

# OBSERVATIONS ON THE EFFECTS OF GUMS

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## Introduction

Gums, those large molecule carbohydrates which are precipitated from sugar solutions by acidified alcohol, constitute a major impurity in Natal raw sugars.

The effects of gums upon polarisation, the viscosity and the filterability of sugar solutions have been studied. Initially it was hoped to place special emphasis on the effect of starch, one of the more abundant gums, but the difficulty of simulating true cane starch has rendered a study of its absolute effects difficult.

## Method of Investigation

Gums were precipitated from solutions of Tail End Syrup and Affination Syrup using acidified alcohol. The precipitated solution was centrifuged and the gums washed by successive mixing, centrifuging and decanting with alcohol. The washed gums were dissolved in hot water and reprecipitated with acidified alcohol. After further washing the gums were re-dissolved. The gums and starch content of the final solution was determined. (1 and 2).

Starch solutions were prepared by dissolving analytical grade starch in distilled water. The gum and starch content of the solution was recorded. Portions of these gum and starch solutions were used for the investigations.

Polarisations were made using a Schmidt and Haensch polarimeter, while use was also made of a Zeiss automatic polarimeter.

Filterability determinations were made at 80°C using a modified Colonial Sugar Refining apparatus.

A Hoesppler falling sphere viscometer was used for the viscosity determinations.

## Polarisation Effects

Addition of known quantities of gum solution to semi-normal sucrose solution gave the following readings:—

|                             |      |      |      |
|-----------------------------|------|------|------|
| Grams ml in 100 ml solution | 0    | 0.29 | 0.58 |
| Polarisation °s             | 50.0 | 52.5 | 55.0 |

These gums exhibited a polarisation of 8.6°S per gram, 2.24 times the polarisation of sucrose.

Further determinations were made with a range of gum additions from 0.0254 g to 0.5078 g per 100 ml of test solution. A similar series of tests was made using starch in concentrations from 0.0234 g to 0.4678 g per 100 ml of solution. Duplicate tests were conducted, the solutions of one series being treated with 0.5 ml of lead acetate solution and filtered before polarisation.

The polarisations of the starch and total gums were found to be 8.55°S per gram and 7.88°S per gram respectively. Clarification with the small quantity of

lead acetate solution used had no apparent effect on the polarisation.

Extending the investigations the Hernández borax method (3) was used to obtain a series of polarisations of sucrose/gum/borax solutions with, and without, lead acetate clarification. Polarisation results below are the average of five readings each by two analysts.

TABLE 1  
Concentration in Final Solution, ml in 100 ml

| NORMAL SUCROSE SOLUTION | (0.468%) GUM SOLUTION | 54° BRIX LEAD ACETATE | 5% BORAX | POLARISATION DEGREES |
|-------------------------|-----------------------|-----------------------|----------|----------------------|
| 25                      | —                     | —                     | —        | 25.025               |
| 25                      | —                     | —                     | 20       | 24.472               |
| 25                      | 10                    | —                     | 20       | 24.904               |
| 25                      | 10                    | 0.5                   | 20       | 24.707               |
| 25                      | 10                    | 1.0                   | 20       | 24.456               |
| 25                      | 10                    | 2.0                   | 20       | 24.262               |
| 25                      | 10                    | 5.0                   | 20       | 23.995               |
| 25                      | 10                    | —                     | —        | 25.418               |
| 25                      | 10                    | 0.5                   | —        | 25.387               |
| 25                      | 10                    | 1.0                   | —        | 25.105               |
| 25                      | 10                    | 2.0                   | —        | 25.075               |
| 25                      | —                     | 5.0                   | —        | 25.075               |
| 25                      | —                     | 5.0                   | 20       | 24.482               |

Solutions containing gums and 5.0 ml lead acetate without borax could not be clarified sufficiently.

It is interesting to note the depression in the pol of the sucrose solution caused by the addition of borax. A similar phenomenon is described by López Hernández (3) who suggests the possibility that a very small scale molecular displacement of hydroxyl ions during the manufacturing process results in sucrose isomers with hydroxyl ions in cis-positions, the polarisation of which can be neutralised by borax.

The effects of the various additions on the sucrose pol can be represented as shown in Table 2.

