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Study of the Influence of Non-Sucrosic Material on Sugar Recovery from Sugarcane Juice

by

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Introduction: The present study was undertaken on the basis of the report that the sugar recovery at Amaravathy Co-operative Sugar Mills Ltd., Krishnapuram was low when compared to the other factories in Tamil Nadu. Even a small increase in recovery would consequently increase the production of sugar to a considerable extent.

Judged from the molasses purity, the lossess of sugar are minimum at the Amaravathy Factory. But the quantity of molasses per unit cane processed is more which results in greater losses in quantity of sugar. The percentage of molasses released during the process is largely dependent on non-sugar (non-sucrose material) fraction of juice. A perusal of Pol percentage and non-sugar percentage of primary and mixed juices with recovery as from the data furnished by the factory, showed that the recoveries can be expressed as functions of these two factors. The present study was undertaken in two phases. The first was to find out the cause of low recovery in the factory. This revealed that the non-sugar fraction had much to do with the recovery. Hence as a second phase, the fraction of non-sugars which contribute most to the low recovery was investigated.

Materials and Methods: *First phase of study:* To evaluate the milling efficiency, the data from this factory were compared with the factories at Ambur, Padalam, Mundiampakkam and Kallakurichi during the year 1966-67. Multiple regression of the data collected over four years from 1964 to 1967 at Amaravathi Co-operative Sugar Mills was done to relate the Pol, non-sugars and purity of molasses with recovery. Pol-Brix relationships for two varieties of cane Co. 419 and Co. 449 which are prevalently cultivated by the farmers of the area, were also worked out. The results of the statistical analysis are discussed below.

Second phase of study: To arrive at the fraction of non-sugar that contribute to the low recovery, the following components of the primary and mixed juices were analysed.

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Character:	*Method:*
Brix %	Hydrometry
Pol %	Polarimetry
Purity %	Calculation
Reducing sugar %	Lane-Eynon
Acidity	Alkalimetry
Lead number	S.T.A. India
Total nitrogen	S.R.S. Anakapalli
Inorganic nitrogen	S.R.S. Anakapalli
Protein	By difference
Ash (Mineral constituents) Na, K, Mg and Ca	International

Results and Discussion: 1. *Recovery in relation to Pol %, non-sugars and final molasses purity:* The recovery was studied in relation to Pol percentage and non-sugars in mixed juice percentage cane which represent overall recovery of juice from cane. The molasses purity was considered as it indicates the efficiency of chemical process in sugar manufacture. The correlation and regression coefficients are furnished in Table 1.

TABLE 1

Particulars	Correlation coefficient r	Coefficient of determination		Regression equation
		n-2	%	
Recovery *Vs* Pol %	0.96***	44	92	$Y=0.96X_1-1.14$
Recovery *Vs* Pol and non-sugar	0.97***	44	94	$Y=0.96X_1-0.099X_2-0.93$
Recovery *Vs* Pol and purity of molasses	0.98***	44	96	$(Y=0.96X_1-0.023X_3-0.40)$
Recovery *Vs* Pol, non-sugars and molasses purity	0.99***	44	98	$Y=0.96X_1-0.099X_2-0.023X_3-0.12$

(Y=recovery, X_1=Pol, X_2=non-sugars, X_3=purity of molasses in mixed juice % cane).

The partial regression coefficient for Pol percentage is highly significant (P%=0.001) while partial regression coefficient for non-sugars and purity of molasses were significant at 5% level. The simple correlations between the four factors are not significant except for Pol with recovery %.

Correlation Coefficients

$YX_1=+0.96^{***}$	$X_1X_2=-0.08$
$YX_2=-0.12$	$X_2X_3=-0.16$
$YX_3=-0.16$	$X_1X_3=-0.12$

Ninety-eight % of the variations in recovery could be accounted for by the variations in Pol, non-sugars and purity of molasses. In a complex system, this coefficient of determination is remarkably good and recovery can be predicted with an average difference of $\pm$ 0.04 by considering the Pol, non-sugars and purity of molasses alone.

The recovery as predicted by the above regression equation and observed for different factories closely agree. Hence all the factories follow the same regression pattern indicating that milling efficiencies are almost the same in all the factories. The values are given in Table 2. A small increase in the observed recovery at Mundiampakkam factory may be due to slightly higher overall extraction efficiency.

TABLE 2

Factory	During 1966—67			
	Observed recovery	Calculated recovery	Calculated Observed %	Overall extraction %
Amaravathy	8.02	7.97	99.38	73.43
Ambur	9.66	9.60	99.38	77.87
Padalam	9.35	9.26	99.04	77.81
Mundiampakkam	8.85	8.63	97.52	78.42
Kallakurichi	9.30	9.20	98.93	77.66

Increasing the overall extraction at the Amaravathy Co-operative Sugar Mills may increase the overall recovery. But high non-sugars present in this tract will limit the possibility of such an increase. This has to be tried with caution.

