# INTERNATIONAL SUGAR JOURNAL

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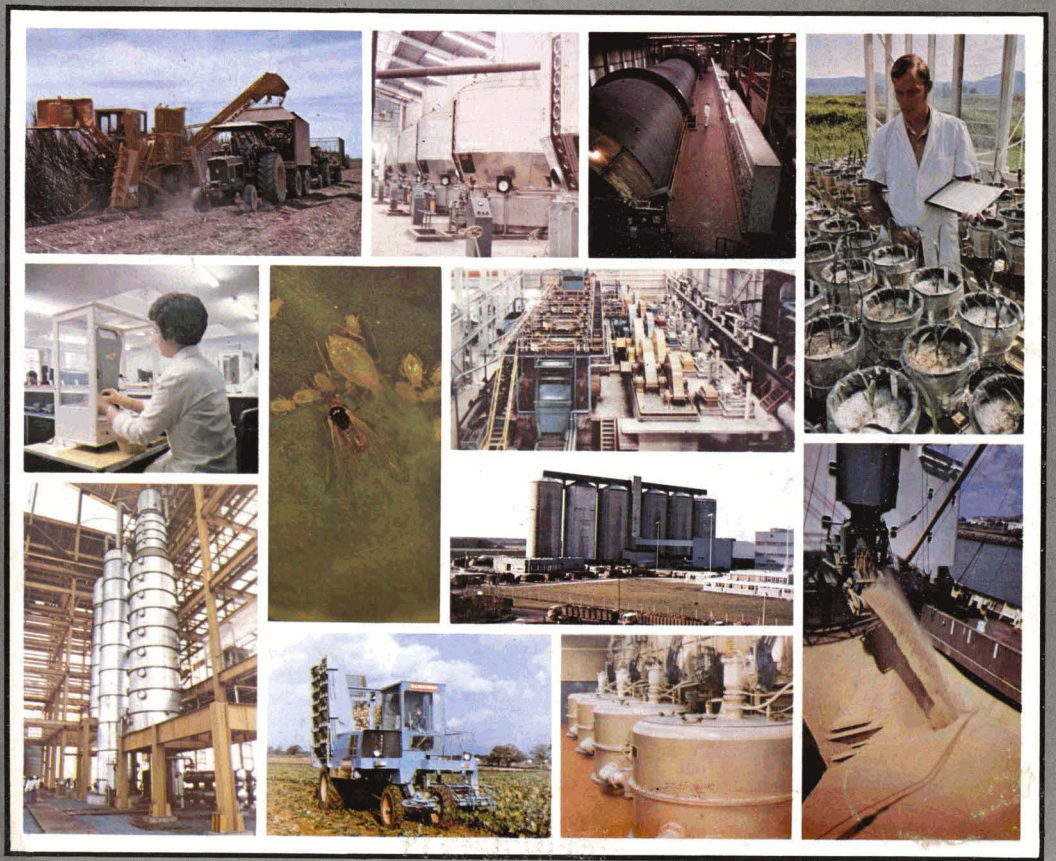

JULY 1979

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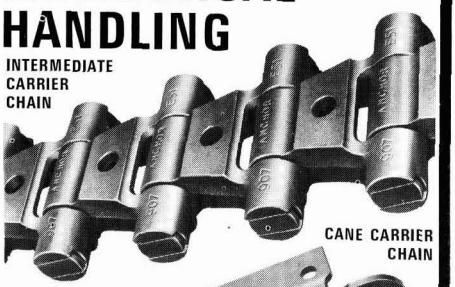

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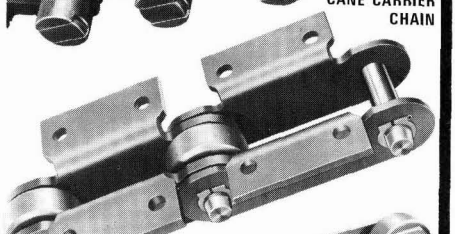

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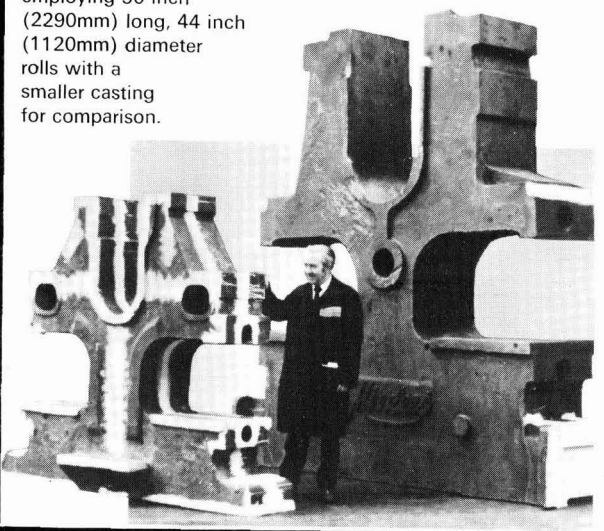

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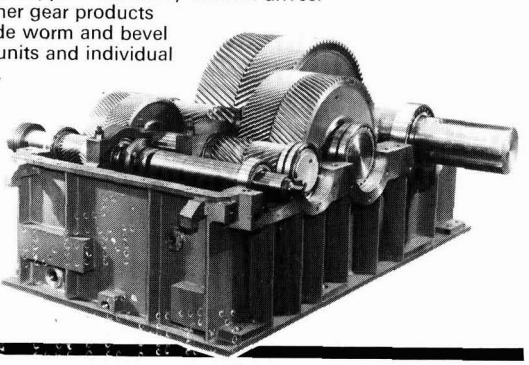

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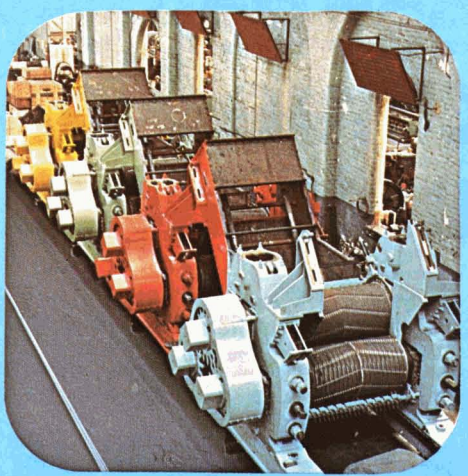

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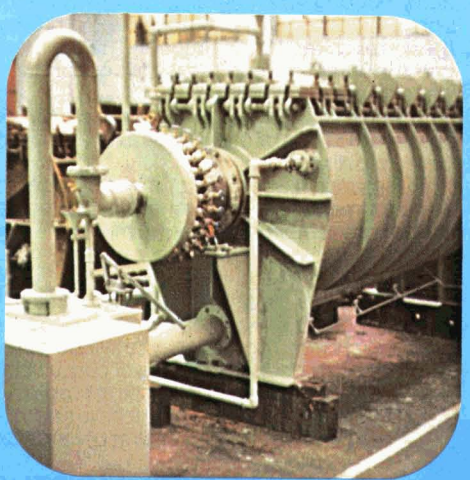

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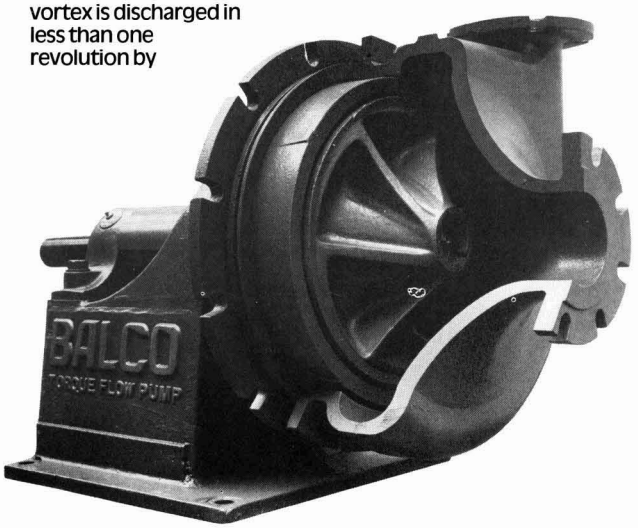


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# NOTES AND COMMENTS

## ACP sugar deliveries in 1977/78[1]

When the ACP sugar protocol came into force on June 30, 1976, total quotas for the ACP countries were of the order of 1,304,700 tonnes, white value. In 1976/77 all countries except Surinam met their quota obligations; Surinam's shortfall was 801 tonnes and, as it did not declare *force majeure*, its quota was cut from 4000 to 3199 tonnes. All other shortfalls or surpluses were within the allowed tolerance and were added to or subtracted from the 1977/78 quotas. Quotas in effect and deliveries for the period are tabulated below.

| Country | Quota in effect | Delivery | Difference |
|---|---|---|---|
| | tonnes, white value | | |
| Barbados | 49,346·9 | 49,847·8 | + 500·9 |
| Belize | 37,491·6 | 39,231·3 | + 1,739·7 |
| Congo | 9,924·7 | 4,881·8 | — 5,042·9 |
| Fiji | 162,935·0 | 164,818·8 | + 1,883·8 |
| Guyana | 156,199·3 | 161,280·8 | + 5,081·5 |
| India | 23,804·9 | 23,173·9 | — 631·0 |
| Jamaica | 117,062·9 | 120,794·5 | + 3,731·6 |
| Kenya | 4,906·8 | 0 | — 4,906·8 |
| Madagascar | 9,891·2 | 9,964·6 | + 73·4 |
| Malawi | 19,508·5 | 20,060·0 | + 551·5 |
| Mauritius | 490,752·4 | 490,667·3 | — 85·1 |
| St. Kitts | 14,136·1 | 14,846·5 | + 710·4 |
| Surinam | 3,199·0 | 2,666·5 | — 532·5 |
| Swaziland | 110,309·9 | 111,492·4 | + 1,182·5 |
| Tanzania | 9,405·4 | 9,679·3 | + 273·9 |
| Trinidad | 65,710·0 | 69,335·1 | + 3,625·1 |
| Uganda | 4,590·6 | 0 | — 4,590·6 |

Of the 17 ACP countries, 11 exceeded the allowed quantities for 1977/78, deliveries above the agreed quotas totalling 19,354 tonnes (1·48%). On the other hand there were quota shortfalls of the order of 15,789 tonnes which reduces the total surplus to 3565 tonnes. Over-deliveries and quota shortfalls within the allowed tolerance are charged against or added to the 1978/79 quotas.

Congo, Kenya, Surinam and Uganda exceeded the allowed tolerance in their deficits, however, and consequently the EEC Commission announced in the *Official Journal* of April 18 that the quotas for these countries had been reduced to 4957, 93, 2667 and 409 tonnes, white value, respectively, with effect from July 1, 1978. The cuts could cause some political problems for the EEC, especially in the case of Uganda. It could be argued that it is the obligation of the EEC countries to help the Ugandan economy which suffered greatly under the Amin regime. The quota cut seems unjustified if the country can deliver the originally agreed quantity in 1978/79.

The People's Republic of the Congo, on the other hand, exported on average 10,000 tonnes, white value, to non-EEC countries during 1975/77; if these exports had not taken place the country would have been able to meet its export obligations under the ACP protocol. It is difficult to understand why the Congo did not meet its obligations as the price paid by the Community is three times the world market price. According to EEC sources, Surinam also should have been able to meet its obligations under the ACP sugar convention.

Taking into account the delivered quantities and the announced quota cuts, the situation for 1978/79 is as follows:

| | |
|---|---|
| Agreed quantities for 1977/78 | 1,303,899·0 tonnes |
| Quota reductions because of non-fulfilment of supply obligations | —15,073·0 ,, |
| Over-supply 1977/78 | —19,345·3 ,, |
| Quota shortfalls 1977/78 | 716·1 ,, |
| Corrected supply quota for 1978/79 | 1,270,187·8 tonnes |

## World sugar prices

The London Daily Price for raw sugar began and ended the month of May at £96 per ton, c.i.f. UK, bulk basis, between extremes of £94 and £100 per ton. The higher figure was reached on May 10 after a gentle improvement with news of progress towards agreement on sugar legislation in the USA. From that date until almost the end of the month, the price hovered between £97 and £99 per ton, but with news from Cuba of a good 1979 crop, the price fell to its low point for the month on May 26, recovering slightly by the end of the month.

The white sugar price started the month at £103 and ended at £104.50 per ton and stayed within close limits during the period. Towards the end of the month there was increased demand from countries of the Middle East and North Africa and this was reflected in a higher premium over the LDP which at one point reached £10, but was reduced again to £8·50 by the end of May.

## Cameroun sugar and the EEC[2]

Cameroun's expanding sugar production is now proving an embarrassment to the EEC, despite the fact that Community grants and soft loans financed the country's first industrial plantations and mill. In an EEC Commission report criticizing the member states' inconsistent sugar investment policy in ACP countries, it is stated that ACP states are expected to be producing 4,800,000 tonnes by 1981, increasing the amount available for export by 900,000 tonnes. Cameroun alone, a country which has just started to export sugar at the level of 12,000 tonnes per year, is expected to have 100,000 tonnes available for export in 1981.

Starting in the late 1960's, Cameroun successfully applied for EDF aid to start a sugar industry for domestic consumption. Not only was the Commission prepared to approve aid for this purpose, but firms in the then six member states were very happy to sell processing equipment and services. If the Cameroun Government has decided to increase production with new sugar factories and plantations (the last with indirect Chinese assistance), it is because it feels that there is adequate effective demand, first in the home market, second in Nigeria and third in the francophone states which used to be supplied by the raw sugar output of Congo (Brazzaville).

## Geplacea call for interim special stock financing[3]

The Group of Latin American and Caribbean Sugar Exporting Countries (GEPLACEA) has urged Members to call on the International Sugar Organization to find ways to finance ISO special stocks until its own fund becomes operational. The Chairman of the GEPLACEA working party on the International Sugar Agreement, Horacio Tabío York, told Reuters that the working party

[1] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 246-247.
[2] *World Sugar J.*, 1979, **1**, (11), 32.
[3] *Reuters Sugar Rpt.*, April 30, 1979.

report, adopted by delegates at the end-April GEPLACEA meeting, stressed the importance of the special stocks, but also that ways should be found to ease the financial strain they place on exporter countries.

Delegates agreed that their representatives, along with other exporter and importer members of the ISO, should examine possibilities for temporary stock financing as allowed under article 52 of the Agreement. Importing countries could offer several solutions for the correct management of the stocks fund. For instance, they could make voluntary contributions and/or grant special loans for the financing fund on suitable terms, as permitted under article 52. Such financing would only be necessary until the ISO invokes article 51 of the Agreement which requires all members to contribute to the fund.

Tabio York said the ISO has not invoked article 51 as many members are not prepared to contribute to the fund without the participation of the US, the world's largest importer. GEPLACEA delegates also accepted the working committee's recommendation that all suitable means should be used to persuade the US to ratify the Agreement by the June 30 deadline set by the International Sugar Council and to stress to the US the negative effect non-ratification is having on their economies.

Delegates also approved the working party's concern over the sugar marketing policy being followed by the European Economic Community. They agreed to recommend to their governments that representations should be made to both the EEC and individual member countries that the EEC should contribute to a more orderly sugar market, and in particular stress the need for early accession to the International Sugar Agreement.

The GEPLACEA delegates also agreed to urge their respective governments to support the complaints made before the General Agreement on Trade and Tariffs (GATT) by Australia and Brazil over EEC sugar marketing policies. In addition GEPLACEA member countries will be recommended to point out the serious implications of the EEC's marketing policies and non-participation in the ISA on the economies of developing sugar-producing nations.

### Booker McConnell Ltd., 1978 report

Of the Engineering Division of the Booker Group, Fletcher and Stewart Ltd. made a record profit on increased turnover. At Mumias, in Kenya, the second phase of the sugar factory extension was completed and commissioned on schedule while the third phase will be completed this year. About half of the equipment necessary for the Juba sugar project in Somalia was shipped in 1978 and the balance will follow in 1979, with subsequent installation and commissioning. The Assalaya factory in the Sudan was virtually completed in 1978, with operations due to start this year. In the Philippines, commissioning of the North Cotabato factory was delayed and hampered by lack of cane, while the Batangas refinery project is due for completion in late 1979 or early 1980. Order intake for unit equipment was satisfactory.

The services of Booker Agriculture International, the sugar management and consultancy company in the group, were successful and profitable; BAI manages Mumias Sugar Co. and Chemelil Sugar Co. in Kenya and both had record years, producing 92,500 and 47,200 tonnes, respectively. Nigerian Sugar Co. suffered from dumped sugar imports and is making representations to the Nigerian Government to control them. Management and technical services, as well as consultancy assignments, were undertaken in Costa Rica, Indonesia, Madagascar, Malaysia, Nigeria, Papua-New Guinea, Saint Kitts, Senegal, Sri Lanka and Tanzania.

### HFCS regime for the EEC[1]

The EEC Commission has now formulated proposals in respect of high-fructose corn syrups, which follow the recent ruling of the Court of Justice that, while the production levy was not itself illegal, the level at which it had been levied could not be sustained. The Commission proposes that the same disciplines governing sugar be applied to HFCS for the 1979/80 season before the whole pattern of sugar arrangements is reviewed by June 30, 1980. The same arrangement of A- and B-quotas as applies to sugar is proposed but, bearing in mind the fact that sugar producers pass on 60% of the levy to the beet growers, it is suggested that the syrup producers should pay only 40% of the levy on their B-quota production, basis dry weight. This would work out at just over 40 U.A. per tonne.

### Europe sugar beet area, 1979[2]

F. O. Licht GmbH recently published their second estimate of beet areas in Europe in 1979. Only a few weeks have elapsed since their first estimate, however, and the changes introduced include mainly small reductions which are recorded for France, Holland, Ireland and Italy as well as Czechoslovakia, East Germany and Hungary. The East European reductions offset the anticipated increases of 20,000 ha in the USSR and 5000 ha in Rumania. An increase of 2000 ha is noted for West Germany but areas for the other countries of Western Europe are unchanged and the net reduction for the EEC as a whole—14,000 ha—is the overall reduction expected for Europe. At 7,860,000 ha, however, this is still a small increase over the 7,817,000 ha sown to beets in 1978.

### CITS 16th Congress—Corrigendum

It will be appreciated that much of our report on the CITS Congress in Amsterdam was based on the official programme and records since it was prepared before the Congress itself took place. Two points need to be corrected: on the advice of his doctors, the President of the Scientific Committee, Professor Schneider, was unable to travel from his home to attend but the Life Honorary President, Dr. A Carruthers, accepted the task of presiding over the Congress and accomplished it with skill and patience. He received the appropriate acclaim at the end of the meetings. Second, owing to bad weather, the ladies programme was changed slightly so that, instead of visiting the flower gardens of Keukenhoff as planned, a tour of The Hague was arranged for the ladies.

**Portugal beet sugar production plans**[3].—The Council of Ministers has approved the installation of a sugar factory using beet as raw material, with an annual capacity of 50,000 tonnes, or enough to supply 20% of the local market.

[1] C. Czarnikow Ltd., *Sugar Review*, 1979, (1429), 41.
[2] *International Sugar Rpt.*, 1979, **111**, 208.
[3] *Bank of London & S. America Review*, 1979, **13**, 124.

# Breeding better beet

By Dr. M. H. ARNOLD (Head of Sugar Beet Department, Plant Breeding Institute, Cambridge)

*Paper presented to the Conference: "Sugar Beet—Which Way Forward?" February* 1979

THE biggest contribution that the plant breeder has made to the sugar beet industry during the last ten years has been through the provision of improved monogerm varieties. Indeed, the removal of the need for costly hand singling has been a dominant factor in maintaining the position of sugar beet as a profitable crop in the agricultural systems of developed countries. The advent of monogerm seed and its now almost universal adoption have not been achieved, however, without creating some entirely new problems.

First among these is the problem of crop establishment. In the days of multigerm varieties and hand singling, only the most vigorous seedlings were left to produce the crop. With monogerm varieties, drilled to a stand, there is relatively little seedling selection and virtually every seedling that emerges must contribute to the root harvest, whether it is vigorous or not. With monogerm varieties, therefore, good emergence and early vigour of growth have assumed far greater importance than with the old multigerm varieties drilled for chopping-out. These problems are receiving attention from plant breeders, but rapid progress is difficult and major advances will not be made quickly. It is possible that more rapid progress will be achieved agronomically through a greater understanding of what constitutes a good seedbed, how to prepare it and the best way of drilling seed into it. This is one of the many areas where the plant breeder, the crop physiologist and the agronomist must work together towards a common goal.

Another problem that has developed following the introduction of monogerm varieties and the great reduction in hand labour that has accompanied their use, has been the occurrence of weed beet. The problem of weed beet, first recognized in the continental countries of Europe, has only recently become important in the UK. Weed beet can arise from a number of different sources. Some of the most striking forms are those which have arisen by contamination of certain monogerm varieties with annual forms of wild beet, which occur in southern Europe where seed of these varieties was produced. Consequently, many farmers, agricultural journalists and others associated with the industry came to associate the problem entirely with contaminated seed and concluded that a solution to the problem lay entirely with the seed producers.

This attitude was unfortunate, however, because it overlooked two other important sources of weed beet, namely the normal bolter and the ground-keeper. Seed shed from both types of plant can lead to the development of an infestation of weed beet. Recent work at the Plant Breeding Institute has shown that the weed beet which became a serious problem on a farm at Heacham (Norfolk) evolved almost entirely from normal bolters of multigerm varieties grown there prior to 1967.

Consequently, although seed contamination has occurred in some varieties in some years, it cannot be held to be the only nor necessarily the most important source of weed beet. A solution to the weed beet problem will be found only if it is tackled by all concerned—seed producer, agronomist and farmer.

Turning to future improvement in sugar beet varieties, we should not expect spectacular or sudden advances. Rather, we should look for the steady and continuous progress which has been a feature of monogerm varieties since they were first recommended in 1966. These improvements will be mainly in sugar yield and possibly in resistance to diseases. Large improvements in sugar percentage are unlikely and bolting resistance has probably reached levels beyond which it is not practicable to proceed. Far-reaching changes, such as the use of naked, pre-germinated seed with fluid drilling, will only be feasible if appropriate varieties and improved technology can be developed side by side and, even then, the result might not have a worthwhile economic advantage.

