A LABORATORY INVESTIGATION OF THE EFFECTS OF TOPS AND TRASH ON EXTRACTION, JUICE QUALITY AND CLARIFICATION

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Abstract

The effects of tops and trash on extraction, juice quality and clarification were investigated on the laboratory scale. It is shown that both tops and trash have pronounced adverse effects on juice purities and clear juice quality, while trash also reduces pol extraction. All the effects were statistically highly significant and increased linearly with extraneous matter contents of up to 30%.

Introduction

The sucrose content of the sugar cane stalk is a function of its physiological maturity, the conditions under which it is grown (climate, soil, cultural practices etc.) the cane variety and the degree to which it has suffered from pests and diseases. In practice, time delay and harvesting systems are also very important in this connection. The amount of extraneous matter in the form of tops and trash that accompanies the cane is a function of the harvesting system used and will have an important bearing on the sucrose content of the cane brought to the mill. Indeed, the sucrose content of the extraneous matter bears little relation to that of the stalk it accompanies as an examination of Table 1[1] reveals.

Table 1

A typical analysis of clean cane and extraneous matter

	Brix%	Pol %	Apparent Purity	Fibre %	Moisture %	Non-Pol %
Clean cane	16,7	14,8	89	12,8	70,5	1,9
Tops	6,7	1,4	21	16,6	77,7	5,3
Trash	7,8	1,5	19	58,6	33,6	6,3

The influence of the extraneous material on extraction, juice quality and clarification, has long been an area of uncertainty.

A series of laboratory scale experiments was therefore conducted over the last two years in order to quantify the effect of tops and trash on these processes.

Investigational Procedure

The investigation was carried out on two varieties:

14 months old NCo 376 during July/August, 1976 and 14 months old N55/805 during August/September, 1977.

In each test sufficient fresh cane was stripped of tops, trash, dirt, etc., in the laboratory. The cane, tops and trash were shredded separately in a Jeffco cutter grinder, each material being then thoroughly mixed and stored in separate, sealed plastic bags to minimise evaporation.

The juice was extracted using a 45 ton Pinnette Emidicau hydraulic press[2]. The procedure involved pressing 1 000 g of the shredded cane with zero up to 30% tops or trash by weight, for 2,5 minutes at 25 000 kPa. On the release of the press, 250g of distilled water (25% on clean cane) was poured uniformly over the surface of the pressed bagasse and the pressing continued for a further 2,5 minutes. On this second release, the press was again closed and the bagasse subjected to a final dry pressing for 2,5 minutes. This procedure yielded approximately one litre of juice of brix and purity similar to mill mixed juice. The final products of pressed bagasse and juice were collected and weighed. Juices were analysed for pol, brix, reducing sugars and ash.

The juice from the N55/805 cane variety was also subjected to a laboratory clarification test. The apparatus[3] and techniques[4] used have been described elsewhere. Clear juice was also analysed for optical density,[4] while mud volumes and masses were recorded.

Results and Discussion

Each test involved extracting juice by the press method from a constant mass of clean cane (1 000g) and comparing this with juice pressed from 1 000g of clean cane plus varying increments of tops or trash. In this way comparison can be made directly with the control sample of clean cane, thus eliminating the day-to-day variations in cane quality. By comparing the results with the control (arbitrarily assigned the value of 100) changes and trends due to varying quantities of tops or trash, can be illustrated.

For example, juice extracted from clean cane would contain say, 2,5% non-pol, while juice extracted from another sample of that clean cane, but this time containing 10% tops, contains 3,2% non-pol. Then the impurity index is:

$$\text{Impurity Index (non-pol)} = \frac{100 \times 3,2}{2,5}$$

$$= 128$$

The various indexes were then related to percentages of tops or trash through linear regressions. All the regressions reported were found to be significant at least at the 1% level.

1. Effect on Juice Purity –

It was found for both varieties that both tops and trash have a very definite linear effect in depressing juice purity over the range investigated. This is due to two quite distinct charcteristics:

(a) To the significantly *increased* quantities of *brix* extracted in the juice when pressing increments of *tops* with the cane; and

(b) To the significantly *decreased* quantitites of *pol* extracted in the juice when pressing increments of *trash* with the cane.

Table 2 reveals the extent of these effects.

Table 2

Percentage change in juice purity caused by the addition of 1% of tops or trash to clean cane.

	Addition of 1% of:	
	Tops	Trash
Percentage change in juice purity	–0,38	–0,33

2. Effect on impurities extracted –

Increasing increments of both tops and trash in the cane to be crushed add significantly to the quantities of impurities extracted in the juice and hence to the back-end loading in the factory. This is to be expected, for tops contain a large proportion of low purity juice. Surprisingly trash contributes enormous quantities of ash and also raises the other non-pol in the juice. The chief offender, however remains tops whose contribution in most instances was double that of trash. Non-pol loadings (i.e. brix minus pol), reducing sugar and ash levels were examined and all were found to increase dramatically in a linear fashion with the inclusion of tops. This is illustrated in Table 3 and Figure 1.

