

The Ripening of the Sugar-cane.

BY

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I request permission to place before you this short paper entitled "The Ripening of the Sugarcane." At the outset let me preface my paper with the remark that nothing of the nature of completeness is claimed. No paper bearing on Agriculture can be complete without the full collaboration of pure Agriculturists. I had no doubt had occasion to discuss this with a few eminent Agriculturists informally and I am glad to record that the criticisms so obtained have been very fruitful by way of throwing new light on certain of our experiences. It is with the idea of discussing with a varied audience that this Conference is composed of that I put forward this paper before you.

In a paper read before the Science Congress at Bombay, an attempt was made to study the life of the cane at various stages of its growth. It was shown therein that it was possible to examine the sugar contents of the various parts of the cane without actually cutting it and when subjected to such an examination it was found that the cane exhibited a characteristic change in its sugar contents from the bottom to the top as the cane ripened. If the sugar contents of the various internodes are plotted against the number of the internode counting from the bottom, the curve so obtained slopes down at the early stages of the life of the cane and tends to become horizontal as it becomes ripe. The main theme of the paper referred to was to study the chemistry of the carbo-hydrate metabolism of the cane and it is only as a side-issue that this problem of ripeness suggested itself. It, however, seemed full of possibilities and was therefore pursued with greater concentration than at first. The results of the last two years are herein presented in a short form.

Before entering the subject proper, it is essential to discuss the methods now obtaining for determining the ripeness of the cane. The usual method is what may be called the *co-efficient of purity*

method. Briefly outlined the method consists in finding out the purity of the juice of the cane at about the time of its ripening period and when the value so obtained reaches a certain limit, which is different for different varieties, the cane is declared to be ripe. That this method is not satisfactory is admitted. Many of you who have been at the farms might know the comparatively little importance attached to cane analysis as compared with certain botanical characters that point to its ripeness such as profuse tillering, the closing up of the head of the cane etc. For the same variety the purity varies from place to place and from season to season. Differences of 5 to 10 per cent are very common between one place and another. In this connection a few discrepancies met with in the course of our investigation might be mentioned. Certain late shoots have given a co-efficient as high as certain others of the same variety and plot which were two months older. It must however be admitted that this method if modified might serve as a better index. For the same variety and season the purity might be determined at various intervals during its ripening period and when the value is at the maximum the cane may be said to be ripe. There is one weak point about this method, namely, that it is not handy. Further, we do not know when the value of the co-efficient will be at its maximum and it may therefore be necessary to allow the cane to stand on the field long after it has become ripe with all the attendant draw-backs.

Another method is that put forward by Migake Ishida of the Formosa Agricultural Experiment Station. The writer has proposed a new criterion which he calls the *maturity co-efficient*. It is the ratio of glucose to sucrose multiplied by one-hundred. It is claimed that the ripeness of the cane is indicated by a large and sudden increase in the ratio. We are not in possession of sufficient details to dispose of this method finally. But judging from the figures quoted by the writer himself there are during one full cycle of the life of the cane more than one period when the ratio shows a sudden increase. Further, the writer himself admits that the ratio is dependent for its value on factors like the soil, the climate, the variety etc.,

We have seen that the co-efficient of purity is a variable quantity and therefore not a reliable guide for determining whether the cane is ripe or not. It is natural that it should depend so much, as it does, on the delicate balance of sucrose on the one hand and the other soluble substances of the cane juice on the other, such as glucose, gums, salts, etc. In its place we have to search for a factor which can be expected to be more independent of the internal balance and economy of the cane.

At the beginning I referred to a paper wherein it was shown how, as a cane ripens, there is a kind of levelling tendency among the various internodes in the matter of their total sugar contents. To put it in other words, when the cane is unripe the top internodes contain much less sugar than the bottom ones, and slowly increase their sugar content until at the time of ripening they contain as much as the bottom ones. Putting the above in strictly mathematical language, the ratio of the sugar contents of the bottom and the top internodes approaches unity at the time of ripening. Conversely when the ratio is unity the cane is ripe.

Work done during the years 1921 and 1922 with accurate information regarding the age of the canes analysed has confirmed the conclusions arrived at. But what is more important than a mere confirmation of the old results is the incidental proof of its independence of climatic conditions. Work carried out during four seasons shows a remarkable consistency in the general nature of the curves on which this method is based considering the fact that we are dealing here with a living organism. It appears as though the effect of different climatic conditions, while it is widely different between cane and cane, seems to be practically of the same intensity among the various parts of the same cane. The ratio therefore is based on a property of the cane which we can fairly claim to be independent of weather conditions. The purity co-efficient is the ratio of two large summations whose corresponding quantities have a varying relation between one another. This might give ample scope for probable error to creep in. On the other hand the ratio that is now

proposed has as its basic principle a general property of the sugar-cane at the time of its ripeness which is independent of external conditions. Our criterion then to judge whether a cane is ripe or not is to find out if the ratio of the sugar contents of the top and bottom internodes is unity or not. Such a test might be applied with ease to single canes, but, when the question of judging a crop comes in, the application of the test is not quite as easy.