With all the characteristics required from a good monogerm variety in a modern agricultural system, the plant breeder has a difficult task in maintaining all characters at an acceptable level, while striving to improve any single one of them. If he is not careful, in striving to increase sugar percentage he may lose root yield; if he concentrates too intensively on disease resistance, he may produce a variety which performs well relative to other varieties only when the disease occurs. He must at all times rigorously preserve the monogerm character and ensure that any new variety he produces will stand up to critical evaluation for a wide range of characters, including such features as resistance to the wide range of herbicides now commonly used for weed control in sugar beet. The sugar beet breeder knows that he has to "walk even to stand still", and he always wants to be better than that.

As in the past, so in the future, major steps forward will come not from the plant breeder alone, but from new combinations of agricultural technology and genetic change.

*Summary*

The adoption of monogerm sugar beet varieties has permitted great labour savings but a number of difficulties have also resulted and these are discussed. Problems in breeding of sugar beet with improved characteristics are described and it is considered that advances will come from combinations of agricultural technology and genetic change.

**La sélection de betteraves meilleures**

L'adoption de variétés de betteraves sucrières monogermes a permis d'importantes économies de main-d'oeuvre, mais il en est résulté un certain nombre de difficultés et celles-ci sont discutées. Les problèmes de la sélection d'une betterave sucrière de caractéristiques améliorées sont décrits et on considère que le progrès viendra de combinaisons de la technologie agricole et de modifications génétiques.

**Züchtung von besseren Rüben**

Die Einführung von monogermen Zuckerrübensorten hat grosse Arbeitsersparnisse ermöglicht, jedoch haben

sich auch eine Anzahl von Schwierigkeiten ergeben, die diskutiert werden. Probleme bei der Züchtung von Zuckerrüben mit verbesserten Eigenschaften werden beschrieben, und der Autor ist der Meinung, dass Vorteile aus Kombinationen von Landwirtschaftstechnologie und genetischem Wechsel ergeben könnten.

**Crianza de mejores remolachas**

El adopción de variedades monogermenales de remolacha de azúcar ha permitido grandes economías en mano de obra pero varias dificultades han resultado también y éstas se discuten. Problemas de la crianza de remolacha de azúcar con caracteristicas mejoradas se describen y el autor considera que avances vendrán de combinaciones de tecnología agrícola y cambio genético. □

# Electrokinetics applied to sugar refining

By D. V. FREELAND*, R. RIFFER* and J. G. PENNIMAN†

*Introduction*

COLLOIDS, which can be either dispersions or true solutions of single large molecules, are frequently charged (see Fig. 1). A shell of oppositely charged ions at the solid-liquid boundary has a neutralizing effect.

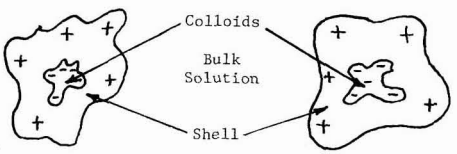



Fig. 1

This double layer acts as an electric condenser which can be described as in electrostatics as

$$\zeta = 4\pi\ ed/D$$

where $\zeta$ is the zeta-potential, $e$ is the concentration of charge, $d$ is the thickness of the double layer, and $D$ is the dielectric constant of the medium. The electrokinetic properties of such a system will clearly be affected by this electrical double layer. The thickness of the layer is determined primarily by the concentration and valence of counter ions in the solution. An important property of the zeta-potential is that it is substantially independent of particle size.

A related term, the electrophoretic mobility $\mu$, is defined as

$$\mu = \frac{edE}{\eta}$$

where $\eta$ is the viscosity and $E$ is the potential gradient. This mobility is a measure of the velocity of the colloidal particle under an applied potential. The temperature effect on $\mu$ is due to viscosity and dielectric constant changes.

In our testing, a Lazer-Zee Model 500† was used to measure zeta-potential. The instrument uses a low-power laser to illuminate particulates suspended in an aqueous medium. The particles are caused to move as a function of this electrostatic charge by impressing a DC voltage across the sample cell. The direction of movement is determined by the sign of the charge; positively charged particles migrate toward the cathode while negatively charged particles migrate toward the anode. The speed of movement is directly proportional to the magnitude of the charge. Electroosmosis—movement of fluid with respect to the sample cell—is eliminated by making measurements at the stationary layer. The moving particles are viewed through a microscope containing a prism interposed between the objective lens and the eyepiece. The prism is mounted on a galvanometer which causes the prism to rotate a few degrees and then return to its starting position and repeat the rotation. The prism is adjusted until this apparent motion exactly cancels the particle motion caused by the applied field, at which point the zeta-potential is displayed on a digital readout.

We noted some interesting mobility effects. The instrument can be used to test for maximum mobility—to maximize dispersion as in paints—or minimal stability as in clarification. Samples from sugar process streams at Crockett refinery were generally negatively charged, but we observed a small number of positively charged particles on several occasions. That is, we could detect migration in both directions.

Pioneers in colloidal chemistry[1,2] were able to describe the stability of dispersions in terms of free-particle sedimentation rate and sedimentation volume. By the late 1950's the relationship between zeta-potential and flocculation in cane sugar refining was under investigation[3].

Colloidal particles generally carry a characteristic net electrical charge; in sugar refining the charge is typically negative. Since similarly charged colloids repel one another, their removal by clarification is hindered. Such systems are stable: they exhibit no tendency for change. In contrast, an unstable system can be characterized by a tendency for suspended material to form aggregates and settle out. This results from lower levels of repulsion. In an early study M. C. Bennett[3] concluded that both settling rate and sedimentation volume are optimized when the zeta-potential is zero. As the zeta-potential approaches zero, settling rate increases and sediment volume is reduced.

*Effect of pH on zeta-potential*

We determined the dependence of colorant zeta-potentials on solution pH by measurements in buffer systems, using various raw sugars. Sugar-free colorant fractions were prepared by two methods, dialysis and adsorption on polystyrene. In all cases, the isoelectric points—the points at which the net charge on the colorant molecule is zero—were 3·0 ± 0·2 pH units.

* Research Department, California and Hawaiian Sugar Company, Crockett, CA, USA.
† Pen Kem Inc., Croton-on-Hudson, NY, USA.

[1] Alexander & Johnson: "Colloid Science", Vol. II. (Oxford U.P.) 1949, p. 613.
[2] Overbeck: "Colloid Science", Ed. Kroyt. (Elsevier, Amsterdam.) 1952, pp. 1, 337, 355.
[3] Bennett: *Nature,* 1958, **182,** 1439-1440.

The isoelectric points are quite low, in the range of those for glutamic and aspartic amino-acids, with which the colorants are believed to share certain chemical structure similarities.

When our molasses ion exclusion process[4] was being developed, it was found that separation of molasses components was improved by lowering the pH from 5·5 to about 4·0. It was hypothesized that more favourable distribution coefficients were achieved by approaching colorant isoelectric points. The zeta-potential measurements on molasses colorants furnished evidence for this.

Fig. 2 describes the pH dependence of zeta-potential for several raw sugars. The more easily refined raws exhibit relatively low zeta-potentials at pH levels near neutrality, in contrast to the raws that are less easily decolorized. Researchers believe that a zeta-potential in the range of $\pm$10 mV is characteristic of an unstable —but settleable—solution. In our determinations, "good raw" colorants exhibited a net charge within this range, while those from more refractory sugars were well outside the desired range. Thus, zeta-potential can indicate quantitatively which raws will be difficult to decolorize.

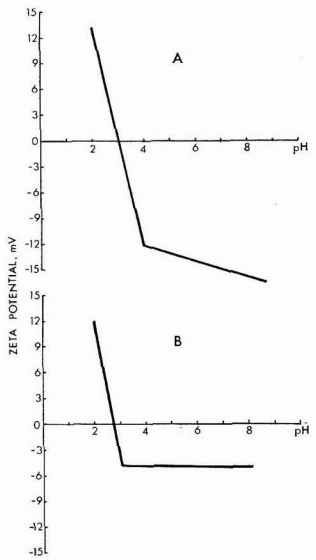



Fig. 2. Influence of sugar quality on zeta-potential: (A) poor sugars, (B) good sugars

The electrophoretic mobility of a colloid depends on frictional forces as well as on electrical charge. One would expect that for an amphoteric molecule as colorant, the molecule would contract from an extended rod-like configuration of large rotational corss-section (similar to the polyethylene glycols) to a globular or random-coil configuration as the isoelectric point is approached. This was demonstrated by viscosity measurements on sugar-free colorants at very low concentrations in buffers of varied pH. Since molecular size varies greatly with ionic strength, this was held constant. Viscosity diminished as the isoelectric point was approached (see Fig. 3.)

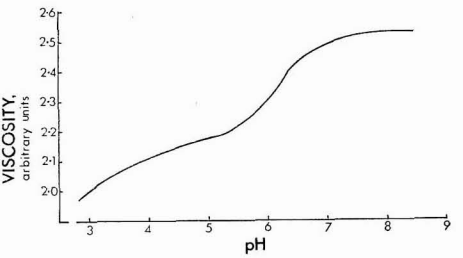



Fig. 3. Colorant viscosity changes with pH

The curve is linear from pH 3·0 to 5·4, but then there is an abrupt change of slope, perhaps corresponding to a major unfolding of the molecule. In addition to molec-

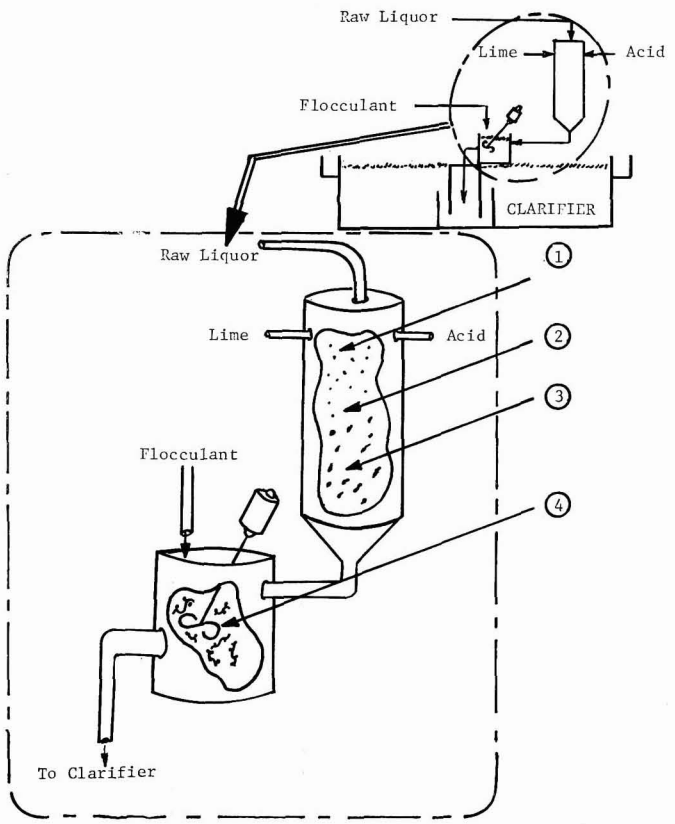



Fig. 4. Decolorization sequence in raw liquor clarification. (1) Lime and phosphoric acid are added to the raw liquor stream. (2) The two react to form insoluble calcium phosphate. (3) Calcium phosphate and suspended particles form a coagulum. (4) The coagulum attaches to the flocculant and, as the system pressure is released, air flotation is achieved.

[4] Riffer: US Patent 4,046,590.

ular cross section, increased solvation and the drag effect of counter ions contribute to decreased mobility. One would predict that the viscosity would exhibit a minimum at the isoelectric point, but we were unable to substantiate this because of the low solubility of the colorant at low pH.

*How zeta-potential affects refinability*

We have demonstrated that there exists variation in the zeta-potentials of raws. These variations lead to parallel variations in clarification. Partial decolorization is accomplished in the clarifiers by a calcium phosphate flocculation[5], according to the sequence in Fig. 4.

A charge on the colorants hinders the coagulation described in step 3. By modifying the zeta-potential toward a zero charge, repulsive forces between suspended solids can be diminished, thereby destabilizing the system and improving coagulation. One would expect refractory raws exhibiting large zeta-potentials to allow less decolorization during primary clarification. In contrast, raws exhibiting a narrow zeta-potential range of 0 to —5 mV should permit greater decolorization. This is generally what is observed. Fig. 5 illustrates this phenomenon for 0·02% $P_2O_5$.

a more negative zeta-potential. Thus, the polysaccharide concentration could be an important element in refinability.

Characterization of colorants by zeta-potential also has important implications for ion exchange decolorization of raw liquor. Resin decolorization proceeds by two distinct mechanisms, matrix adsorption and ion exchange. Both mechanisms are dependent upon the rate of diffusion of colorant molecules to adsorption sites and retention at such sites. Even highly polar colorants are not retained at ion exchange sites when their net charge is zero or positive. Resin type (e.g. acrylic or polystyrene) and cross-linkage might be chosen so as to optimize removal of specific colorant types as characterized by zeta-potential. Furthermore, specific colloids—likewise identified by zeta-potential—might be particularly effective at mechanical blinding of the resin so that decolorization efficiency drops off.

*Primary waste treatment plant implications*

Waste treatment presented an additional problem that could be quantified by zeta-potential measurement. Sedimentation rate at the waste treatment clarifier decreases markedly over shutdown. To combat this difficulty, Crockett's Production Department has tried liming to very high pH but with only limited success. During the course of our zeta-potential studies we

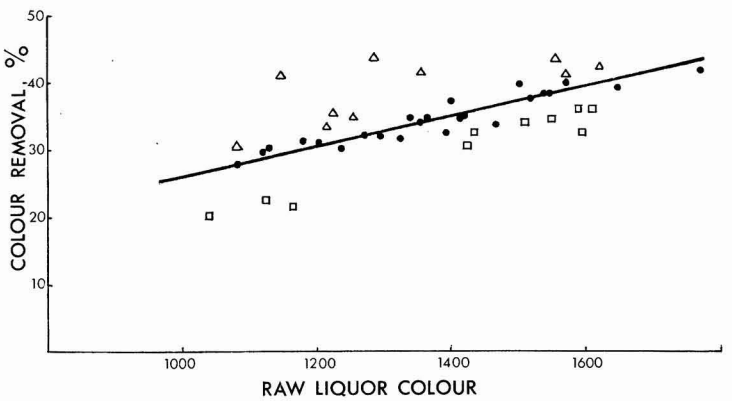



Fig. 5. Effect of raw sugar blend changes on clarification efficiency. Triangles represent blends containing 7·5% less on average of difficult-to-decolorize sugars and 1·9% more of easy-to-decolorize sugars by comparison with the blends represented by squares.

Cane sugar starches have also been shown to have a major negative influence on raw sugar clarification[6]. Starch is believed to wrap itself around the calcium phosphate precipitate and prevent it from being incorporated into the growing coagulum. This results in fewer sites being available to which colorants can adhere. Thus, colour removal is reduced. Our tests have confirmed this. Amylose and amylopectin, the components of starch, do not alter the zeta-potentials of sugar-free colorants. Starch belongs to the group of non-ionic colloids in which electrokinetic phenomena are small or absent; thus starch does not have a zeta-potential of its own.

Indigenous sugar cane polysaccharide exhibits a strong negative charge down to pH 3. This material would be expected to have an adverse affect on coagulation similar to starch but, in addition, to contribute to

observed that this decreased performance coincided closely with an influent zeta-potential change from —10 mV to a shut-down average of +3 mV. The absolute magnitude of the charge is within the ±10 mV settleable zone. How, then, does one account for the large change in settling rate? By noting that the cationic flocculant becomes useless as a bridging agent. The settling rate is reduced by 60 to 90%. A positive zeta-potential, we speculated, could result from the presence of polyvalent cations.

To test for the contribution of metal cations, EDTA was added to a waste sample of positive zeta-potential. EDTA is a sequestering agent which binds polyvalent cations such as calcium in a complex much more tightly

[5] Guerra: *I.S.J.*, 1976, **78**, 3–7, 35–39, 73–75.
[6] Murray, Runggas & Shepherd: *Proc. 50th Congr. S. African Sugar Tech. Assoc.*, 1976, 1–5.

than they are held in a shell of counter ions around colloid aggregates. We observed that, as EDTA was added, the zeta-potential became less positive.

In control samples, EDTA had little effect on the zeta-potential of colorant alone. Added sodium or calcium ion made the zeta-potential of colorant less negative. Added EDTA reversed the influence of calcium but not sodium. Thus, we believe calcium to be implicated in the positive zeta-potential observed in waste streams. But at this point we are uncertain whether this is due to a build-up of calcium or to the gradual disappearance of negative contributors. We plan to monitor calcium concentration and zeta-potential during our shut-down periods to determine whether a correlation exists.

*Modification of zeta-potential*

As we have demonstrated, pH adjustment can be used to modify zeta-potential. However, in most refinery operations pH must be controlled to minimize inversion and degradation losses.

Two detergents—one anionic and one cationic polyelectrolyte—were chosen as modifiers on the basis of earlier testing done by Bennett & Schmidt[7]. Sodium lauryl sulphate (SLS) and cetyl trimethylammonium bromide (CTAB) possess negative and positive charges, respectively. The result of our chemical modification efforts are shown in Fig. 6. The colorants prepared by polystyrene adsorption exhibited zeta-potentials of —17 to —26 mV. By adding CTAB we reduced the negative zeta-potential and ultimately crossed the zero-potential point at about $1{\cdot}6\times10^{-2}$ meq of CTAB. Addition of SLS increased the negativity of the zeta-potential and thereby increased the stability of the solution.

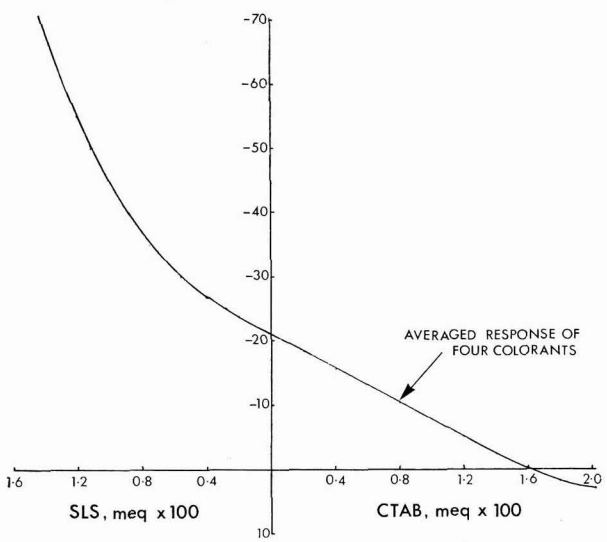



Fig. 6. Zeta-potential modification using detergents

The appearance of small charged particles increased as the zeta-potential became more negative. Conversely as the zero-potential point was approached, solution clarity decreased. This is apparently coagulation caused by oppositely charged aggregates which become more visible as they agglomerate. It is this type of zeta-potential modification—chemical addition—that leads us to believe we can improve flocculation by modifying the zeta-potential.

Zeta-potential modification could also be used to solve the waste treatment problem. The waste treatment clarifier apparently operates in two modes. The first and most common arises during operation of the refinery, when the waste constituents are kieselguhr, char dust, scums, sucrose, lime, etc. In the second mode, at shutdown, the major streams to be processed are more solid-free, with char waste water and plant hose-down water constituting the majority of feed, and high levels of mineral solids (primarily calcium). The two feed types require different methods of handling; one flocculant could be selected for normal operations and another for shutdown. Since they are to be used to agglomerate suspended solids, we would select flocculants with charges appropriate for the suspended solids.

A better solution would be modifying the zeta-potential by treatment with a detergent. Since we generally operate with a flocculant having applicability limited to slightly negative influent zeta-potentials, we would seek to maintain our shutdown zeta-potential in this range. We therefore anticipate using sodium lauryl sulphate to increase the negativity of the zeta-potential on shutdown to maintain it in the range of 0 to —5 mV.

*Summary*

Non-sugar constituents of raw sugars were characterized by their zeta-potential, an electrokinetic property. Our studies have demonstrated that zeta-potential is an important indicator of refinability, that is, the relative ease with which a raw sugar can be decolorized. We also found that modification of zeta-potential can be used to optimize clarification in both raw liquor and waste streams. Zeta-potential measurement is thus evolving as an important tool for the sugar technologist.

**L'électrocinétique appliquée au raffinage du sucre**

Les constituants non-sucre des sucres bruts ont été caractérisés par leur potential zêta, une propriété électrocinétique. Nos études ont démontré que le potentiel zeta est un indice important de la raffinabilité, c.-a-d. la facilité relative avec laquelle un sucre brut peut être décoloré. Nous avons également trouvé que le potentiel zêta peut être utilisé pour optimaliser la clarification à la fois dans la liqueur brute et dans les circuits de décharge. Le potentiel zêta devient ainsi un outil important pour le technicien du sucre.

**Anwendung der Elektrokinetik bei der Zucker-raffination**

Nichtzucker-Bestandteile von Rohzuckern wurden durch ihr Zeta-Potential, eine elektrokinetische Eigenschaft, charakterisiert. Unsere Untersuchungen haben gezeigt, dass das Zeta-Potential ein wichtiges Merkmal der Raffinierbarkeit ist, d.h. wie relativ leicht ein Rohzucker entfärbt werden kann. Wir haben auch festgestellt, dass eine Modifikation des Zeta-Potentials verwendet werden kann, um die Klärung sowohl von Kläre als auch von Abwässern zu optimieren. Die

[7] *I.S.J.*, 1959, **61**, 201–205.

Zeta-Potential-Messung entwickelt sich daher zu einem wichtigen Hilfsmittel für den Zuckertechnologen.

**Electrocinética aplicada a la refinación del azúcar**

Se han caracterizado los componentes no-sacarosa de azucares crudos por su zeta-potencial, un propriedad electrocinética. Nuestros estudios han demostrado que zeta-potencial es un indicador importante de refinabilidad, es decir, la facilidad relativa de descolorización de un azúcar crudo. Hemos descubrido que modificación del zeta-potencial puede usarse pare optimizar clarificación de flujos de licor crudo y da efluente. Medición de zeta-potencial se desarrolla por tanto como una técnica de utilidad para el tecnólogo azucarero. □

# Phospholipids in cane juice and their fate during clarification*

By ANIL GARG

(National Sugar Institute, Kanpur, India)

*Introduction*

CANE juice contains phosphate in both organic and inorganic forms. The first recognition of the presence of organic phosphate compounds in cane juice was made by the experiments of Honig[1,2]. He observed that direct determination of phosphate in cane juice always gave a value lower than that determined after digestion of organic matter present in the juice. This indicated that some of the phosphate was present in inorganic form and was directly available for estimation, while the rest was present in the form of complex organic compounds from which it became available only after destruction of the organic matter. Later he reported that about half of the total phosphates in juice was present probably as organic phosphates, such as phytin or phytic acid, hexose phosphates or other phosphorylated sugars, nucleotides, phosphoproteins, phospholipids or phosphatides, etc.

