

# THE MUTUAL CLARIFICATION PROJECT—PROGRESS REPORT No. 2

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### Abstract

Data collected in connection with the Mutual Clarification Project during the 1969-70 season are presented and discussed in relation to juice and sugar quality. An explanation is offered for partial removal of starch which happens in the factories not using a specific removal process. The results of a factory test comparing liming at the boiling point of juice with the normal liming method are reported.

Mutual Clarification Project during last season and weekly summaries were regularly issued by the Sugar Milling Research Institute from August onwards. Details of participating factories (and lengths of their contribution) are summarised in Table 1. Although several mills continued crushing during January 1970, the week ending 4th January, 1970, was used as a closing week for the purpose of calculating average performance figures.

### Introduction

Ten factories submitted data required for the

The procedure followed and the analytical methods used in this project have been described in the previous report (1).

**TABLE 1**  
Factories Participating in M.C.P.

Factory	EM	FX	AK	DL	GH	JB	TS	ME	IL	UK
No. of weeks	18	25	28	28	24	17	18	24	20	28
Period	2.8.69 7.12.70	23.8.69 8.2.70	2.8.69 8.2.70	2.8.69 8.2.70	16.8.69 1.2.70	2.8.69 30.11.70	2.8.69 18.1.70	2.8.69 11.1.70	2.8.69 4.1.70	2.8.69 8.2.70

**TABLE 2**  
Analysis of Mixed and Clear Juices

Factory		EM	FX	AK	DL	GH	JB	TS	ME	IL	UK
<i>Mixed Juice</i>											
P <sub>2</sub> O <sub>5</sub> ppm/juice	Max.	250	324	237	230	280	143	303	272	188	335
	Av.	229	308	193	192	267	129	264	209	156	318
	Min.	200	288	124	139	230	115	228	170	125	290
Starch ppm/Bx	Max.	2075	2182	2865	2092	2032	2095	2360	2470	2470	2175
	Av.	1704	1852	2137	1725	1514	1668	1620	1716	1237	1859
	Min.	1150	1490	1560	1494	762	1362	1189	1060	869	1316
Purity	Av.	83.16	83.54	84.48	84.71	85.00	82.00	84.87	83.63	84.10	87.18
<i>Clear Juice</i>											
P <sub>2</sub> O <sub>5</sub> ppm/juice	Max.	40	64	76	51	51	36	55	85	45	44
	Av.	31.7	57.3	58.3	40.5	48.5	30.6	44.1	39.5	34.3	33.8
	Min.	20	52	32	31	40	29	38	15	28	30
Ca (Mg) ppm/juice	Max.	—	700	590	552	—	841	680	710	864	624
	Av.	—	558	565	527	—	613	641	642	689	583
	Min.	—	507	549	488	—	560	580	539	525	546
Starch ppm/Bx	Max.	1590	1570	1847	1668	1550	879	1523	2130	894	892
	Av.	1238	1255	1325	1409	1019	678	1271	1553	690	628
	Min.	700	1000	853	1158	529	592	922	1200	497	305
Suspended matter % clear juice	Max.	.023	.473	.020	.042	.037	.043	.029	.240	.066	.090
	Av.	.010	.050	.011	.032	.025	.030	.013	.095	.034	.034
	Min.	.006	.008	.007	.018	.018	.014	.005	.017	.012	.010
Turbidity	Max.	85†	.710	.270	.200	.330	.290	.320	.380	—	.440
	Av.	77.3	.516	.219	.141	.247	.274	.202	.250	—	.285
	Min.	74	.330	.190	.110	.180	.260	.140	.180	—	.200

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## Results and Discussion

### General

A survey of participating factories was carried out during the season and the information relevant to M.C.P. is summarised below:

All factories extract juice by conventional milling, the only exception being EM, which uses diffusion. In the latter case, the press water is limed to pH 7.0 and returned to the diffuser. At JB and IL starch removal, using enzymes present in the juice, is practised. Lime is added to the mixed juice to bring the pH to 6.0, after which the juice is kept in retention tanks for eight minutes at 70°C. At UK starch is removed from the mixed juice by the Rabe process. All other factories, except ME, use the starch removal processes in the syrup stage.

The juice is heated to boiling point and flashed before liming at EM, FX, AK, DL, TS and ME. At JB lime is added to boiling juice before the flash tank and IL practises the conventional liming method. The juice leaving the vacuum clarifier at UK is heated to boiling point and flashed before being sent to subsidisers.

The pH of muds is brought up to 7.0 at JB and the pH of filtrate to 7.5 at IL by the addition of lime. Flocculant is also used. No chemicals are added to the muds at other factories.

### Mixed Juice and Clear Juice

The average analytical values of various parameters determined in mixed and clear juices are presented in Table 2. In order to give an indication of the fluctuations which occurred, the maximum and minimum values obtained are also recorded. The average analytical figures for sugars (affinated) produced by the participating mills in the period under review are reproduced in Table 3.

