four minutes it is ignited. This method can be worked in about the same, or even less, time than the oxidation method, and we think it preferable.

The following instance will show that others may sometimes get a better result with the Bamber method than with any other though they may not know it. Some time since we disagreed with a blast-furnace company on the analysis of some iron. A large sample was carefully prepared under the joint direction of ourselves and a representative of the furnace, and samples sent to some six or seven chemists. Three of them were commercial chemists of national reputation and the others were employed by large iron and steel manufacturing concerns. The iron was guaranteed below 0.050 sulphur. We found 0.060 and all the works chemists checked us quite closely, their results averaging about 0.057, with none lower than 0.055. The commercial chemists checked each other quite closely at 0.045. Some time after, having in the meantime done some work with the Bamber method. we sent another sample of this same iron, without any comment, to one of the commercial chemists who had previously reported on it, with a request that a sulphur determination be given us by the Bamber method. In due time the report came back stating that this had been done and the result was 0.056. This incident illustrates very concisely two points which we have attempted to make; that the oxidation method will give accurate results if handled by men who understand it, as most iron and steel works chemists do, while those not using it so often and not so thoroughly acquainted with all the necessary and apparently insignificant details will be more likely to get nearer the truth with the Bamber method.

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THE DETERMINATION OF PHOSPHATES IN AQUEOUS EXTRACTS OF SOILS AND PLANTS.[1]

BY OSWALD SCHREINER.

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IN AN earlier paper[2] a colorimetric method for determining small amounts of phosphates in the presence of silica was pre-

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[1] Published by permission of the Secretary of Agriculture.
[2] This Journal, **25**, 1056 (1903).

sented. The facts on which the method was based were there given, together with some test results with the method itself, as follows:

1. A series of solutions of known phosphate and silica content were analyzed, the found results agreeing quite well with the calculated values.

2. The influence of other salts in quantities likely to be found in natural waters, or aqueous extracts of soils or plants was tested:

   (*a*) On an artificially prepared solution of phosphates and silicates, containing sulphates, bicarbonates, chlorides and nitrates.

   (*b*) By taking a natural water and noting whether the presence of the more complex natural ingredients had any influence in determining any added phosphate by this method.

   (*c*) By treating a soil solution in the same manner.

   (*d*) By treating a plant solution in the same manner.

The tests there given indicated the applicability of this method to natural water or soil and plant extracts. The difficulty of obtaining amounts of such solutions sufficient for absolute or gravimetric determinations to check the colorimetric results would have delayed unduly the publication of the former paper on this subject. Since the work described in the earlier paper was done, however, an equipment has become available by which large quantities of soil extracts can be readily obtained.

Veitch[1] has already discussed the possible influence of substances likely to occur in natural water or soil extracts on the development of the phosphomolybdate color, although his actual procedure was different from the one used in this work, as he removes the silica by evaporation and heating, according to the method of Woodman and Cayvan.[2] His results also showed that moderate amounts of other salts did not influence the coloration beyond the possible errors of reading. Iron salts were found to affect the results, but not until present to the extent of 20 parts per million of solution, and a concentration greater than 0.1 to 5 parts per million was seldom obtained in aqueous extracts of soils. That the ingredients naturally occurring in soil extracts

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[1] This Journal, **25**, 169 (1903).

[2] *Ibid.*, **23**, 96 (1901).

have no marked influence on the phosphomolybdate coloration is shown by the following comparison, taken from the article cited, between the colorimetric method as used by Veitch and the standard volumetric method upon soil samples sent out for that year by the Association of Official Agricultural Chemists.

	P_2O_5, parts per million of dry soil.	
Sample No.	Colorimetric.	Volumetric.
2	1.50	1.33
3	1.06	0.64
4	0.94	1.26
5	0.87	0.99
6	5.60	5.10
7	2.56	2.63
8	2.12	1.95

In the course of certain investigations conducted for Dr. Cameron, in which gravimetric determinations were being made, it was deemed desirable to use this data to check results obtained by the colorimetric method. These results cover a number of different soil types, and the phosphates were, therefore, determined in solutions of such different composition with regard to other soluble soil components as would be obtained from soils of widely different origin.