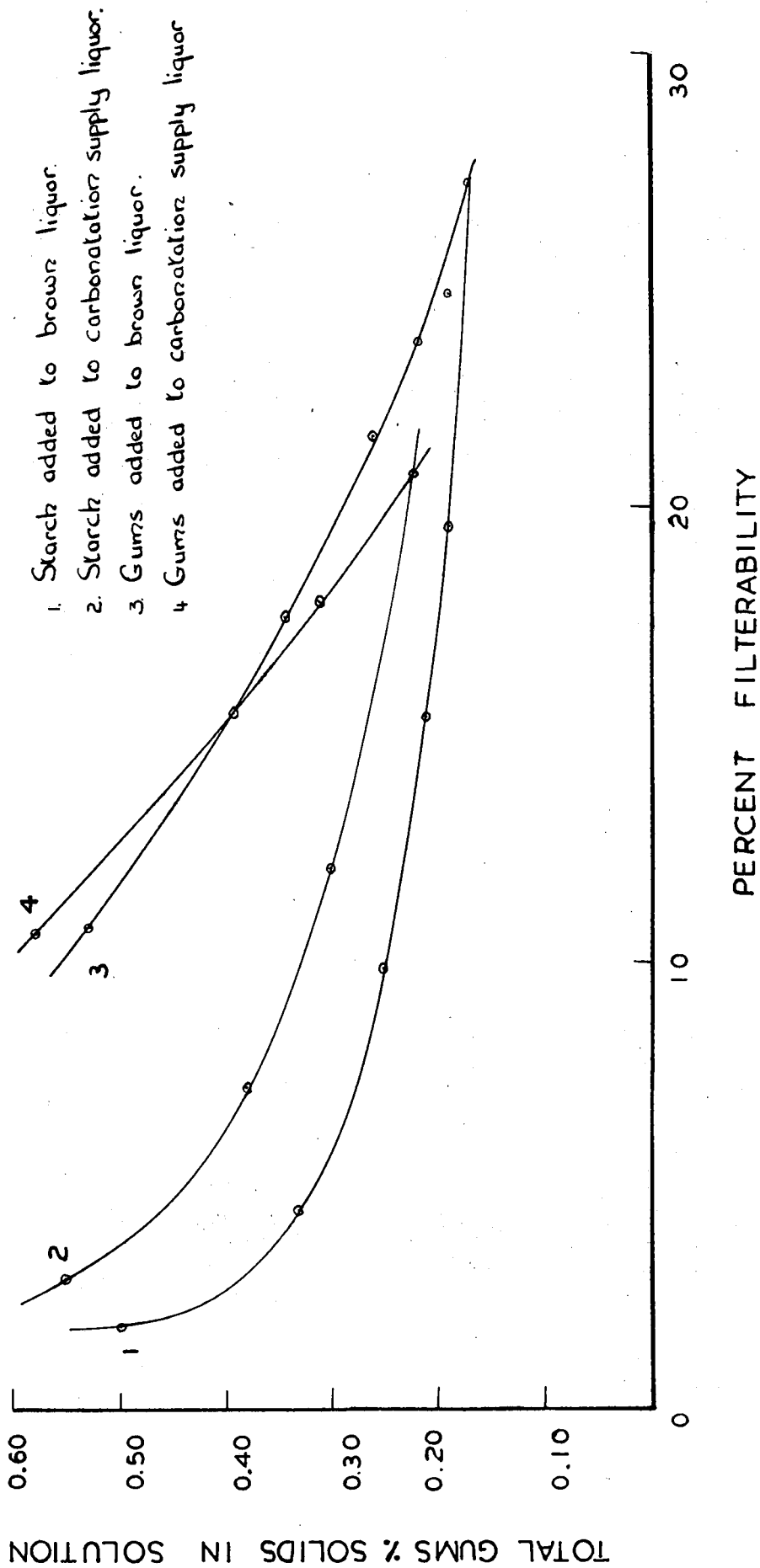
The polarisation of gums is apparently reduced by clarification with larger amounts of lead acetate than usually used for sugar solution polarisation. This reduction of the pol is accentuated by the addition of borax. Indeed, on the addition of both lead acetate and borax the polarisation may be reduced well below the figure for the equivalent gum-free solution.

A possible explanation is that the gums consist of both dextro-rotatory and laevo-rotatory fractions and that the dextro-rotatory fractions are more affected either by precipitation by lead acetate or neutralisation by borax, than the laevo-rotatory fraction.

The total apparent polarising effect of the gums in the sucrose/gum/borax/5 ml lead acetate mixture is —10.41°S per gram. For comparison the positive effect of those gums added to pure sucrose is 8.40°S per gram, while the positive effect of adding gums to an unclarified sucrose/borax solution is 9.23°S per gram.

GRAPH ONE

THE EFFECT OF GUMS ON FILTERABILITY



### Filterability

Known quantities of gums and starch were added to aliquots of liquors, the original gum contents of which were also known. The effect on the filterability of the liquor is summarised in Table 3 and Graph 1.