TABLE 3  
Analysis of Affinated Sugar (Average Values 31.12.69)

	Gums ppm	Starch ppm	Inorg. P <sub>2</sub> O <sub>5</sub> ppm	Cond. %	Ash %	Filter %
EM	950	245	32	0.076	39	
FX	1012	165	31	0.084	44	
AK	660	76	22	0.047	55	
DL	710	95	35	0.068	48	
GH	894	187	16	0.057	48	
JB	987	135	20	0.074	41	
TS	860	133	30	0.071	52	
IL	1016	135	25	0.050	41	
UK	910	149	18	0.049	38	

The amount of phosphate present in mixed juice fluctuated considerably at all factories but on the whole was reasonably high. Two exceptions were JB and IL, where the phosphate was consistently low. Mono-calcium phosphate as well as flocculant were therefore regularly added to the mixed juice at JB. At IL only flocculant was used. Although UK had the highest P<sub>2</sub>O<sub>5</sub> content of mixed juice, both phosphate and flocculant were continuously added in

order to fulfil the requirements of the Rabe process. TS used flocculant only intermittently. The average consumption of these chemicals and of lime by various factories is given in Table 4.

TABLE 4  
Consumption of Chemicals (Average)

Factory	kg lime/ metric ton cane	kg phosphate/ metric ton cane	Flocculant, ppm mixed juice
EM	0.58		
FX	0.53		
AK	0.51		
DL	0.53		
GH	0.55		
JB	—	0.089	3.61
TS	0.60	—	0.47*
ME	0.54	0.053**	5.00**
IL	0.52	—	5.02
UK	0.51	0.079	6.75

\* Seven weeks only

\*\* One week only

There is no correlation between the soluble phosphate content of clear juice and the amount of inorganic P<sub>2</sub>O<sub>5</sub> found in the affinated sugar. This is illustrated in Fig. 1, where the factories are arranged in a descending order of phosphate crystal content. If the level of phosphate in clarified juice is taken as an index of the efficiency of juice clarification, as is sometimes done (4), one will have to conclude that clarification at, for example, AK and GH was not very good. Yet the phosphate contents of their crystals were low. In contrast, at DL phosphate in the clear juice was considerably lower than in the above two factories but phosphate in crystal was the highest recorded. It appears therefore that, within limits, boiling house work plays a more important role in determining the amount of P<sub>2</sub>O<sub>5</sub> included in the crystal, than does clarification.

The level of phosphate attained in clarified juice seems to be dependent on the amount of soluble phosphate present in mixed juice. Why this should be so is not clear, as better phosphate removal would be expected in the case of mixed juices rich in phosphate. In this connection the good performance achieved by IL is particularly surprising.

As expected, a reasonably good correlation (correlation coefficient 0.63) was found between the suspended matter present in clear juice and the filterability of affinated sugar (Fig. 2a). This was also true, although to a smaller extent, in the case of ash in sugar (Fig. 3a). The importance of efficient clarification if good quality sugar is to be produced is therefore obvious. In this connection it would appear (Table 2) that clarifier capacities at EM and FX are not adequate.

If FX is excluded, there was also a correlation between turbidity of clear juice and filterability of sugar (Fig. 2b). However, the influence of turbidity on the ash content of affinated sugar seems to be negligible (Fig. 3b).

The average Ca (Mg) content of the clarified juices was about 600 ppm (Table 2) but varied considerably not only between factories but also within one fac-

tory. The smallest fluctuations were recorded at AK, DL and UK and the largest at IL and JB. Somewhat surprisingly, no correlation was found between Ca (Mg) content of clear juice and percentage ash in affinated sugar (Fig. 3c). A possible explanation for this may perhaps be found in the fact that the greatest single component of the ash in sugar is potassium (3), and the contribution of Ca (Mg) is therefore somewhat obscured.

*Starch Removal*

In the last report (1) attention was drawn to the fact that a considerable but erratic drop in starch content between mixed and clear juice is recorded in the factories which are not using any specific method to accomplish this removal. As shown in Table 5, the elimination of as much as 45% of the starch present in mixed juice has been recorded this season. In order to explain this disappearance of starch, an investigation was carried out at AK.

