it meets everybody's wishes and is not entirely arbitrary.

It would be better to retain the letter B for the present, till those who are not workers in this field of research have become used to the single F and G, for the letter B stands for a certain conception which, untenable though it may have proved to be, will but slowly disappear from popular literature to make place for a more correct term. The history of anti-rachitic vitamin is there to remind us that new conceptions take time to penetrate, even now and then one finds it identified with the vitamin A, and that in circles where one would not expect this. It is to be feared that the uninitiated, when suddenly confronted with the letters F and G, will not know to what they refer. Of course the British proposers, who only want to prevent confusion, will not mind whether this aim is reached by means of letters or figures. Figures, with their quantitative character, would seem to be less desirable than letters to distinguish qualitatively different matter. It would be quite possible for any one not to know, for the moment, whether 1 or 2 referred to the antineuritic vitamin, a doubt which will not be so likely to arise concerning letters, especially not if, as in this case, they offer a mnemo-technical advantage, F being the initial of the name of the man who first tried (and at what pains!) to detect the chemical nature of the anti-neuritic vitamin, while G reminds of Goldberger, who found the P(ellagra) P(reventive) vitamin, which there is reason to suppose is identical with the more heat-stable, growth-promoting component. If Funk could have made up his mind to agree to the designation of the antirachitic vitamin by the letter D, as the majority of workers do, instead of by the letter E, the latter having already been taken by Evans to indicate the anti-sterility vitamin, a provisional agreement would have been reached and in the realm of the vitamins it would be *tout pour le mieux dans le meilleur des mondes.*

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ULTRA-VIOLET EXHIBITS

I NOTE in SCIENCE for December 7, 1928, a very readable account of an operating ultra-violet exhibit in the Natural Science Museum in London.

I am wondering if a great number of readers of SCIENCE might not get the idea from the article that such a demonstration as there depicted is new, or, even more, that it is the first time such a demonstration has been arranged in a museum. I believe it is quite generally known that such exhibits in ultra-violet have been shown in laboratories, lectures and the like in this country hundreds of times, and that many thousands of people have witnessed them. I particularly wish to call attention to the fact that this museum in New York has an ultra-violet exhibit whereby the visitor may see the fluorescence and phosphorescence of a variety of materials by pressing a button and thereby illuminating the stage with ultra-violet.

The Museums of the Peaceful Arts has now had this visitor-operated exhibit working for a period of about nine months. The museum makes no claim that there is any new science presented by this exhibit, but it is found to be very interesting to all classes of visitors and is typical of a large number of exhibits in the institution. It shows not only the different fluorescent effects of various materials but also the effect upon a statue from the Bureau of Standards, revealing it in dress under ordinary illumination and with its dress disappearing under ultra-violet light.

I might mention that the Buffalo Museum of Science has recently set up a similar very interesting exhibit, possibly antedating the one described in the London *Times*. Also the Newark Museum of Science and the Philadelphia Museum are planning similar educational exhibits.

F. C. BROWN

SPECIAL ARTICLES

A PRELIMINARY REPORT UPON THE UTILIZATION OF THE SPECTROPHOTOMETER IN THE DETERMINATION OF MINUTE AMOUNTS OF ALUMINUM[1]

THE ready employment of spectrophotometric data for the successful quantitative determination of dyestuffs used as food colors[2] as well as for the micro-analytical determination of boron[3] has suggested the employment of the spectrophotometer as an aid for the accurate determination of aluminum.

The introduction of aurine tri-carboxylic acid as a qualitative test for aluminum by Hammett and Sottery[4] and its progressive employment as a quantitative reagent by Yoe and Hill[5] have led to its adoption by physiological and agricultural chemists.[6] The test consists in the formation of a red compound or absorp-

[1] Contribution from the Utensil Fellowship, Mellon Institute of Industrial Research, University of Pittsburgh.

[2] Mathewson, *Jour. Assoc. Off. Agric. Chem.*, 2: 164 (1916). Bureau of Standards Technical Paper No. 440.

[3] Holmes, *Jour. Assoc. Off. Agric. Chem.*, 10: 522 (1927).

[4] Hammett and Sottery, *Jour. Amer. Chem. Soc.*, 47: 142 (1925).

[5] Yoe and Hill, *Jour. Amer. Chem. Soc.*, 49: 2395 (1927).

