent and methods which have been employed for their reduction, are submitted.

The loss which is generally the largest and in the ma-

jority of cases most easily reduced, is the heat carried away by the dry flue gases escaping from the boiler. Under this heading are included the sensible heat in the carbon dioxide and carbon monoxide, if any, formed by the combustion of the carbon in the fuel and the heat in the air in excess of that theoretically required leaving the boiler at the temperature of the escaping gases.

The principal causes of this loss are as follows:

(a) Improper methods of firing, which allow large quantities of air to enter the furnace either through the grates or fire doors.

(b) Condition of boiler settings. If the settings are cracked and the iron work is badly warped, a large amount of air is drawn through any openings, thereby reducing the draft available at the grate, diluting and cooling the gases as they pass over the heating surface.

(c) Poor quality of coal. Coals which contain a high percentage of ash or have a tendency to clinker cause an uneven distribution of the air through the fuel bed. When such a condition exists, large volumes of excess air enter the furnace and carry away heat in the flue gases. If the fuel is particularly fine, it will pack on the grate and produce an effect similar to that noted above.

This loss depends upon the weight of gases per pound of carbon burned together with the temperature at which these gases leave the boiler. The data which are required for this computation are the temperature of the flue gases, temperature of the boiler room, composition of the flue gases, the heating value of the coal and the carbon content of the fuel and ash pit refuse.

Several tests conducted in a plant in which the loss of heat in the flue gases was originally high are submitted in Table I. The plant in question consisted of hand-fired horizontal return tubular boilers equipped with plain grates upon which Pennsylvania semi-bituminous coal containing about 9.00 per cent of ash and 22.00 per cent of volatile matter was burned. The fires in this plant were carried at a thickness not exceeding 7 inches and were uneven, thereby permitting a very large air excess. The thickness of the fire was increased and the methods of firing were altered which resulted in a reduction of the loss of heat due to the enormous air excess from 36 to 12 per cent, with a resultant increase of about 20 per cent in the boiler efficiency. These tests afford conclusive evidence that the air excess maintained throughout the latter tests was somewhat lower than could be recom-

<sup>1</sup> Presented at the Boston Meeting of the American Institute of Chemical Engineers, June 25-28, 1913.

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