**TABLE 5**  
Per cent Starch Removal between MJ and CJ

Factory	June	July	Aug.	Sept.	Oct. °
AK	44.8	44.1	42.0	43.0	38.0
TS	27.4	4.6	10.5	10.5	25.5
DL	31.3	27.2	22.9	14.3	13.5
FX				33.6	29.7
ME				25.0	10.0

In the first part of this investigation it was established that no significant starch removal takes place in the clarifiers. This is apparent from Table 6, where the results of starch analysis on daily composite samples of mixed juice, limed juice, clear juice and returned to Oliver filtrate are reproduced. A small amount of starch is removed in the muds as indicated by the analysis of limed and clear juices and this would explain the fact that the starch content of the returned filtrate is higher than that of the clarified juice. It is clear, however, that the bulk of the starch is decomposed before juice reaches the clarifier and for this reason the tank situated under the mixed juice scale and into which Oliver filtrate is returned was next investigated. For this purpose continuous hourly samples of mixed juice and returned Oliver filtrate reaching the tank, and of a mixture of the two leaving the tank, were analysed for starch content. The results are reproduced in Table 7. The large difference between the "expected" starch content of the mixture of mixed juice and filtrate (calculated from brix and starch balances) and that actually found is a clear indication that the removal is taking place during the retention time of the juice in the tank.

It was found that the mixture of mixed juice and returned filtrate at an average temperature of 40°C and pH 5.5 remains, under normal working conditions, two to three minutes in the tank before it is pumped to the heaters. One would therefore expect that under those conditions the soluble starch

**TABLE 6**  
Daily Composite Starch Figures at AK

Stream	Starch, ppm				
	Mon.	Tues.	Wed.	Thur.	Fri.
Mixed juice	1695	1620	2015	2220	2440
Limed juice	—	1132	1200	1680	—
Clear juice	1230	1078	1173	1500	1250
Filtrate	1560	1280	1500	2420	1920

**TABLE 7**  
Continuous Hourly Samples at AK

	Starch, ppm /Bx		
	1	2	3
Mixed juice	1 468	1 300	1 355
Filtrate	784	1 010	1 172
MJ + F (after tank)	878	907	1 228
Expected MJ + F	1 390	1 275	1 340
% Removal in tank	33	28	8

returned in the filtrate would be efficiently hydrolysed by the enzymes present in the mixed juice. This hypothesis was tested in the laboratory experiment which simulated factory conditions. Mixed juice containing 15% filtrate (average undiluted filtrate % mixed juice at AK is 17.1% — see Table 10) and adjusted to pH 5.5 was placed in a thermostatically controlled heated tank and kept at 40°C. Samples of the mixture were collected at intervals and analysed for starch. The results reproduced in Table 8, confirmed that a starch removal in excess of 40% could be obtained under such conditions.

**TABLE 8**  
Starch Removal — Laboratory Experiment  
(Mixed juice containing 15% filtrate; temp. 40°C; pH 5.5)

Time	Starch, mg/l	% removal
0 min	0.41	—
0.5 "	0.33	19.6
2.0 "	0.24	41.5
5.0 "	0.19	53.7
8.0 "	0.19	53.7
15.0 "	0.19	53.7

It would appear therefore that the recorded differences in starch content between mixed juice and clear juice are due to the enzymatic hydrolysis of the soluble starch in the returned filtrate which takes place in the tank situated under the mixed juice scales. The difference in the magnitude of the removal at various mills can be explained by the fact that normal working conditions vary from factory to factory, i.e. different enzyme content of juice, different amount of filtrate containing soluble starch,

different pH and temperature and different tank dimensions giving variable retention times.

#### pH Data

The pH's of the treated juice, clear juice and syrup recorded by various mills are summarised in Table 9. The low pH of syrup at FX as well as the high pH of syrup at UK are worth noting.

The considerable fluctuation in the pH of treated juice at ME, where automatic liming is not practised, was confirmed by three-hourly continuous pH recordings. Differences of up to one pH unit were obtained in these runs. A closer investigation of the pH control even in the factories which have automatic liming systems will be rewarding. In a number of cases the electrode is situated too far from the point of lime addition, resulting in a significant response lag.

#### Performance of Filters

Information on filter station performance is presented in Table 10.

In view of the uncertainty about the accuracy of figures supplied, it is difficult to discuss the results. It would appear from the figures returned that at several factories retention of filters was on the low side despite a satisfactory average per cent suspended solids in muds. If the latter figures are correct either insufficient bagacillo was added to muds or possibly the bagacillo was too coarse. These and other points need closer investigation and a further study of individual filter stations is clearly indicated.

#### Comparison of "Hot" and Normal Liming

In both Australia and Mauritius (2) the opinion is strongly held that liming at the boiling point of juice results in better clarification and sugar of higher quality. A limited amount of laboratory work carried out previously in South Africa did not support this view. It was therefore decided to undertake as part of this project, an investigation into the relative merits of liming at the boiling point of juice (referred to here as hot liming) and liming at about 70°C (referred to here as normal liming).

At the beginning of the last season UF switched from normal to hot liming. However, the facilities for normal liming are still available at this mill and thanks to the co-operation of the factory, which agreed to apply over a period of eight weeks hot and cold liming alternately, a controlled factory scale test was arranged.

