SEASONAL VARIATIONS IN MOLASSES COMPOSITION

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Abstract

The results of analyses of weekly samples of final molasses from four Natal factories throughout the 1970 campaign are presented in graphical and tabular form. The seasonal variations in the concentrations of some of the molasses constituents are discussed.

Introduction

Huletts Central Laboratory was established in 1966 to analyse weekly samples of sugar and final molasses from each of the Hulett factories.

Because of renewed interest at the 1970 S.A.S.T.A. congress, both in molasses analyses (MacGillivray and Matic[5]), and in differences in non-sucrose recoveries at different factories (S.A.S.T.A.[7]), it was decided to increase the analytical coverage for molasses during the 1970 season, by including other non-sucrose constituents and to publish the data obtained. It is hoped that the record of the analysis throughout the season of various constituents of the final molasses from Hulett factories will complement the data published previously on the composition of South African final molasses.

Experimental

Final molasses was sampled continuously at the scales. The primary sample was collected daily and composited in the factory laboratory. At the end of the week the composite was thoroughly mixed, a portion was analysed by the factory laboratory, and a further portion sent to the central laboratory. In addition, some factories submitted a special sample of undiluted molasses for viscosity measurement.

The samples received by the central laboratory were heated to $\pm 70°C$ in a large water bath and thoroughly mixed before analysis was started.

The methods of analysis were as follows:

(a) Solids were determined by the Karl Fischer method using a modification of the technique described by Oosthuizen[6].

(b) Sucrose by Lane and Eynon titration after hydrolysis with invertase (S.A.S.T.A.[4]).

(c) Reducing sugars — Lane and Eynon titration[4].

(d) Ash — double suphitation[4].

(e) Colour — as described by MacGillivray and Matic[5].

(f) Viscosity was measured at 80% total solids and 50°C. Details of the method are included elsewhere in these Proceedings (Wilkes and Jennings[9]).

(g) Starch, gums and unfermentable reducing substances were all determined by methods described by Douwes-Dekker[3].

(h) Chloride — automatic potentiometric titration (Comrie[1]).

(i) K_2O and Na_2O — by flame photometry (Dean[2]).

(j) MgO — by atomic absorption (Soffiantini[8]).

Results

For ease of presentation, molasses tonnage figures obtained from the factories have been used to group the weekly data into monthly weighted averages. These data are presented in Tables I to XII and figures 1 to 12.

TABLE I

True Purity (sucrose % solids)

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	44,6	42,7	42,4	43,4
June	45,3	43,0	43,2	41,7
July	44,6	42,7	42,8	40,4
August	44,9	41,9	42,5	40,4
September	44,7	43,6	43,3	41,7
October	46,0	42,8	44,2	41,8
November	46,3	42,9	44,3	42,6
December	—	43,4	45,5	43,3

TABLE II

Reducing Sugars % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	15,9	17,6	18,8	19,0
June	13,9	16,9	17,0	18,5
July	15,5	16,4	17,3	18,0
August	15,9	17,8	18,7	18,6
September	17,3	18,8	17,8	18,0
October	15,8	19,2	17,6	18,0
November	14,0	18,6	16,5	17,3
December	—	19,1	16,6	17,2

TABLE III

Ash % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	19,12	18,67	18,84	17,98
June	19,17	19,89	19,58	18,54
July	18,98	20,59	19,30	20,00
August	19,29	21,17	19,48	19,71
September	18,58	20,07	20,13	20,09
October	18,93	18,84	19,11	20,22
November	19,06	19,30	19,45	19,49
December	—	18,70	19,06	19,09

TABLE IV

Colour (a*c) 560 nm

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	61,36	45,42	44,12	44,67
June	53,65	37,35	35,64	45,02
July	52,15	36,74	32,26	43,61
August	41,27	29,31	29,29	38,07
September	41,34	26,87	31,45	36,53
October	38,33	26,96	29,10	33,98
November	55,46	31,76	33,60	37,19
December	—	35,19	36,85	29,58

TABLE V

Viscosity at 80% solids, 50°C, poise

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	112	102	80	80
June	130	135	87	74
July	99	88	72	75
August	89	52	88	94
September	90	73	75	82
October	86	101	82	69
November	110	115	103	81
December	—	75	102	65

TABLE VI

Starch % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	0,60	0,23	0,32	0,41
June	0,60	0,37	0,35	0,36
July	0,25	0,28	0,28	0,32
August	0,28	0,24	0,28	0,34
September	0,25	0,40	0,28	0,32
October	0,31	0,29	0,34	0,35
November	0,31	0,31	0,32	0,30
December	—	0,27	0,35	0,34