So far, no authenticated studies have been made of the qualitative and quantitative pattern of different phosphate-containing organic and inorganic compounds present in cane juice. All previous studies in phosphates have been confined mainly to their quantitative determination directly in cane juice and their significance for juice clarification. Needless to say, without a detailed understanding of the qualitative and quantitative pattern of different forms of phosphates present in cane juice, little factual information can be gained about their probable role or significance in clarification, around which revolves the whole technology of sugar manufacture. A comprehensive study has therefore been undertaken to carry out the complete qualitative and quantitative analysis in juice of one of the major phosphate groups, *viz.* phospholipids.

Phospholipids are a group of combined or conjugated lipids, having the specific property of containing a phosphate radical in their molecules, together with glycerol, fatty acids and a nitrogenous base as key components. They are amphipathic molecules, having a hydrophilic property due to the phosphomonoester moiety as well as a hydrophobic property due to the glyceride group. They are an essential part of all bioplasm, whether of plants of or animals[3]. They are especially located in membrane structures and are considered to be generally essential for their maintenance and proper functioning.

Phospholipids are widely distributed in biological materials. Many more phospholipids of animal origin have been reported to occur than from plant sources. Knop[4] and Topler[5] isolated, from plant sources, a phosphorus-containing material soluble in certain fat solvents. The fact that phosphorus-containing lipids occurred generally in plant seeds and other vegetable sources was first reported by Hoppe-Seyler[6] and Heckel & Schlagdenhauffen[7]. Since then a number of workers have isolated various phospholipids from different sources such as bacteria, yeasts, moulds and other lower plants; cereal, grain and oil-producing plants; vegetables such as carrot, pea, bean seed, etc.

No systematic studies on the qualitative and quantitative aspects of phospholipids in cane juice have as yet been made. However, some workers have arbitrarily assumed them to be present in cane juice on the basis of their general occurrence in plants. It was Wijnberg[8] who first indicated that lecithin was a constituent of crude cane wax, although he could not confirm this. Hatt *et al.*[9], while analysing the wax from sugar cane, reported that the presence of glycerol and phosphorus could be considered due to a phospholipid fraction. The evidence provided by these workers was an indirect one, since neither could they isolate the phospholipids as such nor could they identify the nitrogen-containing moieties usually associated with the phospholipids. During the study of a wax-like solid obtained from cane juice, Shorey[10] observed that the substance contained both phosphorus and nitrogen, and had the physical properties of lecithin. A Soviet patent[11] has described a procedure in which phospholipids and other materials present in molasses solution may be separated by precipitation with copper sulphate and then recovered from the precipitate by methanol extraction. Honig[12] was able to calculate the total phospholipid content of bagasse by colorimetrically estimating the phosphate

* This paper forms part of a Ph.D. Thesis, Kanpur University, India.

[1] *West Indies Sugar Corp. Rpt*, 1952, (1).

[2] "Principles of sugar technology", Vol. I. (Elsevier, Amsterdam) 1953, pp. 344–348.

[3] Thudicum: "A treatise on the chemical constitution of the brain". (Baillière, Tindall & Cox, London) 1884, p. 12.

[4] *Landw. Ver. Sta.*, 1859, **1**, 26.

[5] *ibid.*, 1861, **3**, 85.

[6] "Physiologische Chemie" (August Hirschwald, Berlin) 1877.

[7] *Compt. rend.*, 1886, **103**, 388.

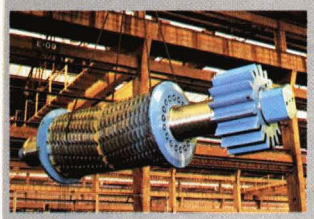
[8] "Over rietwas en de mogelykheid zyner technische gewinning" (Amsterdam) 1909, p. 112.

[9] *Proc. 17th Conf. Queensland Soc. Sugar Cane Tech.*, 1950.

[10] *J. Amer. Chem. Soc.*, 1898, **20**, 113.

[11] Troiskil: *USSR Pat.* 42,551 (April 30, 1935); *Chem. Abs.*, 1937, **31**, 7280.

[12] *Proc. 8th Congr. ISSCT*, 1953, 710–718.



El azúcar representa una importante fuente de energía en el mundo entero. El extraerlo de la caña de azúcar con eficiencia es siempre una tarea difícil que depende sobre todo de las características y de la calidad del equipo utilizado.

El nombre Farrel es conocido y respetado mundialmente en el campo de la producción azucarera. Hace más de un siglo que sus técnicos están construyendo y perfeccionando los equipos para la molienda de la caña de azúcar.

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# Zanini y Farrel tienen al mundo entero para certificar el resultado de la tecnología que ofrecen.


Fator

content of the residue obtained after separating fatty acids, oils and sterols from the total lipids fraction with the help of solvents such as alcohol and acetone at 40° and 25°C, respectively. Total lipids were extracted from bagasse with a 1:1 mixture of benzene and alcohol. The organic phosphate present in the residue was liberated by acid digestion. Honig[13] suggested the possibility that the phospholipid present in cane juice was lecithin, but he could not provide conclusive evidence.

The present paper deals with the detailed analytical studies performed on the phospholipid content of the cane juice of variety Co 1148 at 12 months of age with the help of a thin-layer chromatographic technique. Similar studies have been made for clarified juice and filter muds.

## EXPERIMENTAL

Samples of fresh raw cane juice were obtained by crushing cane with a laboratory crusher. For complete extraction of lipids, the cane crushing was repeated three times. The raw juice was clarified by the standard methods of sulphitation and double carbonatation[14,15]. The filter mud obtained after clarification by each process was also subjected to phospholipid analysis. Five samples each of raw juice, clarified juice and filter mud were analysed for phospholipids and an average value calculated in each case. The total amounts were then obtained from the measured volumes of raw and clarified juice and mud.

### *Extraction of phospholipids and removal of the non-lipid fraction*

Various solvent mixtures were tried, but the chloroform:methanol mixture, devised by Folch *et al.*[16] for animal tissue, was finally chosen for the extraction of total lipids from cane juice. The phospholipids were then fractionated by thin-layer chromatography.

*Phospholipid extraction:* Raw juice was extracted with a 2:1 v/v chloroform:methanol mixture such that the total volume of the extractant did not exceed half the volume of raw juice. At each stage the solvent mixture and raw juice were mixed thoroughly by stirring for about half an hour and the mixture then centrifuged at 2000 rpm for about 10 minutes. The lipids, being soluble in the solvent system used, passed into the lower layer which was separated with a separating funnel, while the middle residual layer (filter cake) and the upper supernatant layer were extracted again. The extraction process was repeated twice more, when the solvent system remained colourless instead of turning a golden yellow.

The same extraction process was used for clarified juice and filter mud, but the total volume of solvent used was halved.

*Removal of the non-lipid fraction:* The total lipid fraction of raw juice, clarified juice and filter mud, extracted as above, was degraded to break the linkages between protein-lipid complexes by taking the extract down to dryness under reduced pressure and repeating this several times after addition of water-saturated chloroform. The protein was insoluble in the chloroform:methanol mixture and was filtered off. Other non-lipid impurities were then washed out from the deproteinized crude lipid extract with a salt solution devised by Folch *et al.*[16] After washing, the resulting purified solution was made up to the desired volume by the addition of 2:1 chloroform:methanol. The lipid extract, free of proteins and other non-lipid impurities, normally contains only a part of its weight as phospholipid; the remainder is made up of free fatty acids and other lipids. This purified phospholipid preparation served as the starting material for all subsequent analysis and chromatographic separations.

### *Thin-layer chromatographic separation of phospholipids*

Thin-layer chromatography has been developed as a powerful tool for the separation of lipids. It is an adsorption chromatography which is performed on open layers of adsorbent materials supported on the surface of glass plates.

*Apparatus and solvent:* A TLC kit supplied by Shandon Southern Products Ltd., Runcorn, Cheshire, England, was used in all the investigations. The adsorbent silica gel "G" containing 12% calcium sulphate as binder was obtained from B.D.H. (India). Glass plates (20×20 cm) were coated to a depth of 0·25 mm with a suspension prepared by adding 25 g of the silica gel in 60 $cm^3$ of distilled water containing 2·5 g of ammonium sulphate[17]. The thin layer of silica gel was allowed to dry at room temperature and then was activated by heating in an oven at 100°C for 30 minutes. For the development of the chromatogram, chromatographic jars measuring 250×250×120 cm were used. A 115:45:7·5, v/v/v mixture of chloroform:methanol:ammonium hydroxide was used as the developing solvent[18].

*Spotting and development:* The activated plate was placed flat on the laboratory bench and a measured volume (0·1 $cm^3$) of the purified phospholipid extract was spotted carefully with a micropipette on the gel surface at a distance of 2 cm from one end. A mixture of standard phospholipids (purchased from Biochemicals Unit, V.P. Chest Institute, New Delhi, India) was also spotted for detecting the unknown phospholipids. The plate was then placed vertically with the spots lowermost, in a glass chromatographic chamber containing the developing solvent. It was allowed to develop till the solvent front had ascended a distance of 17 cm. The time required for such development was about 2 hours. In each case, duplicate plates were run at the same time; after full development of the chromatograms, one plate was used for detection of the spots and another for their quantitative analysis.

### *Detection of phospholipids*

The plates were removed from the chromatographic chamber after full development and permitted to dry briefly. The spots were then detected by spraying with a variety of reagents specific to various phospholipids

*General method:* The spots were revealed by placing the plates in a glass chamber full of iodine vapour[19,20]. Violet coloured spots appeared immediately, and the plates were taken out of the chamber and the spots outlined with a pencil. The violet spots were allowed to

[13] *West Indies Sugar Corp. Rpt.*, 1954, (4).
[14] Honig: "Principles of sugar technology", Vol. I. (Elsevier, Amsterdam) 1953, pp. 582-653.
[15] *Idem ibid.*, 655–710.
[16] *J. Biol. Chem.*, 1957, **226,** 497.
[17] Waldi: "TLC, a laboratory handbook" (Ed. Egon Stahl) (Academic Press, New York) 1965, pp. 161–163.
[18] Abramson & Bleecher: *J. Lipid Res.*, 1964, **5,** 628.
[19] Sins & Larose: *J. Amer. Oil Chem. Soc.*, 1960, **37,** 383.
[20] Marinetti: *J. Lipid Res.*, 1962, **3,** 1.

fade out by sublimation of the iodine and the outlined spots confirmed by spraying with more specific reagents.

*Specific method:* The chromatographic plates were heated at 100°C for 10 minutes and then sprayed with the ninhydrin reagent specific for the detection of amino-phospholipids[20]. The plates were again sprayed with the modified Dragendorff reagent[21,22] for the positive detection of choline-containing phospholipids.

The presence of phospholipids in the unfractionated lipid extract was detected by a test devised by Casanova[23]. This comprises adding a drop of 12% ammonium molybdate to 5 drops of lipid extract followed by addition of concentrated sulphuric acid; a red coloration changing to green and then to blue is an indication of he presence of phospholipids.

*Quantitative determination of phospholipids*

The quantity of total phospholipids was determined[24] by estimating the phosphate content of the lipid extract and then multiplying it by a conversion factor of 25. The quantity of individual phospholipid fractions was determined after eluting them from their respective spots on the plate and then by estimating their phosphate content individually and multiplying it by the same conversion factor. Phospholipid spots were scraped from the glass plate, along with the silica gel, and then eluted with a 100:30:20:2 ethanol:chloroform:acetic acid:water solvent mixture at 40°C for 30 minutes[25]. Phospholipids extracted by the solvent mixture were separated from the silica gel powder by centrifuging. The elution process was repeated three times in each case. The total phosphate content in the lipid extract and in the eluted phospholipid fraction was determined after digestion of its organic matter to liberate the organically bound phosphate into free reactive inorganic ortho form. The estimation was carried out by the colorimetric method using a Klett Summerson photoelectric colorimeter. The blue colour was developed after reduction of the phosphomolybdate complex using stannous chloride[26], and its intensity measured at 660 nm.

*Total organic phosphates*

The total organic phosphate content in raw juice was calculated as the difference between the total phosphate and inorganic phosphate contents. The total phosphate content of the juice was determined after digestion of the measured volume of juice, while the inorganic phosphate content was estimated directly[27].

Similar experiments were carried out with the clarified juice and filter mud samples.

## RESULTS

The presence of phospholipids in the crude lipid extract was confirmed earlier before fractionation by Casanova's test, specific for phosphorus[23]. After fractionation of the lipid extract, four spots appeared immediately on putting the thin-layer chromatogram into the iodine vapour-filled glass chamber. Iodine was found to be the best detection agent for these spots. The identity of various phospholipids was established by comparing the $R_f$ values with those of standard samples of phospholipids and with the help of specific spray reagents. Two component compounds of the phospholipid fraction were confirmed: phosphatidyl choline (PC) and phosphatidyl ethanolamine (PE). Their $R_f$ values, i.e. the ratios of the distances travelled by specific spots to the distance travelled by the developing solvent, were found to be the same as those of standard PC and PE. Further confirmation of PC was made with the help of Dragendorff's reagent, which is specific for choline present in the compound. On spraying with this reagent, an orange/violet coloured spot appeared. For detection of PE, ninhydrin reagent was used, which turned the spot from colourless to violet owing to the reaction with the free amino group present in the molecule. Attempts to identify the remaining two spots were fruitless. However, these spots were most likely due to phospholipids because they clearly showed the presence of a phosphorus moiety in their molecules when the chromatographic plate was treated with Hanes & Isherwood's reagent which is specific for phosphorus[28]. A mixture of four known phospholipids dissolved in chloroform:methanol mixture was spotted and developed in the same manner and under the same conditions as those for the unknown mixture. The $R_f$ values of the known phospholipids and those of the detected compounds, plus their response to various spray reagents, are shown in Tables I and II, respectively. The four spots appearing on thin layer chromatograms are shown in Fig. 1. The spots numbers 2 and 4 were identified as PC and PE, respectively, while the remaining two were unidentified. These two identified components were detected in all the samples chromatographed, i.e. raw juice, clarified juice and filter mud; however, the total quantity found in each case was not of the same order.

**Table I. $R_f$ values of standard phospholipids**

| *Component* | *value* |
|---|---|
| Lysophosphatidyl choline ..... | 0·62 |
| Phosphatidyl choline ..... | 0·67 |
| Lysophosphatidyl ethanolamine... | 0·86 |
| Phosphatidyl ethanolamine ..... | 0·96 |

**Table II. $R_f$ values of cane juice phospholipids and their response to chemical sprays**

| | *Compound* | *$R_f$ value* | *Spray reagent Ninhydrin* | *Dragendorff* |
|---|---|---|---|---|
| (1) | Unidentified ..... | 0·60 | — | — |
| (2) | Phosphatidyl choline ..... | 0·67 | — | + |
| (3) | Unidentified ..... | 0·82 | — | — |
| (4) | Phosphatidyl ethanolamine | 0·96 | + | — |

+ = Positive — = Negative

The results regarding total phospholipid contents of the raw juice, clarified juice and filter mud are presented in Table III. The quantitative data regarding PC and PE in all the three samples are listed in Table IV. The analysis of total phosphate content, i.e. total organic and inorganic phosphate, was also performed in the same three samples and the results are presented in Table V.

**Table III. Total phospholipids in cane juice ($\mu g.cm^{-3}$)**

| | *Treatment* | *Total $P_2O_5$* | *Total phospholipids* |
|---|---|---|---|
| (1) | Raw juice ..... | 0·286 | 7·15 |
| (2) | Clarified juice: | | |
| | (*a*) by carbonatation process ... | 0·064 | 1·60 |
| | (*b*) by sulphitation process ... | 0·088 | 2·20 |
| (3) | Filter mud*: | | |
| | (*a*) from carbonatation process | 0·130 | 3·25 |
| | (*b*) from sulphitation process | 0·124 | 3·10 |

* Obtained after clarification of measured volume of raw juice


[21] Lepage: *J. Chromatog.*, 1964, **13**, 99.
[22] Beiss: *ibid.*, 104.
[23] *Bull. Chem. Farm.*, 1911, **50**, 309.
[24] Jamieson & McKinney: *Oil and Soap*, 1935, **12**, 70; *Chem. Abs.*, 1935, **29**, 3541.
[25] Biezenski: *J. Lipid Res.*, 1967, **8**, 409–410.
[26] Jackson: "Soil chemical analysis" (Prentice Hall, India) 1973, pp. 135–151.
[27] Garg: Unpublished work, 1977.
[28] *Nature*, 1949, **64**, 1107.

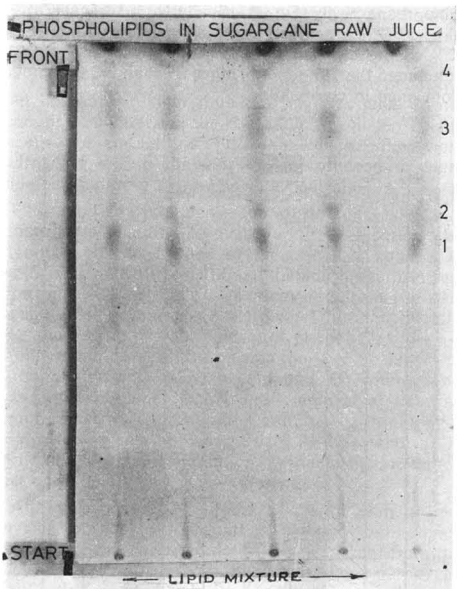


Fig. 1

**Table IV. Phospholipid composition of cane juice ($\mu g.cm^{-3}$)**

| Treatment | Total $P_2O_5$ | Total phospholipids |
|---|---|---|
| (1) Raw juice: | | |
| (*a*) Phosphatidyl choline ..... | 0·105 | 2·625 |
| (*b*) Phosphatidyl ethanolamine | 0·081 | 2·025 |
| (2) Clarified juice: | | |
| (*i*) by carbonatation process: | | |
| (*a*) Phosphatidyl choline ... | 0·028 | 0·700 |
| (*b*) Phosphatidyl ethanolamine | 0·022 | 0·550 |
| (*ii*) by sulphitation process: | | |
| (*a*) Phosphatidyl choline..... | 0·037 | 0·925 |
| (*b*) Phosphatidyl ethanolamine | 0·020 | 0·500 |
| (3) Filter mud*: | | |
| (*i*) from carbonatation process: | | |
| (*a*) Phosphatidyl choline ..... | 0·032 | 0·800 |
| (*b*) Phosphatidyl ethanolamine | 0·049 | 1·225 |
| (*ii*) for sulphitation process: | | |
| (*a*) Phosphatidyl choline ..... | 0·051 | 1·275 |
| (*b*) Phosphatidyl ethanolamine | 0·054 | 1·350 |

* Obtained after clarification of measured volume of raw juice

**Table V. Phosphates in juice ($mg.litre^{-3}$)**

| Juice | Total phosphate | Inorganic phosphate | Organic phosphate |
|---|---|---|---|
| (1) Raw ..... | 627 | 452 | 175 |
| (2) Clarified: | | | |
| (*a*) by carbonatation process ..... | 150 | 80 | 70 |
| (*b*) by sulphitation process ..... | 220 | 120 | 100 |

## DISCUSSION

A positive correlation has been reported between the milling technique and the amount of lipids extracted in raw juice[12]. It is accepted that the juice obtained using a laboratory crusher contained a higher percentage of lipids than the juice obtained after intensive disintegration of cells in sugar factories. The adsorption of lipids by the bagasse bed is said to be the main cause of reduction in the lipid content of juice obtained by improving milling. In cane milling, about 40% of the total lipids become dispersed in the juice while the remainder is left in the bagasse and eliminated with it[29]. They constitute, on average, about 0·8–1% of dry bagasse. For this reason, in our experiments, crushing of cane with the laboratory crusher was repeated three times to extract as much of the lipid content of the cane as possible. The phospholipids, which contain highly unsaturated acids, are very unstable and adequate precautions must therefore be taken to prevent their oxidation. Hence, they were immediately extracted with a 2:1 v/v chloroform:methanol solvent mixture. Various solvent mixtures had been tried for lipid extraction from cane juice, but 2:1 chloroform:methanol found to be the best, all lipids in cane juice being soluble in this mixture. Since a major proportion of lipids is bound with proteins, a polar solvent like methanol, in conjunction with the non-polar solvent chloroform, is needed to sever these bonds.

It has long been recognised that extracts of lipids, however prepared, contain appreciable quantities of water-soluble contaminants such as inorganic salts, proteins, amino-acids, etc. These non-lipid contaminants were washed out as described earlier. Adequate precautions were taken during the oxidation of organic matter to make the organically bound phosphorus completely free. Several oxidizing agents were tried, including nitric acid and hydrogen peroxide, sulphuric acid and hydrogen peroxide, sulphuric acid and perchloric acid, etc., but the mixture of sulphuric acid and phosphorus-free hydrogen peroxide was found to be the most suitable. Oxidation with perchloric acid mixture resulted in "bumping" of the lipid-containing solvent and was therefore not suitable for the purpose. On the other hand, the nitric acid mixture volatilized some of the phosphorus in the lipid extract and did not yield an accurate figure for the phosphate content.

The quantity of phospholipids in mixed cane juice was calculated indirectly by Honig[2] from the phosphate content of cane wax. He observed that crude cane wax contained 0·4–0·6% phosphate and the phospholipid content of juice was equivalent to 3–5 $\mu g$ phosphate per $cm^3$ which was precipitated in an unaltered form during clarification and removed from the juice along with the mud. His studies also suggested that the phospholipids in clarified juice usually do not exceed 2 $\mu g.cm^{-3}$. During the present studies, the total phospholipid content in clarified juice was found to be 1·6 and 2·2 $\mu g.cm^{-3}$ after carbonatation and sulphitation, respectively (Table III), results which were found to be nearly identical with those of Honig[2]. Juice composition varies with so many factors—variety of cane, maturity, climatic conditions, fertilization, etc.—that the phospholipid content may also be expected to vary.