The soil solutions were in all cases prepared in the conventional manner, using 1 part of soil to 5 parts of water, shaking vigorously for three minutes, and after standing twenty minutes filtering through a Pasteur-Chamberland filter with pressure. It is obvious that any colorimetric method absolutely demands a colorless solution before applying the test. This is not always obtained directly from the soil, especially if it has been recently or heavily manured. Moreover, samples which have been dried out in the laboratory frequently give colored solutions though samples of the same soil fresh from the field give colorless solutions. The color may, however, be readily removed either by adding carbon black to the soil itself so as to have it present during the shaking process, or better, though with more loss of time, by decolorizing the solution after filtering. There seems to be a wide-spread impression that only animal charcoal will decolorize solutions. The necessity of a decolorizing agent free from mineral matter led to the examination of other materials, and for the information of those who may have similar solutions to decolorize it might be stated that certain carbon blacks prepared from petroleum on a large commercial scale do this quite satisfactorily. The sample used in these experiments was the "G. Elf" carbon black, manufactured by G. L. Cabot, Boston, Mass.

The perfectly clear and *colorless* solutions were then used for analysis. The colorimetric determinations were made in the manner described in the earlier paper referred to, and recorded. The gravimetric determinations were made by various laboratory assistants who have had an exceptionally long training in making phosphate determinations, and as a matter of routine work. The quantity of solution furnished them was nearly always 3 liters, although necessity occasionally compelled the use of a smaller volume, in some instances as low as 600 cc. The method of the Association of Official Agricultural Chemists was followed for all gravimetric determinations. In no case did either analyst know the result of the other until all work was completed and recorded in a finished form.

It was thought of interest at this time to give these comparisons of the two methods made on soil solutions as far as they have been obtained in the course of other work. The results are given below. In the first column the individual solutions are numbered; in the second is given the name of the type of soil from which the solution was prepared, and in the third and fourth the results obtained by both the colorimetric and gravimetric methods. In the last column the actual weight of magnesium pyrophosphate, on which the gravimetric determination depends, is also given, followed by the letters (A), (B), or (C), to indicate the different analysts.

Some further gravimetric checks on the colorimetric method were made on plant solutions obtained in the course of a series of experiments conducted for Prof. F. H. King. In cases Nos. 24 and 25, sixteen solutions of plants grown on eight different soil types were made by macerating 10 grams of the ground and dried plant with 1,000 cc. of water, decolorizing the solutions with carbon black. The sixteen solutions thus obtained were then analyzed colorimetrically by the regular laboratory assistants charged with the routine work. A composite of all sixteen solutions in equal amounts was analyzed gravimetrically. On account of the varying phosphate content of the separate solutions

COMPARISON OF COLORIMETRIC AND GRAVIMETRIC RESULTS ON SOIL SOLUTIONS.[1]

