poses, and the treatment. The new antidote advocated chiefly consists of a combination of sodium nitrite and sodium thiosulphate. Precise instructions as to how a case of cyanide poisoning should be managed are given.

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CARBO ACTIVATUS.*,[1]

BY JOSEPH ROSIN,[2] GEO D. BEAL[3] AND CHESTER R. SZALKOWSKI.[4]

The demand on the part of the medical profession for a charcoal superior in adsorptive powers to Carbo Ligni U. S. P. X culminated in instructions from the present Sub-committee on Scope to admit a carbon from any source, standardized for its adsorption potency.

Decolorizing carbons have, during the past twenty years, assumed a prominent position both in industry and in the chemical laboratory. Such carbons have had their decolorizing powers greatly beneficiated by chemical treatment, and it is likely that such beneficiation received its greatest impulse during the late war in the production of adsorbent carbon for gas mask canisters.

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During the past few years, more thoughtful physicians and pharmacists have experimented with activated carbons for internal medication with a considerable degree of success. Many theories and counter-theories have been evolved, and some have denied that charcoal could have any place in medicine. Clinical experience has triumphed, however, and to-day there is a growing interest in the use of adsorptive agents in medication.

Adsorbent carbons may be produced by the charring of different forms of organic matter. Among these are wood, bone, blood and various industrial wastes. During the past few years one of the most promising has been produced by carbonizing sulphite waste liquor from the pulping of wood for paper. Mere carbonization, as a rule, is not sufficient, so that activation is resorted to, which usually involves some sort of chemical treatment. Mystery surrounds some of these processes, while others are carefully protected by patent, so that a bibliography of activation methods would be out of place here.

Having in mind some of the chemical treatments that have been proposed for activation, we have paid particular attention to chemical impurities in the carbon, and tests for purity have assumed an importance exceeded only by the evaluation of adsorptive properties. Tests for the determination of the purity, *i. e.*, freedom from toxic or inert substances, are based upon those commonly applied for these same substances, modified in some instances to suit the combination in which these agents may be found. These tests may be quickly summarized as follows:

The loss on drying at 120° C., *i. e.*, moisture, does not exceed 15 per cent.

The ash, obtained upon ignition in a platinum crucible, does not exceed 4 per cent.

The acid-soluble substance in 1 Gm., found by boiling the carbon with 1 to 4 hydrochloric acid and determining the sulphated ash in the extract, does not exceed 0.035 Gm.

The carbon contains no coloring principles soluble in boiling normal sodium hydroxide.

Upon boiling 3 Gm. of carbon with 60 cc. of distilled water and filtering, the filtrate is colorless and neutral to litmus, and 10-cc. portions of the filtrate contain no more chloride than 1.5 cc. of fiftieth-normal hydrochloric acid and no more sulphate than 1 cc. of fiftieth-normal sulphuric acid.

The carbon yields no hydrogen sulphide on boiling with hydrochloric acid, nor hydrocyanic acid on distilling with tartaric acid.

A solution prepared by the combined solvent action of diluted hydrochloric acid and bromine water fails to respond to the usual tests for heavy metals.

These tests, however important they may be in demonstrating the harmlessness of the carbon on internal administration, play no part in determining the possible therapeutic efficiency of the material.

The German Pharmacopœia is the only one that to this time has made any determined effort to provide a thoroughly adsorbent carbon. Reliance has been placed in the adsorption of methylene blue and of mercuric chloride. In the first instance it is directed to add 25 cc. of methylene blue solution (0.15 Gm. in 100 cc. of water) to 0.1 Gm. of carbon that has been dried at 120° C. and finely powdered. It is expected that this volume of solution will be decolorized, so it is directed to add further 5-cc. portions of methylene blue until no more decolorization is obtained.

At least 35 cc. of methylene blue solution must be required to produce a blue color perceptible after five minutes' shaking. This indicates an adsorption capacity for 0.525 Gm. of methylene blue per Gm. of carbon.

The requirement of the Swiss Pharmacopœia is that 0.2 Gm. of dried adsorbent carbon must decolorize 32 cc. of methylene blue solution, of the above concentration, during five minutes' shaking. This amounts to an adsorption capacity for 0.24 Gm. of methylene blue per Gm. of carbon.

Our first experiences in applying the methylene blue adsorption test to activated carbon were quite unsatisfactory. The finer particles of carbon resist sedimentation, so that we had great difficulty in determining the end-point with any degree of delicacy, due to the obscuring of a faint blue color by the suspended matter. Even when sharp end-points were obtained, the best carbons failed by more than 30 per cent of having the required power of the German Pharmacopœia. This did not seem to be within reason, since these carbons were industrial products treated to enhance their decolorizing properties.

