

REPORT ON KEEPING PROPERTIES AND REFINING QUALITY OF SOUTH AFRICAN RAW SUGARS, 1935-36 SEASON

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To get an indication of the actual keeping properties, as well as the refining quality of Natal Raw Sugars, it was decided to make a systematic analysis of the output of the different factories. This work was started at the Experiment Station in 1934 and a report was read at the Queensland Congress in 1935 (1). Owing to unforeseen circumstances, however, the work had to be rushed towards the end and the report was therefore of a preliminary nature. It was thought advisable in consequence to continue the investigation on the 1935 crop.

To make a comprehensive survey of the total output, all the factories were asked to send samples to the Experiment Station representing every 100 tons of raw sugar produced. On arrival these samples were well mixed and kept in tightly closed tins. One portion (about 5 lbs.) was analysed and the other half kept in the tin for six months.

The following methods of analysis were adopted:

Polarization.

Normal weight of sugar was dissolved in 200 ml. flasks and clarified with basic lead acetate. The polarization was done in 40 cm. tubes at room temperature.

Moisture.

About 8 to 10 grams were dried in Petri dishes in an electric oven for 24 hours at 98°C.

Ash.

The sulphated ash method was adopted and the results are given without reduction.

Gums.

10 grams sugar are dissolved in 20 ml. water in a 250 ml. beaker. A mixture of 86 ml. 96 per cent alcohol and 14 ml. glacial acetic acid is slowly added from a burette with constant stirring. This is allowed to stand overnight and is then filtered through an asbestos mat crucible previously tared. The gum precipitate is then washed free from sucrose with the alcohol-acetic acid mixture and during the last stage with 95% alcohol. It is now dried for three hours and then weighed.

Reducing Sugars.

The Lane & Eynon method was adopted.

Sulphur Dioxide.

The iodine titration method as described by the South African Sugar Technologists was used and the results expressed as parts per million.

Filtration.

The standard Elliott Filtration test was used (2) and (3) 2,000 grams sugar were dissolved in 2,000 grams water and 40 grams Kieselguhr (2% of the sugar used) added. The filtration is done at 27.5°C. and under a vacuum of 26 inches for 30 minutes. The filtrate is now divided by 30 and gives the revised "filtration rate."

pH.

The pH measurements were done in a Hellige potentiometer using a hydrogen electrode.

RESULTS

Averages of Factories	Pol.	H ₂ O	S.F.	Ash	Gum	R.S.	Filtration		pH
							SO ₂	rate	
Factory No. 1	97.32	0.92	0.34	0.68	0.23	0.17	34.27	99.5	6.33
after 6 months	97.06	0.99	0.34	0.68	0.24	0.19	—	101.3	5.74
Factory No. 14	98.61	0.46	0.34	0.29	0.43	0.14	52.82	44.0	7.19
after 6 months	97.23	0.69	0.25	0.30	0.46	1.18	—	44.5	6.25
Factory No. 5	98.53	0.43	0.29	0.36	0.39	0.15	64.81	52.5	7.48
after 6 months	97.54	0.55	0.22	0.37	0.43	0.76	—	54.5	6.72
Factory No. 2	97.55	0.94	0.39	0.52	0.38	0.19	47.65	68.6	6.78
after 6 months	95.86	1.14	0.28	0.54	0.41	1.58	—	80.7	5.40
Factory No. 18	98.29	0.51	0.30	0.42	0.44	0.21	99.63	38.6	6.95
after 6 months	97.87	0.45	0.21	0.43	0.49	0.31	—	37.9	6.39
Factory No. 20	98.14	0.60	0.32	0.41	0.37	0.17	72.78	47.6	7.16
after 6 months	97.66	0.58	0.26	0.42	0.40	0.47	—	55.7	6.60
Factory No. 11	97.59	0.79	0.34	0.32	0.35	0.51	39.96	50.5	6.33
after 6 months	95.72	0.94	0.22	0.33	0.36	2.40	—	49.9	5.40
Factory No. 8	95.93	1.52	0.38	0.89	0.56	0.45	57.75	36.4	6.70*
after 6 months	96.01	1.50	0.38	0.86	0.56	0.43	—	41.9	5.78
Factory No. 4	98.66	0.40	0.31	0.30	0.39	0.21	37.70	52.6	6.85
after 6 months	97.65	0.49	0.21	0.33	0.43	0.77	—	52.7	6.36
Factory No. 21	97.73	0.75	0.34	0.53	0.52	0.23	47.57	25.6	6.90
after 6 months	96.58	1.08	0.32	0.54	0.49	0.72	—	29.8	6.01
Factory No. 19	97.10	0.91	0.31	0.56	0.44	0.37	34.13	—	6.28
after 6 months	96.38	0.93	0.26	0.56	0.41	0.98	—	—	6.09
Factory No. 6	98.02	0.64	0.33	0.53	0.49	0.21	57.67	44.2	6.90
after 6 months	97.04	0.82	0.28	0.54	0.52	0.74	—	45.0	6.34
Factory No. 15	96.69	1.17	0.35	0.68	0.51	0.43	57.74	42.8	6.38
after 6 months	96.18	1.33	0.35	0.69	0.60	0.61	—	47.5	5.82
Factory No. 12	98.47	0.37	0.24	0.38	0.43	0.15	57.03	44.7	6.98
after 6 months	98.21	0.40	0.22	0.39	0.44	0.18	—	46.7	6.37
Factory No. 10	98.98	0.19	0.19	0.24	0.41	0.11	55.86	56.4	6.81
after 6 months	98.67	0.22	0.17	0.26	0.41	0.15	—	56.9	6.30
Average of all factories	97.99	0.66	0.32	0.46	0.40	0.21	54.31	53.52	6.86
after 6 months	97.12	0.78	0.26	0.46	0.43	0.79	—	55.70	6.14