Hot liming is carried out at UF at 102°C. Lime at 6° Be, fed by gravity from an automatically controlled splitter box, is introduced into the juice line about 300 mm before the flash tank. After flashing, the juice flows through a pipe with mixing baffles for a distance of 2 m and eventually reaches a distribution box from where it is fed to clarifiers. The pH electrode, situated in the distribution box, is 6 m distant from the flash tank. This represents about 40 seconds juice retention time. The splitter box is operated by a Leeds and Northrup pH controller through an electrical servo-motor. The limed juice is normally kept at pH 7.3-7.4, which results in a clear

TABLE 9  
pH Data

Factory		EM	FX	AK	DL	GH	JB	TS	ME	IL	UK
Treated juice	Max.	8.1	8.0	8.3	8.1	8.0	8.5	8.2	8.3	8.0	8.2
	Av.	8.0	7.9	8.1	7.8	7.9	8.3	8.0	8.1	7.9	8.1
	Min.	7.9	7.8	8.0	7.7	7.6	8.2	7.9	7.2	7.9	8.1
Clear juice	Max.	7.4	7.3	7.6	7.7	7.5	7.7	7.3	7.4	7.6	7.8
	Av.	7.2	7.2	7.4	7.3	7.3	7.5	7.2	7.3	7.4	7.6
	Min.	7.2	7.1	7.2	7.1	7.3	7.4	7.2	7.2	7.3	7.4
Syrup	Max.	6.6	6.5	6.7	7.1	6.9	6.8	6.7	6.6	6.9	7.4
	Av.	6.4	6.3	6.6	6.5	6.8	6.6	6.5	6.4	6.7	7.2
	Min.	6.3	6.2	6.5	6.2	6.7	6.5	6.5	6.2	6.7	6.8

TABLE 10  
Filter Station Performance

Factory		EM	FX	AK	DL	GH	JB	TS	ME	IL	UK
% Suspended solids in mud	Max.	10.8	5.9	5.2	5.4	7.3	10.0	8.3	13.0	9.9	16.0
	Av.	8.6	5.1	4.5	4.1	6.1	8.1	6.8	9.4	7.7	8.9
	Min.	6.8	1.2	3.9	3.3	4.3	6.4	5.5	7.3	5.5	5.0
Retention	Max.	80.7	86.2	86.2	93.2	89.4	91.7	79.4	86.1	87.8	96.0
	Av.	79.2	69.7	78.1	90.7	83.3	89.4	70.7	76.8	79.6	92.9
	Min.	77.4	59.0	75.1	87.7	79.1	86.1	62.6	61.5	69.5	88.6
Undiluted filtrate % mixed juice	Max.	14.8	55.8	40.7	—	—	16.1	35.8	19.7	22.4	18.6
	Av.	11.7	57.3	17.1	—	—	12.8	18.1	15.8	18.6	14.9
	Min.	7.8	44.7	10.1	—	—	8.6	5.3	13.0	4.3	11.4
Filter cake % cane	Av.	3.22	6.00	5.07	5.06	4.70	4.54	3.32	5.94	3.53	4.00
Sucrose % filter cake	Av.	0.80	1.65	1.49	1.32	1.46	1.76	1.68	0.89	1.47	1.61

juice of pH 6.8–6.9. The control system keeps this latter pH within very close limits.

The normal liming is carried out at 70°C in a tank equipped with a stirrer. Retention time in the tank is approximately four minutes. The limed juice is pumped through a secondary heater into the flash tank, from where it follows the same path as described above. The pH of the limed juice is 7.5–7.7, resulting in a clear juice pH of 7.0–7.1.

The change from one liming method to the other was effected every second Friday. Sampling commenced on Monday following the change and the analyses were carried out on the following:

- (a) mixed juice—daily composite,
- (b) limed juice (taken from distribution box)—four catch samples daily,
- (c) clarified juice—daily composite
- (d) mud (taken before addition point of bagacillo)—daily composite of four catch samples,
- (e) filtrate from Oliver filters—daily composite,

**TABLE 11**  
Clarification Data (UF)

	"Hot" Liming 2 weeks average	Normal Liming 2 weeks average	"Hot" Liming 2 weeks average	Normal Liming 2 weeks average
P <sub>2</sub> O <sub>5</sub> mg/l MJ	209	200	207	212
Sulph. Ash % MJ	0.470	0.472	0.416	0.407
P <sub>2</sub> O <sub>5</sub> mg/l CJ	21.0	17.8	19.9	23.2
Sulph. Ash % CJ	0.516	0.521	0.467	0.482
Colour CJ	0.35	0.72	0.43	0.70
Turbidity CJ	0.15	0.46	0.25	0.60
% Suspended solids in muds	5.0	6.0	4.5	7.1
Retention of filters	87.2	89.9	82.8	86.6