A striking feature of the curves of ripe canes is their relative flatness as distinguished from the definitely steep ones of unripe canes. This emboldened us to presume that if a cane be divided into two halves and crushed the two juices thus obtained will contain almost the same percentage of sugar in the case of a ripe cane. It was therefore thought that if a sufficient number of canes were cut into two halves and crushed separately the sugar contents (brix) of the two juices would be almost the same if the crop was ripe.

On these lines some work was done at the beginning of this year at Samalkot and Anakapalle which goes to justify our assumption. In the tables below are given the results obtained.

Table No. I.

Name of variety.	Date of analysis.	Brix.		Top.		Jaggery yield Percentage on weight of cane.
		Bottom.	Top.	Bottom.	Top.	
Purple Mauritius	26-12-'22	15.63	14.42	0.92		7.8
"	21-1-'23	16.92	15.89	0.94		8.8
J-2-47.	28-12-'22	14.86	13.52	0.91		7.3
"	27-1-'23	15.83	15.23	0.96		8.7

By the kind permission of the Deputy Director of Agriculture, I Circle, a small plot containing a single variety was placed at our disposal. It was divided into portions and each portion was analysed at intervals of a month on the lines indicated above. It will be found from the above table that the ratio definitely rises towards unity with corresponding increase in the jaggery yield.

Table No. II.

Variety.	Brix.		Top.	Jaggery yield.	Average yield.
	Bottom.	Top.	Bottom		
B-34-12	19'61	19'48	0'99	11'76	11'80
B-1529	22'27	22'38	1'00	12'68	12'80
B-208	22'05	20'65	0'94	12'54	12'60
J-247	18'65	16'78	0'90	9'50	11'00
Java Hebbal	19'80	18'85	0'95	10'75	11'00

It will be found from the above table that where the ratio is close to unity the yield of jaggery has come up to the general average and that where the ratio is so low as 0.9 as in J-247 the yield of jaggery is only 9.5 per cent as against a general average for 12 years of 11 per cent.

Further experiments are in progress of which it is not possible to make any remarks at present. Before closing the paper it is necessary to say a word or two about the applications of this method. More than anywhere else, this method is of value in manurial and varietal experiments where a knowledge of the exact period of ripeness is essential to give comparable results. Two cane fields manured one with phosphate and the other with nitrogen are not likely to be ready for harvest at about the same time. The one may promote an abnormal vegetative growth and delay the ripening. If two such fields are cut at the same time the results are not comparable. In such instances the method I have suggested might come in quite handy.

As stated at the beginning nothing of the nature of completeness is claimed for the paper and I should be glad if it would bring about a full crop of discussion which can help me on to further fruitful researches on this side of the question. In conclusion I have to thank the Government Sugar Cane Expert for affording me all facilities at his station. I have also to express my thanks to Dr. R. V. Norris

for his kind advice and encouragement and to M. R. Ry. B. Viswanath Garu for the guidance he gave me.

Discussion.

Mr. K. Raghavachari—observed that the subject discussed in the paper was of great practical importance for Agriculturists. Generally fields of cane are planted at one time but the time of their ripening in most cases varies and again, the cutting of the cane being a slow process, their harvest naturally covers a long time. He wished to know if it would be possible for the chemist to retard or accelerate the ripening.

Rao Sahib T. S. Venkataraman—observed that the duration of the period of ripening was a varietal character; some ripened early, while others kept on without ripening for a longer time. He believed that Mr. Raghavachari's question was more the problem of a Botanist than of the Chemist.

Rao Sahib M. R. Ramaswami Sivan—congratulated Mr. Kasinathan on his paper which he said was likely to make a land-mark in our knowledge of the subject under discussion. He observed that the effect of allowing cane to remain after maturity was to induce inversion, which was detrimental to the sugar manufacturer, but as far as jaggery making was concerned, it did not very much matter.

Mr. Govinda Kidavu—said that under West Coast conditions, the time of ripening was of importance. He added that manuring had the effect of retarding the time of ripening.

Mr. Rajagopal Nayudu—stated that methods of cultivation had a great deal to do with the ripening of canes. He was of opinion that Sugarcane required aëration from the beginning and recommended planting cane at 3 to 4 feet apart and at $1\frac{1}{2}$ feet in the same line. He enlarged on the importance of deep cultivation and manuring. He remarked that manuring should have been done before the nodes appeared, otherwise leafy growth would result. He also observed that removing the leaves had the effect of hastening ripening.
