AN ANALYSIS OF THE JAVA RATIO

by J. Antonowitz

The Java Ratio is a factor obtained by dividing an average sucrose per cent cane value by an average sucrose per cent first expressed juice value and multiplying the result by 100, i.e.

$$\frac{\text{Sucrose per cent Cane}}{\text{Sucrose per cent First Expressed Juice}} \times \frac{100}{1}$$

On the basis of this definition, it is assumed that if a Java Ratio calculated from data extracted from the calculated analysis of a specific quantity of cane—the tons of cane crushed during one week—be applied to the sucrose per cent First Expressed Juice determination from each and every individual consignment of cane crushed during that week, it will give an equitable estimate of the sucrose per cent cane of any individual consignment sampled during that week.

If during any given weekly period, individual Java Ratio's were determined specifically for each consignment of cane crushed, the average or *mean* of this collection of Java Ratio's would coincide with the calculated value for that week. If we ignored the weekly Java Ratio determination and calculated the weekly value as the mean of a very large number of determinations (done during that week) we should be correct in assuming that as the mean was calculated from a very large sample (a great number of determinations) the accuracy of the mean determination was beyond doubt. This would be perfectly true only if the Java Ratio was such a statistic that, if a number of such statistics can be obtained and compared, the discrepancies among them will grow less and less as the samples from which they are drawn are made larger and larger; that is, as the samples are made larger and larger without limit, the statistic will tend to be a fixed value characteristic of the population sampled, and is therefore expressible in terms of the parameters of the population.

It is just here that the concept that the Java Ratio is a suitable factor to use for calculating the sucrose per cent cane from the sucrose per cent First Expressed Juice breaks down. The Java Ratio calculated for the week's crush is virtually the summation of a large number of actual and widely divergent values influenced by many factors and can in no way whatever be considered to be a fixed value characteristic of the population sampled. To repeat, the mean Java Ratio for a week's crush can only be equated to the one parametric function, i.e., to that particular week's crush, and not to any particular cane consignment which was crushed during that week.

Compare the expression—

$$\frac{\text{Sucrose per cent Cane}}{\text{Sucrose per cent 1st Exp. Juice}} = \frac{\text{Java Ratio}}{100}$$

with the mathematical function—

$$\frac{\text{Circumference of circle}}{\text{Diam. of Circle}} = \pi$$

both appear to be identical in form. Given π it is possible to calculate the diameter or the circumference of any circle if either dimension is given.

When calculating the relationship of the diameter to the circumference for an infinite number of circles, the greater the number of calculations made, the closer to the real value π is the calculated ratio. In contrast, when calculating the Java Ratio for a fixed crushing period (or a fixed quantity of cane), even if an infinite number of Java Ratio determinations could be made over that period, their mean value could only approach the particular value for that particular cane crushing period or quantity. That is, the Java Ratio is a value specific to a given set of circumstances and not a general abstracted value and thus cannot be considered to be a consistent statistic.

A wide deviation from the mean value in any particular determination in a series of determinations would not necessarily imply an error in determination but would merely emphasise that the Java Ratio is a continuously variable function operating between limits which are determined quite arbitrarially by chance circumstances.

These chance circumstances are, bad topping of cane, high or low fibre content, complete or incomplete trashing, state of cleanliness of the cane or the milling train, vagaries in the milling performance, rain, state of maturity of the cane, inadvertant dilution or decomposition of the juice sample, etc.

Any method of analysis for the evaluation of cane thus based on an arbitrarially variable function can only be justified in the absence of a more rational method for the sucrose per cent cane determination.

The actual sucrose content of a cane consignment is a value characteristic of the consignment of cane as such and of nothing else. The ratio sucrose per cent cane is of course influenced by the cleanliness or otherwise of the cane, and the state of maturity of the cane. The ratio—

$$\frac{\text{Wt. of Sucrose in Cane} \times 100}{\text{Wt. of Cane}}$$

must therefore give the proper evaluation of a consignment of cane because any extraneous matter is weighed as cane, consequently to be certain that he receives the maximum possible sucrose per cent cane values for his product, the supplier must ensure that all extraneous matter which contains no sucrose be removed from his cane. If the supplier actually was credited with a true direct analysis of the sucrose content of his cane, he would see the real significance which cleanliness plays in getting high returns, and not take advantage of the fact that an analysis based on a common Java Ratio places a premium on dirty and high fibre cane at the expense of the supplier of clean low fibre cane.
In contrast the ratio

$$\frac{\text{Sucrose per cent Cane}}{\text{Suc. per cent 1st Exp. Juice}} \times \frac{100}{1}$$

varies in the total sucrose content of the cane *as determined by the Miller,* and the factors which influence the sucrose content of the First Expressed Juice. (Degree of crushing and/or cleanliness or dilution of First Expressed Juice.)

This means that the above ratio is a combination of the characteristics of the particular consignment of cane being crushed at that time *and* the process of crushing to which it is being subjected and will thus vary accordingly.

The degree of the variation of the Java Ratio in relation to the richness of the 1st Expressed Juice can be gathered from a glance at Table 3 of the S.A.S.T.A. publication prepared by W. O. Christianson in 1952 entitled "Cane Testing with particular reference to the use of the Java Ratio in Natal." This table shows the effect of double crushing on the richness of the expressed juice, and reference is made to a "Report of Cane Testing Investigation carried out at Gledhow in 1935 (page 13)." The Report shows Java Ratio figures for the *total juice* expressed, not First Expressed Juice (which is obligatory for cane evaluation). These Ratios calculated on Total Juice expressed are much higher than the First Expressed Juice Ratios. Here is very conclusive evidence that the Java Ratio is *not* a characteristic of the cane as is the true Sucrose per cent cane ratio, but a combined characteristic of the cane and the crushing process to which it has been subjected. Because the milling process as such can have no significance whatever to the supplier of cane, no legitimate reason can be sustained for tying the evaluation of any consignment of cane to the milling process.