Monthly Averages.	Pol.	H ₂ O	S.F.	Ash	Gum	R.S.	Filtration		pH
							SO ₂	rate	
July period	97.93	0.70	0.33	0.49	0.39	0.22	55.47	59.8	6.97
after 6 months	97.19	0.73	0.25	0.49	0.44	0.50	—	57.6	6.36
August period	98.21	0.62	0.34	0.40	0.43	0.18	56.31	49.5	6.89
after 6 months	97.10	0.79	0.26	0.41	0.47	0.89	—	52.1	6.24
September period	98.13	0.59	0.31	0.42	0.42	0.20	58.65	49.1	6.95
after 6 months	97.32	0.69	0.25	0.44	0.44	0.80	—	52.3	6.19
October period	97.81	0.71	0.32	0.50	0.39	0.24	53.98	58.3	6.76
after 6 months	96.90	0.87	0.28	0.50	0.42	0.90	—	63.3	5.90
November period	97.94	0.63	0.30	0.47	0.37	0.22	38.66	—	6.74
after 6 months	97.33	0.71	0.27	0.48	0.38	0.61	—	—	6.23
Average July - November period	97.99	0.66	0.32	0.46	0.40	0.21	54.31	53.52	6.86
	97.12	0.78	0.26	0.46	0.43	0.79	—	55.70	6.14

* Only two samples.

Discussion.

On the whole the samples kept well in tins. Sugar from certain factories, however, show a rapid and high deterioration while others kept exceedingly well. This can often be explained by the difference in the safety factor, but not always. Factory No. 5, for example, has a better safety factor than Factory No. 1 but did not keep nearly as well. W. & L. Kopeloff, (4) as well as Owen (5), however, point out that the safety factor must be considered simultaneously with the degree of infection. It will also be noted that under our conditions of storage (in tightly closed tins) the safety factor falls on keeping. This does not make the sugar more safe as the factor becomes unreliable if deterioration has already set in (5). If, therefore, some of the sugars had been kept for a long period in the closed sample bottles before sending them to the Station the safety factor would be too low and unreliable. It is also well known that the safety factor does not hold strictly for high grade sugars. The size and evenness of the crystals will also undoubtedly affect the keeping properties of the sugar. That, notwithstanding these considerations, the safety factor is of prime importance in the sugar industry as a guide to the keeping properties of a raw sugar, is shown by the following averages:—

Range of S.F.	No. of Samples	Drop in Pol.
Below .20	5	.29
Between .20 and .29	35	.65
Between .30 and .39	70	.91
Above .40	13	1.53

These results stress the necessity for keeping the safety factor as low as possible.

It is sometimes stated that the deterioration depends on the acidity of the sugar. From our results and from the range of pH shown, no such conclusion can be drawn, and that a high pH does not necessarily prevent deterioration is shown in the samples from Factories Nos. 5 and 14. A remarkable drop in pH has been noticed on the storage of all sugars.

The gum contents usually increased slightly though small decreases have occasionally been recorded on keeping.