TABLE VII

Gums % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	3,70	3,51	3,22	3,36
June	3,62	3,36	3,22	4,04
July	3,51	3,37	2,87	3,66
August	3,07	2,69	2,60	3,57
September	3,29	2,95	2,89	3,34
October	3,32	3,16	3,11	3,51
November	3,90	3,57	3,30	3,64
December	—	3,24	3,38	3,69

TABLE VIII

Unfermentable Reducing Substances % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	4,15	4,44	4,40	4,70
June	3,86	4,09	4,22	4,48
July	4,15	4,12	4,39	4,53
August	4,44	4,73	4,45	4,94
September	4,71	4,55	4,43	4,67
October	4,65	4,71	4,49	4,91
November	4,10	4,29	4,26	4,86
December	—	4,56	3,83	4,47

TABLE IX

Chlorides % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	2,74	3,02	2,97	2,80
June	2,94	3,20	3,14	2,27
July	2,98	2,61	2,50	3,24
August	3,03	3,88	3,46	3,46
September	2,01	3,53	3,53	3,37
October	3,13	3,38	3,45	3,59
November	3,03	3,27	3,39	3,36
December	—	3,08	3,17	3,17

TABLE X

K_2O % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	—	—	—	—
June	5,93	5,78	5,82	5,74
July	5,86	6,28	6,00	6,28
August	6,00	6,66	6,27	6,44
September	5,93	6,52	6,30	6,49
October	5,81	6,00	6,05	6,50
November	5,91	5,94	6,23	6,34
December	—	5,25	5,43	5,97

TABLE XI

Na_2O % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	—	—	—	—
June	0,22	0,25	0,18	0,16
July	0,22	0,28	0,17	0,16
August	0,20	0,28	0,15	0,17
September	0,21	0,22	0,17	0,16
October	0,16	0,18	0,14	0,13
November	0,19	0,22	0,16	0,16
December	—	0,22	0,19	0,16

TABLE XII

MgO % Solids

Month (1970)	Empangeni	Felixton	Amatikulu	Darnall
May	—	—	—	—
June	1,36	1,48	1,48	1,43
July	1,31	1,46	1,46	1,41
August	1,35	1,43	1,39	1,44
September	1,22	1,40	1,41	1,46
October	1,29	1,19	1,34	1,35
November	1,22	1,37	1,36	1,40
December	—	1,25	1,33	1,43

Discussion

The principal object of this paper is to present data which could contribute to our knowledge of the composition of South African molasses. It is felt, however, that a few comments on variations in the concentrations of the various components of the molasses will not be out of place.

1. True purity, sucrose % solids. The true purity of molasses increased towards the end of the season, though the increase was less marked in the case of Felixton. The end-of-season increase in purity has been apparent in previous years, in fact the trend was less severe in 1970, possibly due to the shorter campaign. Purity was lowest at Darnall, which averaged zero Douwes-Dekker purity difference for the year, an outstanding achievement.

2. Reducing sugars. The significantly lower reducing sugar content of Empangeni molasses is a feature which has puzzled Research and Development for some years. When considered in conjunction with the high undetermined sucrose losses recorded by this factory, the untypical reducing sugar balance becomes even harder to explain.

3. Sulphated ash. There was a pronounced peak in the ash content of Felixton molasses for the period July to September. Darnall molasses increased in ash content in mid-season while Empangeni generally achieved low ash figures.

4. Colour. There was a marked decrease in the colour of molasses over the first six months of the season. Thereafter the colour increased slightly at Amatikulu and Felixton, continued to drop at Darnall, but increased markedly at Empangeni in November. Empangeni molasses, like its sugar, was always of a higher colour than that of other factories.

5. Viscosity. There were similar trends for Empangeni and Felixton in the viscosity of molasses at 80% total solids, 50°C. At both factories viscosity decreased after the first two months but increased again in November. At Amatikulu and Darnall the molasses was less variable.

6. Starch. The starch content of molasses at Huletts factories has decreased significantly since the advent of the enzyme process. The effect of the introduction of this process early in the season at Empangeni is reflected in Figure 6.

7. Gums. The gum content of the molasses decreased in mid-season before increasing again in the last three months. There was a pronounced peak in the gum content of Darnall molasses in June and this factory generally suffered more than the others from gums.

8. Unfermentable reducing substances. The glucose contents varied between 4 and 5% on solids for most of the season with a tendency towards higher values between August and October, particularly at Darnall.

9. Chlorides. The main features in the chloride data are a number of low figures: for Empangeni in September, Felixton and Amatikulu in July, and Darnall in June. These anomalies upset otherwise smooth trends. No explanation is offered for the sudden drops in chloride content for several consecutive weeks.

10. K_2O. Potash figures for all factories rose during the first three months and dropped sharply at the end of the season. Felixton recorded both the highest potassium content, in August, and the lowest, in December.