**TABLE 12**  
Analysis of Affinated Sugar (UF)

	"Hot" Liming 2 weeks average	Normal Liming 2 weeks average	"Hot" Liming 2 Weeks average	Normal Liming 2 weeks average
Gums, ppm	667	800	725	550
Starch, ppm	42	68	35	50
P <sub>2</sub> O <sub>5</sub> Inorg., ppm	17	13	13	18
P <sub>2</sub> O <sub>5</sub> Total, ppm	27	23	23	20
Ash (SO <sub>4</sub> ) %	0.108	0.085	0.080	0.130
Ca, ppm	139	146	160	135
Mg, ppm	21	17	21	19
Colour (unaffinated)	0.27	0.24	0.23	0.21
Susp. matter %	0.013	0.020	0.015	0.010
Filterability	43	48	51	49

(f) sugar—weekly composite.

The results are reproduced in Tables 11 and 12.

It is apparent from Table 11 that there was a significant difference in respect of colour and turbidity of clear juices produced by the two liming methods. In both cases better juice was obtained by hot liming. However, normal liming resulted in higher solids in muds despite a decrease in flocculant addition (3.4 ppm for hot liming and 1.9 ppm for normal liming). This was confirmed in laboratory settling experiments using limed juice (Fig. 4) during which mud volume after 120 minutes was found to be 30% smaller in the case of normal liming. It appears also that slightly better filter retention was obtained when the normal liming method was used.

In contrast, the results of the analyses of affinated sugars produced during this period (Table 12) were remarkably uniform. No significant differences in either filterability or colour were found. It would appear from this investigation that the method of liming has little influence on sugar quality. However, further experiments must be carried out before final conclusions on the merits of hot liming are arrived at.

### Conclusions

As stated already in the previous Progress Report, the basic aim of the M.C.P. was twofold: to point out sources of inefficiency in the clarification process and to provide information necessary for effecting improvements. The first part has now been largely fulfilled. Further accumulation of weekly data has become unnecessary and will be discontinued.

Filter stations and pH measurement have emerged as two obvious subjects for further study. Additional work is also required in connection with hot liming. It is therefore proposed to concentrate on these aspects of the M.C.P. in the coming season and in this way it is hoped to achieve the second part of the basic aim.

### Acknowledgements

Our thanks are due to personnel of all factories which submitted data during last season and particularly to the management and staff of Amatikulu and Umfolozi mills, without whose help a part of this work could not have been carried out.

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### Discussion

**Mr. Bruijn** (in the chair): There are correlations between the properties of clear juice and the quality of raw sugar, although they may not be very good.

Has not the importance of clarification been over-rated and should we rather not be studying the boiling and crystallisation stages?

**Dr. Matic:** It is mentioned in the paper that once a certain level of clarification has been achieved, whatever that level may be, then the boiling house operations are very important.

If the juice is badly clarified and full of suspended matter, then of course there will be an effect on the final product.

**Dr. Graham:** It is stated that at Umfolozi lime is fed by gravity into the juice line before the flash tank. Is this correct?

In table 11 the colour figure given for hot liming is very low. The pH also has a marked effect on colour measurement and has this been taken into account?

When turbidity was measured, was compensation made for colour?

In this paper when hot liming is mentioned, it does not refer to saccharate liming.

What is the pH of mud at Jaagbaan that it has to be brought up to 7.0?

Why is the pH of the clear juice at Illovo brought up to 7.5?

**Dr. Matic:** I will answer the questions in reverse order.

The figures reported in the paper are as reported by the factories and they have been averaged.

Colour and turbidity were determined by standard methods and the pH has been adjusted as is normally done in colour measurement.

Mr. Conijn would perhaps explain the arrangements of Umfolozi.

**Mr. Bruijn:** The turbidity was measured by filtering off some of the juice and using the filtered juice as a blank, so colour was compensated for by the filtered solution.

**Mr. Conijn:** At Umfolozi, we do not inject into the flash tank but into the feed pipe about one foot from the flash tank, by gravity feed.

**Mr. van Hengel:** The pH's at Umfolozi of 6.8 and 6.9 when using hot liming and 7.0 and 7.1 when using normal liming, are considerably lower than other factories, i.e. Umzimkulu 7.6.

I think we should look critically at clarified juice pH and the resulting syrup pH. To take Umzimkulu as an example, I do not think it necessary to keep the pH of the syrup as close to 7.0 as possible at this temperature.

I think that, provided there is reasonable clarification, the pH of the syrup or clarified juice has an influence on whether or not free flowing C masseccutes will be obtained.

Mr. Thumann, formerly of Umfolozi, and his successor, Mr. Conijn, I am sure agree with me on this.

**Mr. Conijn:** I think the pH should be kept as low as possible because of the effect on the colour of the sugar.

**Mr. Jennings:** The low syrup pH at Felixton corresponds with the best non-sucrose ratio for Natal factories and the high pH at Umzimkulu corresponds with the highest non-sucrose ratio for factories contributing to the M.C.P.