Saturation of the carbon is best obtained by reliance on the mass effect of an excess of dyestuff. Several procedures for the quantitative determination of methylene blue being available, we used our own modification of the iodometric method to determine such an excess after treatment with the carbon. When tenth-normal iodine is added to an aqueous solution of methylene blue containing 3 per cent or more of sodium acetate as a buffer a periodide of methylene blue is precipitated, and the consumption of iodine, determined by titration of the filtrate with sodium thiosulphate, is 6 atoms for each molecule of methylene blue.

The method finally decided upon reads as follows:

> "Dissolve 0.25 Gm. of methylthionine chloride (methylene blue) in enough distilled water to make 250 cc. of solution. Measure exactly 50 cc. of the solution, at 25° C., into each of two 100-cc. glass-stoppered flasks. To one flask add exactly 0.25 Gm. of Activated Charcoal, stopper the flask and shake vigorously for five minutes. Filter the contents of each flask through a filter which has not been previously moistened, rejecting the first 20 cc. of each filtrate. Measure exactly 25 cc. of each remaining filtrate into 250-cc. volumetric flasks. Add to each flask 50 cc. of a solution of sodium acetate (1 in 10) and mix thoroughly, then add from a burette 35 cc. of tenth-normal iodine, keeping the mixture in constant rotation. Stopper the flasks and allow them to stand for fifty minutes, shaking vigorously at intervals of ten minutes. Dilute each mixture to exactly 250 cc. with distilled water, mix thoroughly, allow to stand for ten minutes and filter each through a filter that has not been previously moistened, rejecting the first 30 cc. of each filtrate. Determine the excess of iodine in 100 cc. of each filtrate by titration with tenth-normal sodium thiosulphate. The difference between the two titrations, multiplied by 5, amounts to not less than 3.5."

One cc. of tenth-normal iodine is equivalent to 0.005328 Gm. of methylthionine chloride. Sixteen samples of carbon, including wood charcoal, sponge charcoal, bone-black and activated carbons, adsorbed methylthionine chloride equivalent to from 0.505 to 4.789 cc. of tenth-normal iodine per 0.25 Gm. of carbon, corresponding to from 1.08 to 10.02 per cent of the weight of activated carbon. Carbon, in order to satisfy the U. S. P. monograph, must adsorb approximately 7.5 per cent of methylthionine chloride.

The German Pharmacopœia also determines the degree of adsorption of mercuric chloride by activated carbon.

Two-tenths Gm. of dried and finely sifted carbon is shaken for five minutes with 200 cc. of a 0.3 per cent solution of mercuric chloride and then filtered through a previously unmoistened filter, rejecting the first 25 cc. 100 cc. of filtrate is then treated with 25 cc. of tenth-normal sodium arsenite and 3 Gm. of potassium bicarbonate, heating the mixture to boiling for five minutes. After cooling one adds 3 cc. of diluted hydrochloric acid and titrates with tenth-normal iodine The titration must require at least 8.8 cc. of tenth-normal iodine, so that at most 16.2 cc. of tenth-normal sodium arsenite will be consumed in the reduction of the unadsorbed mercuric chloride. The minimum adsorption required is 0.08 Gm. of mercuric chloride per 0.1 Gm. of carbon.

Careful consideration was given to the mercuric chloride method, and quite satisfactory results were obtained. The determination of the unadsorbed mercury requires a somewhat roundabout procedure, involving the use of two standard solutions, sodium arsenite and iodine, and intermediate boiling and cooling. For these reasons, and because the adsorption of metallic salts is not a normal use of activated carbon, the method was not recommended for adoption by the U. S. P. XI.

With the adsorption of methylene blue representing one type of toxin elimination by the use of activated carbon, a study was made of the use of more definite organic bases as standardizing agents. Several alkaloids were tried for this purpose, but strychnine was selected as the reagent to be used, both because of its rapid and uniform adsorption and because of the availability of positive precipitation reactions for small amounts of strychnine. Directions for the test as adopted for U. S. P. XI are as follows:

"Dissolve 0.1 Gm. of strychnine sulphate in 50 cc. of distilled water, add 1 Gm. of Activated Charcoal, shake the mixture vigorously for five minutes, filter immediately through a dry filter, and reject the first 20 cc. of filtrate. The addition of 1 drop of hydrochloric acid and 5 drops of mercuric potassium iodide T.S. to a 10-cc. portion of the subsequent filtrate produces no turbidity."