Successful analysis of intact phospholipids present in cane juice was performed, without separating them from other lipids, by use of a thin-layer chromatographic technique. When subjected to TLC on silica gel, polar lipids like phospholipids are fractionated first while the remaining neutral lipids accumulate at the end of the solvent front (Fig. 1). This observation may also be confirmed by fractionation of a standard compound mixture.

It can be seen from Table V that raw cane juice contains 627 $\mu g.cm^{-3}$ of total phosphates comprising 72% inorganic phosphate and the rest organic. Upon carbonatation, about 76% of total phosphates are removed

[29] Balch & Broeg: *Sugar Bull.*, 1944, **22**, 106-127.

in contrast to only 65% removed by sulphitation. It should also be noted that during clarification more inorganic phosphates (82-73%) are removed than organic phosphates (60-43%).

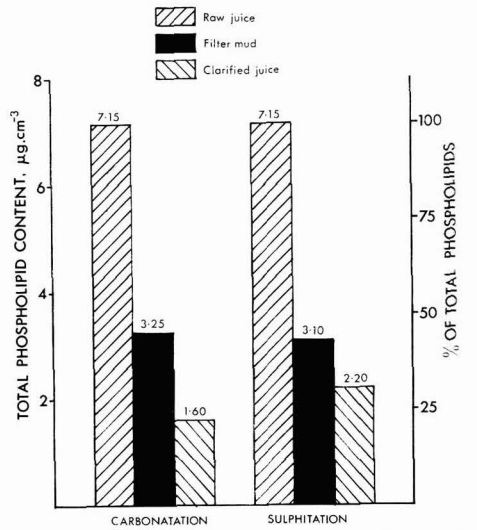


Fig. 2. Effect of clarification process on the total phospholipid content of cane juice

It is apparent from Tables V and III that total phospholipids in raw cane juice comprise a very small fraction (0·16%) of organic phosphates. When the juice is subjected to carbonatation and sulphitation, 45 and 43% of the phospholipids are removed in filter mud, leaving 22 and 31% in the clarified juice, respectively (Fig. 2).

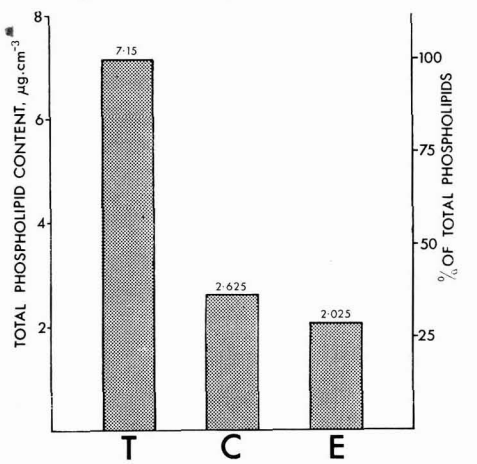


Fig. 3. Phospholipid constituents of cane juice: (T) Total phospholipids, (C) Phosphatidyl choline, (E) Phosphatidyl ethanolamine

The individual phospholipids, PC and PE, comprise 37 and 28% of total raw juice phospholipids (Fig. 3). Carbonatation and sulphitation remove 30 and 49% of PC in the filter mud, leaving 27 and 35% in the clarified juice, respectively (Fig. 4). Similarly, in the case of PE, 61 and 67% is removed in the filter mud, leaving 27 and 25% in the clarified juice (Fig. 5). Hence, it may be concluded that, in general, more PE than PC is removed from juice in clarification.

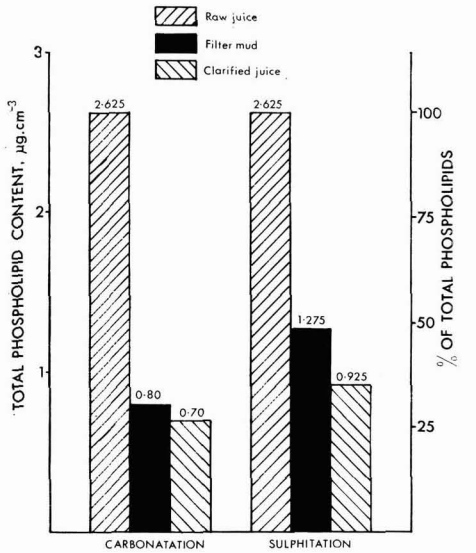


Fig. 4. Effect of clarification process on phosphatidyl choline content of cane juice

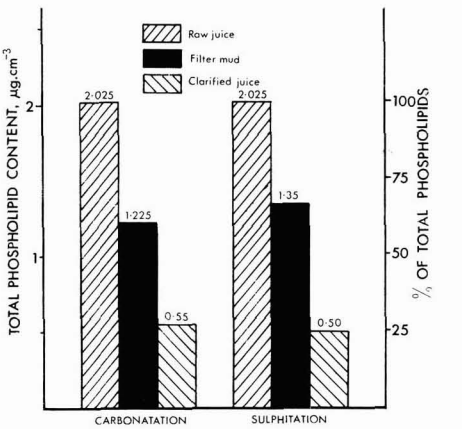


Fig. 5. Effect of clarification process on the phosphatidyl ethanolamine content of cane juice

The reduction in phosphate content of phospholipids clarification is possibly due to two factors:

1. It is possible that, during lime clarification, some of the phospholipids undergo small changes in chemical composition as well as in their solubility owing to the combined action of alkalinity and heat. The released phosphate may be acted upon in the same way as inorganic orthophosphate during removal of colloidal and colouring impurities by adsorption on the surface of thick calcium phosphate floc formed by the reaction with CaO in the added lime.

2. The phospholipids may be adsorbed on the surface of thick calcium phosphate floc and removed along with other impurities in the filter mud.

From the above data, it can be seen that the phospholipid contents in filter mud and clarified juice do not account completely for the content in raw juice. This is because of certain phospholipids which either were hydrolysed during the clarification process or were undetected during extraction and analysis.

Filter mud analysis also leads to the conclusion that some of the quantity removed during clarification was adsorbed on the surface of the floc and some was hydrolysed. Of the total phospholipids present in raw cane juice, 3·25 $\mu g.cm^{-3}$ was recovered from the carbonatation filter mud and 3·10 $\mu g.cm^{-3}$ from sulphitation filter mud. The overall removal of phosphate or phospholipids during clarification was found to be 32·16% in carbonatation and 25·8% in sulphitation. Among individual phospholipids, the overall removal of PC was about 42·85% in carbonatation and 16·19% in sulphitation, whereas only 12·34 and 8·64% PE was removed in carbonatation and sulphitation, respectively, indicating that carbonatation is more efficient.

Although the actual effects of clarification on the physical or chemical properties of the phospholipids have not been studied in detail, it is apparent from the above-mentioned data that these also play a part in the clarification phenomena.

## ACKNOWLEDGEMENT

The author is indebted to Dr. N. A. Ramaiah, Director, Dr. A. P. Gupta, Professor of Sugar Chemistry, and Dr. P. K. Agarwal, Biochemist, National Sugar Institute, Kanpur, India, for their ungrudging help and useful criticism. He is also grateful to the Ministry of Agriculture and Irrigation, Government of India, Department of Food, for the award of a fellowship.

## SUMMARY

Phospholipids were studied qualitatively and quantitatively in raw cane juice from variety Co 1148 by a thin-layer chomatographic technique using plates coated with silica gel "G". The total phospholipid content was calculated to be 7·15 $\mu g.cm^{-3}$ on raw juice. Among these phospholipids, phosphatidyl choline and phosphatidyl ethanolamine were identified and determined colorimetrically, their contents being 2·625 and 2·025 $\mu g.cm^{-3}$, respectively. The phosphate content of the phospholipid mixture and of individual phospholipids was also determined. Mixed phospholipids contained 0·286 $\mu g.cm^{-3}$ phosphate on juice, while phosphatidyl choline and phosphatidyl ethanolamine contained 0·105 and 0·081 $\mu g.cm^{-3}$ phosphate, respectively. The fate of the phospholipids during the clarification process was also studied using the same technique. It was observed that the carbonatation process removed a higher percentage of the total as well as of individual phospholipids than did sulphitation (32·16 *vs.* 25·87% total phospholipids, 42·85 *vs.* 16·19% phosphatidyl choline, and 12·34 *vs.* 8·64% phosphatidyl ethanolamine, respectively).

### Les phospholipides du jus de canne et leur sort au cours de l'épuration

Les phospholipides ont été étudiés qualitativement et quantitativement dans le jus brut de canne de la variété Co 1148 par une technique de chromatographie en couche mince avec utilisation de plaques à couche de silicagel "G". On a calculé que la teneur totale en phospholipides était de 7,15 $\mu g.cm^{-3}$ de jus brut. Parmi ces phospholipides on a identifié et déterminé colorimétriquement la phosphatidyl-choline et la phosphatidyl-éthanolamine, leur teneur étant de 2,625 et 2,025 $\mu g.cm^{-3}$ respectivement. La teneur en phosphate du mélange de phospholipides et celle des phospholipides individuels a également été déterminée. La teneur en phosphate du mélange de phospholipides était de 0,286 $\mu g.cm^{-3}$ de jus, tandis que la phosphatidyl-choline et la phosphatidyl-éthanolamine contenaient 0,105 et 0,081 $\mu g.cm^{-3}$ de phosphate respectivement. Le sort des phospholipides au cours de l'épuration a également été étudié par la même technique. On a constaté que la carbonatation élimine un pourcentage plus élevé à la fois de phospholipides totaux et individuels que la sulfitation (respectivement 32,16 contre 25,87% en phospholipides totaux; 42,85 contre 16,19% en phosphatidyl-choline et 12,34 contre 8,64% en phosphatidyl-éthanolamine).

### Phospholipide im Rohrsaft und ihr Schicksal während der Klärung

Phospholipide wurden qualitative und quantitativ in Rohrrohsaft der Sorte Co 1148 dünnschichtchromatographisch untersucht, wobei mit Silicagel "G" beschichtete Platten verwendet wurden. Der Gesamtgehalt an Phospholipiden im Rohrsaft wurde mit 7,15 $\mu g.cm^{-3}$ berechnet. Unter diesen Phospholipiden wurden Phosphatidyl-Cholin und Phosphatidyl-Äthanolamin identifiziert und kolorimetrisch zu 2,625 und 2,025 $\mu g.cm^{-3}$ bestimmt. Der Phosphatgehalt der Phospholipid-Fraktion und der einzelnen Phospholipide wurde auch bestimmt. Die Phospholipid-Fraktion im Saft enthielt 0,286 $\mu g.cm^{-3}$ Phosphat, Phosphatidyl-Cholin und Phosphatidyl-Äthanolamin enthielten jeweils 0,105 und 0,081 $\mu g.cm^{-3}$. Das Verhalten der Phospholipide in der Saftreinigung wurde mit der gleichen Technik untersucht. Man beobachtete, dass im Carbonatations-prozess insegesamt ein höherer Prozentsatz von einzelnen Phospholipiden entfernt wurde als im Sulfitationsprozess (32,16 statt 25,87% der Phospholipide insgesamt, 42,85 statt 16,19% Phosphatidyl-Cholin und 12,34 statt 8,64% Phosphatidyl-Äthanolamin).

### Fosfolípidos en jugo de caña y su hado durante clarificación

Fosfolípidos se han examinado cualitativemente y cuantitavemente en jugo crudo de caña de variedad Co 1148 por una técnica de cromatografía sobre capa delgada que emplea placas tratado con gel "G" de silice. El contenido de fosfolípidos estuvo 7·15 $\mu g.cm^{-3}$ de jugo crudo, por calculación. De estos fosfolipidos se han identificado fosfátido-colina y fosfátido-etanolamina determinado en cantidades de 2·625 y 2·025 $\mu g.cm^{-3}$, respectivamente. El contenido de fosfato de la mezcla de fosfolípidos y de fosfolípidos individuales se ha determinado también. Fosfolípidos mezclados contuvieron 0·286 $\mu g$ de fosfato por $cm^3$ de jugo mientras la fosfatido-colina y fosfatido-etanolamína contuvieron 0·105 y 0·081 $\mu g.cm^{-3}$ de fosfato, respectivamente. El hado de los fosfolípidos durante clarificación se ha estudiado también por uso de la misma técnica. Se ha observado que el proceso de carbonatación elimina un mayor porcentaje que sulfitación del total tanto como fosfolípidos individuales (32·16 contra 25·87% de fosfolípidos totales; 42·85 contra 16·19% de fosfatido-colina y 12·34 contra 8·64% de fosfatido-etanolamina, respectivamente). □

# SUGAR CANE AGRONOMY

**Effects of "Polaris" on growth and juice quality of sugar cane.** J. Fernandes, G. M. Azzi, D. Camposilvan, V. L. F. Neto and A. Kumar. *Proc. 16th Congr. ISSCT,* 1977, 1913-1922.—"Polaris" at 4 kg.ha$^{-1}$ was found after 110 days to increase pol % cane and total weight of juice and to reduce the reducing sugars % juice in cane. The maximum difference in pol % juice was obtained in the first six internodes and in reducing sugars in the first ten internodes from the top. "Polaris"-treated cane of variety IAC 48/65 can be sent to the mill without topping after a good burn in the field before harvest, or it can be topped higher than untreated cane.

**Ripening sugar cane with "Ethrel" plant growth regulator in Colombia.** H. Jaramillo, F. Schuitemaker and C. Garcia. *Proc. 16th Congr. ISSCT,* 1977, 1931-1936. "Ethrel" application at 2 litres.ha$^{-1}$ and 1 litre.ha$^{-1}$ plus surfactant increased sugar production per hectare in CP 57603 cane by 3% and 13%, respectively, over the controls over a period of 17 weeks. In other trials, application of 1 litre.ha$^{-1}$ plus surfactant and plus 20 kg.ha$^{-1}$ of urea gave increases of 19·7% and 6·4% in CP 57603 cane, while 2 litres.ha$^{-1}$ "Ethrel" and 1 litre.ha$^{-1}$ plus surfactant gave increases of 26% and 65%, respectively, with POJ 2878 cane.

**Varietal differences affecting nitrogenase activity in the rhizosphere of sugar cane.** A. P. Ruschel and R. Ruschel. *Proc. 16th Congr. ISSCT,* 1977, 1941-1947. Nitrogenase (ethylene) activity was estimated in roots, germinated cuttings and whole cane plants (2 months old) in intact and disturbed systems, under low and normal (air) oxygen atmosphere. Strong evidence of a genetic effect on nitrogenase activity of the sugar cane rhizosphere was observed; this activity was high for NA 56-79 and CB 46-47 varieties and almost nil in CB 41-76 cane. Correlation between rhizosphere nitrogenase activity and the leaf N content was postulated. The rate of nitrogenase activity increased with time in NA 56-79 and CB 46-47. Nitrogenase activity was observed in roots and in germinated cuttings without roots and shoots.

**The effect of surfactants on the effectiveness of "Sencor".** H. J. Yeh. *Taiwan Sugar,* 1977, **24,** 457-460. Investigations showed that surface-active agents added to "Sencor" post-emergence herbicide (recommended for control of broad-leafed weeds and certain annual grasses in cane) applied to pot-grown corn enhanced its herbicidal activity and increased its resistance to washing-off by rain.

**Irrigation of sugar cane.** Anon. *Bull. Expt. Sta. S. African Sugar Assoc.,* 1977, (17), 28 pp.—The irrigation of sugar cane by furrow or sprinkler systems is described in detail with the aim of advising growers in rain-fed areas on how to determine whether irrigation is warranted, helping farmers (especially in semi-arid areas) to plan and control irrigation schemes, and providing a general background to the subject for all growers. The theme is treated under the following headings: supplementary and total irrigation; factors affecting irrigation; amount of water required; methods of irrigation; design of irrigation schemes; irrigation control; and other factors relating to irrigation (including water quality, drainage, water table, leaching requirement, trashing and burning of the cane crop, effect of irrigation on cane sucrose content, drying-off, and the cost of irrigation).

**The sugarman.** E. Lorduy. *The Furrow,* 1978, (March/April), 14.—Mention is made of a Spanish farmer in the province of Málaga who combines beet with cane growing. The cane is ploughed-out every 5 years and the land then fallowed for 1-3 years; the decision on whether to grow beet or not is made on a year-to-year basis. Both beet and cane are processed at the same factory.

**A parametric approach to evaluation of soil productivity for land use planning and crop development.** A. A. Tomaneng. *Sugarland* (Philippines), 1977, **14,** (5), 10.—See *I.S.J.,* 1978, **80,** 271.

**Field losses in sugar cane production through cane drying, burning and delayed harvest.** M. Ilaga. *Sugarland* (Philippines), 1977, **14,** (5), 11, 20.—See *I.S.J.,* 1978, **80,** 271.

**Application of plant growth substances to improve germination and yield of ratoon cane.** S. Y. Peng and L. T. Twu. *Taiwan Sugar,* 1978, **25,** 8-17.—In an attempt to find ways of improving the yield of ratoon crops in Taiwan, pot and field experiments were carried out with CCC (chlorocholine chloride) growth regulator. At three sites, application of 10 litres a.i. per ha increased the number of tillers and cane yield by considerable amounts, far greater than results given by "Ethrel" at 5, 10 or 15 kg.ha$^{-1}$. Lower CCC dosage rates were not as effective as the 10 litres.ha$^{-1}$. These results were achieved in December-February when low temperatures usually retard ratoon cane germination by 1 month. CCC application did not affect sugar formation. Good chemical weed control was found to be necessary for CCC to be effective; herbicide could be applied separately or in a mixture with CCC. A high rate of N application was found to weaken the cane and render it highly sensitive to CCC.

**Narrow-row spacing of sugar cane.** R. J. Matherne and J. E. Irvine. *Sugar J.,* 1978, **40,** (10), 40-41.—See *I.S.J.,* 1978, **80,** 305.

**Considerations on the irrigation of sugar cane.** A. J. Gonzalez. *La Ind. Azuc.,* 1978, **85,** 32-34 (*Spanish*).—Aspects of the use of supplementary irrigation in dry periods, to maximize cane production, are discussed and reference made to a number of books on the subject. The influence of the nature of the soil and the quality of the water are referred to and the water needs of cane and its constitution discussed, with brief mention of the methods of irrigation used in Puerto Rico, Peru and Mexico.

**Index of weed cover in the action of "Diuron 80" in mixed form.** D. P. Yamit and J. J. Rizo. *ATAC*, 1977, **36**, (4), 10-15 (*Spanish*).—Plots estimated visually to have 20, 40 and 60% weed cover in cane were sprayed with three mixtures of "Ametryne" and "Diuron" in order to achieve control of the weeds, mainly *Rottboellia exaltata* (90%) but also *Cyperus rotundus* and *Echinoclea colonum*. The cane was harvested at 10 months and cane and sugar yields recorded. Best results were obtained with a combination of 2·0 kg "Ametryne" and 2·4 kg "Diuron" per ha, which gave 90% control in the plots with 20% weed cover and 87% control in those with 40% weed cover up to 60 days after the last application.

**Behaviour of three cane varieties under irrigation and dry conditions.** E. Llerena, R. González, J. Ruíz and H. Fernández. *ATAC*, 1977, **36**, (4), 30-38 (*Spanish*). Three cane varieties were grown under rainfed and two supplementary irrigation regimes, with measurements of yields of cane and sugar at harvest after 15 months. It was clear from the results that differences were negligible as between varieties and the two regimes by comparison with the difference between irrigated and non-irrigated cane. Rational application is necessary to avoid excessive use of water and further work is needed to determine the optimum conditions of irrigation.

**Effect of "Polaris" on the agricultural yield of sugar cane.** J. Fernandes, D. Camposilvan and V. L. F. Neto. *Brasil Açuc.*, 1977, **88**, 343-350 (*Portuguese*).—Dosages of 4-6 kg.ha$^{-1}$ of "Polaris" were applied aerially to cane on 34 commercial fields in the states of Paraná and São Paulo. The cane included 13 varieties and both plant and ratoon crops. All the trials provided an increase in sugar yield although the results differed with variety and vegetative conditions. The best result was an increase of 3·979 kg.ha$^{-1}$ of sugar against a control plot yield of 13·498 kg.ha$^{-1}$.

**Study of the interference of flowering on the agro-industrial qualities of some sugar cane varieties.** J. C. Salata and L. J. Ferreira. *Brasil Açuc.*, 1977, **88**, 351-356 (*Portuguese*).—Considerable numbers of stalks of cane, flowering and non-flowering, of four varieties were examined to establish differences between them which would be attributable to flowering. It was not possible to generalize as to whether a flowering cane would cause problems, and further study is needed to establish the additional influence of weather. Flowering does not reduce the sugar % cane but reduces the volume of juice and gives a higher quantity of "gums". The reduction in juice volume is a varietal characteristic and is greater (51·5%) with IAC 48-65 than with IAC 52-150 (37·5%). The varieties NA 56-62 and IAC 51-205 present little difficulty as a consequence of flowering and, while IAC 48-65 is defective because of the loss of juice, its good performance on sandy soils means that it is desirable to continue to plant it in such areas while seeking a means of inhibiting flowering.

**Analysis of sugar cane growth.** P. R. C. Castro, A. A. Lucchesi, E. Alves and S. B. Paranhos. *Brasil Açuc.*, 1977, **88**, 358-362 (*Portuguese*).—Two varieties were grown under greenhouse conditions and their growth analysed in terms of dry matter production, leaf area and leaf area ratio, net assimilation rate and relative growth rate. The variety CB 41-76 showed higher dry matter production, leaf area and net assimilation rate, although NA 56-79 showed a higher leaf area ratio and the relative growth rate was almost identical on average for both varieties.

**Fertilization of sugar cane ratoons with vinasse supplemented with nitrogen and phosphorus.** J. A. Magro and N. A. da Glória. *Brasil Açuc.*, 1977, **88**, 363-366 (*Portuguese*).—Trials were carried out on two dark red latosols with different levels of extractable P, and varying amounts of N and P in the form of mixed triple superphosphate and diammonium phosphate added to vinasse used as fertilizer. The results showed no favourable effects from the supplementary nutrients.