11. Na_2O. Felixton molasses contained most sodium, reaching a peak in July and August before following the overall trend to a low figure in October. The sodium contents of the other molasses showed less variation.

12. MgO. Apart from Darnall all mills showed a drop in magnesium as the season progressed. Darnall molasses usually contained most magnesium. Empangeni usually contained least.

Figure 1 TRUE PURITY (SUCROSE % SOLIDS)

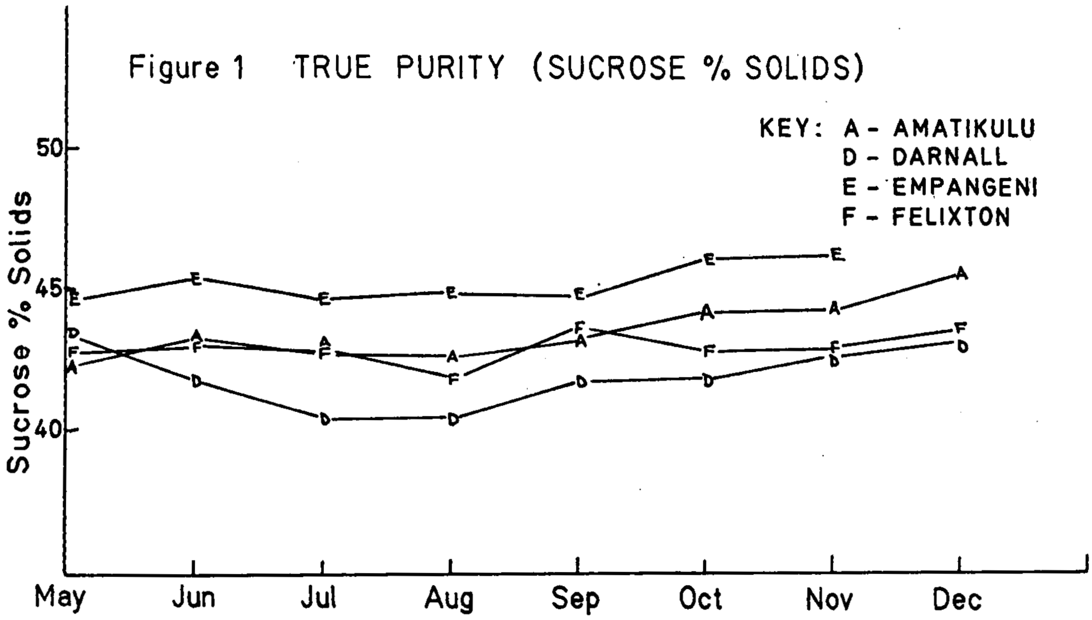


Figure 2 REDUCING SUGARS % SOLIDS

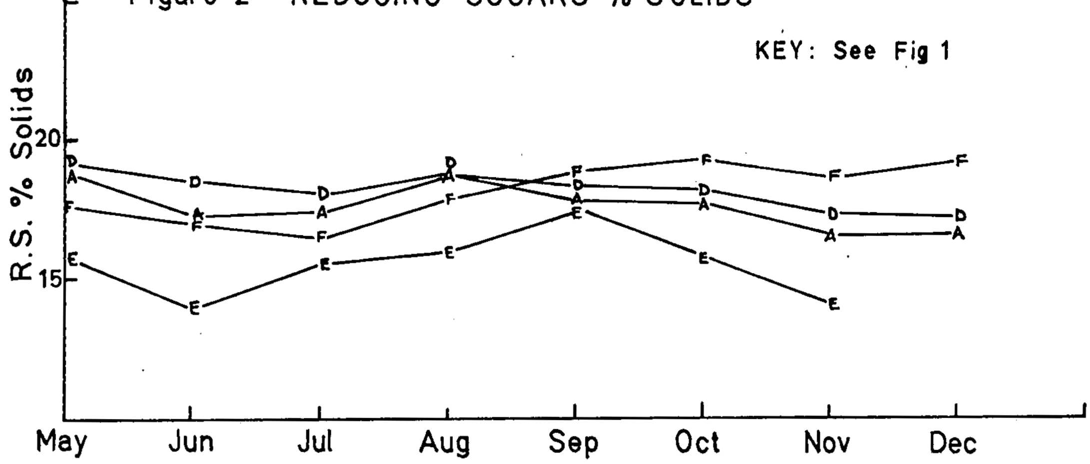
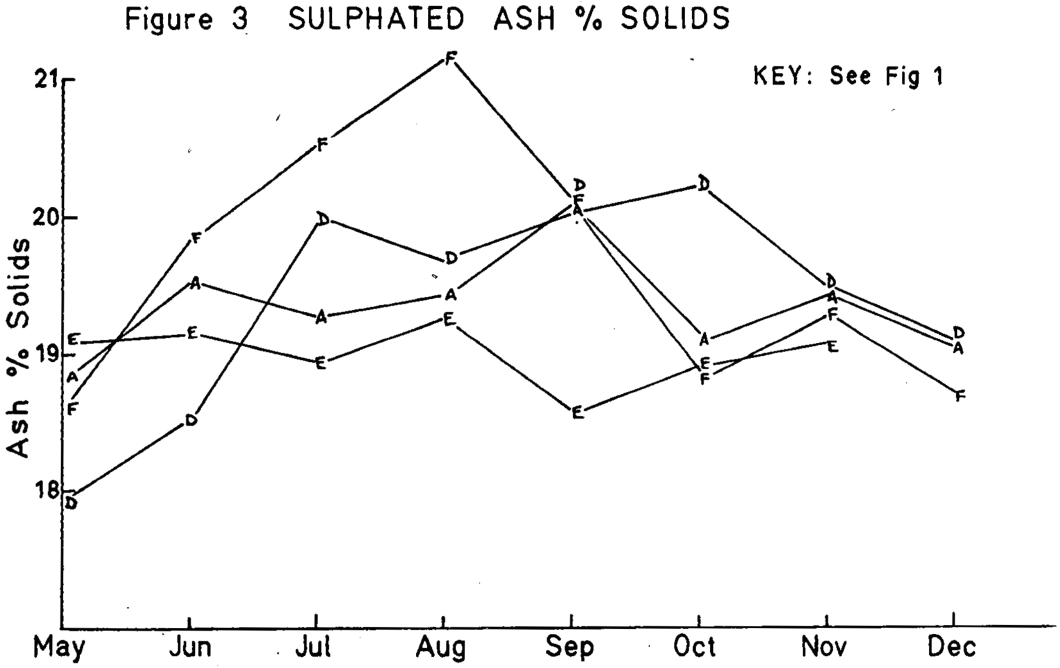


Figure 3 SULPHATED ASH % SOLIDS



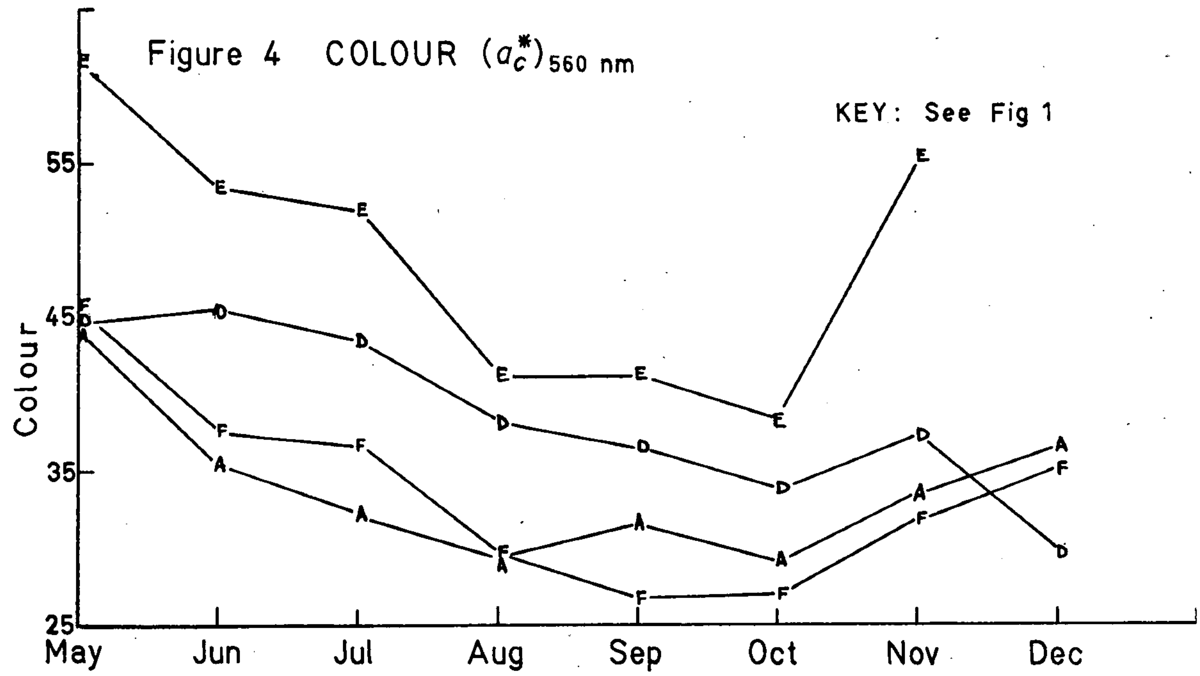


Figure 4 COLOUR $(a_c^*)_{560\ nm}$
KEY: See Fig 1
Colour
55
45
35
25
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

