PHOSPHATE DETERMINATION IN SUGAR JUICES BY COERULEO-MOLYBDATE METHOD, WITH NOTES ON THE EFFECT OF PHOSPHATE CONTENT ON CLARIFICATION

By P. L. DRAEGER

Mr. P. L. Draeger then read the following paper on "**Phosphate Determination in Sugar Juices by the Coeruleo-Molybdate Method, with Notes on the Effect of Phosphate Content on Clarification.**"

REAGENTS:

Solution A.—100 c.cs. of 10% Ammonium Molybdate.
300 c.cs. of 50% (by volume), Sulphuric Acid.
Stored in a blackened paraffined bottle.

Solution B.—0.1 gram Pure Tin, 1 drop 4% Copper Sulphate Solution.
10 c.cs. Pure Hydrochloric Acid.
Warm till all dissolves.
Prepare fresh each day.

STANDARD PHOSPHATE SOLUTION.

Solution No. 1.—1.34 grams Trisodium Phosphate ($12\ H_2O$) in 250 c.c. distilled water
1 c.c. : 1 mgr. P_2O_5

Solution No. 2.—10 c.cs. Solution No. 1 in 1000 c.cs. distilled water.
1 c.c. : $\frac{1}{100}$ mgr P_2O_5

Solution No. 3.—10 c.cs. Solution No. 2 in 500 c.cs. distilled water.
1 c.c. : $\frac{1}{5000}$ mgr. P_2O_5

The standards last for about three weeks and should be kept in paraffined bottles so that there should be no silica interference.

PHOSPHATE ESTIMATION.

One c.c. of mixed or raw juice diluted to 500 c.c. with phosphate free water, 98 c.cs. of this diluted juice are poured into a Nessler cylinder, 2 c.cs. of Solution A and 5 drops of Solution B are added, stir with a glass rod. Into another Nessler cylinder pour 98 c.cs. of the Standard Phosphate Solution No. 3, add 2 c.cs. of Solution A and 5 drops of Solution B and stir. The blue colour develops, and in five minutes reaches maximum intensity. Place the two cylinders over a white tile or piece of white paper in a good light and tilt to obtain a good reflection. Match the colours by pouring from the darker cylinder into a measuring glass until the depth of colour in both cylinders is the same; after a little practice one-half c.c. will be seen to affect the final end point, hence, the error is practically negligible. If due care be taken in the calibration of pipettes, etc., and in the preparation of the reagents, the limit of error can be kept under 2%. If the depth of colour in both cylinders is the same the original juice will contain 0.01 mgrs. P_2O_5 per 100 c.cs. When the depth of colour in one cylinder is deeper than in the other, discard from the darker one into a graduated measuring cylinder until they both match. Note how many c.cs. were discarded. For example, say 75 c.cs. were discarded from the cylinder containing the diluted juice, then the calculation becomes:—

$$\frac{0.01 \times 100}{100 - 75} : 0.040 \text{ grs. per 100 c.c. of the original juice.}$$

Note.—It is essential that the stannous chloride solution (Solution B) be prepared freshly each day and that all apparatus be kept scrupulously clean.

For clarified juices, etc., use 10 or 100 c.cs. diluted to 500 c.cs.

With this method an estimation can be done in seven minutes and with greater accuracy than heretofore possible when using the volumetric Uranium method.

The P_2O_5 content of our raw diluted juice at Illovo fluctuates between 0.007 and 0.020; some tests have indicated as low as 0.003. We hope in time to make phosphate determinations on all samples of juice drawn by our cane testers so as to know just where and when to increase the phosphoric acid in the process.

There are two ways of increasing the phosphate content to a figure which will permit of easy and efficient clarification.

1. By determining the P_2O_5 content of the raw juice and adding phosphate as required.

2. By applying to the soil fertilizers or mixtures of fertilizers of high phosphate content.

The latter method is the more thorough way of increasing the phosphate content as by its application to the soil it would serve the dual purpose of giving higher returns per acre and at the same time cane with more easily workable juice.

In practice we found that the best results were obtained by keeping the mixed juice to 0.035 grs. P_2O_5 per 100 c.c., though unfortunately we cannot adduce any figures on turbidity or colloid elimination through the lack of the necessary apparatus.

Under 0.030% in the mixed juice the clarified juice is turbid and lacks sparkle, and the settling and filter press stations are severely handicapped and slowed down.

Over 0.040 in the mixed juice gives a perfectly bright clarified juice, though the settlings appear to be more voluminous and more flocculent, taking longer to settle, which causes a certain amount of slowing down at this station; the filter press is not impaired, however.

Apparently there is nothing to be gained by exceeding 0.035%, but, as already mentioned, a cataphoresis apparatus and turbidmeter alone can prove this.

Chairman: Both of these papers are of particular interest, having a direct bearing both on the agricultural and on the manufacturing side of the Industry. It is interesting to note in the Table I. of Mr. McRae's paper how the phosphate content of the juice from the various districts differs, and on attempting to classify them it will be found that the soils which are typical of the alluvial flats and soils generally, which are rich in organic matter and consequently have a high content of available phosphate, show a much higher phosphate content in the juice with few exceptions in that table, and apparently it may be taken to be a general rule. It occurs to one that we have here an excellent indication of the extent of the phosphorus requirements of the soil. With regard to the other paper it apparently confirms the results found in Hawaii and elsewhere that a certain definite minimum of phosphate content of the juice is necessary for efficient clarification.

Mr. Dymond: Has any correlation been found between high phosphate content and the age of the cane?

Chairman: No, I don't think that has been determined locally as regards sugar cane. I know that in the other grasses it is often found that the age of the grass is a very important factor in its phosphate content. It is always found greater I believe in the mature plant. One would expect that to be the case also in sugar cane. So far as my recollection goes that was not found to be so in Hawaii. Here no experiments have yet been carried out. It is a thing we have in mind.

Mr. Rault: A few years ago, when Mr. Farnell initiated the tests, he found that there was a marked difference between cloudy juice and the clear settled juice before and after heating, due probably to some buffer which was present in certain cane juices. I think phosphates have a lot to do with this changing in pH. Could Mr. Draeger tell us whether he has recorded any such difference in proportion to the phosphate content of the juice, the difference between the two juices before and after settling?

Mr. Draeger: No, I am afraid I can't tell you. All our tests were done with a constant pH of 7.2.

Chairman: Evidently a great deal of work has still to be done on this very important matter, and these papers form an excellent beginning.