**Advances in the chemical control of weeds in sugar cane in Argentina.** R. A. Arévalo. *La Ind. Azuc.*, 1978, **85**, 60-61 (*Spanish*).—The development of chemical weed control in Argentina from its commercial introduction in 1960 is described, as are the techniques applied by small growers (less than 8 ha) and larger growers. The large growers (more than 500 ha) treat 90% of their cane area while middle-sized growers (between 8 and 500 ha) treat 50%; small growers treat only 20% of their cane area. Treatment is better established (73%) in Salta and Jujuy than in Tucumán and the Litoral (40%). Usage of individual herbicides in 1960, 1969 and 1977 is tabulated.

**Flat planting of cane.** L. L. Lauden. *Sugar Bull.*, 1978, **56**, (9), 4.—Research is being conducted on planting of cane in lines 2 ft apart on flat land without use of ridges or water furrows. On three plots of 6-8 acres in Louisiana, the cane stands were good, despite unsatisfactory covering of the planted seed cane; experiments over a 3-year period at the USDA Experiment Station near Houma have shown that cane yields can be more than doubled by the planting method. Problems with opening of the planting furrows and in covering of the seed cane remain, although a number of ideas are being tested and improvements are expected. One cane harvester manufacturer has shown interest in helping to develop tools for the work. At Louisiana State University, planting methods to increase stalk population are being studied, including planting of cane in 1, 2, 3, 4 and 5 drills on flattened conventional rows. The 3-drill system has shown promise.

**Fertilizer and soil fertility practices for sugar cane production in Louisiana, 1978.** O. D. Curtis, D. T. Loupe, L. E. Golden and R. Ricaud. *Sugar Bull.*, 1978, **56**, (9), 8-11.—Recommendations are given on rates of N, P, K and S to apply. Soil fertility improvement practices mentioned include application of lime, filter cake and gypsum.

**The control of Johnson grass and other weeds in Louisiana sugar cane, Spring 1978.** D. T. Loupe, L. L. McCormick, R. Millhollon and E. R. Stamper. *Sugar Bull.*, 1978, **56**, (11), 8-17.—Recommendations are given on chemical control of Johnson grass, Raoul grass (itch grass), browntop panicum, and Bermuda grass. An appendix lists the common, trade and chemical names of the pre- and post-emergence herbicides used in the treatments.

# CANE PESTS AND DISEASES

**Behaviour of the adults of the root froghopper *Mahanarva fimbriolata* (Stal, 1854) (Hom.: Cercopidae) according to climatic parameters.** A. de C. Mendes, P. S. M. Botelho, N. Macedo and S. S. Neto. *Proc. 16th Congr. ISSCT,* 1977, 617-631.—By means of seven light traps, examined twice weekly during three years, the population fluctuations of the froghopper *M. fimbriolata* were studied at Araras Experiment Station, São Paulo, and related to climatic conditions employing statistical techniques. The froghopper was found during November-April, with peak population in the first two weeks of March. Climatic factors influenced the mean population curve to the extent of 80·8%, of which 55·9% was due to soil temperature.

**Seasonal fluctuations in the populations of nematodes associated with sugar cane and their control.** K. Singh and S. R. Misra. *Proc. 16th Congr. ISSCT,* 1977, 633-642.—Population studies over two years of nematodes in a sandy loam cane soil of the Indian Institute of Sugar Cane Research, Lucknow, showed that numbers fell between March and June to fairly low levels but then increased between July and October with the monsoons, falling again between the summer months of October to January, followed by another peak in February. There were variations between population changes of different genera, *Tylenchorhynchus* spp. and *Pratylenchus* spp. showing the most pronounced changes. Application of nematicides might be most effective when applied towards the end of summer, when the populations are lowest. Tests of nematicides indicated that "Dasanit" at 20·kg.ha$^{-1}$ was the most efficient, as it reduced the nematode population greatly and had a residual action as well as helping to control top borer and shoot borer. DD, "Vapam" and "Nemagon" were less preferable, in that order. The nematode population had recovered in all cases by harvest date, however.

**Ecological notes on the sugar cane froghopper *Mahanarva fimbriolata* (Homoptera: Cercopidae) in São Paulo State, Brazil.** M. K. El-Kadi. *Proc. 16th Congr. ISSCT,* 1977, 663-670.—A survey was made of infestation with *M. fimbriolata* in a 3-ha plantation, counts being made weekly of infested and uninfested stools per 10 m of row and the insect counts recorded from one infested stool, classifying 1st to 4th instar nymphs and adults. This procedure was followed in ten random locations in the plantation. The initial instars commenced in November as long as environmental conditions remained favourable (high humidity and minimum soil temperature 15°C). The insect passes through three generations between November and May with the highest population in the second generation, in January and February. While first and second generations did not overlap, this did occur with the second and third generations.

**Influence of climatic factors on the population fluctuations of the sugar cane moth borer *Diatraea saccharalis* (Fabr. 1794) (Lep.: Crambidae).** P. S. M. Botelho, A. de C. Mendes, N. Macedo and S. S. Neto. *Proc. 16th Congr. ISSCT,* 1977, 643-655.—Light trapping was used to study population fluctuations of *D. saccharalis* at Araras Experiment Station, São Paulo, over three years, and the variations correlated with meteorological data. Adults were found to be present throughout the year but populations varied, with a peak in the second two weeks of August and two secondary peaks in the first two weeks of January and the second two weeks of March. Meteorological factors are responsible for 41·3% of the population fluctuations, temperature variation being responsible for 27·8% of this.

**Management of populations of *Diatraea saccharalis* (Fabr. 1794) (Lepidoptera: Crambidae) in sugar cane fields of São Paulo, Brazil.** F. O. Teran and W. R. Novaretti. *Proc. 16th Congr. ISSCT,* 1977, 671-687.—An account is given of activities in two mill areas since 1974 for the control of the stalk borer *D. saccharalis,* including infestation surveys, population surveys and directed releases of borer parasites (mainly *Metagonistylum minense*). Organization and integration of these activities have made it possible to pinpoint in advance zones where corrective measures have to be applied and has made possible satisfactory control of the borer. The main feature of this scheme is the protection and management of natural enemies which are responsible for preventing widespread, severe infestations in the cane fields of São Paulo. Application is also being made of basic knowledge on other ecological factors, mainly concerned with variations in host plant culture, which would normally favour severe borer infestations and corresponding losses of cane and sugar.

**Susceptibility of the main commercial sugar cane varieties to the moth borer *Diatraea saccharalis* (Fabr. 1794) in Southern-Central Brazil.** N. Macedo, A. de C. Mendes and P. S. M. Botelho. *Proc. 16th Congr. ISSCT,* 1977, 693-701.—A randomized design, with four replications, to determine the susceptibility of 16 cane varieties to moth borer attack in four locations over three crops, was carried out in 1973/75. The varieties showed different degrees of susceptibility, the most resistant being IAC 50-134, CB 45-155, CB 56-156 and Co 775, intermediate ones being CB 53-98, Co 740, CB 49-260, CB 61-80, CB 47-355, CB 56-171 and IAC 51-205, and the most susceptible varieties being IAC 52-150, CP 51-22, NA 56-62, IAC 52-326 and CB 41-76. Plant cane was the most often attacked in all the localities, and the period of highest infestation was July, for all years and all localities. The localities showed different infestation levels, the highest being in the Bom Jesus mill area.

**Introduction and rearing of *Apanteles flavipes* Cameron (Hym.: Braconidae) in Brazil.** A. F. Mendonça, S. H. Risco B. and J. M. B. Costa. *Proc. 16th Congr. ISSCT,* 1977, 703-710.—An account is given of the successful introduction of *A. flavipes* from Trinidad since 1974, at first in Alagoas and subsequently in all parts of Brazil. The parasite has rapidly adapted to the cane plantations of Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Bahia and Rio de Janeiro for control of *Diatraea* spp. A smaller recovery of releases has been obtained in Sergipe although establishment has been confirmed. It appears that in São Paulo and Amapá

*A. flavipes* has become adapted, although more slowly than elsewhere in Brazil.

**Activity patterns of *Mythimna phaea* Hamps., *Athetis ignava* Gn. and *Simplicia extinctalis* Zell. (Lepidoptera: Noctuidae) which infest trashed sugar cane fields.** A. J. M. Carnegie. *Proc. 16th Congr. ISSCT,* 1977, 711-718.—Between 1971 and 1976 light trap records were kept of the three title moths, the caterpillars of which during the day remain under the trash blanket from unburnt harvested cane, emerging at night to feed. The *M. phaea* moths were most plentiful in March-June, with a second, smaller peak around September, these peaks being followed by fields outbreak of caterpillars. Moths of *S. extinctalis* were most plentiful in October-March. The *M. phaea* caterpillars fed on the living cane while the other two species fed on dry trash and associated fungi. In laboratory cultures, larvae of *A. ignava* frequently ate neither growing cane nor dry trash, although cannibalism sometimes occurred.

*Pulvinaria iceryi:* **a potential pest of sugar cane in Réunion.** J. Etienne. *Proc. 16th Congr. ISSCT,* 1977, 719-728.—The scale insect, *P. iceryi,* usually lives on wild grasses and moves to sugar cane when its host plants are destroyed by various factors including severe drought or by use of chemical herbicides. When it moves on to cane its fecundity is greatly increased and an unexpected outbreak can occur. The cane leaves show a characteristic yellow coloration, sometimes with purple lines according to variety, before drying up; the shoots are stopped and the stools die. In Réunion outbreaks of *P. iceryi* are rapidly stopped by the beneficial action of chalcidoid parasites and damage is not important at present. However, attacks have been increasing in recent years, and upsetting the balance between the insect and its parasites could be very harmful to the sugar industry. Care with the application of insecticides in cane areas is consequently recommended.

**Sampling, distribution and natural control of *Diatraea* spp. on sugar cane and grasses in Trinidad.** W. G. des Vignes. *Proc. 16th Congr. ISSCT,* 1977, 729-735.—Observations were conducted on the distribution and sampling of larval populations of *Diatraea* spp., its parasites and hyperparasites on sugar cane and grasses in four areas of Trinidad using a stratified random sampling technique on cane and sequential sampling on grasses. Taylor's power law indicated that the index of aggregation varied little in different strata of a cane field. The number of samples to be collected at given levels of error was estimated. The total number of larvae collected in the five strata was generally well correlated with the smaller composite sample. Regression analyses showed a very highly significant positive relationship between number of *Diatraea* collected on cane and the *Paratheresia claripalpis* population and a very highly significant negative relationship between the number of *P. claripalpis* and the hyperparasite population. It has been suggested that the minor parasite population may have been recently reduced and the "natural control" of the pest become less effective than formerly.

**Artificial rearing and virgin female trap of the yellow borer moth, *Eucosma schistaceana* Snellen (Lep.: Olethrentidae).** Y. Ito and M. Kinjo. *Proc. 16th Congr. ISSCT,* 1977, 737-744.—The yellow borer moth was successfully reared under aseptic conditions through three generations on an artificial diet including powdered sugar cane tissues. Traps baited with virgin females attracted many male moths, suggesting the possibility of using the sex pheromone for forecasting the abundance of moths.

**The effects of borers and rot diseases on the quality of sugar cane.** G. M. de A. Silva and R. S. de Moraes. *Proc. 16th Congr. ISSCT,* 1977, 745-754.—The characteristics of sugar cane determining its quality were measured for samples attacked by the combination of borer and rot disease, and the quality loss correlated with the extent of attack. Brix and pol % cane were significantly reduced, with losses of 3·09% and 4·74% on the original pol for cane with 10% infestation in 1974 and 1975, respectively. The reducing sugars content and fibre % cane were higher in damaged stalks in both seasons, so that the losses in sugar production are due not only to a smaller sucrose content but also to the reduction in recovery compared with cane of normal quality.

**Losses by *Anacentrinus insularis* Buch. and related fungal diseases on sugar cane.** R. Acosta B. and F. A. Rodríguez. *Proc. 16th Congr. ISSCT,* 1977, 759-771. Small pieces of weevil-attacked sugar cane were cultivated during 10 days in Czapeck culture media so as to examine the fungi present. The samples came from 56 mill areas throughout Cuba and included cane of three varieties, and the results showed that the fungal disease attacks were associated with weevil damage. On the basis of 84 samples of three and six stalks of three varieties, with four replications, plant and ratoon crop, grown on three soils, a rating scale of 0 to 8 was developed (although the maximum damage encountered was rated as 4). When decreases in the parameters examined (weight, purity and sugar content of cane) were compared by means of the Student t-test, the decreases obtained showed, in 65% of the cases, significant differences ranging from 1 to 5%.

**National programme of biological control of the sugar cane borers *Diatraea* spp. in Brazil.** S. H. Risco B. *Proc. 16th Congr. ISSCT,* 1977, 797-817.—An account is given of the work carried out during the first two years, 1975/76, of the programme devised by Planalsucar for control of the borer (*Diatraea* spp.) in Brazil. Studies have been made of the pest's biology, behaviour, natural enemies, etc., and the advantage of utilizing the complex of natural enemies has been assessed. The paper also discusses the introduction of the Cuban fly, *Lixophaga diatraea* T., and the Indian wasp, *Apanteles flavipes* C., the latter yielding good results in the control of the borer.

**Complex of borers (*Diatraea* spp.) which affect the sugar cane crop in the Tocuyo Valley, Venezuela.** E. N. Morales and N. Falcon C. *Proc. 16th Congr. ISSCT,* 1977, 819-824.—Studies during 1976 have shown the presence of five borer species: *D. busckella, D. centrella, D. saccharalis, D. impersonatella* and *D. rosa,* which affect cane to an infestation intensity of 12·19% averaged for the 3000 ha of cane land in the Tocuyo Valley. The principal natural enemy is the Amazon fly, *Metagonistylum minense,* which achieves 24·15% parasitization.

# CANE BREEDING AND VARIETIES

**The morphology and cytology of *Saccharum officinarum* L. indigenous to the Philippines.** N. S. Diviniagracia and D. A. Ramirez. *Proc. 16th Congr. ISSCT,* 1977, 211-225.—Of the seven varieties of *S. officinarum* indigenous to the Philippines, morphological and cytological examinations show the existence of four groups based on chromosome number: Group I (Negros Purple and Luzon White — 2n = 80), Group II (Cebu Purple and Zambales White — 2n = 120), Group III (Palawan White — 2n = 128) and Group IV (Pampanga Red and Hilongos — 2n = 136). Chromosome mosaics were observed in the somatic cells both from root tips and microsporocytes. Pachytene analyses showed normal pairing in all the varieties except for some chromosomes of Pampanga Red which exhibited loose pairing. Although bivalents were predominant in all cells at diakinesis and metaphase I, univalents and multivalent associations were also observed, which indicated partial homology among *Saccharum* chromosomes. Laggards and bridges were the chromosome aberrations observed at anaphase I and telophase I.

**Studies on successive inbred generations of selected sugar cane cultivars.** A. S. Ethirajan, P. N. Santhakumariamma and N. Velayutham. *Proc. 16th Congr. ISSCT,* 1977, 269-273.—A critical clonal evaluation of more than 250 first-generation inbreds of six cultivars was made. Segregants among the selfed population, which were significantly superior to their respective progenitors in yield and quality, were isolated. There was greater phenotypic stability in the performance of these selfs in regard to their sugar content. Repeated cycles of selfing in Co 775 and CP 44-101 gave indications of concentration of genes for quality. The potentiality of the selected inbreds as genetic stocks for breeding high quality types was indicated.

**Cytogenetical studies of interspecific and intraspecific hybrids of *Saccharum*.** P. A. Kandasami. *Proc. 16th Congr. ISSCT,* 1977, 251-267.—The character "oldness of the spikelet pair" in *S. officinarum* and *S. spontaneum* breeds true. It is observed that this character is inherited maternally in the hybrids of the interspecific reciprocal crosses of the two species. When the $F_1$ hybrids of *S. officinarum* × *S. spontaneum* are crossed with *S. spontaneum* as male parent, all the hybrids possess the spikelet pair in which the pedicelled one is older than the sessile, a character of the male parent. The second nobilization cane (first back-cross to *S. officinarum*) also behaves just like the first nobilization cane in the transmission of this character to its progeny when pollinated with *S. spontaneum*. The gametic behaviour in intraspecific crosses of *S. officinarum*, interspecific crosses of *S. officinarum* × *S. spontaneum* and its back-cross to both the parents, namely $F_1$ × *S. spontaneum* and *S. officinarum* × $F_1$, has been studied. The gametic behaviour in the crosses *S. officinarum* × *S. officinarum* "types" and *S. officinarum* "types" × *S. spontaneum* has also been studied. Based on the gametic behaviour and oldness of the spikelet pair of the eleven clones (*S. officinarum* "types") in crosses with *S. officinarum* and *S. spontaneum*, their genuineness or otherwise (whether they are *S. officinarum* clones or not) is pointed out. The hybrid nature of these eleven clones is also discussed. The hybrid nature of the three *S. robustum* clones (28 NG 289, 51 NG 70 and 51 NG 91) is deduced from their cytological behaviour and the probable species involved in the origin of these clones are discussed.

**Phenotypic stability of some sugar cane varieties (*Saccharum* spp.) in Brazil.** R. Ruschel. *Proc. 16th Congr. ISSCT,* 1977, 275-281.—The results of plant cane harvests of three groups of varieties, at Campos Experiment Station during 1956/57, 1964 and 1970, are analysed. Mean varietal yields were compared with mean test yields in different locations under a range of environmental conditions and regression coefficients and yield differentials plotted on coordinate axes. The variety CB 45-3 showed a decrease in yield over the periods studied but, in relation to the three groups tested, it maintained an excellent level of stability, which recommends it as a standard for clone selection. From the results, it was concluded that the mean of the varieties CB 45-3 plus CB 56-20 provides a good standard of comparison for cane yield per hectare in the selection of new varieties in the State of Rio de Janeiro.

**Aspects of the use of *Saccharum spontaneum* in the West Indies programme.** D. I. T. Walker, D. MacColl and P. S. Rao. *Proc. 16th Congr. ISSCT,* 1977, 291-303. Many forms of *S. spontaneum* are being used in a genetic base-broadening programme in the West Indies. Some problems and preliminary results in this breeding programme are described. Flowering time is broadly related to the latitude of origin; most forms have responded to photoperiod manipulation. About 90% of hybrids have 2n + n chromosome contributions from noble cane and *S. spontaneum*, respectively. Nobilizations exhibit a wide range of adaptability, fibre and sugar contents, those from certain *S. spontaneum* forms being superior and others inferior. Resistance to smut disease in nobilizations was low overall but a few *S. spontaneum* forms or combinations among pairs of these may be promising sources of resistance.

**Frost resistance of sugar cane clones and varieties. A study of some progenies.** R. Cesnik, A. I. Bassinello and F. F. S. Oliveira. *Proc. 16th Congr. ISSCT,* 1977, 305-314.—More than 20,000 seedlings from 27 distinct polycrosses were watered and then frozen for three hours at temperatures between —4° and —9°C, and then planted-out in normal conditions of 10-30°C. Clones from unfrozen and frozen seedlings, as well as unfrozen clones and commercial cane varieties, were planted in the field and observations made of the chlorotic bands along the margin of the leaves. The polycross progenies of L 62-96, CP 47-49 and Co 678 showed good cold resistance under this treatment. No chlorotic bands were observed with F 141 or US 59-16-1 but their descendants showed high susceptibility and moderate resistance, respectively. The data obtained from this and similar studies will permit planning of crosses for introduction of genes which provide cold resistance and high economic value.

# SUGAR BEET AGRONOMY

**The effect of some herbicides on the chemical composition of sugar beet grown on a boggy, peaty soil.** T. Banaszkiewicz and H. Kozaczenko. *Gaz. Cukr.*, 1978, **86,** 21-22 (*Polish*).—Two-year trials showed that on peaty soils, application of "Venzar", "Pyramin", "Betanal" and "Antyperz" at various dosage rates and in various combinations tended to cause a rise in the $Na_2O$ content and a fall in the CaO and $K_2O$ contents by comparison with untreated controls; MgO and N were little affected. Both root yield and sugar content were enhanced by herbicide application.

**The quality of roots of irrigated beets on light soils.** J. Simon. *Listy Cukr.*, 1978, **94,** 49-54 (*Czech*).—In field tests carried out on light soils in 1971-74, the accumulation of sugar, ash and amino-nitrogen was investigated under various irrigation regimes (0, 20, 40 and 60% of utilizable soil water) and N application rates (120, 180 and 240 kg.ha$^{-1}$). Irrigation had a negative effect on sugar content, particularly in drier years when the amount applied exceeded 200 mm. At the highest rate tested (60% of utilizable soil water) the ash and amino-N contents in the root fell, while increased N application had a negative effect on sugar content in interaction with irrigation. Maximum sugar yield (9·61 tonnes.ha $^{1}$) was achieved at the highest irrigation rate and lowest N rate, while the lowest sugar yield of 4·86 tonnes.ha$^{-1}$ occurred at highest N rate and no irrigation.

**Beet cleaning at the clamp.** J. Pichenez. *Sucr. Franc.*, 1978, **119,** 182-191 (*French*).—While climate is the dominant factor affecting the amount of soil taken up with the beets during harvest (a large part of the harvest in France occurring in wet, and hence muddy, conditions), other factors also play a role, including type of soil, beet population (a high population being associated with small beets which are difficult to clean without risk of considerable losses) and beet fanginess, which increases soil retention. The effect of harvester type on the dirt tare is discussed, followed by a brief examination of the advantages and disadvantages of beet cleaning as part of the harvesting operations; tests have shown that a Soviet 6-row harvester gave a dirt tare half that given by a French SMC system but a beet weight loss which was double that with the SMC. Comparison of different systems show dirt tares ranging from 34·72% to 50·48% at reception. with losses in the range 2·42-3·63%. It is considered that a maximum reduction of dirt tare together with the advantages of harvesting with modern equipment will be accomplished only by cleaning the beets as they are taken from the clamp by cleaner-loader to road transport. The performances of various types of cleaner are discussed with the aid of tabulated data, showing reductions in dirt tare normally of the order of 30-50% at beet losses below 1%. The economics are briefly examined. It is finally pointed out that the amount of soil removed from a beet field represents a considerable quantity of important minerals and organic matter.