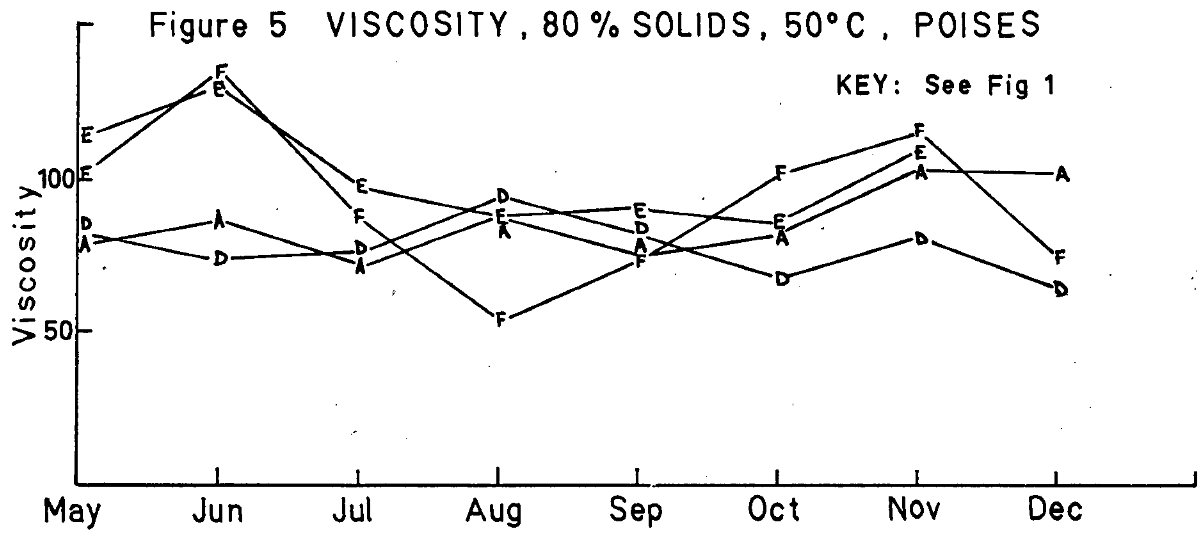


Figure 5 VISCOSITY, 80 % SOLIDS, 50°C, POISES
KEY: See Fig 1
Viscosity
100
50
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

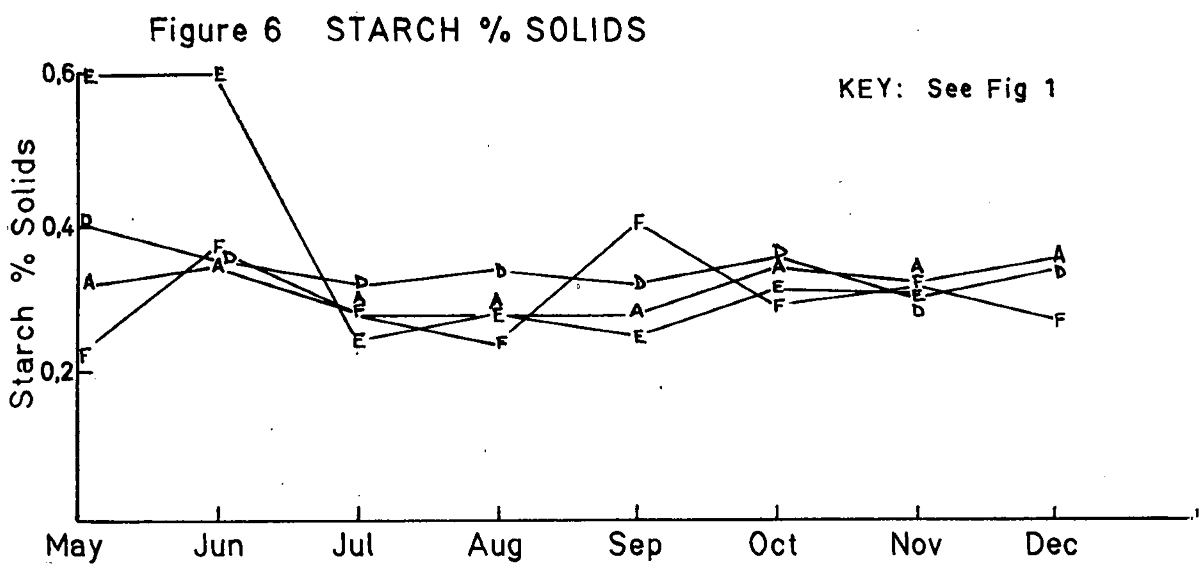


Figure 6 STARCH % SOLIDS
KEY: See Fig 1
Starch % Solids
0,6
0,4
0,2
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 7 GUMS % SOLIDS