No. of solution.	Sample.	Parts PO_4 per million of solution. Colorimetric.	Gravimetric.	$Mg_2P_2O_7$ actually weighed. Gram.
1.	Fertilizer (A)	5.5	4.2	0.0034 (A)
2.	" (B)	9.8	10.2	0.0060 (A)
3.	" (C)	23.7	28.5	0.0167 (A)
4.	Janesville loam	0.7	0.6	0.0020 (B)
5.	" "	0.9	1.4	0.0048 (B)
6.	" "	0.9	1.0	0.0034 (C)
7.	" " fertilized (*a*)	2.1	2.1	0.0015 (A)
8.	" " " (*b*)	3.3	3.6	0.0025 (A)
9.	" " " (*c*)	6.6	5.8	0.0041 (A)
10.	" " " (*d*)	39.1	42.4	0.0298 (A)
11.	Norfolk sand	2.3	1.7	0.0023 (A)
12.	" " fertilized (*a*)	3.9	4.3 2.9	0.0152 (A) 0.0103 (C)
13.	" " " (*b*)	4.0	4.1	0.0032 (A)
14.	" " " (*c*)	4.4	4.4	0.0034 (A)
15.	" " " (*d*)	28.1	34.7	0.0264 (A)
16.	Hagerstown loam	0.7	0.4	0.0015 (B)
17.	" "	0.7	0.5	0.0018 (B)
18.	Sassafras sandy loam, fertilized	2.9	3.4 3.5	0.0121 (C) 0.0122 (C)
19.	Hagerstown clay loam	0.8	0.3	0.0011 (B)
20.	" " "	1.0	0.3	0.0011 (B)
21.	Garden soil	5.7	6.1	0.0217 (B)
22.	" "	5.1	4.3	0.0151 (A)
23.	Miami loam	1.9	1.8 2.0	0.0062 (C) 0.0072 (B)

the gravimetric result can, of course, only be compared with the average of the sixteen separate colorimetric determinations. With sample No. 26 the checks were made on a single solution, the gravimetric determinations being in duplicate.

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[1] In connection with the duplications in the amounts of water-soluble phosphates dissolved from any one soil (unfertilized), as shown in the above table, attention should be called to the results of Schloesing's work on water-soluble phosphates (See memoir by Paturel: *Ann. Agron.*, **28**, 385 (1902)). Schloesing has suggested that the water-soluble phosphates obtained by any one method of extraction is practically a constant for any one soil, and a definite characteristic of that soil. Interesting in this connection, although not strictly comparable, are Schloesing's (*Compt. Rend.*, **134**, 1383 (1902)) gravimetric determination of the water-soluble phosphate from the unmanured wheat soil of Broadbalk Field, Rothamsted (See abstract and note by Miller, of the Rothamsted Station in *J. Chem. Soc.*, **82**, II, 626 (1902)), and the colorimetric determination for soil from the same field made in this laboratory (Bull. No. 22, p. 45). Schloesing found gravimetrically 7 parts P_2O_5, while the colorimetric result was 8.4 parts P_2O_5 per million of soil.

The results obtained with these three sets of solutions were as follows:

COMPARISON OF COLORIMETRIC AND GRAVIMETRIC RESULTS ON PLANT SOLUTIONS.

No. of solution.	Sample.	Parts PO_4 per million of solution. Colorimetric.	Parts PO_4 per million of solution. Gravimetric.
24.	Corn plant	60.5	60.4
25.	Potato plant	43.9	45.2
26.	Corn plant	44.5	46.0 43.5

The results presented above show that, in general, there is a good agreement between those obained by the colorimetric and the gravimetric methods. The satisfactory degree of accuracy shown by the colorimetric method, together with its great speed and ease of manipulation, and the comparatively small amount of solution required, makes it one of great value where small concentrations are involved.

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[CONTRIBUTION FROM THE LABORATORY OF THE PENNSYLVANIA STATE COLLEGE AGRICULTURAL EXPERIMENT STATION, NO. 10.]

THE RAPID ANALYSIS OF CREAM OF TARTAR AND TARTARIC ACID BAKING-POWDERS.

BY R. O. BROOKS.

Received April 28, 1904.

THE simple method of analysis given below, utilizing principally carbon dioxide determinations before and after fusion and Kenrick's[1] polariscopic method for tartaric acid, was worked out by the writer in connection with his study of the official methods of analysis for baking-powders and baking-powder chemicals, for which he was appointed associate referee by the Association of Official Agricultural Chemists, at the annual convention in November, 1903.

The analysis of a baking-powder containing cream of tartar (potassium bitartrate) and free tartaric acid, as outlined in the provisional official methods of the Association of Official Agri-

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[1] This Journal, **24**, 936.