**How to carry out weed control in maize while considering subsequent crops: winter wheat and sugar beet.** W. Haquenne. *Le Betteravier,* 1978, **12,** (119), 11 (*French*).—A warning is given that use of a herbicide such as "Atrazine" in winter wheat can, under certain conditions, have a marked adverse effect on a subsequent beet crop; the circumstances in which this can occur are a summer and winter of low rainfall and two applications of the herbicide or one late application at a higher dosage rate. Advice is given on the most suitable herbicides to apply; if "Atrazine" or "Simazine" is used as pre-sowing or pre-emergence treatment, the dosage rate should not exceed 2·5 kg.ha$^{-1}$, and neither should be used as post-emergence herbicide, a foliar spray being applied where complementary treatment is necessary. "Bladex" and "Bellater" have a less persistent action than "Atrazine" or "Simazine", but they are also less phytotoxic. "Lasso" and "Sutan" as pre-sowing herbicides (the former also usable as a pre-emergence treatment) do not endanger subsequent crops when used at their normal dosage rates.

**Post-emergence weed control in sugar beet.** J. M. Belien and J. F. Salembier. *Le Betteravier,* 1978, **12,** (119), 12-13 (*French*).—Advice is given on complementary and emergency post-emergence treatment. Splitting the contact herbicide "Betanal" into two equal doses for successive application (the second possibly in combination with a soil herbicide) is a new technique which is mentioned.

**Greater safety in N fertilization of sugar beet using the "Nmin" method?** H. C. Scharpf and J. Wehrmann. *Die Zuckerrübe,* 1978, **27,** (3), 18-19 (*German*).—In order to avoid excessive N application to beet, the authors recommend a system in which the soil N content is determined and no more N applied than is necessary to meet a given total requirement at a given time, allowing for the N taken up from the soil supply. The question is discussed of whether to analyse the soil twice (in March and May), which gives the best information and provides for greatest control of N fertilization but is time-consuming, or whether to analyse only once (in March or May), which is subject to greater error. The importance of dividing the amount of N applied into that required for seed and that needed for the growing beet is stressed. Recommendations are given for N application where specific rotations are followed.

**Results of an investigation on sugar beet cultivation in a polluted environment (the Plain of Garet in Eastern Morocco).** C. Mathieu and F. W. Hesse. *Sucr. Maghrébine,* 1977, (21-22), 32-41 (*French*).—Investigations were conducted into the effect on beet quality of soil salinity of varying degrees up to extremely high and of phreatic irrigation water salinity. Of the samples taken from five plots at harvest, only those from two plots were of passable quality, while the others were classed as mediocre, very poor and unusable. It is recommended to sow early and harvest either in May or early June and thereby avoid the increase in sodium content and glucose number in July, which causes a considerable increase in molasses losses.

# BEET PESTS AND DISEASES

**Fungicidal protection against powdery mildew in beet culture.** P. Meeus. *Publ. Trimest. Inst. Belge Amél. Betterave,* 1977, **45,** 131-141 (*French, Dutch*).—Tests conducted in 1976 with seven fungicides are reported. All the treatments reduced the intensity of powdery mildew at four sites; root yields were thus increased, while sugar content was not affected. However, since the outbreak of the disease in 1976 was small, no conclusion could be drawn on comparative fungicide performance. Moreover, the time of application was important in assessing effectiveness of treatment. Application when 90% of the beets first showed symptoms of the disease, as carried out in the tests, is recommended as a means of keeping the incidence at a sufficiently low level.

**Insecticide treatments at sowing.** L. van Steyvoort and E. Seutin. *Le Betteravier,* 1978, **12,** (117), 12A (*French*). While most of the organo-chlorine compounds such as "Heptachlor" and "Aldrin" have been banned in Belgium, it is pointed out that granular products currently available are less effective, so that there is risk of recurrence of such insects as wireworm (*Agriotes* sp.) and pygmy mangold beetle (*Atomaria linearis*) after 15 years of use of the organo-chlorines had practically eliminated all the pests associated with drilling time. "Temik 10 G" at 10 kg.ha$^{-1}$ gives very good control of aphids and hence beet yellows as well as the mangold fly (*Pegomya hyoscyami*) but is very weak against wireworm; "Dacamox 10 G" at 10 kg.ha$^{-1}$ is equally effective against aphids but is weak against the mangold fly, while its effect on wireworm has yet to be determined in Belgium. "Curater 5 G" at 15 kg.ha$^{-1}$ is highly effective against both mangold fly and wireworm but is inadequate for aphid control. None of the three has yet shown capability of controlling other pests (pygmy mangold beetle, millepedes or symphalids) at drilling time. Advice is given on when and where to use the insecticides; a warning is given about over-application of "Dacamox", which at excessive rates is phytotoxic to beet (on the other hand, too low an application rate reduces its effectiveness).

**A laboratory study on the ability of fungicides to control beet rotting fungi.** W. G. Miles, F. M. Shaker, A. K. Nielson and R. R. Ames. *J. Amer. Soc. Sugar Beet Tech.,* 1977, **19,** 288-293.—The effects of fungicides on *Rhizopus* spp., *Botrytis* spp., *Fusarium* spp. and *Penicillium* spp. isolated from beets were determined. Of three methods tested, the best was found to be one in which the fungicide was added to mycophil agar just before it was poured into petri dishes, plain mycophil agar plates being used as controls. A 4-mm agar plug containing the fungus was transferred to the centre of the petri dish, and measurements (in mm) made of the amount of growth from the edge of each plug at intervals of 3, 6, 8, 10 and 16 days after transfer. Of the various temperatures tested, 23°C (room temperature) was the most suitable; it was better than 5°C (a target storage temperature), 10°C (commonly reached late in storage) and a temperature in the range 1·5-15°C (which occurs at the top of a storage pile). Of the 14 fungicides tested, only propionic acid at 1000 ppm and sodium-*o*-phenyl phenate at all dosage rates (250, 500 and 1000 ppm) completely controlled all the fungi, although others were completely or almost completely effective against certain fungi, the most resistant of which were *Rhizopus* spp. "Benomyl" with or without "Captan" and 2-(4-thiazolyl) benzimidazole with or without 2,6-dichloro-4-nitraniline were the most effective against the other fungi.

**Four years' experience with "Temik 10 G".** G. Wiebe. *Die Zuckerrübe,* 1978, **27,** (2), 16 (*German*).—The benefits of "Temik 10 G" as nematicide are discussed on the basis of 4-years' experience in Lower Saxony. Good chances of maintaining yield in an infested field occur when the number of cysts is in the range 6-20 per 100 cm$^3$ of soil; the usual application rate of 10 kg.ha$^{-1}$ is equivalent in cost to a yield of 2 tonnes of beet per ha, so that, at 40 tonnes of beet per ha, a 5% drop in yield would justify using the nematicide.

**Are granular insecticides restricted to rich farmers?** Anon. *Le Betteravier,* 1978, **12,** (118), 12D (*French*).—It is pointed out that, even in years of moderate virus yellows outbreaks, at least 2 tonnes of beets per ha will be lost in infected fields, and that the corresponding loss of money will exceed the most expensive treatment against aphids. Hence, farmers in Belgium, where the yellows intensity is always greater than in neighbouring countries, cannot afford not to use granular insecticides for aphid control.

**Chemical control of *Heterodera schachtii* and sugar beet production in Imperial Valley, California.** D. G. Kontaxis and I. J. Thomason. *Plant Disease Reporter,* 1978, **62,** 79-82.—Control of the nematode *H. schachtii* with two fumigants and two systemic nematicides was tested during two consecutive seasons. Best results (approx. 65 tonnes of beet per ha) were given by 1,3-D on its own or combined with "Aldicarb" or "Carbofuran", and by DD plus "Aldicarb"; the yields of untreated beet were 16 and 14 tonnes.ha$^{-1}$. The nematode populations were about the same in treated and untreated fields at harvest, indicating the effectiveness of crop protection in the early growth stages. While treatment was profitable in 1975, in 1976 a sharp fall in the price of sugar made it uneconomical.

**Beet yellows.** L. van Steyvoort. *Le Betteravier,* 1978, **12,** (119), 14 (*French*).—Advice is given on treatment for aphid control as a means of combating beet virus yellows.

**Trials on maintenance of yield with infestation by the cyst beet nematode *Heterodera schachtii*.** W. C. von Kessel. *Die Zuckerrübe,* 1978, **27,** (3), 10-16 (*German*). Trials on beet nematode control with various chemicals applied to the soil are reported. The equipment used and most suitable method of application are discussed. Of the nematicides, "Telone" at 175 litres.ha$^{-1}$ and Shell DD at 250 litres.ha$^{-1}$ gave the highest sugar yield per ha, although they had little effect on weeds. The economics of treatment are briefly indicated.

# CANE SUGAR MANUFACTURE

**Sugar boiling—some useful strategies.** J. Ziegler. *Sugar J.*, 1978, **40**, (8), 8-15.—Various aspects of pan design and boiling are discussed, including massecuite circulation and the effect of stirrers, supersaturation, syrup feed, crystal growth rate, consistency and viscosity, the boiling of high-purity syrup, final Brixing, purity compensation, handling of light and heavy feed syrups, how to overcome the problems of inadequate feed syrup and loss of vacuum, boiling of intermediate- and low-purity syrups, problems associated with boiling of large grain, and cutting-over of massecuite.

**FSC plans boost in crush capacity.** R. Karan. *Fiji Sugar*, 1978, **3**, (1), 15-17.—Whereas cane production in Fiji during the period 1972-76 was insufficient to justify expanding any of the factories, the situation has now changed, and the Fiji Sugar Corporation has set itself a target of some 3 million tonnes of cane to be crushed in a 30-week season. To attain this, it will be necessary to increase the crushing capacity of all four factories. Details are given of the performance of each factory in the four seasons up to and including 1977, and the main items in the expansion plans of each factory for 1977/78 and 1978/79 are listed.

**Cane preparation, mill settings and operation of the milling plant of El Potrero factory.** F. J. Medina. *Mem. II Conv. Nac. Tecn. Azuc. Mexico*, 1972, 169-185 + diag.; through *S.I.A.*, 1978, **40**, Abs. 78-253.—Many parameters of factory performance are tabulated for seasons 1963-64 to 1971-72; the functions of cane preparation are indicated, and the system for cane preparation and milling at El Potrero factory is described with a diagram. Recommendations are made about routine checks and analyses and calculation of mill settings. A typical hourly report sheet shows, for each of the six mills: main analytical parameters of juice and bagasse, roller pressures, and extractions (cumulative, individual, and % residual); cane composition and judgment on the extractions achieved are included. Formulae for calculating settings, from parameters of incoming cane and of mill design, are given with a tabulated example.

**Factory research and development in South Africa.** Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1977.

*Extraneous matter in cane:* While the method used for ashing of cane samples in order to estimate the soil content[1] can be used for bagasse, problems have arisen regarding representative sampling. However, statistical analysis of data has shown that combining six samples taken at hourly intervals into one composite will necessitate analysis of only ten samples per week to give meaningful results; the confidence interval derived from the averages will be only one-third of the mean, which will permit comparisons of sets of data.

*Use of Brix profiles as indicators of diffuser performance:* In order to predict when juice percolation problems, leading to flooding, are likely to occur, an attempt was made to relate juice Brix to diffuser performance. Ideal Brix curves were derived by regression analysis of data for diffusers operating well in all aspects. Equations were obtained for both cane and bagasse diffusers. Average Brix profiles were established for each factory for comparison with the ideal curves, and it is intended to define a set of eight standard Brix curves for typical problems; so far, three have been established, and an example of their application is given.

*Hydrocyclone tests:* In an attempt to reduce the concentration of suspended solids in mixed juice and diffuser press water, several types of hydrocyclone were tested. At a rated capacity of 20 $m^3.hr^{-1}$ a "Celleco 300" hydrocyclone installed on the mixed juice line at one factory removed 32% of the total suspended solids and 55% of the ash constituents; however, the underflow had a rather high pol of 7% and would have required at least one washing to reduce pol losses, thus making the system sufficiently complicated that its installation became unjustifiable. A "Spargo" hydroseparator installed in the press water line at another factory was unable to bring about any further reduction in suspended solids over that obtainable in a short-residence settling tank while it also necessitated installation of a vibratory screen to remove bagasse which had been blocking the system.

*Juice clarification:* In investigations of the effect of filtrate recycling from mud filters to mixed juice, it was found that the calcium phosphate precipitate suspended in the filtrate may be largely redissolved during heating of the mixed juice at its natural pH. The effect of adding 20% filtrate on mixed juice was primarily dilution of the juice when the suspended solids content in the filtrate was below 1·5%; the settling rate was higher and the turbidity slightly lower than when the suspended solids content was greater than 1·5%. The final mud volume steadily increased with increase in the filtrate solids, however, although variation occurred with the proportion of filtrate recycled. Addition of 200-600 ppm starch to juice caused a slight increase in turbidity with increase in starch addition but no change in the initial settling rate or final mud volume. The difference between the effect of the starch on clarification and on refinery liquor phosphatation is probably connected with the differences in physico-chemical properties of the juice of high impurity content and liquor of very low impurity level. Addition of large amounts of field soil to mixed juice raised the clear juice turbidity as a result of the large proportion of colloidal material present. Its addition also appeared to affect the type of flocculant needed for optimum settling, one of low degree of hydrolysis being most effective. An increase in the Mg concentration of mixed juice caused minor changes in clarification, including a slight fall in settling rate and increase in the Ca content of the clear juice. Turbidity was little affected. Increase in the time between harvesting and processing of cane adversely influenced settling rate and mud volume, considerably increased the gum content and colour and significantly reduced the starch content, although juice clarity was little affected.

*Evaluation of performance of SRI clarifiers:* Investigations on the performance of two SRI clarifiers operating

[1] Brokensha & Mellet: *I.S.J.*, 1978, **80**, 217.

in parallel at a juice rate of about 400 tons.hr$^{-1}$ (normal retention time being 32 min) showed that hot liming was more effective than intermediate liming as regards juice colour and turbidity; values given by hot liming were 22·4 units at 420 nm and 0·12 at 720 nm, respectively, compared with 28 and 0·25, respectively, given by a "Rapidorr" clarifier at a neighbouring factory. While sudden fluctuations in juice flow rate adversely affected clarification efficiency, a gradual increase in the flow rate obtained by throttling one of the clarifiers did not affect the performance of the other operating with intermediate liming at a throughput of 120% of the normal. A high residual $P_2O_5$ level in clarified juice was due to a high content in the mixed juice and not to the short retention time in the clarifiers. The increase in CaO and MgO from mixed to clear juice was about the same (90 ppm) for both clarification systems and was well within the accepted limit.

*Magnesium oxide as a clarifying agent for juice:* Studies showed that 650°C and an incineration period of 6-72 hours gave maximum yield of MgO from magnesite; dead-burning of MgO took place at temperatures above 650°C and the product would not react with water or sucrose solutions. Laboratory tests showed that, although pure activated MgO was inferior to lime as regards clarification efficiency, a mixture of 30% MgO and 70% CaO gave as good results with mixed juice as did CaO on its own.

*Operation of a pilot horizontal belt filter on clarifier underflow:* A 0·5 m$^3$ Philippe belt filter used for clarifier mud in parallel with rotary vacuum filters gave (under best mud conditions) a filter cake pol of 1·2-2·1% and a moisture content of 69·0-75·4% compared with a seasonal average of 1·05% and 72·38%, respectively, for the rotary filters. Lime, bagacillo and flocculant had to be added to the mud before belt filter treatment, whereas the mud handled by the rotary filters was untreated. The belt filter used 200-300% wash water on filter cake, compared with 125-150% with the rotary filters. The belt filter capacity (100-150 kg cake per m$^2$ filtration area per hr) was higher than that of the rotary filters, but retention time was only 1·6 minutes compared with 4-4·5 minutes. This short retention time and variation in mud quality were two major reasons given for the poor performance of the belt filter; until the factors causing fluctuations in mud quality are known and can be controlled, horizontal belt filters are considered unlikely to be suitable for clarifier mud filtration.

*Performance of a long-tube vertical evaporator:* While long-tube evaporators are used as 1st effects in South Africa, they are generally believed to be unsuitable for use as other effects in a multiple-effect evaporator because of the adverse effect of viscosity on the "climbing ability" of the film inside the tube. However, investigations with a pilot plant showed that the heat transfer coefficients of the Kestner evaporator used as 3rd, 4th and 5th effect were higher than those of a Roberts body, the value of the coefficient for the Kestner as 5th effect being double that of the Roberts. Even after 5 weeks' continuous operation as a 3rd effect, the average coefficient for the Kestner was still higher than for a comparable Roberts unit, and it seems that the Kestner performs well at high Brix of the feed syrup chiefly because of the increased vapour rates resulting from the higher vacuum.

*Slurry preparation and full seeding of pans:* The weight of seed slurry which would theoretically be required to produce crystals of the size found in *B*- and *C*-massecuite was calculated for each of 16 factories which use slurry for pan seeding, the calculation being based on certain assumptions regarding slurry quantity and massecuite crystal content by weight. Comparison of the calculated values with the weight of slurry actually used by the factories showed that for both massecuites, most of them used more slurry than theoretically required, while a few used less than required.

*Optimization of a continuous* C*-pan:* A fractional factorial experiment comprising 16 tests with five variables at two levels each was undertaken with the aim of establishing optimum values of steam pressure, injection steam pressure, massecuite level, seed rate, vacuum, seed Brix, molasses Brix and massecuite Brix to give a throughput of 13·5 m$^3$.hr$^{-1}$. A low Brix profile was found to be optimum.

*Mathematical modelling of circulation and heat transfer in vacuum pans:* Work on a computer programme to calculate the heat transfer rate and fall in circulation velocity due to friction was aimed at optimum dimensioning of pans. In the programme, the circulation velocity at which the friction loss in the flow channels equals the driving force produced by the ascending vapour bubbles was found by iteration. Measurements of the heat transfer rate in a *C*-pan differed by about ±15% from the calculated values. However, difficulties arose when the programme was applied to determination of optimum downtake diameters. It is thought that they resulted from errors in estimating the friction loss of boiling massecuite in the tubes, and work is being undertaken to determine this loss as a function of massecuite properties and boiling regime.

*Crystallization of* A*-massecuite:* Correlations for crystallization rate, heat transfer rate and power requirements as a function of massecuite properties derived from measurements on Stork Werkspoor rapid cooling and Blanchard crystallizers were used to produce a mathematical model of the crystallizers. Use of the model showed that the three most important factors for crystallization are retention time, cooling and mixing. Cooling has the disadvantages of increasing the viscosity of the mother liquor (making centrifugal work more difficult) and raising the supersaturation coefficient, thus risking the formation of false grain. Where power limitations necessitate the addition of *A*-molasses, it is preferable not to cool the massecuite and to minimize the molasses addition. Cooling plus molasses addition increases centrifugal load but does not cause any increase in purity fall. If molasses has to be added because of high massecuite viscosity resulting from a high crystal content, it is better to do so in the mingler of the centrifugals rather than in the crystallizers. Crystallization rates are favoured by a high reducing sugar: ash ratio and small grain size.

*The effect of sand and moisture in bagasse on its burning properties:* A special bagasse burner system similar to one used for pulverized coal was employed in tests to determine the effect of moisture content (in the range 8-20%) and sand content (up to 40%) on the burning properties of bagasse. Results showed that if primary air is used at ambient temperature, the bagasse moisture content should be below 15% and its particle size the lowest possible. Since this requires an improvement in bagasse drying and shredding, it is suggested that

preheating the air supply would be a possible alternative to bagasse drying.

**The Sucro "AMS" cane juice continuous clarifier.** C. M. Madrazo and E. A. Guena. *Sugar News* (Philippines), 1977, **53,** 359-367.—The Sucro "AMS" clarifier described consists of a vertical tank with inverted conical bottom. Juice is introduced into the clarifier from a vertical rotary pipe attached to the axis. Four stationary trays, sloping at an angle of 15° towards the centre of the clarifier, are welded to the outer wall; three rotating trays attached to the feed pipe slope downwards away from the central axis, a space being formed between each stationary tray and the corresponding rotary tray to allow passage of incoming juice and of mud which is descending towards the thickening chamber in the inverted cone. A bottom stationary tray sloping down from the central axis receives the mud, which is spread out towards the cone wall by a scraper and falls to a receiving compartment at the apex of the cone. Clear juice is discharged through ports corresponding to the trays attached to the wall. The performances of three "AMS" clarifiers at Lopez Sugar Corporation are discussed. At a retention time of 1·62 hours (corresponding to a daily crush of 8000 tonnes of cane and contrasting with 3 hours' retention in two Bach clarifiers also operating at the factory), clear juice clarity was in the range 26-30 Kopke units, compared with 22 units before the new clarifiers were installed. The result was improved sugar quality and reduced molasses losses. The operation of the clarifiers is so simple as to be almost automatic.

**Retention flocculation processes in sugar manufacture.** J. T. Rundell, H. W. B. Heineman and A. W. L. Pett. *Sugar News* (Philippines), 1977, **53,** 368-373.—A review is presented of flocculation processes, with an explanation of primary and secondary flocculation. The possible application of flocculation with polyacrylamides to syrup clarification in a sugar factory and liquor clarification in a refinery are briefly examined with the aid of flow diagrams.

**"Talodura" process for Philippine raw sugar factories.** C. M. Madrazo. *Sugar News* (Philippines), 1977, **53,** 310-313.—The Tate & Lyle-developed phosphatation-flotation process for cane syrup, involving addition of "Talodura" flocculant to the syrup in a special clarifier, is described and its economic advantages estimated.

**Giant sugar port project captures the imagination.** Anon. *Producers' Rev.*, 1978, **68,** (2), 20-22.—Details are given of a deep-water wharf under construction some 6 km offshore from Lucinda in Queensland which will accommodate ships of up to 40,000 tonnes displacement and will be linked to the existing bulk sugar terminal by a fully-enclosed, cyclone-proof belt conveyor 5·76 km long.

**Multiple-effect evaporators in raw sugar factories.** H. S. Birkett. *Sugar J.*, 1978, **40,** (10), 23-25.—The heating surface area of each evaporator effect and juice heater, exhaust steam requirements of evaporator, juice heaters and vacuum pans, and evaporator condenser requirements (including amount of injection water) are tabulated for five triple-, five quadruple- and three quintuple-effect evaporators to show what changes would be needed in Louisiana sugar factories to achieve self-sufficiency in energy.