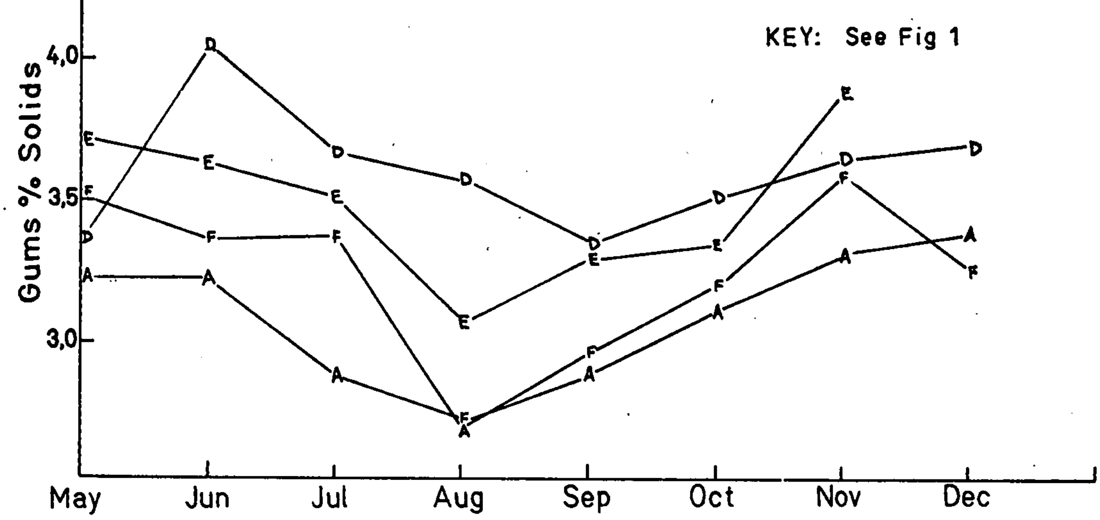


Figure 8 UNFERMENTABLE REDUCING SUBSTANCES % SOLIDS

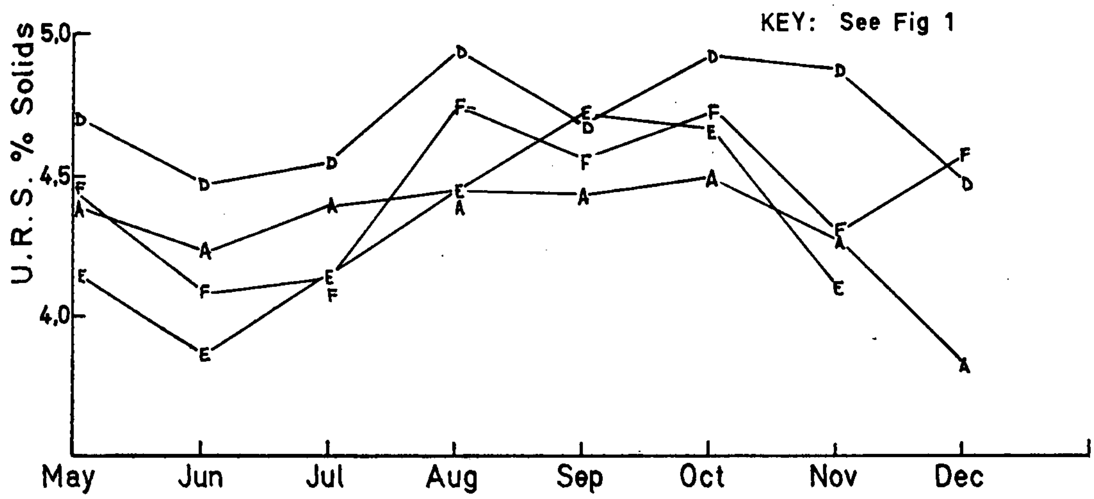


Figure 9 CHLORIDES % SOLIDS