Sugars with a high filtration rate usually had a low gum content, and conversely, but that there is any relation between the two has been disputed in the past. J. C. Kean and H. G. Hill (6) found that colloids affect the filtrability; but that the alcohol precipitate gave little or no indication of it. F. W. Hayes (1) could not find any connection between the two properties. In many cases we had an increase in gums on storage and yet the filtrability remained constant or increased slightly. Here of

course the change in pH and its influence on the colloids and dirt layer should be taken into account (7). There still, however, remains the fact, as we have already stated, that we found in general high gums associated with a low filtration rate and a good filtrability with low gums. On a statistical analysis of the relation between gums and filtrability at the time of receipt of the samples a correlation coefficient $r = 0.8565$ was found for 91 samples. This of course is "highly significant" and we cannot but come to the conclusion that there was a high degree of association between gums and the filtration rate. The following averages will illustrate this:—

Range of gums	No. of samples	Filtration Rate
Below .30	11	99.6%
Between .30 and .39	21	56.6%
Between .40 and .49	42	46.6%
Above .40	17	37.0%

There has been a definite drop in filtrability as compared with the previous season and only Factory No. 1 has maintained a very high standard. The average filtrability for the season under consideration was 53.5% as compared with 79% the previous year.

On examining the sugars after six months storage the writer was struck by tiny specks floating on the surface of some of the solutions. On closer observation it was found to be living acarids. Samples of these sugars were sent to Dr. R. Lawrence, Director of the Pietermaritzburg Museum, who identified them as *Carpoglyphus* anonymous. These organisms are closely related to the cheese and flour mites which all fall under the family *Tyroglyphidae*. *Carpoglyphus* anonymous has been found in sweet wines in France as well as in certain dried fruit, such as dates, figs, prunes and raisins. They live on the sugar or other carbohydrates and nitrogenous substances (8).

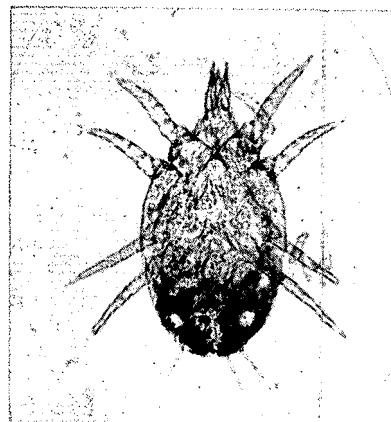


Fig. 1 is reproduced from a photograph of an Acarid, magnification 110, photo S.A.S.A. Exp. Stn.

We are therefore dealing with a new form of sugar contaminator. Upon examining the point, it was found that the optimum conditions for the development of these acarids are apparently excess of moisture and darkness. Samples were dried out in a desiccator both in the dark and exposed to light. In both cases the acarids died out after a number of days, but they managed to hold out longer in the dark. Where excess moisture was allowed the multiplication took place more quickly in the dark.

The acarids were found in exceptional cases in sugars with as low a moisture as 0.35 per cent but generally they are associated with sugars of a high moisture, the dry sugars being usually free from them. In quite a number of cases a large number of dead bodies were found in the samples and none alive. This is probably due to a drying out of that sugar at a certain stage to such an extent that they could not survive. This contamination was largely confined to samples from certain factories. Those from factories Nos. 1, 20, 18, 12, 14 and 10 were free.

It is perhaps to be regretted that these acarids were only found after storage and that there was

the possibility of one sugar being infected from another, though such possibility is rather remote. It is, however, recommended that a microscopic examination be made at the factories at different times to ascertain whether the sugars are infected and to what extent.

About fifty samples were kept in bags as it was realised that the results obtained from the tins would not be strictly comparable with sugar kept in bags under varying conditions of atmospheric humidity. It seems, however, that a period of six months is too long to keep most of our sugars in a bagged condition without making any attempt to regulate the humidity. The deterioration was excessive in most cases and though others kept exceptionally well some of them were affected by the badly deteriorated sugars next to them. For this reason as well as for the fact that we consider the number of these samples from each mill insufficient to be representative we shall only give the average of all the samples. On the whole, however, the samples from the various factories showed much the same tendencies as those from the corresponding mills, stored in tins. The results obtained are:—

Average of all bagged samples.	Pol.	H ₂ O	S.F.	Ash	Gums	R.S.	SO ₂	pH
After 6 months.	97.76	0.64	0.27	0.51	0.40	0.27	55.93	6.78
	91.61	2.95	0.35	0.50	0.40	3.74	—	5.73

It may be noted that in nearly all these samples acarids were found and in some instances in exceedingly large numbers.

In conclusion the writer expresses his sincerest appreciation to Dr. R. L. Lawrence, Director of Pietermaritzburg Museum, for his assistance in identifying the acarids and to the different factories for their wholehearted co-operation which made this report possible.

References.

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- (3) A. A. Blowski, "Facts About Sugar" Vol. 20, No. 32, pp. 758.

- (4) N. & L. Kopeloff, Louisiana Bull. No. 170, p. 42.
- (5) W. L. Owen, Louisiana Bull. No. 162.
- (6) J. C. Kean and H. C. Hill. Ind. Eng. Chem., April, 1931, p. 421.
- (7) Dr. Honig and Khainovsky, "Archief voor de Suikerind. in Nederl. Indie," 1927, No. 17.
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