**Latest experience with BMA cane diffusion plants (Egyptian system).** Anon. *BMA Information,* 1977, (16), 15-20.—Descriptions are given of the BMA bagasse and cane diffusers, and actual performance data are mentioned. A bagasse diffuser installed in 1976 at Inkerman factory in Queensland gave, during one week, a reduced extraction of 97·6% and a final bagasse pol of 1·39 at a cane pol content of 16·5 and a fibre content of 13·4%. Reduced extractions of 97·7% and 97·0% have also been achieved at two other factories where BMA cane diffusers were installed in 1977.

**The BMA pressure leaf filter.** Anon. *BMA Information,* 1977, (16), 21-23.—A description is given of the BMA 95 PF 1 pressure leaf filter, 32 of which were supplied to Egypt in 1976.

**A new approach to prevention of scale formation on evaporation tubes.** N. E. Chiang, S. L. Sang and C. J. Lu. *Taiwan Sugar,* 1978, **25,** 19-22.—Sections of brass tubing were coated with a mixture of epoxy:melamine of varying weight proportions. After preliminary tests had shown that a 30:70 mixture was the only one not to undergo any change when immersed in boiling water for 3 hours, brass tubes coated with the mixture were subjected to pilot plant and factory trials in which 60°Bx remelt liquor was evaporated. After ten hours, only a little, easily removable, flaky scale appeared on the tube surface, whereas a 0·7 mm thick deposit, which could not be removed by hand, had formed on an uncoated tube surface. After 57 days in a factory evaporator, coated tubes showed some flakes of scale which were easy to remove with a plastic brush. No differences were found between coated and uncoated tubes as regards heat transfer coefficient.

**Industrial evaluation of disinfectants.** M. T. Hernández, N. Herrera and R. Sánchez. *Centro Azúcar,* 1977, **4,** (1), 19-28 (*Spanish*).—Evaluation of the germicidal action of disinfectants applied in cane milling is proposed by means of the resazurine test to assay the bacterial infection of crusher and mixed juices, respectively. The method was applied to tests on a commercial disinfectant, "Biocide", and it was shown that satisfactory control could be achieved by shock dosing of 10 ppm of this material at 4-hour intervals.

**Control of cane feed at a sugar factory.** J. R. Abreu G. *Centro Azúcar,* 1977, **4,** (2), 21-33 (*Spanish*).—A system of cane mill feeding is described which is appropriate to the characteristics of sugar factories in Cuba, having a single carrier. A D.C. motor with controlled rectifiers is proposed as a prime mover, with sensors of the blanket thickness operating with potentiometers as transducers. The mathematical modelling for use with an analogue computer is also included, together with the results obtained.

**Elimination of colloidal substances from cane juice.** M. Darias P. and M. C. Ruiz G. *Centro Azúcar,* 1977, **4,** (2), 35-51 (*Spanish*).—The elimination of proteins and polysaccharides by coagulation and adsorption were

studied for different pH levels between 3 and 9, using pure solutions of dextran and egg albumin and, in the case of coagulation studies, in the presence of ions occurring in cane juice. The elimination of the above colloidal substances was also studied in cane juice as a function of pH and $Ca^{++}$ concentration. Maximum elimination of protein from cane juice occurred at pH 2-4, around the iso-electric point, but in alkaline conditions it occurred at pH 8-9 by formation of a complex with or adsorption on insoluble compounds present. The effect of pH on polysaccharide elimination is irregular and maximum separation occurs by formation of a complex with protein. The effect of pH on colloid elimination is affected by the precipitation of salts, in turn influenced by the $Ca^{++}$ level in the juice.

**Statistical evaluation of cane feeding at a sugar factory.** J. Abreu G., F. Martínez G and R. Ballesteros H. *Centro Azúcar,* 1977, **4,** (3), 43-52 (*Spanish*).—The operation of the cane crushing mills of a sugar factory is directly related to the characteristics of the cane feed and the flow of imbibition water. Raw material received by Cuban factories comes from different areas, in different means of transport and it is also harvested in different ways. The combination of these factors results in erratic feeding of the mills. It has been demonstrated that the operation of the mills is more efficient when the cane feed is uniform and, with the aim of evaluating the operation of the mills, a method of analysis is proposed for the erratic feeding. The method was satisfactorily tested in the 1975 and 1976 harvests.

**Consistency transducer.** F. Pantuso N. *Centro Azúcar,* 1977, **4,** (3), 53-64 (*Spanish*).—A device has been introduced for measurement of massecuite consistency as a function of the torque developed by an electric motor driving a rotor. A mathematical analysis of the method is given as well as an account of its practical use and maintenance.

**Dynamic modelling of the milling train in a sugar factory.** J. Abreu G. and V. Polonik. *Centro Azúcar,* 1978, **5,** (1), 19-27 (*Spanish*).—In order to obtain a dynamic model for milling train calculations, the principal variables involved in its operation are established and the relationships between them analysed. These are used as the basis for a series of equations governing the behaviour of the train and a generalized expression obtained for the outgoing variables of any mill as a function of the incoming variables for the first mill. The transfer function of a specific milling train can then be calculated on the basis of mass dimensions, mill openings, tank capacities and water or mixed juice flow. With this model it is possible to establish the optimal law of cane feeding or imbibition water application and, starting with this, to design the control system for the fundamental variables of the milling train.

**Investigation of the sensitivity of the parameters of the process of sucrose crystallization in discontinuous manner.** M. Rodríguez B. and V. Polonik. *Centro Azúcar,* 1978, **5,** (1), 39-53 (*Spanish*).—An analysis is made of the sensitivity of the principal parameters describing the process of crystallization in batch-type pans, in terms of their variability, in order to simplify a mathematical model of the process for design of an optimal control system. The simplified model developed has been verified using an analogue computer.

**Zeta-potential of calcium phosphate precipitates.** R. Fajardo G. and L. D. Bobrovnik. *Centro Azucar,* 1978, **5,** (1), 55-67 (*Spanish*).—The electro-osmotic method was used to study the zeta-potential of calcium phosphates produced in cane juice clarification, and the influence of pH, polyelectrolyte addition, colouring matter and proteins on the magnitude and sign of the zeta-potential discussed. From the experimental results, the authors conclude that zeta-potentials of the precipitates are positive below pH 7·0 and negative above this. Polyelectrolytes, proteins and colouring matter reduced the positive values of the precipitates studied, the last having the greatest effect. X-ray diffraction and photomicrographic examination showed the precipitates to be formed from $CaHPO_4$ and $CaHPO_4{,}2H_2O$.

**Numerical design techniques for staged classified recycle crystallizers: examples of continuous alumina and sucrose crystallizers.** A. D. Randolph and C. S. Tan. *Ind. Eng. Chem., Proc. Des. Dev.,* 1978, **17,** 189-200.—Two techniques are outlined for the numerical analysis and design of staged, classified recycle processes such as would apply to continuous boiling of massecuite. The two system models are based on (1) complete numerical solution of recycle equations and (2) use of algebraic moment equations to define the moments of distribution in each stage. A RECYC computer programme was used to analyse a theoretical system comprising three pans (of 2000, 4000 and 6000 gal working volume) operating in series which was designed to give a narrow range of crystal size distribution (CSD), e.g. having a C.V. less than 0·23 and a mean particle size of about 800 μm. Values of input parameters are tabulated and assumed conditions are stated. The effects of number of stages, of classified recycle, of seed rate, of recycle fraction, of classifier sharpness, of large particle recycle and of size dispersion were determined and optimum conditions established. It was found that the mean crystal size fell with increase in seed rate, while the production rate (daily tonnage) increased with seed quantity but with smaller mean size as a result of increased specific surface. Size dispersion caused by fluctuations in the crystal growth rate limits the ultimate narrowness of the CSD that is obtainable.

**Basic energy and its utilization in the cane sugar industry.** W. Leibig. *Zuckerind.,* 1978, **103,** 412-417. The question of reducing fuel consumption and increasing power generation in cane sugar factories is discussed. It is considered possible to reduce the consumption of normal steam (1 bar at 100°C) from 55-70% in a raw sugar factory and from 70-80% in a white sugar factory to about 50% on cane. Five examples of sugar factories, using a live steam pressure of 20-60 bar and an exhaust steam pressure of 3 bar, are cited to show how an increase in pressure from 20 to 60 bar will permit an increase in power generation from 1·40 to 1·95 kW per tonne of cane. A nomogram is presented for calculation of steam and power generation as a function of bagasse yield and calorific value, boiler efficiency and steam pressure. A heat scheme for a 6000 t.c.d. factory producing live steam of 40 bar and 450°C is described, and the monetary benefits obtainable from the greater power generation calculated.

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# BEET SUGAR MANUFACTURE

**Nomogram for application of the filtration coefficient $F_k$ to the control of filtration processes.** J. Čepelák and R. Osvald. *Listy Cukr.*, 1978, **94,** 54-57 (*Czech*).—Equations are derived for calculation of filtration parameters, and from these a nomogram is devised for calculation of the value of $F_k$ of 1st carbonatation juice which is attainable under given circumstances. The coefficient is found in terms of the active filtration period (sec), filtration cycle frequency ($hr^{-1}$), unit volume of filtrate ($m^3/m^2$) and mean output ($m^3/m^2.hr^{-1}$). The required unit volume of filtrate determines the thickness of the filter cake, which is also governed by the amount of CaO added in liming. The nomogram is applicable to all types of filter. A worked example is given.

**Calculation of the massecuite centrifugalling process. II.** E. Svoboda and J. Klepal. *Listy Cukr.*, 1978, **94,** 58-69 (*Czech*).—On the basis of a series of calculations applicable to boiling house processes and on information used as input for control of these processes, an equation has been developed for calculation of the water content in the raw sugar after massecuite curing or in refined sugar after single affination with steam or hot water and steam, or double affination with hot liquor followed by hot water and steam. Graphs are presented of the water content in the spun products as a function of crystal content at a given rotary speed of an ARO 800 centrifugal. From the equation is developed an algorithm, and appropriate sequence diagrams are presented.

**Electron microscopic studies of sugar beet and sugar cane tissue. A contribution to an explanation of the sucrose extraction mechanism.** R. Shokrani and H. J. Delavier. *Zuckerind.*, 1978, **103,** 301-307 (*German*).—An examination of beet and cane tissue was undertaken as part of a study of material transfer during solid-liquid extraction. All cells were found to be surrounded by a multi-layered membrane which acted as a semi-permeable barrier; this has to be broken down by heating or pressure to permit passage of soluble or dissolved cell tissue components. Round pores in the membrane become oval under the effect of denaturing and approximately double their diameter, forming continuous "channels"; however, their diameter is then far greater than that required for the passage of sucrose and non-sucrose molecules. The article is accompanied by 18 electron photomicrographs.

**The automatic press filter and its practical application in the sugar industry.** H. Weidner. *Zuckerind.*, 1978, **103,** 311-313 (*German*).—Details are given of the P3 automatic filter press, manufactured by Eberhard Hoelsch & Söhne GmbH & Co. and developed from a patented Soviet design originally intended for the petroleum industry. The juice is fed at the top of a stack of elements over each of which passes an endless polypropylene belt, the drum around which the belt is wound being alternately on the left and right of the press going from top to bottom. Filtrate passes through the belt into a channel and thence flows to a central vertical discharge pipe. After filtration (which lasts 2-3 min), wash liquor is introduced at the top and passes through the gap between the membrane at the bottom of each element and the filter cake standing on the belt, then passing into the filtrate discharge system. The next stage in the cycle is after-pressing, when the membranes are pressed onto the filter cake to reduce the moisture content and recover further sugar. Compressed air is blown through the filter cake (the membranes having been returned to their upper position), after which the stack of elements is released, and the filter belt put into motion to allow the cake to fall into mud chests, one on each side of the filter. The belt is then sprayed with water. Comparison of the performance of a 25-$m^2$ filter press at Appeldorn with that of a 164-$m^2$ chamber-type filter press (four of which were used to handle the rest of the 1st carbonatation juice) showed that, at a cycle time of 9 min as opposed to 40 min in the conventional filters, the cake solids content was 75% (65% in the conventional filters) and cake pol 0·007% on beet (compared with 0·015%). Specific dry solids throughput was 167 as opposed to 10·7 $kg.m^{-2}.hr^{-1}$. The capital costs of the new filter press are given.

**New beet yard at Aarberg.** Anon. *BMA Information,* 1977, (16), 10-14.—Details and illustrations are given of the beet reception system at Aarberg in Switzerland, which includes a 16,000-tonne capacity polar silo having two concentric flumes. The inner diameter is 70 m and the maximum piling height 8 m; beets are piled at a rate of 600 tonnes.$hr^{-1}$ and reclaimed at 250 tonnes.$hr^{-1}$. The beets are unloaded from trailers by the wet system and fed via a drum washer and belt conveyors to the silo; they are retrieved from the silo by an automatically travelling spray bridge. Fans having adjustable blades for variation of air volume and pressure are used to ventilate the piled beets; they are automatically switched on when the ambient temperature is at least 2°C lower than the temperature in the pile, which is measured by contact surface thermometers mounted on the central ventilating duct and compared with the ambient temperature. The side of the beet trailer to be unloaded is slowly lowered by a hydraulically operated lever system actuated by the driver through a pushbutton.

**BMA juice purification plants for the beet sugar industry.** Anon. *BMA Information,* 1977, (16), 24-26. Details are given of the BMA System 65 carbonatation scheme and the equipment involved.

**Economy of the BMA-Zsigmond-Gryllus softening process.** Anon. *BMA Information,* 1977, (16), 27-29. The economic and technical advantages of the title ion exchange process, in which $Ca^{++}$ ions in thin juice are exchanged for $K^+$ and $Na^+$ ions before evaporation, are discussed. The resin is regenerated by the thick juice whereby the $K^+$ and $Na^+$ ions replace the $Ca^{++}$ ions; since the solubility limit is exceeded, the excess calcium salts are precipitated from the juice and removed by filtration.

**Vertical BMA cooling crystallizer.** Anon. *BMA Information,* 1977, (16), 30-31.—The crystallizer described has a capacity equivalent to 225 tonnes of massecuite and a cooling surface area of about 253 $m^2$. First installed in a West German sugar factory in 1976, it proved so satisfactory in performance that more were installed for the 1977 campaign.

**Improvements in economical waste water treatment.** Anon. *BMA Information,* 1977, (16), 37-38.—Aerobic-anaerobic treatment of waste water, including sugar factory effluent, is described.

**Solid wastes from the sugar factory.** F. Bellabarba. *Ind. Sacc. Ital.,* 1978, **71,** 14-17 (*Italian*).—The four main types of solid wastes from a sugar factory are considered in turn, *viz.* soil and foreign bodies, carbonatation muds, lime kiln waste and flume water solids. From experience at the author's sugar factory at Fano (Pesaro) the amounts of each type for a standard factory of 5000 tonnes daily slice are set out and their treatment to render disposal less onerous is discussed.

**Ion exchange resins in the sugar industry.** V. Maurandi. *Ind. Sacc. Ital.,* 1978, **71,** 22-27 (*Italian*).—A review is presented of the fundamental parameters of ion exchange: selectivity coefficient, exchange strength and penetration, as well as qualitative aspects of exchange kinetics. The use of resins for introduction of Mg ions to improve low-grade exhaustion, and the practical limits for technological variations are discussed. The $H^+$-$OH^-$ and $NH^+_4$-$CO_3^{--}$ processes for sugar syrup deionization are considered and the inversion of sucrose occurring in the former is pointed out. Methods for minimizing such inversion are discussed from theoretical and practical points of view.

**Results of industrial tests on a spray saturator.** V. P. Pasechnik, I. M. Fedotkin, A. N. Timonin, V. N. Gladkii and V. B. Vyskrebtsov. *Sakhar. Prom.,* 1978, (5), 69-72 (*Russian*).—A conventional carbonatation vessel was modified so that it could be operated by feeding limed juice through a pair of spray nozzles at the top and allowing the finely dispersed droplets to come into intimate contact with bubbled $CO_2$ and thus undergo thorough and rapid absorption. Tests over a 17-day period, in which the vessel was operated both conventionally and by the new method, showed that spray feeding increased $CO_2$ utilization efficiency to 90% in contrast to only 65-70% with conventional operation. More colour and lime salts were removed by the new method and juice purity was higher. Similar trends were found in the carbonatation of raw sugar remelt liquor.

**Decolorization of sugar solutions with sodium sulphite.** L. D. Bobrovnik, N. I. Odorod'ko and A. P. Kozyavkin. *Izv. Vuzov, Pishch. Tekh.,* 1978, (1), 51-53 (*Russian*).—With the aim of determining the nature of the decolorization process brought about by addition of sodium sulphite, and particularly the role played by the $CaSO_3$ precipitate which is formed, two low-grade sugar solutions of 64·8°Bx and 94·1 purity were prepared, one having a colour content of 33 optical density units per 100°Bx while the other contained 45·3 units per 100°Bx. Calcium sulphite, obtained by reacting $Na_2SO_3$ with $CaCl_2$, was added to the solutions at 0·5-7·0% by weight; after 1 hour at 90°C the solutions were filtered and their colour, lime salts, free $SO_2$ and pH determined. A graph demonstrates the increase in colour removal resulting from increased quantities of $CaSO_3$, the effect being much greater with the solution of lower initial colour, *viz.* a maximum colour reduction of 37·4% compared with 15·7%. The lime salts content was reduced by 34·0% and 13·2%, respectively. By far the greatest fall in content occurred with the melanoidins; the fall in caramelan and alkaline decomposition products was only slight. Treatment with 0·1% sodium sulphite by weight gave a greater fall in colour and lime salts than did treatment with 1·25% calcium sulphite; the two sulphites together did not improve greatly on the decolorizing efficiency of the sodium sulphite alone, but considerably increased the quantity of lime salts removed by sodium sulphite.

**The diffuser as a chemico-technological system.** A. I. Fel'dman, O. V. Stratienko, L. V. Zotkina and V. M. Lysyanskii. *Izv. Vuzov, Pishch. Tekh.,* 1978, (1), 96-98 (*Russian*).—In a mathematical examination of beet diffusion as a model of a chemico-technological system, it is shown that of eleven variables contained in the model, only the equivalent cossette radius answers all the requirements of a regulable (optimizable) variable for purposes of automatic control.

**A beet leaf catcher.** F. Hruška. *Listy Cukr.,* 1978, **94,** 84-87 (*Czech*).—Details and illustrations are given of a vertical beet leaf catcher which basically consists of a rake conveyor which traps the trash as the water passes over it, and an air duct down which the trash is blown by air fed from a fan rotating at 2900 rpm.

**Some aspects of nitrogen in beet.** M. O'Sullivan. *Sucr. Belge,* 1978, **97,** 175-180.—See *I.S.J.,* 1978, **80,** 121.

**The efficiency of automatic stabilization of the carbonatation processes of beet sugar manufacture.** K. E. Reznik and V. D. Vitvitskii. *Trudy Vsesoyuz. Proektno-Konstr. Nauch.-Issledov. Inst. Pishchepromavtomatika,* 1975, **14,** 120-124; through *S.I.A.,* 1978, **40,** Abs. 78-609.—If the pH of 2nd carbonatation is stabilized so that thin juice contains minimum residual $Ca^{++}$ there will be (*a*) direct savings due to less evaporator scaling and (*b*) indirect savings, e.g. lower loss in molasses and better sugar quality. Equations are derived to evaluate the direct thermal and economic savings, and their relation to pH deviation from optimum is shown. A diagram is given of the pH stabilization system installed at Novokubanskaya sugar factory in 1974.

**A building project for a sugar terminal at Dunkirk.** Anon. *Sucr. Franç.,* 1978, **119,** 247 (*French*).—An outline is given of a sugar terminal which was planned to open in September 1978 and which includes a warehouse having a bulk sugar capacity of about 50,000 tonnes. Ships of up to 20,000 tonnes can dock at the 320-m quay. White sugar for export is loaded into the warehouse from rail trucks, and from the store is taken by a system of conveyors to automatic bagging, weighing, palleting or depalleting plants. A mobile loading gantry directly connected to the upper gallery of the warehouse permits sugar to be loaded into the ship's hold by means of a feeding screw and telescopic distributor[1].

[1] See also *I.S.J.,* 1979, **81,** 128.

# LABORATORY STUDIES

**Some aspects of the role of the amino-acids in the aminocarbonyl reaction.** L. González C., A. Lí de A., M. R. Pérez M. and L. Bobrovnik. *Centro Azúcar*, 1977, **4**, (2), 53-68 (*Spanish*).—Colour formation by reaction between an amino-acid (alanine, glutamic acid and aspartic acid) and a carbonyl compound (dextrose, glyceraldehyde) in the presence and absence of a colour formation inhibitor ($Na_2SO_3$) was studied using gel filtration, paper chromatography, electrophoresis on cellulose acetate, UV and visible spectroscopy. It was found that colour formation was greater with increased concentrations, depended on the amino-acid (alanine produced most colour), and on the carbonyl compound (glyceraldehyde produced more colour) and was less in the presence of the inhibitor.

**Some aspects of the role of dipeptides in the aminocarbonyl reaction.** L. González C., L. Bobrovnik and E. Valdés B. *Centro Azúcar*, 1977, **4**, (2), 69-88 (*Spanish*). Colour formation between dextrose and three dipeptides was studied using gel filtration, paper chromatography, electrophoresis on cellulose acetate, UV spectroscopy, etc. Colour formation was greater with β-alanyl-β-alanine than with glycyl-glycine and this was greater than with DL-α-alanyl-asparagine. Comparison of dextrose and glyceraldehyde for reaction with glycyl-glycine showed that the latter was more reactive. $Na_2SO_3$ inhibited colour formation.

**Study of the microflora of fresh bagasse on the semi-industrial scale.** T. Sais H., A. García R. and A. Morales G. *Centro Azúcar*, 1977, **4**, (2), 89-98 (*Spanish*). The micro-organisms in fresh bagasse are capable of growth at 37°C during 48 hours and the majority are those capable of growth on McCleskey agar and cellulose agar media. The greatest part of the micro-organisms capable of utilizing the cellulose present are bacteria and moulds. The principal micro-organisms identified were mesophilic bacteria, gram-positive sporogenic bacilli, *Staphylococcus* spp. and *Micrococcus* spp., *Aspergillus* spp. moulds and *Pichia* spp. yeasts. None of the yeasts found in fresh bagasse have been recorded in the literature as capable of causing deterioration of stored bagasse. Moulds present which have been reported as causing deterioration include *Monilia sitophyla* and *Cladosporium herbarum*.