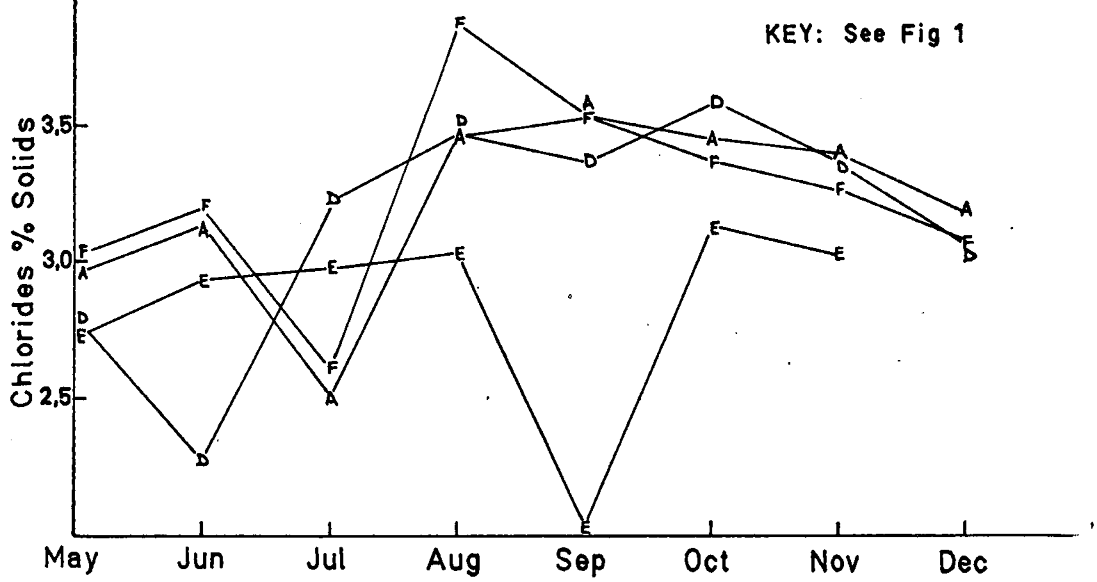


Figure 10. K_2O % SOLIDS.

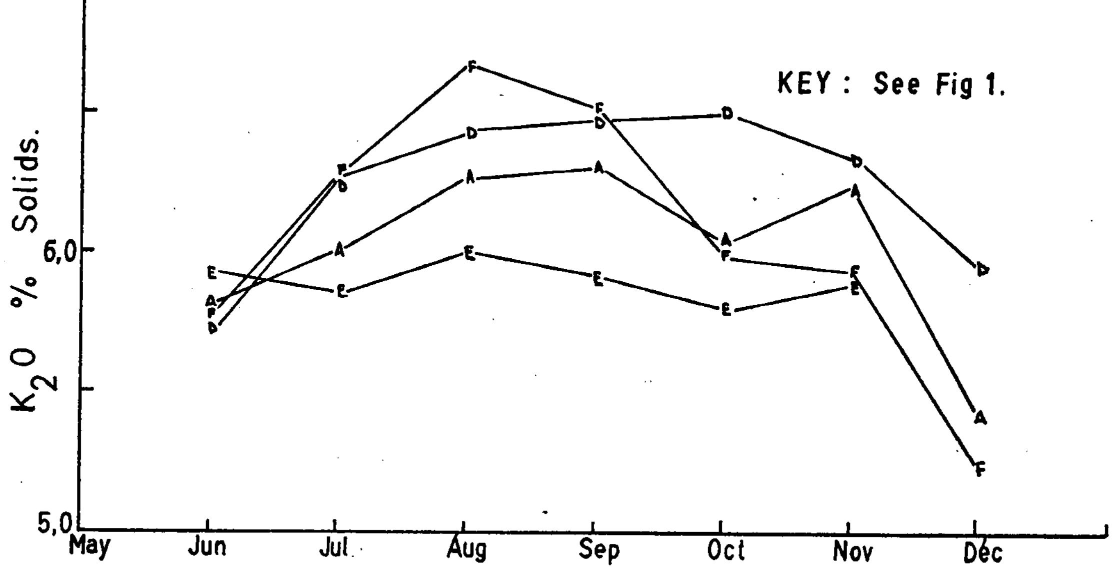


Figure 11. Na_2O % SOLIDS.

