faint yellow tint, but readily detected by the pink tint developed by the test.

Commercially, the yellow azo dye is generally used in conjunction with an orange variety. The latter does not give the Fuller's earth test.

For practical purposes the test is readily applied by spreading some of the clarified fat to be tested upon a white porcelain surface and stirring into the fat a pinch of Fuller's earth and observing the change in color. A pink to violet-red color will appear within a few moments if any considerable proportion of this coloring-matter is present. If the experiment is performed in a glass tube it is readily preserved for court exhibits where such are desirable. The test may therefore be used as a valuable adjunct in testing for this coloring-matter in fats as well as differentiating between certain of the azo dyes.

DISCUSSION: *C. A. Crampton.*—I wish to call attention to the very valuable and *apropos* nature of this test. It seems to be a very good one and is especially valuable because this form of coloring-matter seems to have driven out of use the old-fashioned butter-color which was made of annatto. The manufacturers say the dyes "hold up" better than annatto, by which is meant, I suppose, that they will stand time and exposure to light much better. In the paper to be presented to-morrow, I hope to show some samples of this butter-color dye, which will illustrate the extent to which it is used in a certain class of butters.

J. F. Geisler.—It is generally claimed that these azo dyes are not detrimental to health. They are certainly used in very minute quantities.

E. A. de Schweinitz.—A number of physiological experiments have recently been made to determine the effect of these dyes, and, as a result, it is stated that they are not poisonous even when used in considerable quantities.

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THE LECITHINS OF SUGAR-CANE.

BY EDMUND C. SHOREY.

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IN a former paper on the principal amid of sugar-cane, mention was made of an attempt to estimate the amount of different nitrogenous bodies in molasses, according to a scheme by

which the albuminoids were precipitated by cupric hydroxide, and the nitrogen in the precipitate, produced in the filtrate from the cupric hydroxide by phosphotungstic acid, was designated peptones. The reagent used was a solution of sodium phosphotungstate in dilute sulphuric acid, and this was added to the filtrate from the cupric hydroxide precipitate, previously rendered strongly acid by sulphuric acid. I found that, so used, this reagent produced a copious precipitate in raw cane juice, and in the after products of the sugar house, clarified juice, syrup, and molasses. The precipitate so formed was flocculent and easily washed by decantation, chocolate in color, and varying very little in its character with the source from which it was obtained. This precipitate I found invariably contained nitrogen; *e. g.*, a typical sample of raw cane juice gave, according to this scheme of analysis, the following figures:

	Weight of juice. Per cent.
Total nitrogen	0.034
Nitrogen in cupric hydroxide precipitate	0.023
Nitrogen in phosphotungstic acid precipitate	0.005

In attempting to determine the character of the nitrogenous compound thus precipitated by phosphotungstic acid, I at first adopted the usual method of decomposing this precipitate by digesting with barium hydroxide or carbonate, or milk of lime. By this method I found that salts of a fatty acid were invariably formed, and in order to isolate the body from which the fatty acids were evidently formed by decomposition, I adopted the following method. The precipitate produced by phosphotungstate of sodium, after being well washed by a solution of the precipitant, was nearly dried over sulphuric acid at the temperature of the laboratory, mixed to a paste with dry sodium carbonate, and extracted with ninety per cent. alcohol; which resulted in a dark red solution. The alcohol was removed by distilling in a vacuum, and the residue taken up with a small quantity of water. The watery solution, which was dark red and turbid, was agitated several times with ether. The resulting ethereal solution was light yellow in color, and after evaporation of the ether there was left a light yellow, translucent, wax-like solid, with all the physical properties of the lecithins, containing

nitrogen and phosphorus, and decomposing by alkalies into fatty acids, glycerophosphoric acid, and an alkaloid or alkaloids.

Sugar-cane lecithin was proved to give more than one fatty acid, on decomposition, by the following method: The barium salts obtained by digesting the lecithin with barium hydroxide were decomposed by sulphuric acid, the free fatty acids separated and precipitated by lead acetate. The resulting lead salts were agitated with ether, when a portion was dissolved, and from the portion so dissolved free oleic acid was obtained. From the portion of lead salts insoluble in ether free fatty acids were obtained which were solid at the ordinary temperature with a melting-point of 65° C.; probably a mixture of palmitic and stearic acids. It is thus shown that the lecithin of sugar-cane is a mixture of several lecithins. Schulze and Likiernik have shown this to be the case with the lecithin of vetch and lupin seeds.[1]

I have not yet determined the proportions of different fatty acids yielded by any sample of sugar-cane lecithin.

The alkaloid body resulting from the decomposition of sugar-cane lecithin by barium hydroxide I found to be a mixture of betaine and choline. In separating these bodies the method of Schulze and Frankfurt[2] was followed. The precipitate obtained with phosphotungstic acid was treated in the cold with milk of lime, filtered, excess of lime precipitated as carbonate, and the solution neutralized with hydrochloric acid, evaporated nearly to dryness, and extracted with ninety per cent. alcohol. To this solution an alcoholic solution of mercuric chloride was added, and after several days the double chlorides of mercury and the alkaloids which had been thrown down were removed and decomposed by hydrogen sulphide. The resulting hydrochlorides, on treatment with absolute alcohol, were separated into a soluble and an insoluble portion, proving the presence of both choline and betaine. From the soluble portion choline platinichloride, containing 10.2 per cent. platinum, was prepared.