When the M.C.P. was first discussed, some technologists were critical of the decision to base all the conclusions on quality of sugar and I think the results have proved them right.

The crystallisation stage appears to be of overriding importance. Is it not possibly time to start a Mutual Crystallisation Project?

Some data on molasses should also have been submitted to the M.C.P.

**Dr. Matic:** It is possibly premature at this stage to start a Mutual Crystallisation Project, but I agree that crystallisation should be studied.

Data on molasses have not been included because they are presented in the next paper.

Consideration was given to including in the M.C.P. data on syrup analysis, but it was decided that the response from factories would be poor if too much was requested of them.

We did compare results from syrup as opposed to clear juice, using data from Hulett factories. Plotting of calcium and magnesium in clear juice against sulphated ash in syrup gave poor correlation, when ash in syrup was compared with conductivity ash in crystal, a reasonably good correlation was obtained.

I therefore do not think we have lost much by not including figures for syrup.

**Mr. Alexander:** Were the analyses performed on juices at the factories comparable, as otherwise the conclusions drawn may not be justified?

At least syrup samples could be analysed at one point and would therefore be comparable.

In figure 3, turbidity of clarified juice and suspended matter in clarified juice is plotted against conductivity ash in affinated sugar — what is the connection between the two? Turbidity and suspended matter are insoluble materials in the juices, whereas conductivity in affinated sugar must result from ionised material. Is it expected that suspended matter at some stage goes back into solution to contribute towards the conductivity ash?

**Dr. Matic:** I think your suspicion regarding the analyses might be correct. We looked into the ways certain parameters were analysed and there are differences between factories, so correlations could be affected. Unfortunately, in these co-operative efforts it is difficult to force factories to do everything as you would like it done. However, our conclusions are only tentative and really indicate trends only.

Regarding turbidity, suspended matter and conductivity ash, one would expect the conductivity ash to result from soluble inorganic material. These graphs were plotted to indicate trends and were presented without trying to explain why turbidity and suspended matter appeared to show some correlation with conductivity ash.

**Mr. Jullienne:** Could not the insoluble  $P_2O_5$  in the clear juice be connected with the soluble  $P_2O_5$  in sugar.

**Dr. Matic:** This point was not discussed in our paper because we did not have separate figures for organic and inorganic phosphate.

A certain amount of Phosphate, in addition to inorganic phosphate, is present in crystal and this might influence the line of phosphate shown here, but not to a great extent.

