XXXIX.—The Absorption of Sugar by Bone Black.

By HENRY A. MOTT, Jr., Ph. D., E. M.

It is a pretty generally conceded fact amongst sugar chemists that bone black absorbs sugar. The exact amount of absorption being variously stated, I determined to conduct a series of experiments to ascertain the fact for myself, as also to ascertain what influence the amount of bone black usually employed in sugar tests had on the solution. Bone black is used in two ways by chemists—it is either mixed directly with the solution to be decolorized and shaken up with it, or the solution is poured over a given amount of bone black in a funnel.

It is evident, to determine the amount of sugar absorbed by bone black, experiments should be conducted with perfectly pure sugar, as well as with impure sugars, as the latter contain other substances besides sugar, which affect polarized light, and which are apt to be absorbed, in part, by the bone black, thus effecting the test of the sugar, and showing differences which, in part, could be attributable to this fact.

It is also best in making comparative tests to dissolve sufficient of the sugar to be examined, at once, so that the same solution may be used for all the tests, otherwise errors due to weighing, variance of sample, and diluting, might creep in, and alter the results. In all my recent experiments I have been careful to observe these points.

To find what influence bone black would have on sugar solutions, if the solution was poured over a given quantity of bone black in a funnel, I conducted a number of experiments (about a year ago) which were as follows:

A solution of granulated sugar was made, which tested directly:

Aqueous solution	99.9 per cent.
Solution to which had been added 3 c.c. of sulphate of soda and 7 c.c. of tri-plumbic acetate	99.9 "

Solution filtered over 10 grms of bone black, tested as follows:

First portion filtered	99.5 per cent.
Second "	99.7 "
Third "	99.9 "

An inferior sugar was next taken :

16.35 grms were dissolved in water, to which were added 3 c.c. of concentrated solution of chloride of sodium and 7 c.c. tri-plumbic acetate, and the whole diluted to 100 c.c.

16.35 grms more of the same sugar were dissolved in water, and sulphate of soda was added, instead of the chloride.

16.35 grms more of the same sugar were dissolved in water, and 5 c.c. of tri-plumbic acetate were added, the whole being diluted to 100 c.c., and then filtered over 10 grms of bone black.

The first solution tested	85.3 per cent.
The second "	85.4 "

The third solution tested in three parts :

First part	84.9 per cent.
Second part	85.0 "
Third part	85.3 "

Many other tests were made, using the same bone black, with similar results. With different bone black, perfectly free from water, much greater differences were observed in several experiments.

A sugar (decolorized with 3 c.c. Na_2SO_4 and 7 c.c. Pb sol.) tested, 89.1 per cent.

The same sugar, dissolved in water, and to which were added 5 c.c. Pb sol., and then passed over 10 grms bone black, tested in three portions, gave :

First portion	88.4 per cent.
Second "	88.7 "
Third "	89.1 "

Without any experiments—admitting the fact that bone black absorbs sugars—I think it might reasonably be expected where sugar solutions are poured over a given quantity of bone black in a funnel, that the first portion of the filtrate would be much weaker in saccharine strength than the last portion, for the bone black would naturally saturate itself with the quantity of sugar it is capable of absorbing at once from the first portion, at a sacrifice of its strength. This is actually found to be the case, as the experiments I have just related clearly demonstrate.

Some experiments, conducted by the late Prof. Merrick, and reported in the *Chemical News*, arrive at the same results. It would be necessary to obtain an average if this method of decolorizing were to be adopted—that either the whole solution be allowed to filter through the bone black, and then be thoroughly mixed together, or that when one-half is filtered, it be poured on the bone black and

filtered again. This seems an utter waste of time, when it is possible to mix the bone black directly with the solution at the start. This method, therefore, must be abandoned as possessing no merit whatsoever.

The experiments which I have recently conducted have been made with granulated, centrifugal, Muscovada, molasses and refined sugars, and in each case the bone black was first mixed with the solution before filtering.