Whether choline and betaine exist in sugar-cane in a free condition, or whether they have been obtained wholly as decomposition products of lecithin, I am as yet not prepared to say.

[1] *Ber. d. chem. Ges.*, **24**, 71.

[2] *Ibid*, **26**, 2151-2155.

The usual method of estimating lecithin is to convert the phosphorus contained therein into phosphoric acid by fusion with carbonate of sodium and potassium or with sodium carbonate and potassium nitrate, and determination of the phosphoric acid in the usual way by precipitation with ammonium molybdate and magnesia mixture, and calculating to lecithin from the known per cent. of phosphorus: distearyl lecithin containing 8.798 per cent., phosphorus pentoxide being taken as the type.

The lecithin obtained in the manner already described from a number of samples of raw cane juice, and the phosphorus pentoxide estimated in the usual manner, gave, using the factor for distearyl lecithin, a quantity of lecithin representing a much less quantity of nitrogen than was contained in the phosphotungstic acid precipitate. Of the two conclusions to be drawn from this—that there were other nitrogenous bodies in the precipitate, or that the lecithin was imperfectly separated by the method used—both are true. I have always found the residue from the extraction with ether to contain nitrogen, but I have not yet been able to determine the nature of the body in question. A large portion of the phosphotungstic acid precipitate is made up of a coloring-matter of a glucosidal nature, free from nitrogen.

In itself, there is nothing noteworthy in the isolation of lecithin from sugar-cane any more than there would be in proving the presence of an amid in this plant or any other vegetable product; for it is generally believed that lecithins like the amids are normal constituents of all plants during some period of their growth. In this instance there are, however, several points connected with the manner of its isolation, which are of interest to the analyst.

It has been customary with some chemists in stating the analyses of the nitrogenous constituents of plants free from alkaloids, to give the total and albuminoid nitrogen actually determined, and to designate the difference between these as amid nitrogen. This plan has often been adopted in stating analyses of sugar-cane, and I have several times published analyses of cane according to this method. The error of this is seen on referring to the analysis already given, in which the difference between the total and albuminoid nitrogen is 0.011 per cent. This would ordinarily be designated amid nitrogen, but phos-

photungstic acid, which we know does not precipitate amids, precipitates 0.005 per cent. nitrogen, leaving only 0.006 per cent. as possible amid nitrogen. In some samples of juice I have found that this error would be much greater; *e. g.*, a sample of raw juice gave:

	Per cent.
Total nitrogen	0.033
Albuminoid nitrogen	0.018
Nitrogen precipitated by phosphotungstic acid	0.014

leaving a difference of only 0.001 per cent. as possible amid nitrogen, which according to the plan usually adopted would be stated as 0.015 per cent.

Again, the designation of the nitrogen in the phosphotungstic acid precipitated as peptones, is in the case of sugar-cane erroneous. I have repeatedly examined this precipitate for peptone nitrogen and have found none; and if such nitrogen exists in mature cane it must be very small in amount.

The ease with which lecithin breaks up on treatment with alkalies should be kept in mind by the analyst if he is to ascertain what bodies actually exist in the plant examined. No doubt in many cases, when choline and betaine have been reported as present in plant products, they have been present not as such but in the form of lecithin, which has been broken up in the course of analysis.

To the physiologist lecithin is one of the most interesting and important compounds. The rôle of phosphoric acid in plant growth and the connection of lecithin therewith is an obscure one, and although sugar-cane responds freely to phosphoric acid fertilizers, it seems to me that the part which lecithin plays in plant life can be more advantageously studied in connection with other plants of quicker growth and containing smaller amounts of soluble carbohydrates.

To the sugar manufacturer the presence or absence of lecithin in cane juice can, owing to the small amount ever present, make very little difference, either in the working of the juice or in the yield of sugar obtained.

It is a property of lecithin to be precipitated with other precipitates when it would not be precipitated alone, so that it is probably partially removed from cane juice in clarification. I

have, however, obtained lecithin from refuse molasses, showing that part, at least, of that originally present in the juice had escaped precipitation and decomposition during the treatment of the juice in the sugar house.

The ease with which lecithin is decomposed has suggested one point of interest to the sugar manufacturer. Cane juice is generally concentrated to a syrup in a multiple effect evaporator, the first cell of which is heated by exhaust steam from the engines: the second and succeeding cells are heated by steam from the boiling juice in the preceding cell. The inner or steam side of the drums or coils of these cells soon becomes coated with grease which, if not removed by treatment with alkali, lessens the efficiency of the evaporator. The grease in the first cell is, of course, derived from the oil in the exhaust steam, but that in the second and succeeding cells can be derived only from the boiling juice. It no doubt is derived in part from fats and wax naturally occurring in sugar-cane, but also no doubt due in part to the decomposition of lecithin and the carrying over of the freed fatty acids with the steam. This decomposition takes place slowly in boiling neutral solution; in alkaline solution it is very rapid.

The work done so far on the lecithins of sugar-cane, outlined above, I regard as preliminary, and have in view the following objective points:

1. A more accurate determination of the lecithin present in mature cane supplemented by determinations of the amounts in cane at different stages of growth.

2. An accurate determination of the amounts and kinds of fatty acids yielded by sugar-cane lecithin and thus indirectly the amounts of different lecithins.

3. An estimation of the amounts of choline and betaine in mature cane and a decision as to whether they ever exist free or are only obtained as decomposition products of lecithin.