[6] Myers et al, *Jour. Biol. Chem.*, 58: 598 (1928).

tion complex of aluminum with the aurine tri-carboxylic acid in an acetic acid solution. The excess of aurine tri-carboxylic acid is then decolorized by addition of an ammonia solution containing ammonium carbonate. In the absence of aluminum, a pale yellow color is observed at the completion of the reaction; in the presence of the metal, a residual red color is obtained and the intensity of the color is proportional to the aluminum content of the solution. Up to the present time this color has been compared with standards in the colorimeter or by using Nessler tubes.

The premise upon which the spectrophotometer was employed was that the spectral transmissive properties of the colored aluminum solutions should yield not only a more accurate measurement of the metal content as represented by the color intensity, but also a possibility of extension of the range of accurate quantitative estimation beyond the now feasible limit.

The present brief note summarizes our initial investigation during the latter part of December, 1927. Our purpose in publishing at this time is to announce our use of the spectrophotometer method in this field. A complete report will be published in the near future.

The dye, aurine tri-carboxylic acid, known also as "aluminon," shows considerable variation in properties when purchased upon the open market. Even samples of dye obtained at different times from the same manufacturer showed marked fluctuation in reagent quality. This non-uniformity of properties is probably due to presence of isomers and secondary reaction products, and necessitates careful standardization for each batch of dye employed.

Since the early investigations of Yoe and Hill had demonstrated the importance of the control of the hydrogen ion concentration, the initial transmission studies were made upon solutions of the dye, for the dual purpose of gauging its color change under varying hydrogen ion environment and the shift in the absorption maxima when aluminum was present. Accordingly, solutions were prepared from sulfuric and acetic acids, a requisite amount of aurine tri-carboxylic acid added to give a good final absorption color (about a milligram per cc) and ammonia containing ammonium carbonate added in sufficient quantity to give the desired hydrogen ion concentration. After addition of water to a definite volume, the solutions were allowed to stand for twenty minutes to clear them of bubbles. Measurement of the transmission of a 2-cm layer of the solution was completed by a Hilger wave-length spectrometer, equipped with a Nutting photometer upon which the extinction coefficient could be read directly. One slope of the absorption band was found to extend into the blue-green region (480 to 580 mμ, showing a maximum at 525 mμ)

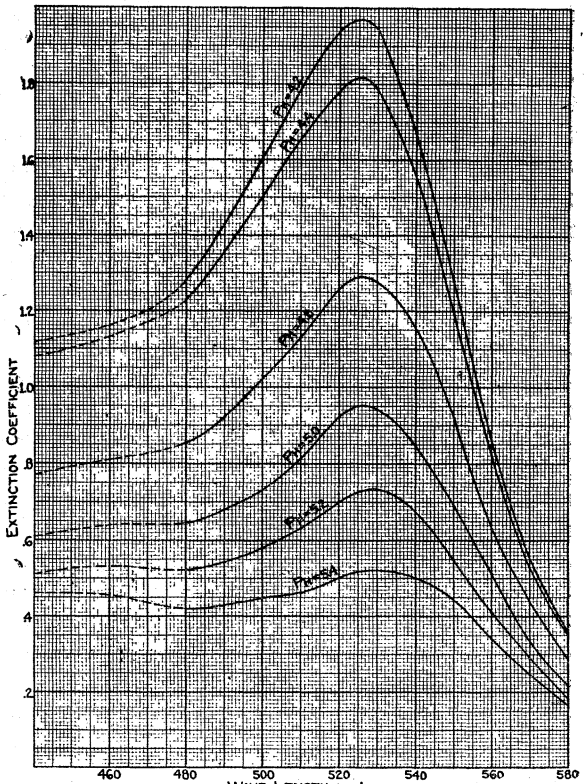

FIG 1 CURVES FOR AURINE TRICARBOXYLIC ACID AT VARIOUS HYDROGEN ION LEVELS

TABLE I

EXTINCTION COEFFICIENTS OF AURINE TRI-CARBOXYLIC ACID SOLUTIONS AT VARIOUS HYDROGEN ION LEVELS

pH	Extinction Coefficients											
	480 mμ	490 mμ	500 mμ	510 mμ	520 mμ	525 mμ	530 mμ	540 mμ	550 mμ	560 mμ	570 mμ	580 mμ
4.2	1.28	1.43	1.61	1.79	1.94	1.97	1.95	1.67	1.28	.85	.55	.36
4.4	1.22	1.36	1.50	1.66	1.78	1.82	1.79	1.56	1.19	.82	.53	.35
4.8	.85	.92	1.03	1.13	1.26	1.29	1.28	1.17	.92	.63	.44	.29
5.0	.64	.68	.73	.81	.92	.95	.94	.85	.69	.51	.33	.22
5.2	.52	.54	.58	.63	.70	.73	.73	.68	.55	.41	.29	.18
5.4	.42	.43	.45	.46	.50	.52	.52	.50	.45	.34	.25	.17

and this allowed evaluation of the extinction coefficients with considerable precision. The average value of three readings was obtained, and the results are tabulated below in Table I and plotted in Fig. 1.

