

SOME OBSERVATIONS ON BAGASSE BOILING.

By J. V. KIRKWOOD.

The importance of accuracy in the sucrose determination of bagasse is often stressed, and it was with this fact in view that certain variations from the official method of analysis were tried out. It was felt that some data of interest may become available by making slight alterations in the method of treating the bagasse during extraction and comparing these with the standard method in use; even if the information was only to lay emphasis upon a strict adherence to the official method it would serve a useful purpose.

In the time available it was only possible to examine three variations. These consisted of the following:—

(1) **Omission of the tamp**, specified in the official method. This simply means leaving off the perforated metal tamp with which the bagasse is kept below the surface of the liquid during the boiling period. It was desirable to ascertain whether this

omission would influence the analysis of the bagasse and to what extent.

(2) **Vigorous stirring every 10 to 15 minutes**.—In this case the tamp was left out and a metal rod with an improvised metal disc of wire network attached at one end was inserted through a hole in the lid of the digester. This was regularly moved up and down at the correct intervals.

(3) **Maintaining a gentle simmer as against the usual vigorous boiling**.—The liquid was brought to the boil, and then the heat reduced until the solution was just simmering with barely any movement of the bagasse in the liquid.

In order to confirm the accuracy of the official method and determine the possibility of any sampling error, duplicate determinations of sucrose per cent. bagasse were carried out before any of the foregoing tests were made. These results and those of the aforementioned tests were statistically analysed and the results summarised in Table I.

TABLE I.—Sucrose per cent. Bagasse.

	No. of samples.	Means.	Difference between means.	Standard error.	Test of significance of the mean difference.	"t" at (1) 19:1 (2) 99:1
(1) Test for error in official method—comparing duplicate samples	15	8.89 8.95	0.06	0.0919	0.6530	(1) 2.145 (2) 2.977
(2) Comparing standard method with standard method—without tamp ...	26	8.43 8.30	0.13	0.0423	3.0730	(1) 2.060 (2) 2.787
(3) Comparing standard method against stirring every 10 to 15 minutes... ..	26	8.43 8.34	0.09	0.0551	1.6350	(1) 2.060 (2) 2.787
(4) Standard method compared with allowing to simmer	13	9.23 9.12	0.11	0.0678	1.6220	(1) 2.179 (2) 3.055

From the results given in Table I. we see that the omission of the tamp compared with the retention of the tamp, i.e. the official method, showed a significant difference, the official method being 8.43 sucrose per cent. bagasse as against the 8.30 sucrose per cent. bagasse for the omission of the tamp treatment. Neither vigorous stirring nor a gentle simmer showed a significant difference from the standard method, although the means for each of these treatments were appreciably lower than those of the standard method. It was noticed that in the treatment where the tamp was left out, the bagasse did not sink below the surface of the liquid for at least twenty minutes after insertion into the digester, and it is suggested that this may be the explanation for

a lower result, as the bagasse which had remained above the surface of the liquid had not had a sufficiently long immersion in the solution to permit of complete extraction.

Vigorous stirring seemed to accelerate the saturation of the bagasse by the liquid and thus result in its being submerged and maintained in circulation.

In the slow simmer treatment it becomes apparent that, subject to the bagasse being kept below the surface and at boiling point throughout the extraction period, the extraction of the sucrose is not materially influenced.

As the South African Sugar Technologists' Association method³ differs somewhat from those used else-

where, a comparison of it with some of the official methods adopted in other sugarcane producing countries would be of interest. Behne¹ has already established that the method developed in Java by Khainovsky gave higher results than either the Queensland or the Hawaiian, as used in Queensland. The apparatus for the Khainovsky method not being available, and as Behne had already found that the Queensland method^{1, 2} gave higher results than the Hawaiian method, it was decided to make a comparison between the official Queensland method and the specified S.A.S.T.A. method.

The Queensland method was carried out using a 1,500 ml. Erlenmeyer flask and an air-reflux condenser of glass tubing. 100 grammes of bagasse were weighed into the flask and 1 litre of water containing 20 ml. of 5 per cent. sodium carbonate solution added. The contents were then shaken, the flask

closed and placed in a boiling water bath for one hour, and it was shaken every 15 minutes during this period. After cooling, the weight of the contents was determined and the extract polarized, using a 400 mm. observation tube. The sucrose per cent. bagasse was calculated as follows:—

$$\text{Sucrose \% Bagasse} = \frac{\text{Wt. of extract} \times \text{Pol. of extract} \times 100}{100 \times 100}$$

where Wt. of extract

$$= (\text{wt. of bagasse} + \text{water after cooling}) - \text{wt. of fibre.}$$

$$\text{Pol. of extract} = \text{From Schmitz tables} \div 2.$$

The weight of fibre is assumed.

Parallel determinations were made on 22 samples of bagasse, and the results are shown in Table II.