Before giving the results of these experiments, it may be interesting to present a few tests made by a number of chemists on the same solutions some few weeks ago, to determine the quantity of sugar bone black is capable of absorbing. The experiments were conducted in Dr. Grund's laboratory. 130,240 grms of a molasses sugar were dissolved in water, some tri-plumbic acetate was added, and the whole was diluted to 500 c.c., thoroughly shaken, and then filtered. A portion of the filtrate was tested. Then 50 c.c. of the filtrate were mixed and thoroughly shaken with 1 grm of bone black; 50 c.c. were mixed and thoroughly shaken with 3 grms of bone black; and to another 50 c.c. of the filtrate were added 5 grms of bone black, and the same was thoroughly shaken. Each was filtered separately and tested separately, by each chemist, as follows:

	Dr. Grund.	Dr. Behr.	De Messemy.	Dr. Mott.
The filtrate tested*	89.1	....	....	....
50 c.c. + 1 grm bone black	89.0	88.9	89.1	89.1
50 c.c. + 3 grms "	88.6	88.8	88.9	88.7
50 c.c. + 5 grms "	88.4	88.3	88.7	88.4

From these experiments it will be seen, taking Dr. Grund's test for the plain filtrate as 89.1, and his test for the filtrate containing 10 grms of bone black in 100 c.c. of solution (5 grms to 50 c.c.), as 88.4 per cent., the saccharine strength of the solution was lowered 0.7 per cent.

This reduction in the saccharine strength I found too great when experimenting with larger quantities of solution, and using the same and greater proportions of bone black.

For example: 260.48 grms of granulated sugar were dissolved in water, and diluted to 1000 c.c., and a portion of the filtrate was tested (1).

To 500 c.c. of the solution were added 100 grms of perfectly dry bone black, the whole was thoroughly shaken, then filtered and tested, first by my assistant Mr. Smylie (who very kindly assisted me in all of the following experiments), and then by myself (2).

* Owing to its being too dark, the tests were not considered reliable.

To 50 c.c. of the filtrate were added 5 c.c. of water, the whole was thoroughly shaken and tested (3).

To 50 c.c. of the original filtrate, 5 c.c. of water and 5 grms of bone black were added, and this was filtered and tested (4).

To another 50 c.c. of the first filtrate were added 4 c.c. of tri-plumbic acetate, 1 c.c. of acetic acid and 5 grms of bone black, the whole thoroughly shaken, filtered and tested (5).

The tests were as follows :

	Smylie.	Mott.
Filtrate No. 1.....	99.60 per cent.	99.60 per cent.
" No. 2.....	98.90 "	98.90 "
" No. 3.....	90.50 " / 99.55 "	90.50 " / 99.55 "
" No. 4.....	90.10 " / 99.11 "	90.20 " / 99.22 "
" No. 5.....	90.30 " / 99.33 "	90.20 " / 99.22 "

From the first two tests it will be seen that the saccharine strength of the solution was reduced 0.70 per cent., by 20 grms of bone black to 100 c.c. of solution ; this would prove that 10 grms reduce it only 0.35 per cent. instead of 0.70 per cent., as in the experiments quoted above. From comparison of filtrates 3, 4 and 5, in this experiment, it is also shown that 10 grms of bone black only reduce the strength of the solution 0.30 per cent.

Another experiment led to similar result :

260.48 grms of granulated sugar were dissolved in water, and diluted to 1000 c.c.

	Smylie.	Mott.
500 c.c. of filtrate + 50 grms of bone black....	99.30%	99.30%
Filtrate alone.....	99.60%	99.60%
50 c.c. of filtrate + 5 c.c. water.....	90.40% / 99.44%	90.40% / 99.44%
50 c.c. + 5 c.c. water + 5 grms bone black	90.10% / 99.11%	90.10% / 99.11%
50 c.c. of filtrate + 4 c.c. tri-plumbic acetate + 1 c.c. acetic acid + 5 grms bone black.	90.10% / 99.11%	90.10% / 99.11%

From these experiments, the reduction in saccharine strength was 0.3 per cent., by 10 grms of bone black.

EXPERIMENTS WITH CENTRIFUGAL SUGAR.

260.48 grms were dissolved in water and diluted to 1,000 c.c., and filtered.

	Smylie.	Mott.
50 c.c. of filtrate + 2 c.c. of conc. solution of salt + 3 cc. of tri-plumbic acetate	87.20%	87.20%
	95.92%	95.92%

500 c.c. of filtrate + 100 grms of bone black were filtered.