Upon shifting attention to the solutions containing aluminum, it was at once ascertained that the residual color due to aluminum complex after decolorization of the excess of dye was so weak that it was impossible to obtain satisfactory measurements in a 2-cm cell. Accordingly a modified Baly cell was devised which allowed use of an absorbing solution about 20 cm in length. This change allowed considerable reduction in the dye concentration of the test, and measurements were obtained which indicated that an increase in the amount of added aluminum gave an almost proportionate increase in the value of the extinction coefficient. It is interesting to note that the aluminum complex caused a shift in the maximum of the dye curve (changing it to 545 mμ) and giving a redder-colored solution. In the following table and graph the values obtained for concentrations of aluminum varying from twenty-five ten-thousandths to three one-hundredths of a milligram of aluminum in one hundred cc of solution are recorded.

TABLE III

INCREASE IN EXTINCTION COEFFICIENT WITH INCREASE IN ALUMINUM CONTENT IN AURINE TRI-CARBOXYLIC ACID SOLUTIONS

Aluminum concentration		Extinction coefficients			
mgm in 100 cc	parts per million	540 mμ	545 mμ	550 mμ	Average increase
.0025	1 in 40,000,000	.15	.15	.14	.15
.005	1 in 20,000,000	.31	.30	.29	.30
.01	1 in 10,000,000	.55	.54	.54	.54
.02	1 in 5,000,000	1.01	1.02	1.01	1.01
.03	1 in 3,300,000	1.57	1.56	1.55	1.55

The close relationship between the increase in the extinction coefficient with increase in aluminum content becomes more apparent near the maxima of the curve, and in the following table this increase has been shown at values of E for 540, 545 and 550 mμ by subtracting the value of E for the aluminum-free solution at these wave-lengths.

TABLE II

EXTINCTION COEFFICIENTS OF SOLUTIONS OF ALUMINUM-AURINE TRI-CARBOXYLIC ACID COMPLEX ADJUSTED TO THE SAME HYDROGEN ION LEVEL (pH = 7.0)

Concentration of aluminum in milligrams per 100 cc sol'n.	Extinction Coefficients								
	500 mμ	510 mμ	520 mμ	530 mμ	540 mμ	545 mμ	550 mμ	560 mμ	570 mμ
.03	1.41	1.56	1.75	1.99	2.15	2.17	2.10	1.76	1.32
.02	1.10	1.19	1.33	1.50	1.59	1.62	1.59	1.38	1.07
.01	.85	.89	.97	1.06	1.13	1.15	1.12	.99	.79
.005	.68	.72	.78	.84	.89	.90	.87	.78	.64
.0025	.61	.62	.67	.72	.73	.74	.72	.64	.54
None	.50	.51	.52	.56	.58	.59	.58	.56	.51

For a further confirmation of the validity of the method even smaller quantities of aluminum were used. Measurements in this case were made with a Koenig-Martens spectrophotometer reading the angu-