2. *Brix-Pol relations for Co.419 and Co.449 varieties:* Correlations, worked out on the basis of small mill tests during the years 1963 to 1967, between Brix and Pol values are given in Table 3.

TABLE 3

Variety	Year	Correlation co-efficient r	Regression equation	Pattern
Co. 419	1963-64	+0.90**	Y=0.90 X−1.35	Good
	1965	+0.93**	Y=1.14 X−5.38	Poor
	1966	+0.59**	Y=0.51 X−5.68	Poor
	1967	+0.85**	Y=1.19 X−7.11	Poor
Co. 449	1963-64	+0.93**	Y=1.18 X−5.72	Good
	1965	+0.95**	Y=1.16 X−5.73	Good
	1966	+0.91**	Y=1.08 X−4.10	Good
	1967	+0.77**	Y=0.94 X−1.90	Good

Durairaj *et al* (1963) studied in detail the Brix-Pol relationship in Co.419 variety at Nellikuppam tract and reported that the pattern of relationship fell into five distinct categories out of which the canes following three patterns, always showed a high non-sugar fraction and therefore they were of poor quality. Based on this, the above regression equations reveal that the pattern of Co.419 was good in 1963-64 while in all other years it was poor. The recovery was also good in the beginning with deterioration in subsequent years. Poor pattern of the Brix-Pol relationship may be due to deterioration in cane Co. 419 or due to accidental segregation in this tract. The possible indications for deterioration in Co.419 was evidenced by the following data at Amaravathi Mills.

	1964-65	*1965-66*	*1966-67*
1. *Increase in fibre %*			
Fibre %	13.32	15.29	15.66
2. *Increase in non-sugars*			
Non-sugars	3.15	3.32	3.09
Non-sugars for 100 Brix	23.42	27.03	24.50

The causes for the deterioration are not fully understood. However, this can be overcome by changing the variety itself or changing the seed materials periodically.

Second phase - To find out the non-sugar fraction causing low recovery: The average values of the analysis carried out for the primary and mixed juices are furnished in Table 4. The values for acidity, nitrogenous matter, ash and mineral constituents seem to be normal, when compared with the

TABLE 4. *Average values of analysis during 1966-67 (Special season)*

Particulars	Primary juice	Mixed juice
Brix %	18.50	14.44
Pol %	14.20	11.02
Purity %	75.25	75.20
Reducing sugar %	1.64 (Maximum value 1.92)	1.69 (Maximum value 2.04)
Acidity (0.1 N NaOH per 100 ml)	21.12	22.41
Total nitrogen %	0.30	0.30
Non-protein N %	0.11	0.11
Organic N %	0.19	0.19
Sulphated ash %	0.60	0.62
Lead number (per 100 ml)	36.10	36.20
	(Composite samples)	
CaO	180 mg / litre of juice	
MgO	120 ,, ,,	
K_2O	800 ,, ,,	
Na_2O	1300 ,, ,,	

values available from foreign literature. Pieter Honig (1953) has summarised the values for various non-sugar fractions in cane juices. A significant relation was obtained among Pol %, reducing sugar % and recovery. The regression equation derived is

$$Y = 2.08X_1 - 4.92X_2 - 2.08X_3 - 0.08$$

(Y = recovery, X_1 = Pol %, X_2 non-sugars, X_3 = reducing sugar)

This shows that reducing sugar is the possible major non-sugar factor interacting with the recovery. The percentage of reducing sugar was as high as 1.92 in primary juice and 2.04 in mixed juice whereas 0.5% is the normal value. On the average about 1.0% of reducing sugar is in excess in the juice at Amaravathi Mills amounting to considerable loss in recovery. Low available potash in the soils of the tract may be responsible for high reducing sugar in canes. Hartt (1934) reported the possible interference with translocation of sugars due to potassium deficiency. He found increased proportions of reducing sugars with deficiency in potassium. Hence, balanced manuring with higher dosage of K for sugarcane in that area is suggested.

Conclussions: From the limited study undertaken, reducing sugar in juice seemed to be the major cause for the low recovey of sugar at Amaravathy Co-operative Sugar Mills when compared with other factories. This necessitates the further detailed investigations for the reason of high reducing sugar in juices. The poor Brix-Pol reiationships, increase in fibre percentage and non-sugars in Co.419, suggest a certain amount of deterioration in this variety.

Among many diverse agronomic factors most of them being out of the control of the factory, changing the variety or atleast the seed materials, timely application of balanced manure with increased dosage of potassium are suggested to be tried on experimental basis. Further, thorough investigations on the follow up of work is needed to pinpoint the reasons for low recovery.

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