TABLE 3

| GUMS PRESENT IN ORIGINAL LIQUOR PER 100g SOLIDS | GUMS ADDED PER 100g SOLIDS | TOTAL GUMS PER 100g SOLIDS | PER CENT FILTERABILITY | PER CENT REDUCTION IN FILTERABILITY |
|-------------------------------------------------|----------------------------|----------------------------|------------------------|-------------------------------------|
| 0.2280                                          | —                          | 0.2280                     | 20.7                   | —                                   |
| 0.2280                                          | 0.0846                     | 0.3126                     | 17.8                   | 14                                  |
| 0.2280                                          | 0.1693                     | 0.3973                     | 15.4                   | 26                                  |
| 0.2280                                          | 0.3529                     | 0.5809                     | 10.6                   | 49                                  |
| 0.2280                                          | 0.0156*                    | 0.2436                     | 19.7                   | 5                                   |
| 0.2280                                          | 0.0780*                    | 0.3060                     | 12.0                   | 42                                  |
| 0.2280                                          | 0.3251*                    | 0.5531                     | 2.9                    | 86                                  |
| 0.1780                                          | —                          | 0.1780                     | 27.1                   | —                                   |
| 0.1780                                          | 0.0085                     | 0.1865                     | 26.9                   | 1                                   |
| 0.1780                                          | 0.0169                     | 0.1949                     | 24.7                   | 9                                   |
| 0.1780                                          | 0.0423                     | 0.2203                     | 23.6                   | 13                                  |
| 0.1780                                          | 0.0846                     | 0.2626                     | 21.5                   | 21                                  |
| 0.1780                                          | 0.1693                     | 0.3473                     | 17.5                   | 35                                  |
| 0.1780                                          | 0.3529                     | 0.5309                     | 10.7                   | 61                                  |
| 0.1780                                          | 0.0156*                    | 0.1936                     | 19.6                   | 28                                  |
| 0.1780                                          | 0.0390*                    | 0.2170                     | 15.3                   | 44                                  |
| 0.1780                                          | 0.0780*                    | 0.2560                     | 9.8                    | 64                                  |
| 0.1780                                          | 0.1559*                    | 0.3339                     | 4.4                    | 84                                  |
| 0.1780                                          | 0.3251*                    | 0.5031                     | 1.8                    | 93                                  |

\*Extra gums added as analytical grade starch.

It can be seen that the addition of analytical grade starch is much more severe in its effects on filterability than the total gums derived from Refinery liquor. Since the gums used contained 54% cane starch it seems certain that the analytical grade starch used in these tests had a much more marked effect on filterability than would pure cane starch.

### Viscosity Effect

The viscosity of prefiltered liquor, with and without the addition of gums, was determined at 60° and 70° Brix, at 40°C, 60°C and 80°C. The viscosities in centipoise are shown in Table 4.

TABLE 4

| BRIX | GUMS ADDED g/100 g SOLIDS | TOTAL GUMS g/100 g SOLIDS | VISCOSITY (cp) |       |       |
|------|---------------------------|---------------------------|----------------|-------|-------|
|      |                           |                           | 40°C           | 60°C  | 80°C  |
| 60   | —                         | 0.2280                    | 23.06          | 10.50 | 5.68  |
| 60   | 0.0850                    | 0.3130                    | 23.85          | 10.84 | 5.91  |
| 60   | 0.3529                    | 0.5809                    | 26.82          | 11.72 | 6.24  |
| 60   | 0.3251*                   | 0.5531                    | 25.51          | 11.46 | 6.14  |
| 70   | —                         | 0.104                     | 104.97         | 36.07 | 16.35 |
| 70   | 0.060                     | 0.164                     | 112.08         | 38.05 | 17.16 |

\*Gums added as analytical grade starch.

The addition of 0.3529 g gums per 100 g solids at 60° Brix increased the viscosity of the liquor by 16.3% at 40°C, by 11.6% at 60°C and by 9.9% at

80°C. The increase in viscosity on the addition of 0.3251 g of starch per 100 g solids was 10.6% at 40°C, 9.1% at 60°C and 8.1% at 80°C.

At 60° Brix the addition of 0.085 g gums, giving a total gum content of 0.313 g per 100 g solids increased viscosity by 3.4% at 40°C, 3.2% at 60°C and 2.3% at 80°C.

At 70° Brix the addition of 0.060 g gums, giving a total gum content of 0.164 g per 100 g solids, increased viscosity by 6.8% at 40°C, 5.5% at 60°C and 5.0% at 80°C.

### Summary

Aqueous solutions of gums precipitated from Refinery liquors were used to observe the effects of gums on the polarisation, filterability and viscosity of sugar solutions.

It was found that gums have an average specific rotation of 149.03°, though this may vary considerably depending upon their composition. This specific rotation is more than twice that of sucrose.

Lead acetate in excess of the amount required for normal raw sugar polarisation causes a drop in the pol of the gums, probably due to precipitation.

When sucrose/gum solutions are clarified by lead acetate following the addition of borax, the resultant polarisation suggests that those gums which are not precipitated or neutralised by this clarification exhibit a negative polarisation of up to 10°S per gram of original gum added in 100 ml solution.

The addition of 0.35 g of gums per 100 g solids may reduce the filterability of a liquor by 61%. 0.32 g per 100 g solids of analytical grade starch (not cane starch) reduced the filterability of brown liquor by 93%.

0.35 g of gums added per 100 g solids increased the viscosity of prefiltered 60° Brix carbonation supply liquor by 16.3% at 40°C, 11.6% at 60°C and 9.9% at 80°C. The increase in viscosity caused by the addition of gums to 70° Brix solutions appeared to be even greater.

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### References

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For discussion on this paper, see page 57.