One of the most important uses of activated charcoal is believed to be the adsorption of gaseous products of fermentation or putrefaction. Attempts were first made at the standardization of its adsorptive capacity for carbon dioxide. The method used consisted of passing the gas into an aqueous suspension and determining the gain in weight. Concordant results were not obtained, and it was also believed that the presence of carbonate ash might produce a false adsorptive power. Experiments leading to the measurement of the adsorption of hydrogen sulphide in gaseous form were more promising, and led to the final adoption of a method for U. S. P. XI, reading as follows:

"Into each of two flasks place 185 cc. of distilled water and 5 cc. of glacial acetic acid and mix thoroughly. By means of a pipette add to each flask 10 cc. of a solution of 2.5 Gm. of crystallized sodium sulphide in 100 cc. of distilled water, placing the tip of the pipette at the bottom of the flask during delivery. Rotate the flask gently for thirty seconds, add to one of the flasks 1 Gm. of Activated Charcoal, stopper the flasks and shake them for five minutes. Filter the contents of each flask through a filter that has not been previously moistened, rejecting the first 20 cc. of each filtrate. Titrate 100 cc. of each subsequent filtrate with tenth-normal iodine, using starch T.S. as the indicator. The filtrate from the Activated Charcoal consumes at least 5 cc. less of tenth-normal iodine than the filtrate from the solution to which no Activated Charcoal was added."

This amounts to a minimum adsorption of 0.01704 Gm. of hydrogen sulphide per Gm. of charcoal.

A summation of the application of the qualitative and quantitative tests mentioned herein is given in the following table.

TABLE I.—RESPONSE OF CHARCOALS TO THE PROPOSED TESTS TO BE INCLUDED IN U. S. P. XI.

Sample.	Acids and Alkalies.	Cl$'$.	SO$_4''$.	S$''$.	Cn$'$.	Complete Carbonization.	Heavy Metals.	Ash %.	Acid Sol. %.	Moisture %.	Strychnine.	H$_2$S Cc. N/10 I.	Methylene Blue Cc. N/10 I.
A*	–	–	–	–	–	–	±	2.46	1.06	8.13	–	9.10	4.70
B*	–	–	–	–	–	–	–	1.87	0.70	10.03	–	6.70	4.80
C	–	–	–	–	–	–	–	3.66	3.22	9.15	–	5.30	3.43
D*	–	–	–	–	–	–	–	3.46	1.66	8.96	–	5.40	4.46
E	–	–	–	–	–	+	–	3.81	3.03	3.57	+	3.86	0.66
F	–	–	–	–	–	–	–	3.24	1.39	3.06	–	5.50	2.83
G	+	+	+	+	+	+	+	56.2	77.24	3.57	+	5.10	1.16
H	+	+	+	+	+	+	+	42.1	60.14	3.54	+	4.88	1.41
I	+	–	+	–	–	+	+	19.57	5.59	4.07	+	4.06	0.91
J	–	–	–	+	+	+	+	44.93	77.64	4.08	+	4.50	0.51
K	–	–	–	–	–	–	+	2.9	1.84	4.95	+	4.06	1.41
L	+	+	+	–	+	+	+	36.61	40.76	4.97	+	5.10	1.52
M	+	–	–	–	–	+	+	5.08	5.15	5.08	+	3.46	1.67
N	+	–	+	–	–	–	+	11.31	1.63	1.83	+	3.86	0.60
O*	–	–	–	–	–	–	–	2.5	2.48	3.55	–	6.70	4.53
P*	–	–	–	–	–	–	–	3.04	2.68	14.40	–	6.10	4.34

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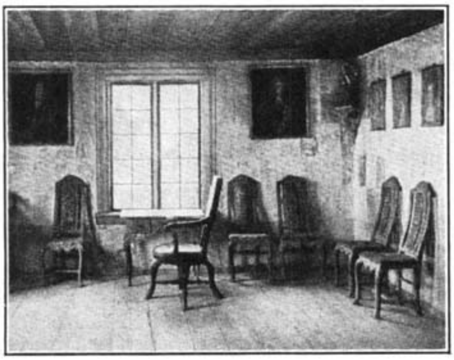
* Conforms to U. S. P. monograph.

A—Activated carbon.
B—Activated carbon.
C—Activated carbon.
D—Activated carbon.
E—Willow charcoal.
F—Activated carbon.
G—Bone-black.
H—Bone-black.
I—Wood charcoal.
J—Animal charcoal.
K—Activated carbon.
L—Sponge charcoal.
M—Willow charcoal.
N—Activated charcoal.
O—Activated charcoal (Willow).
P—Activated charcoal (Vegetable).



A room in the shrine to the birth of modern botany.

The home of Carl Linnæus and museum.

AMERICAN SCIENTIFIC CONGRESS.

President Cloyd Heck Marvin, of George Washington University, has been named by President Roosevelt to serve as chairman of the delegation from the United States to the seventh American Scientific Congress, to meet in Mexico City, September 8th to 17th. Two other Washingtonians, Dr. Neil M. Judd of the United States National Museum and Dr. France V. Scholes of the Carnegie Institution of Washington, are members of the delegation. Other members are President Wallace Walter Atwood, of Clark University; Dr. J. McKeen Cattell, editor of *Science;* President Franklin Stewart Harris, of Brigham Young University, and Prof. Edward V. Huntington of Harvard University.