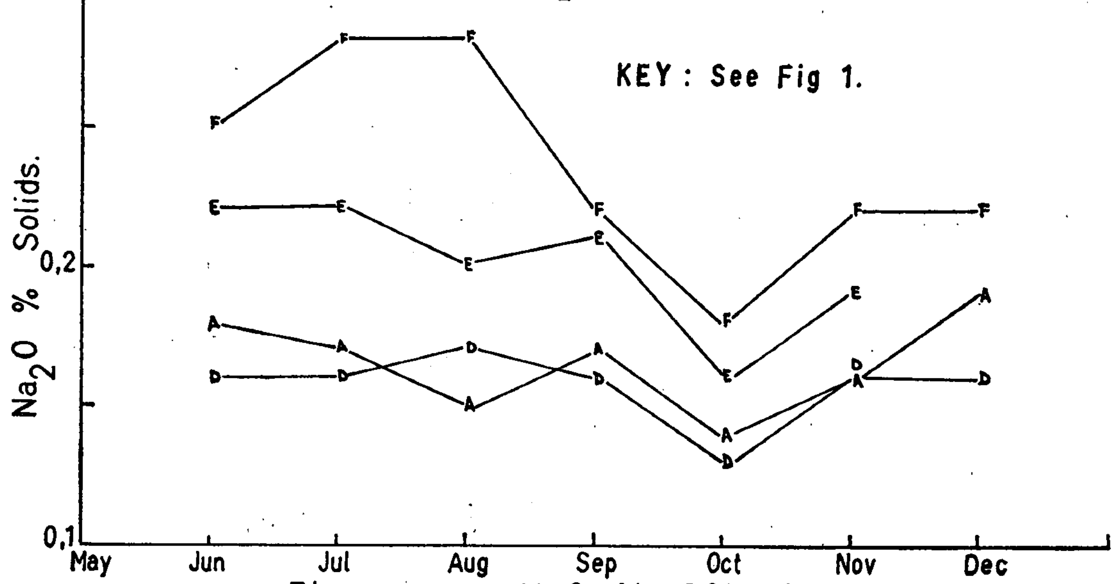
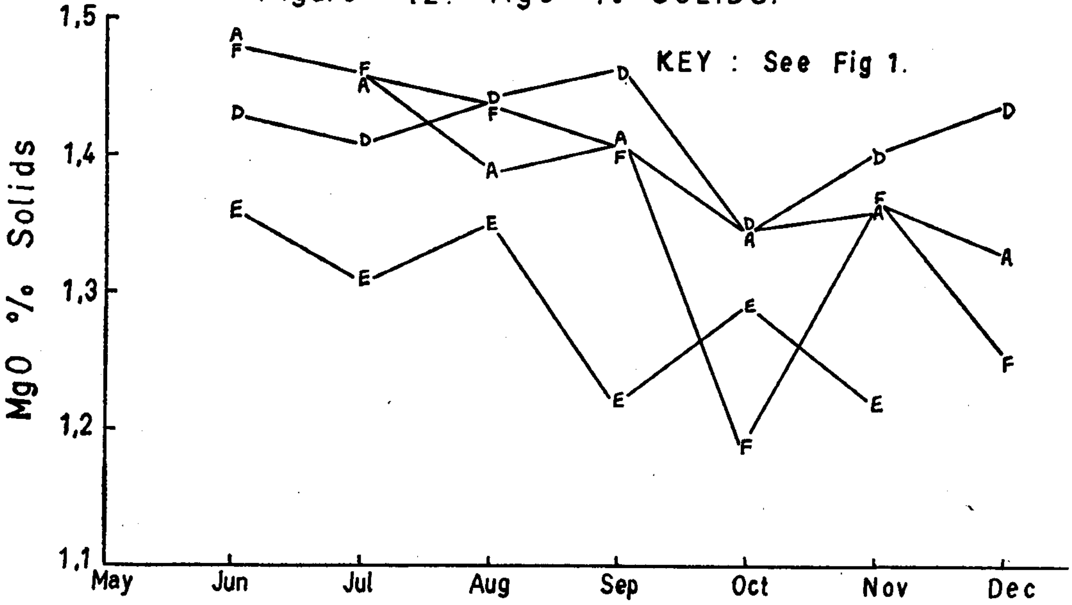


Figure 12. MgO % SOLIDS.



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Discussion

Dr. Matic (in the chair): I am pleased that Huletts have done this work because it confirms the trends indicated in the paper presented last year, although only four samples were then taken at that time.

Mr. MacGillivray: In Table IV it can be seen that the colour of final molasses varies from 27 at FX to 61 at EM. This is such a wide variation that it would be interesting to know where colour formation takes place.

Some steps are taken not to produce colour in factories but an attempt should be made to locate areas of high colour formation.

Mr. Jennings: We intended to look into colour formation at EM but have not started yet.

Some work on colour balance was done at the refinery.

Mr. Lenferna: This work should be co-ordinated with Mr. Schaffler's so that we can understand our processing problems.

Mr. Alexander: We must be able to measure properly in order to determine what is happening. Until we understand what is happening we will be unable to take appropriate action. We must aim at short, accurate methods of measurement.

Mr. Carter: EM has very low reducing sugars and very high colour. Does not destruction of reducing sugars, with nitrogenous products, lead to colour formation?

Dr. Matic: It is possible that reducing sugars are produced and then decomposed, the result being that very little are found in molasses.

Mr. Jennings: They may be destroyed more quickly than they are formed.

Mr. Schaffler: With the new (GC) method it is possible to determine the exact composition of the monosaccharides present.