FIGURE 1

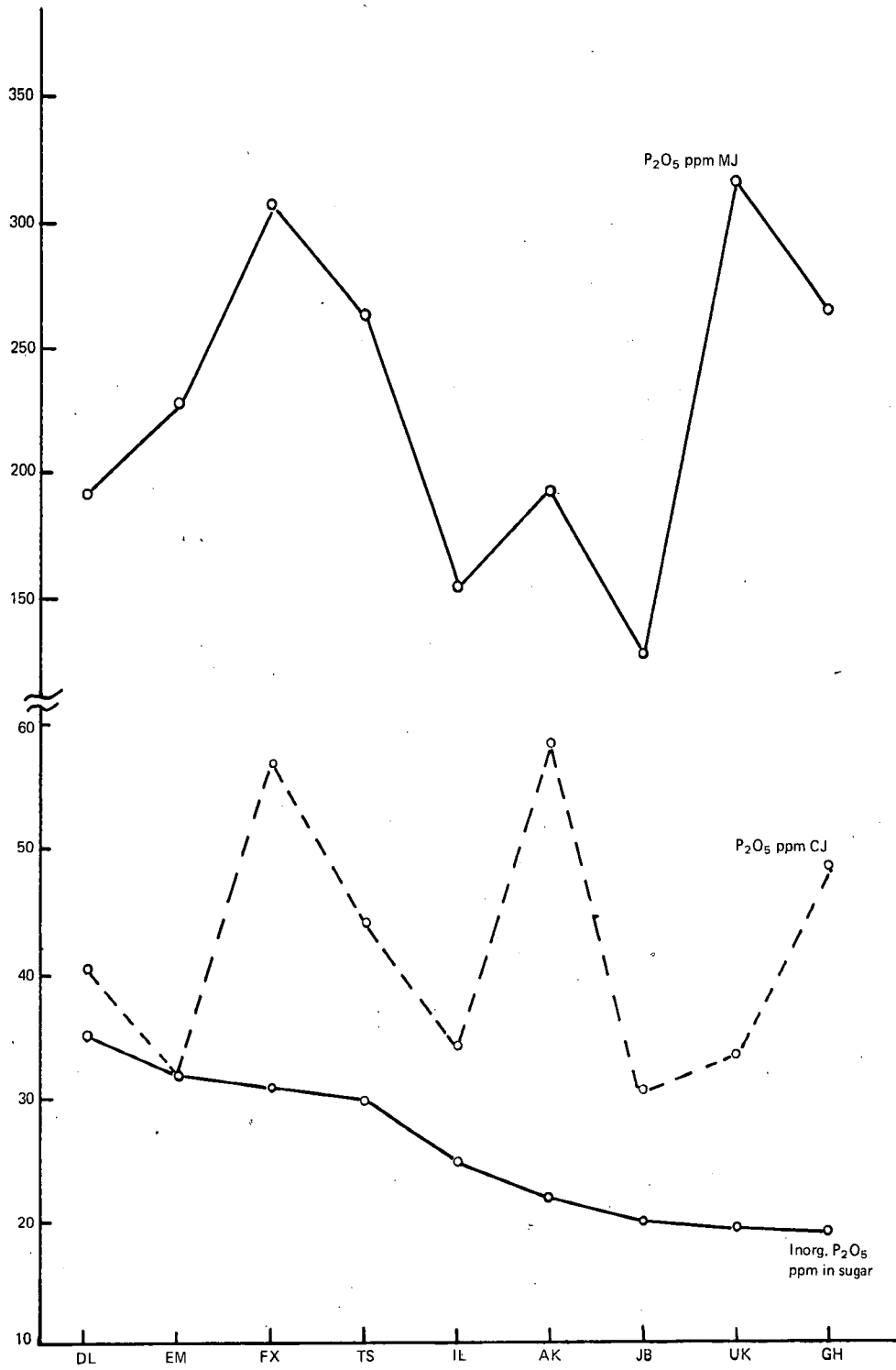


FIGURE 2

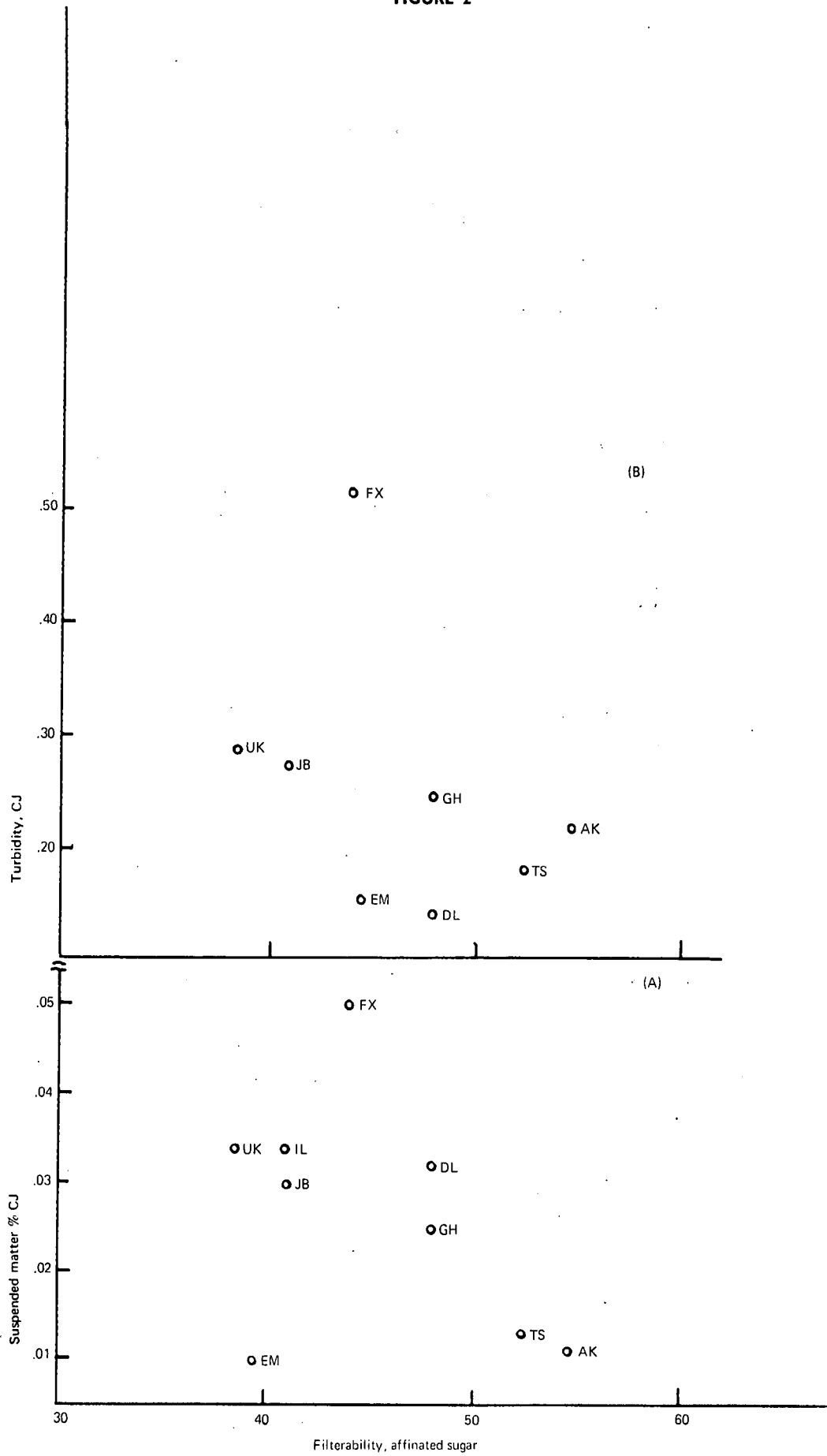