Table 3

Percentage change in masses of impurities extracted caused by the addition of 1% of tops or trash to clean cane

Addition of 1% of:

Percentage change in: . .	Tops	Trash
Mass of non-pol	+2,4	+1,4
Mass of reducing substance	+1,5	+0,4
Mass of ash	+2,3	+2,5

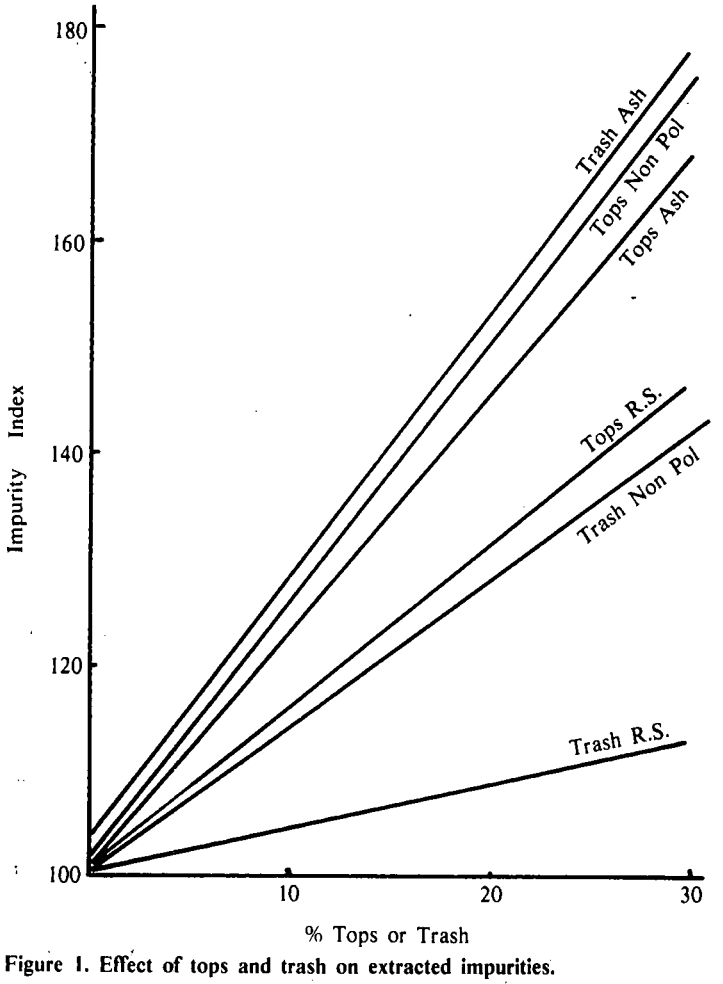

Figure 1. Effect of tops and trash on extracted impurities.

3. Effect on extraction –

Trash showed the most significant effect, with increasing trash contents reducing extraction linearly.

Although in general the two varieties tested showed very similar trends, in the case of pol extraction there appeared a relatively large difference. This could possibly be attributed to a varietal efffect.[5].

Linked with the reduced extractions, there were increases in mass of bagasse and of pol lost in bagasse.

Tops did not appear to influence extractions or bagasse moistures in any way but contributed slightly to increased bagasse production.

These findings are summarised in Table 4.

4. Effect on clarification –

Liming and settling were carried out on samples of juice from the variety N55/805. The pH of the pressed juice decreased with increasing increments of tops or trash introduced with the cane. Consequently, more lime was needed to attain the desired clear juice pH of ± 7,3. the addition of1% tops or trash increased lime consumption by approximately 2%.

Table 4

Percentage change in pol extraction and bagasse % cane caused by the addition of 1% of tops or trash to clean cane

Addition of 1% of:

Percentage change in . . .	Tops	Trash	
Pol extraction	Not significant	N55/805 -0,15	NCo 376 -0,44
Bagasse % cane	+0,88	+3,69	

5. Effect on settling –

Neither tops nor trash were found to influence the initial settling rate[3] of the juice. Tops did not appear to have any influence on the mud characteristics, such as amount produced or density. Trash on the other hand, was shown to have a significant effect (although slight) on mud volume, mud mass and thus mud density. With increasing increments of trash a decrease in sludge volume index[3] was found, i.e. an increase in mud density.

It must be noted, however, that these settling characteristics are not typical of those found under factory conditions. This is due to the absence of sand and soil with the juice samples. It is thus difficult to compare these results directly with factory situations. Suffice to say that the effect of extraneous matter on settling was found to be relatively small.

6. Effect on Clear juice quality –

Effect on purity and impurities – The depressed juice purities exhibited in the press juice as a result of the inclusion of tops and trash were carried over into the clear juice. An improvement in the juice purity over clarification was found, the rise, however, seemed independent of tops or trash and occurred in all cases averaging 1,3 units.

This rise is higher than that of the factory where the purity rise (if any) is not more than 0,5 units but retentions times in the SRI settling kit are only 18 minutes as opposed to 2 hours with conventional clarifiers. In addition, lime saccharate[4] was used and this may have contributed to the greater purity rise.

Reducing sugar levels were decreased over clarification, the decrease being relatively higher when higher reducing sugars were present in the pressed juice. The final level was still higher, however, than that of the clean cane juice.

Ash levels were also increased but this can be directly attributed to the increased lime consumption necessary when tops and trash are present.

Effect on optical densities – It was on the parameters of clear juice colour and turbidity that the most deleterious effects as regards clarification were exhibited. Increased juice colour and the inclusion of fine suspended and colloidal matter make the attainment of VHP sugar more difficult. In addition, problems are increased in the low grade station of the factory. These effects are summarised in Table 5.

Table 5

Percentage change in clear juice colour and turbidity caused by the addition of 1% of tops or trash to clean cane.

Addition of 1% of:

Percentage change in	Tops	Trash
C.J. colour	+1,3	+3,6
C.J. turbidity	+2,8	+4,2

Conclusion

Bearing in mind that proportions of extraneous matter in South African mills vary between 2-5% for tops and 3-10% for trash, the tests carried out reveal that the presence of tops and trash can result in quite serious reductions in extraction, and in mixed and clear juice qualities.

Furthermore, adverse effects carry through the milling and clarification stations and will in fact affect the whole process. Reduced purities, increased ash levels and high turbidities in clear juice will affect both sugar quality and recoveries.

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