	Smylie.	Mott.
50 c.c. of this filtrate + 5 c.c. of water	87.20%	87.20%
	95.70%	95.70%
50 c.c. of same filtrate + 1 c.c. of acetic acid + 4 c.c. of lead solution	96.90%	87.00%
	95.59%	95.70%

From these experiments, 100 grms of bone black to 500 c.c. of solution, or 20 grms to 100 c.c. solution, only reduced the strength 0.20 per cent.; therefore, 10 grms would only reduce it 0.10 per cent.

EXPERIMENTS WITH REFINED SUGARS.

260.48 grms of a refined sugar marked "D" were dissolved in water, and diluted to 1,000 c.c.

	Smylie.	Mott.
50 c.c. of filtrate + 2 c.c. of salt + 3 c.c. of lead solution	75.00%	75.00%
	82.50%	82.50%
50 c.c. of filtrate + ½ c.c. acetic acid + 4½ c.c. of lead solution + 5 grms bone black	74.40%	74.40%
	81.84%	81.84%

From this experiment, 10 grms of bone black reduced the saccharine strength of the solution 0.66 per cent.

EXPERIMENTS WITH GRANULATED SUGAR, USING PREPARED IVORY BLACK INSTEAD OF ORDINARY BONE BLACK.

260.48 grms of the sugar were dissolved in water, and diluted to 1000 c.c.

	Smylie.	Mott.
50 c.c. + 5 c.c. of water	90.60%	90.60%
	99.66%	99.66%
50 c.c. + 2 c.c. of salt + 3 c.c. Pb sol.	90.55%	90.60%
	99.60%	99.66%
50 c.c. + 4 c.c. Pb sol. + 1 c.c. of acetic acid.	90.70%	90.60%
	99.77%	99.66%
50 c.c. + 5 c.c. water + 5 grms bone black	90.00%	90.00%
	99.00%	99.00%

From this experiment, 10 grms of ivory black absorb 0.66 per cent. of sugar.

Without giving any more of the experiments I have conducted, I will briefly state the conclusions I have arrived at :

1st. That 10 grms of bone black will absorb from a solution of perfectly pure sugar (26.048 in 100 c.c.), sufficient sugar to weaken the saccharine strength of the solution 0.30 per cent. to 0.35 per cent.

2nd. That 10 grms of bone black will absorb sufficient sugar, and, also, other substances which effect polarized light, from a solution (26.048 in 100 c.c.) of an impure or raw sugar, so that the saccharine strength of the solution will show a loss of from 0.10 per cent. to 0.66 per cent. by the direct test, but only 0.30 to 0.35 per cent. by the inverted test.

3rd. That some perfectly dried bone blacks will absorb more sugar than others.

4th. That the greatest amount of absorption by 10 grms of any kind of prepared bone black on a solution of pure sugar (26.048 in 100 c.c.), is only sufficient to reduce the saccharine strength of the solution 0.70 per cent.

5th. Since 2 grms of bone black are quite sufficient to decolorize a filtered sugar solution which has been partly clarified and decolorized by means of tri-plumbic acetate, it can be used with safety, as the amount of sugar it will absorb would hardly effect the saccharine strength of the solution appreciably.

6th. Supposing 10 grms of bone black to reduce the saccharine strength of a solution (26.048 in 100 c.c. water) of pure sugar testing 100 per cent., exactly 0.35 per cent., then we can deduce the fact, that 1 ton of bone black will absorb 18.2 lbs. of sugar, or, bone black is capable of absorbing 0.0091168 per cent. of sugar.

XL.—The Practical Determination of the Value of the Sugars of Commerce.

By HENRY A. MOTT, Jr., Ph. D., E. M.

Owing to the many constituents which enter into the composition of sugar in its "crude" or "raw" condition, and to the fluctuations in the proportions of these constituents, and, *above all*, to the difficulty in obtaining an average sample, it becomes almost an impossibility to arrive at an accurate estimate of the value of a cargo of sugar, on the small scale necessary for laboratory investigations. Still many very valuable data may be obtained in the laboratory, which,