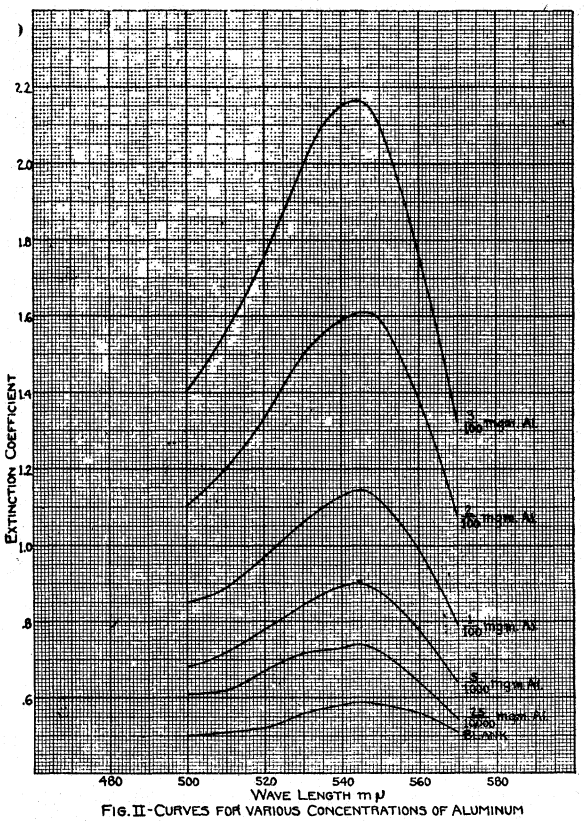

FIG. II-CURVES FOR VARIOUS CONCENTRATIONS OF ALUMINUM AURINE TRICARBOXYLIC ACID COMPLEX

TABLE IV

EXTINCTION COEFFICIENTS OF VARIOUS CONCENTRATIONS OF ALUMINUM AURINE TRI-CARBOXYLIC ACID COMPLEX (ADJUSTED TO pH = 6.8)

Concentration of aluminum		Extinction coefficients					
mgm in 100 cc	parts per million	520 mμ	530 mμ	540 mμ	545 mμ	550 mμ	Increase in E 545 mμ
None	None	.61	.64	.65	.66	.63	–
.001	1 in 100,000,000	.68	.71	.71	.73	.70	.07
.002	1 in 50,000,000	.74	.78	.79	.81	.78	.15
.004	1 in 25,000,000	.80	.87	.91	.94	.91	.28
.005	1 in 20,000,000	.95	1.05	1.08	1.11	1.07	.45
.0075	1 in 13,300,000	1.03	1.16	1.23	1.26	1.22	.60
.01	1 in 10,000,000	1.14	1.28	1.36	1.39	1.34	.73
.02	1 in 5,000,000	1.67	1.84	1.97	2.01	1.94	1.35

lar rotation directly. The solutions were adjusted to a pH of 6.8. This proceeding served to reduce materially the fading with only a slight increase in the extinction coefficient value for the control solutions containing no aluminum. The results are tabulated in Table IV.

While these results in the minute concentrations do not show as sharp a proportionality as those previously mentioned, it may be stated in discussing the preliminary work here reported that we were troubled with several factors which would contribute toward the invalidation of the method as a quantitative procedure. The solutions containing the aluminum complex are subject to fading, which, however, reaches a negligible value under experimental conditions in about twenty minutes. The evolution of minute bubbles as a by-product of the neutralization reaction necessitates rapid work, and care must be taken that they do not accumulate on the cell faces. Finally in systems of this nature it is possible that polymolecular colloids are in fine suspension. All of these factors would contribute toward decreasing the sensitivity of the spectrophotometric method.

The writers take this opportunity to express their appreciation to Mr. Walter C. Holmes and Mr. John T. Scanlon, of the Color and Farm Waste Division of the Bureau of Chemistry and Soils, for their cooperation in rendering possible this preliminary survey.

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NOVEMBER 1, 1928

ISOLATION BY CATAPHORESIS OF VIRUS FROM VACCINIA-RECOVERED RABBITS

DOUGLAS and Smith[1] have shown that vaccine virus is ordinarily electronegative. We have found also that material containing vaccine virus wanders in an electrical field to the positive pole.

Cataphoresis was applied to recover virus present in small amounts in tissues. For, by this method, the virus can be concentrated at the anode from suspension of tissues which fail to reveal infectivity by the usual tests of animal inoculation.

The conditions of cataphoresis were as follows: time, 3 hours; milliamperage, 2 to 4.8; drop in potential, 1 to 2 volts; pH of the suspension (100 cc) of the tissue, 6.9 to 7.8.

By this method we were able to isolate active vaccine virus in suspensions of testicles from rabbits which had recovered from experimental cutaneous vaccinia. This was demonstrated by characteristic lesions in the skin and testicles of healthy rabbits injected with anodic material. The animals used for cataphoresis tests were injected intracutaneously with neurovaccine virus from twelve to fifty-six days prior to the experiment, and at the time their testicles were removed for examination the animals were wholly recovered from the cutaneous vaccine lesions and were apparently normal.

The isolation of the virus from animals wholly recovered from infection and in a healthy condition, and the failure thus far to obtain immunity in the case of filterable viruses unless living virus is used[2] should be considered in relation to the possibility that immunity in virus diseases is linked with the presence in the body of living virus. The ideas here expressed are being investigated at the present time.

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[1] S. R. Douglas and W. Smith, *Brit. Jour. Exp. Path.*, 9: 213. 1928.

[2] *Cf.*, "Filterable Viruses," edited by T. M. Rivers, Baltimore, 1928; and P. K. Olitsky and P. H. Long, *Jour. Exper. Med.*, 47: 835. 1928.