A statistical examination of the accuracy of the application of an average Java Ratio to a whole series of tests is made in the above-mentioned paper on Table I. In the discussion which follows it was pointed out that no test was more than 1.6 per cent sucrose in cane out. This appears to be a relatively small error but is it in fact so small? Basing the calculation on the assumption that the sucrose content of the cane is 14 per cent, an error of ± 1.6 per cent in Sucrose per cent Cane determination would indicate an over or an underestimate of 11.42 per cent. That is, the supplier of 100 tons of sucrose on this basis would be credited with either 111.42 tons of sucrose or 88.58 tons of sucrose, depending upon his good fortune or other wise. Basing the calculation on the number of tests not more than 1.0 per cent sucrose in cane out, it would be evident that 5 out of every 100 suppliers of sucrose would be allocated either 107.14 or 92.86 tons of sucrose for every 100 tons of sucrose sent in.

The only factor in favour of the Java Ratio as a means of cane evaluation is its convenience, i.e. it enables relatively unskilled persons to be employed in the analysis of the juices, while the direct determination of sucrose per cent cane requires skilled personnel which at present are unobtainable. The scarcity of skilled personnel can readily be explained by an almost complete lack of demand for their services. This demand, of course, cannot exist unless there is an awareness or an appreciation of the fact that skilled personnel are an undoubted asset.

The use of *unskilled* personnel for such an important function as an analysis of cane for evaluation purposes is not justified.

Dr. Van der Pol (in the Chair) said that the Java Ratio method for testing cane had been discussed often before. As pointed out by the author of the paper it was subject to grave errors. Recently the Sugar Milling Research Institute had experimented on the direct testing of cane with a view to avoiding the errors inherent in the Java Ratio method.

Mr. Rault: The paper was on a topical subject, much discussed at the present time. The Java Ratio was a comparatively simple method which had served a useful purpose, but had its limitations when dealing with new conditions created by the nature of the cane supplied which was a mixture of genuine stalks and extraneous fibrous matter.

The Java Ratio method could only be superseded by a practical method ensuring the collection of a truly representative sample of the mixture of stalks and foreign matter for testing purposes, provided this testing did not entail a large increase in labour, staff, equipment and time. Perhaps the delegates from Mauritius and Reunion could inform us on their experience in collecting a representative sample.

Mr. Antonowitz said that the amount of crushing to which the cane was subjected affected the Java Ratio and this was also changed by the mud on the cane after floods.

Mr. Christianson stated that the errors due to the Java Ratio method had been fully realised for very many years. Some thirty years ago experiments had been started on the determination of fibre in cane consignments, but in spite of all past experimentation a suitable method for this test had not yet been found, and this determination remained the crux of the whole matter. If one could successfully test cane consignments for fibre content the inaccuracies in our present Java Ratio method would disappear. Up until now, however, the Java Ratio method was the best we had for the determination of sucrose in cane consignments. Paying for cane on a purely weight basis or on an average sucrose per cent cane figure would lead to still greater anomalies.

He questioned the author's statement that crushing conditions affected the Java Ratio. Repeated carefully controlled experiments had shewn that varying the pressure exerted by the crusher had no effect whatsoever on the polarisation of the first expressed juice.

The Chairman pointed out that the Sugar Milling Research Institute were now trying out the effect of increasing pressures on polarisation of the expressed juice.

Dr. Rossouw said that the question of Java Ratio was a thing that affected his office quite considerably. Planters complained when cane was sent from one mill to another. Tests were different and they complained that there must be something wrong with the testing. Much work done on the subject had not been published.

Mr. Antonowitz said that it was important that work which had been done by various committees on this subject should be more widely published.

Mr. Scott said that from an engineer's point of view if everybody would clean their cane we would not get any more arguments about the Java Ratio. With any other food products, the product was graded, but not so with sugarcane.

Mr. Pougnet said that he was concerned as a farmer with the possibility that tests were not carried out accurately in certain mills.

Dr. Van der Pol said that the sampling error would enter into any method of testing cane.

Mr. Hugot said that it was obvious that fibre has a big effect on the Java Ratio. The difficulty was to make a determination of the fibre. However, how difficult, it would be better to try and get a determination of fibre. In Reunion he had growers who supplied two varieties of very different fibre, one high, one low, so an attempt was made to make the determination of fibre although it was not quite satisfactory. In Reunion factory efficiency was taken into account as well as the effect of crushing. He found that when three tons was passed through the mill when the normal quantity was ten tons the lower amount seemed to yield a higher quality juice than in the case of the ten tons. The cane was valued at the extractable sucrose and the factory efficiency affected this greatly. This was by agreement between the factory and the growers. He said that although they were not satisfied with the determination of fibre they still felt that it was better to take it into account. He said that a minimum of about forty tests were made on each planter's cane for fibre but normally the number of tests made was between fifty and eighty.

Mr. Antonowitz said that the factory at which he was the cane was valuated with the aid of the S.J.M. formula to assess the available sugar. Due to the large amount of mud on the cane from the flats the growers got such a low purity of crusher juice they were allocated much less sugar than they were entitled to. This defect was mitigated somewhat by the use of refractrometric purities when necessary.

The Chairman said that we were all agreed that Java Ratio was not the best method but as yet in South Africa we had not been able to improve on it. He hoped that in the near future they would find something more suitable for Natal.