FIGURE 3

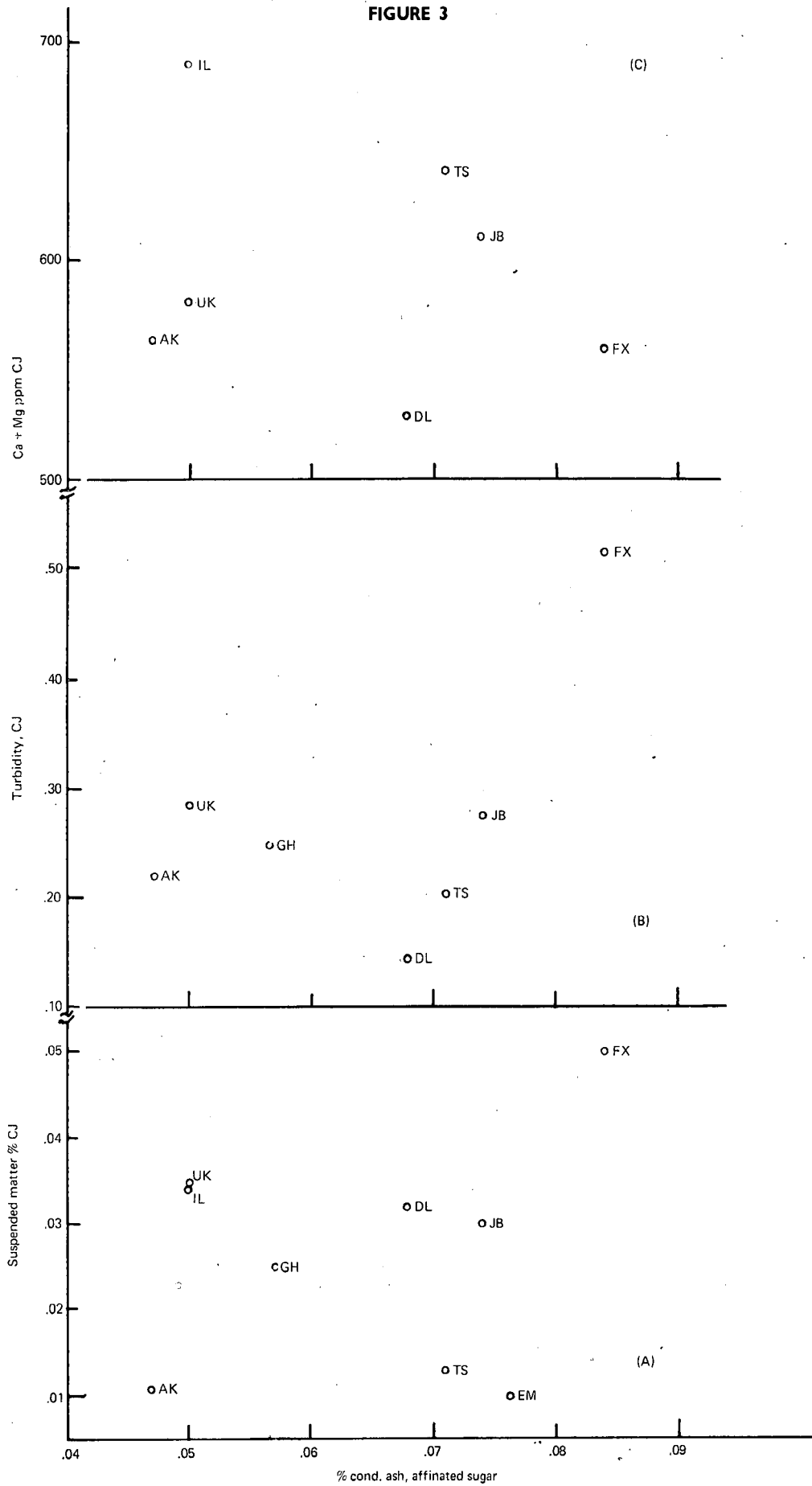


FIGURE 4