TABLE II.—Sucrose per cent. Bagasse.

	No. of samples.	Means.	Difference between means.	Standard error.	Test of significance of the mean difference.	"t" at (1) 19 : 1 (2) 99 : 1
Official S.A. Sugar Technologists' method compared with recommended Queensland method	22	7.62	0.45	0.07134	6.3078	(1) 2.080 (2) 2.831

The sucrose per cent. bagasse as determined by the official South African Sugar Technologists' method³ is significantly higher than that determined by the Queensland recommended method.

Behne¹ found that the Queensland method (using a 1 to 10 dilution) gave a higher sucrose per cent. bagasse than the Hawaiian method, in which a dilution of 1 to 5 is used. This he attributed to poorer circulation in the Hawaiian method as a result of the reduction of the extraction water in proportion to the bagasse.

In our own official method we make use of a dilution of approximately 1 to 7. This will therefore not account for the higher sucrose per cent. bagasse obtained in our method compared to the Queensland method. Circulation is, however, also greatly increased by boiling, and whereas in the Queensland method the contents of the digester never actually boils, in ours, as in the Khainovsky method, vigorous boiling occurs throughout the extraction period, thus affording free circulation of the liquid through the bagasse, and better extraction of the sucrose therein.

Conclusions.

In the two treatments, stirring every 10 to 15 minutes and allowing to simmer, compared with the

standard method, we find no significant difference, but observe that the standard method has a higher average than either of these two treatments. Comparing the specified standard method (S.A.S.T.A.) with the same method but where the tamp is left out, it is shown that there is a highly significant difference between the means, the standard method giving higher results than that without the tamp. In the case of the S.A.S.T.A. method compared with the recommended Queensland method there is also a high significant difference, the S.A.S.T.A. method giving an average of 8.07 sucrose per cent. bagasse as against 7.62 per cent. for the Queensland method.

The foregoing results, therefore, indicate the necessity for keeping the bagasse below the surface of the liquid and in ensuring that a state of ebullition is maintained.

References.

¹ Behne, E. R. (1937) : "The Analysis and Sampling of Final Bagasse." Tech. Comm. Bureau Sug. Expt. Stations, Queensland, Bulletin No. 6, 1.

² Bureau of Sugar Experiment Stations (1934) : "Laboratory Manual for Queensland Sugar Mills," 88.

³ S.A. Sugar Technologists' Association : "Recommended Methods of Chemical Control," 25.

The PRESIDENT said that the work the author had done showed that the South African standard method was the best. It gave higher figures than the Queensland method, and of course one could not extract sugar that was not there.

Mr. RAULT congratulated Mr. Kirkwood and said he thought it was very necessary work that had been done. A few years ago he found that he was not getting complete extraction from the bagasse and he published his results in the Proceedings of this Association. He was then working with mill shredded bagasse. He suggested that Mr. Kirkwood should get some bagasse from the factories and repeat some tests on that.

Mr. HAYES found the paper very interesting, but said that he could not agree with the President that the higher figure was necessarily correct. There was no evidence that the increase in polarization was due to sucrose. The term "polarization" should have been used instead of "sucrose" in this paper.

Mr. DU TOIT said that in spite of the modest title of the paper it was very interesting. The author succeeded in accomplishing what he set out to do in a clear and precise way. Bagasse boiling was, however, a wide subject, and there were many problems which were not dealt with in this paper. He agreed with Mr. Rault that it was necessary to repeat some of these experiments on mill bagasse. It was quite possible that smaller differences between different methods would be obtained if that was done. The bagasse used by the author was from the Experiment Station experimental mill and the extraction was poor, consequently it was difficult to extract all the sucrose in it.

Mr. MOBERLY said he was interested in the paper because it bore out his own experience. He had also found that it was essential to put the tamp on, but after the bagasse submerged it was not necessary any longer. Proper circulation in bagasse boiling was undoubtedly very necessary and that was why he preferred the new almost hemispherical cast iron digesters to the old cylindrical copper ones. The present method of bagasse boiling was capable of a high degree of reproducibility.

The following written comments were received from Mr. DYMOND :—

"I agree with Mr. Hayes that "polarization" should have been used in place of "sucrose." This paper is a valuable addition to the work done by Hedley and Hayes in 1934 and by myself in 1931. Two points emanating from these previous papers must not be forgotten. First, that continuous boiling extracts a polarizable substance, not present when the extraction is conducted at 50°C. This substance Hedley and Hayes showed to be xylose. I still hold the opinion that a truer sucrose percentage is obtained by extraction at lower temperatures and would like to see further work done on this aspect of a difficult problem."

The PRESIDENT said that work on bagasse boiling would be continued and samples of shredded bagasse would also be done. The Experiment Station ought to have some of the new digesters.

The President then called for a hearty vote of thanks to Mr. Kirkwood for his paper. This was carried with applause.