**Action of yeasts on cane juice components.** M. T. Hernández, M. E. Pérez, C. Daucal, N. Herrera and A. Portal. *Centro Azúcar*, 1977, **4**, (3), 3-23 (*Spanish*).—Pure cultures of *Saccharomyces cerevisiae* and *Candida krusei* were grown on sterilized juice and synthetic sucrose medium and measurements made of the sucrose lost, total organic acids produced, polysaccharides and gas formation, and the organic acids analysed by quantitative paper chromatography. The *S. cerevisiae* produced a large amount of acids whereas *C. krusei*, a dextrose and levulose fermenter, was much less active. *C. krusei* is considered a negligible species in respect of sucrose loss from cane juice, but the growth curve for *S. cerevisiae* indicates that there is a potential danger if juice retention in the milling tandem is longer than 0·5 hr.

**Sucrose crystallization velocity in electrodialysed juice.** N. S. Fedorova and L. D. Bobrovnik. *Centro Azúcar*, 1977, **4**, (3), 65-69 (*Spanish*).—Syrup was subjected to electrodialysis and samples recovered at three stages of deionization such that the purity was raised from an initial 91·3 to 93·1, 94·7, and 96·7, respectively, and the viscosity reduced from 0·1366 $NC.m^{-2}$ (80% supersaturation, 80°C) to 0·1320, 0·1083 and 0·0995 $NC.m^{-2}$, respectively. The syrups were crystallized and the crystallization velocity measured for each. It was concluded that the higher the degree of deionization the greater was the acceleration of crystallization although the non-sugars remaining in the syrup after electrodialysis had a greater retarding effect on crystallization than those removed.

**Separation of colouring matter from sugar products.** L. González C., L. Bobrovnik and M. Alegret R. *Centro Azúcar*, 1977, **4**, (3), 71-86 (*Spanish*).—A study has been made of the elimination of colouring matter from model melanine solutions, caramels from sucrose and alkaline degradation products of reducing sugars, using ion exchange resins and different inorganic eluants. The various colorants extracted were examined for UV spectra, colour, amino-group, etc. Another part of the study involved comparing the same ion exchange resin as used above for the sorption of colour from raw sugar solution in order to find the resin most suitable for refining purposes. Best results were obtained with AB 16 GS anion exchange resin while, of the cation exchange resins, the best results were given by resin KU2.

**Formation of crystallization nuclei in the sugar industry. I. Physico-chemical properties of the sucrose-water-ethanol system.** L. Carrazana R., A. P. Koziavkin, C. Pérez and M. Fernández. *Centro Azúcar*, 1977, **4**, (3), 87-109 (*Spanish*).—Theoretical bases are offered for sucrose crystallization in aqueous medium. A physico-chemical study has been made of the sucrose-water-ethanol system as a basis for study of the kinetics of formation and growth of sucrose crystal nuclei in such a system.

**Viscosities of final molasses from the Province of Las Villas.** E. R. Fleites and C. González. *Centro Azúcar*, 1977, **4**, (3), 111-120 (*Spanish*).—Molasses samples collected from 19 sugar factories in Las Villas over a period of ten days were examined and viscosities measured at 55°C using a rotary cylinder type viscometer. All samples showed a degree of pseudoplasticity.

**Differential method for measurement of the volumetric content of sucrose crystals in massecuites.** F. Pantuso N. and V. S. Polonik. *Centro Azúcar*, 1978, **5**, (1), 29-37 (*Spanish*).—A device is described, with an account of its testing, for determination of the crystal content of a massecuite. It comprises a unit with two chambers, each having two identical electrodes and of identical shape, but with one having a screen over the

apertures. The unit is immersed in a massecuite and the electrical resistance is measured using the two pairs of electrodes; for the screened compartment it is that of the mother liquor; in the other compartment, at the same temperature and with other conditions identical, the difference in resistance is due to the presence of the crystals, from which difference the crystal content may be calculated.

**Action of *L. mesenteroides* and other micro-organisms on the components of cane juice.** M. T. Hernández, C. Dauval and M. E. Pérez. *Centro Azúcar,* 1978, **5,** (1), 69-87 (*Spanish*).—The behaviour of a number of micro-organisms forming part of the normal microflora of cane juice in production of acids, polysaccharides and gas by degradation of sucrose has been studied. The time for development was determined for each microbial species and found to be about 30 minutes, which indicates that an increase in their population can occur if there is a delay of this duration in milling. For each gram of acid produced, between 2·77 (*Leuconostoc mesenteroides*) and 11·0 grams (*Escherichia coli*) of sucrose is degraded, depending on the micro-organism, while production of 1 mg of polysaccharide is accompanied by a loss of between 2·85 (*Bacillus subtilis*) and 69·59 (*Aerobacter aerogenes*) grams of sucrose.

**Determination of reducing sugars. Comparative study of four analytical methods and the influence of some salts that are present.** B. Slutzky and A. Lara. *Revista CENIC* (Centro Nacional de Investigaciones Cientificas), *Ciencias Fisicas,* 1975, **6,** (2), 13-22; through *S.I.A.,* 1978, **40,** Abs. 78-455.—Two volumetric methods for the determination of reducing sugars, the modified Lane-Eynon and the Schoorl methods, and two colorimetric methods, the Somogyi-Nelson and the 3,5-dinitrosalicylic acid methods, were evaluated by means of a statistical technique. The four methods were equally accurate and precise. The presence of >0·12% $NH_4Cl$ or >0·75% $Na_2HPO_4$ caused the colorimetric readings to be too low; the presence of NaCl or $KH_2PO_4$ had no effect under the conditions studied. This interference was not observed in the volumetric methods. It is suggested that, in the Somogyi-Nelson method, interference could be overcome by increasing the $Cu^{++}$ concentration in the reagent to increase the excess from 25% to 100%. When 5% or 10% bagasse + acetate buffer were added, the readings in the colorimetric methods were too high.

**Comparative study on the determination of $SO_2$ in sugar products.** C. Christiane. *Thesis for Technisch Ingenieur in de Industriele Scheikunde* (H.T.I. Sint-Lieven, Gent), 1976/77, 64 pp; through *S.I.A.,* 1978, **40,** Abs. 78-461.—The well-known Monier-Williams method for the determination of $SO_2$ in molasses is reliable only for contents >20 ppm and is therefore not sensitive enough for other dark-coloured food products. The coulometric method has been used for $SO_2$ contents <20 ppm, the extraction of $SO_2$ being carried out as in the Monier-Williams method. This coulometric method is rapid, reproducible and sensitive. The spectrophotometric method of Sharp & Brown, based on colour formation by the $SO_2$ present with *p*-rosaniline using the distillate from the Monier-Williams method, requires 30 min stabilization time. Tanner's method, in which $SO_2$ is liberated by boiling in the presence of phosphoric acid and methanol while passing in nitrogen, followed by oxidation to $H_2SO_4$ in a solution of $H_2O_2$ and titration against NaOH, was shown not to be sensitive enough for $SO_2$ contents <20 ppm. The coulometric method is therefore recommended on account of its speed and sensitivity.

**Conductimetric method for determining the purity of sugar solutions.** J. Ponant. *Science and Industry* (Philips, Eindhoven), 1977, (10), 21-23; through *S.I.A.,* 1978, **40,** Abs. 78-479.—The purity of sugar factory solutions is conventionally measured by determining the sucrose content by polarimetry and the dry solids content by densitometry or refractometry. The conductivity of sugar solutions is proportional to the ash content, but also depends on the temperature, sucrose concentration and ash composition. Conductivity increases approximately linearly with temperature. As the Brix increases, the conductivity increases and then decreases. For thick juice and molasses, maximum conductivity was reached at 28°Bx at 20°C but at 33°Bx at 60°C, and the value of this maximum increased linearly with decreasing purity. The purity P of a solution can be found from the conductivity *y* by means of the formula $y = A\,(100 - P)\,x\,e^{-cx^n}$ where $x$ = Brix/(100-Brix) and *A*, *c* and *n* are constants.

**On the methods for conservation and analysis by rasping of beetroots in quality determination: cold treatment.** A. Arbizzani and P. Laghi. *Ind. Sacc. Ital.,* 1978, **71,** 18-21 (*Italian*).—Samples of rasped pulp were split and one part analysed while the pulp was fresh while the other part was frozen at —30°C and the frozen pulp analysed after storage for ten days. There was no appreciable difference between the results except for α-amino nitrogen which was lower in the stored pulp. Use of the technique would permit analysis in a central laboratory of samples from a range of beet reception centres without the risk of product deterioration during the journey.

**The parameters of the kinetic reaction on the surface of sucrose crystals during their growth.** A. I. Gromkovskii, V. S. Bogdanchikova and L. V. Kopkova. *Izv. Vuzov, Pishch. Tekh.,* 1978, (1), 119-122 (*Russian*). Single crystals of sucrose were attached to the blade of an agitator immersed in mother liquor and grown at temperatures in the range 20-80°C and agitator speeds of 700-1800 rpm. Values of the growth rate *v* ($kg.m^{-2}.min^{-1}$) determined at 20-50°C were in agreement with those found by other authors as a function of temperature and supersaturation. Analysis of the data showed that at low supersaturation the reaction order is greater than unity, while it tends towards unity at high supersaturation. Experimental data obtained at high supersaturation were plotted (ln K *vs.* reciprocal of temperature) and found to follow a straight line corresponding to an activation energy of 67·1 $kJ.mole^{-1}$, whereas data from the literature diverged at 60°, 70° and 80°, for which temperatures the corresponding activation energies were 41, 35·5 and 29·3 $kJ.mole^{-1}$, respectively. Substituting the other value of the activation energy given above in an equation for calculation of the reaction rate gave linearity for the entire temperature range 20-80°C. The equations given are suitable for calculation of kinetic parameters within the diffusion, diffusion-kinetic and kinetic regions of the crystal growth process.

# BY-PRODUCTS

**Change in the concentration of potassium, sodium and calcium during fermentation of molasses wort.** V. N. Shvets, A. N. Ogorodnikova and L. T. Prilipko. *Izv. Vuzov, Pishch. Tekh.*, 1978, (1), 90-92 (*Russian*). During fermentation of molasses with three different strains of yeast for up to 72 hours, flame photometry revealed that the $K^+$ concentration in the wort fell during the initial 3-6 hours, after which it slowly increased to a final concentration which was usually greater than that initially. The pattern of behaviour was attributed to entry of potassium together with sugar into the yeast cell, followed by a drop in the fermentation rate when the potassium returned from the cell to the feed material. Hence, the initial fall in $K^+$ concentration increased with the number of yeast cells. A similar trend was observed with $Na^+$, although its final concentration was slightly lower than the initial, while the $Ca^{++}$ concentration remained almost unchanged throughout fermentation.

**Addition of sugar to the concentrate mixture of a straw-based diet for dairy cows.** B. Frank. *Socker Handl.*, 1978, **29,** (1), 1-16.—Dairy cows fed on a basal diet of 6 kg barley straw and 3 kg beet tops silage per day were split into two groups, one of which was also fed 35% dried molassed beet pulp during an entire lactation period of 40 weeks. Results, given in table and graph form, show that the milk yields from the cows fed on the beet pulp were lower than in the control group; since positive results have been obtained in other trials in which hay or grass silage has been incorporated in the basal diets, it is considered that the negative effects of the beet pulp may be associated with a cellulose-rich diet. It is also thought that insufficient is known about the sugar requirements of dairy cattle.

**The perfect feed: beet tops + maize.** D. Charlesworth. *British Sugar Beet Rev.*, 1978, **46,** (1), 10.—Information is given on the practices used by a farmer in growing and harvesting beet on 120 ha in Suffolk. Beet tops are fed fresh or as silage to 400 dairy cows and 200 head of beef; the silage is stacked in three clamps, each containing 610 tonnes. Beet pulp in various forms is also fed to the cattle.

**Production of fusel oil from amino-acids during the alcoholic fermentation of final molasses produced in Okinawa.** K. Hokama, Y. Nakasone, S. Oshiro and M. Toguchi. *Bull. Coll. Agric.* (Univ. of the Ryukyus), 1975, (22), 225-238; through *S.I.A.*, 1978, **40,** Abs. 78-285. Cane molasses media were fermented at 20°Bx, at which concentration the fermentation rate and the rate of amino-acid N consumption were maximum. An increase in amino-acid N content after 42 hours was considered to be due to hydrolysis of the yeast protein owing to autolysis. The amount of fusel oil increased more than 10-fold during fermentation. Since paper chromatography showed that only the neutral amino-acids (valine, leucine and *iso*-leucine) disappeared during fermentation, the fusel oil probably consists of *iso*-butyl, *iso*-amyl and (optically) active amyl alcohols.

**Multi-stage pulping process with bagasse.** S. C. Lin. *Taiwan Forestry Research Inst. Bull.*, 1975, (268), 10 pp; through *S.I.A.*, 1978, **40,** Abs. 78-301.—Partially depithed bagasse was precooked with 1% NaOH. The fraction rejected by a coarse screen was subjected to disc refining followed by pulping by a NaOH, neutral sulphite, soda-oxygen or sulphate process at various reagent concentrations. The product was either recombined with the material which passed through the coarse screen, or processed separately. Tabulated values of pulp yield and properties show that the neutral sulphite process gave the best results. With reagent concentrations of 4% $Na_2SO_3$ + 2% $Na_2CO_3$, it gave a 72% yield of pulp suitable for use in corrugated paper or newsprint. If the concentrations were increased to 10% $Na_2SO_3$ and 5% $Na_2CO_3$, pulp suitable for use in printing paper was obtained in 56% yield. Pulp of the latter quality could be produced in 45-65% yield by soda pulping with 8-10% NaOH at 170°C for 10 min.

**Comminution and pressing of beet fragments and trash. The Selwig & Lange conical press.** H. Lange. *Zuckerind.*, 1978, **103,** 316-317 (*German*).—Brief information is given on a Selwig & Lange conical press used to handle beet fragments, leaves and weeds at Uelzen sugar factory, where there has been a steady increase in the amount of such extraneous matter. Comparison is made with a spindle press.

**Stord presses for beet trash pressing.** P. Mathismoen. *Zuckerind.*, 1978, **103,** 317-320 (*German*).—The development of Stord Bartz presses for beet trash is described and results from Etrepagny sugar factory in France, which is equipped with a BS-49 double-screw press and a SD 15 shredder, are reported. The advantages of the shredder in preparing the material (beet fragments and trash) are reflected, it is stated, in the higher throughput of the press by comparison with the same type of press in other factories. The analysis of the press water is discussed. Disposal of press water still presents a major problem, but the results at Etrepagny have indicated that mixing the press water with other effluent did not appreciably extend the degradation period although its addition to the effluent raised the $BOD_5$ by 40%.

**Characterization of the hydrolytic lignin from bagasse and determination of its functional groups.** C. J. Triana F., R. Montano and D. M. Fernández. *Revista ICIDCA*, 1977, **11,** 41-55 (*Spanish*).—Lignin was isolated from bagasse as the residue from hydrolysis of the cellulose content with sulphuric acid under two sets of conditions and after extraction of one of these with benzene and ethanol. The chemical charateristics and functional groups present were examined for each sample and compared with lignins from wood. The bagasse lignins differed between themselves but showed considerable differences from the wood lignins in respect of carboxyl groups (4·78-7·26% *vs.* 0·33-5·65%), phenolic hydroxyl groups (0·086—0·106% *vs.* 0·2—0·45%) and total hydroxyl groups (5·25—7·93% *vs.* 1·57—8·76%), although the range of carbonyl group contents was similar (7·02 — 14·95% *vs.* 6·30 — 15·0%).

**Optimization of the composition of sucrose-mineral medium and the system of culturing of *Aspergillus niger* L-1, a citric acid producer.** V. M. Golubtsova. *Priklad. Biokhim. i Mikrobiol.*, 1976, **12,** (1), 68-72; through *S.I.A.*, 1978, **40,** Abs. 78-289.—For measuring the activity of *Aspergillus niger* strain L-1 as a producer of citric acid, a modified synthetic medium is proposed, containing refined sugar and a mixture of salts which differs to some extent from those in the Zhuravskii-Terent'eva medium. Yields of citric acid on media based on beet molasses from various factories differed widely from each other, and showed no correlation with the yield on the synthetic medium.

**Comminution and pressing of beet fragments and trash at Oreye sugar factory.** W. Loop and J. Huberlant. *Zuckerind.*, 1978, **103,** 320-322 (*German*).—Details are given of the system used at Oreye in Belgium where beet wash water is passed over a vibratory screen from which the trash is conveyed to two parallel hammer mills and thence to a Wecker P9 double-screw press. The pressed trash is mixed with pulp for eventual pelleting. A Selwig & Lange conical press is also used as auxiliary for handling of excess trash when the total amount is too great for one press to handle. Costs of the system are briefly indicated.

**Hydraulics and efficiency of stamped metal plates.** R. Alemán and G. Portal. *Centro Azúcar,* 1977, **4,** (1), 39-46 (*Spanish*).—A comparative study of the hydrodynamic and mass transfer characteristics of perforated and stamped metal trays for a distillation column has been made and the experimental results are presented. It is concluded that the stamped metal trays are more efficient than perforated trays and that the trays with the larger punched angle present the best characteristics.

**Insulating mixtures with bagasse.** R. Espinosa P. *Centro Azúcar,* 1977, **4,** (1), 47-60 (*Spanish*).—A series of unspecified mixtures of natural and screened bagasse with feldspar, slaked lime and/or gypsum were compared for thermal insulation and mechanical strength properties with asbestos, 85% magnesite and an asbestos-diatomaceous earth mixture as standards. The mechanical strength of the bagasse mixtures was up to 85% higher than the standards and in some cases the insulation properties were also better. Some mixtures should be restricted to internal temperatures below 300°C, while if screened bagasse is used it should be of 9-10 mesh. A number of the mixtures are suitable as insulating materials for steam piping.

**Bleaching of bagasse pulps for the production of cultural papers.** Z. Herrera, M. L. Pérez and N. Fernández. *Centro Azúcar,* 1977, **4,** (1), 61-72 (*Spanish*).—Laboratory tests have been made of the CEH process for bleaching of bagasse pulp, which involves chlorine treatment, alkaline extraction with NaOH, and then treatment with calcium hypochlorite. The amount of chlorine used in the first and third stages was varied with other conditions the same, and the pulps obtained compared for brilliance, viscosity and mechanical resistance. The best pulp characteristics were given using 4% of total chlorine, 80% of this in the first stage.

**Economic evaluation of investment alternatives in plants for the production of biomass.** I. Morrell F., P. García G., P. Hernández S. and J. Artiles S. *Centro Azúcar,* 1977, **4,** (2), 99-107 (*Spanish*).—A mathematical treatment is given to evaluate economically the operation of a yeast plant in terms of a number of variables.

**Cultivation of micro-organisms for the production of biomass from solutions of cane final molasses.** P. Hernández S. and I. Morrell F. *Centro Azúcar,* 1977, **4,** (2), 109-117 (*Spanish*).—A series of experiments were made, varying the conditions for yeast production on a molasses substrate. The highest contents of total reducing sugars showed no inhibitory effect (40% *vs.* 30 and 35%), while the lower temperature (30°C) gave higher yields than the higher (40°C). The effect of pH was less than that of temperature but the optimum was about 3·7 (*vs.* 4·5 and 5·2).

**Cuba 9 project.** P. L. Gutiérrez and R. Molina M. *Revista ICIDCA,* 1977, **11,** 12-13 (*Spanish*).—A pilot plant has been designed by ICIDCA and built by a Czechoslovakian organization under UNIDO auspices next to the Pablo Noriega sugar factory and was planned to begin operations in early 1978, using bagasse from the factory for manufacture of paper and pulp. The design of the plant (the "Cuba 9 project") is described with details of the system for preparation and storage of bagasse, pulping, washing, classification, purification, bleaching, paper making and drying.

**Cuba 10 project.** O. Almazán del O. and A. Roca G. *Revista ICIDCA,* 1977, **11,** 24-31 (*Spanish*).—This is the title of a project for the design of experimental and pilot installations for developing appropriate technology in the production of yeasts and other material for animal fodder on a basis of sugar cane by-products.

**Utilization of carbonatation muds.** G. Vaccari and C. A. Accorsi. *Ind. Sacc. Ital.,* 1978, **71,** 11-13 (*Italian*). After a review of the literature on utilization of filtercake in agriculture, the characteristics of carbonatation muds produced in an Italian sugar factory in the 1977 campaign were determined and show that, on a basis of comparable composition, they would be suitable for use in modifying soils, especially those deficient in calcium.

**Microbiological synthesis of fodder yeast on molasses slops as the first stage of biological purification of effluents from alcohol factories.** L. D. Il'ina, N. G. Sitnik, L. V. Rudnichenko *et al. Trudy IV S'ezda Mikrobiologov Ukrainy,* 1975, 103-104; through *S.I.A.,* 1978, **40,** Abs. 78-420.—Fodder yeast growth utilized about 46% of the dry substance and about 57% of the organic matter in vinasse; % utilizations of several components are indicated. Modernization of the yeast culture scheme has since increased the degree of purification to 70-74%.

**Utilization of waste in pulp, paper, sugar, petroleum and agro-based industries.** M. S. Iyengar. *Chemical Age of India,* 1976, **27,** 1045-1051; through *S.I.A.,* 1978, **40,** Abs. 78-580.—Various waste products from the above industries are briefly considered. Bagasse can be used as the raw material for building boards while cane molasses can be used in the manufacture of food- and pharmaceutical-grade yeast and of oxalic acid.

# Poland sugar exports[1]

| | 1978 | 1977 | 1976 |
|---|---|---|---|
| | *tonnes, raw value* | | |
| Algeria | 77,923 | 58,962 | 6,012 |
| Egypt | 11,909 | 0 | 0 |
| Germany, West | 1,505 | 1,761 | 12,636 |
| Hungary | 0 | 0 | 12,554 |
| Indonesia | 17,786 | 43,118 | 0 |
| Iran | 0 | 11,367 | 0 |
| Iraq | 0 | 0 | 24,368 |
| Jordan | 0 | 0 | 13,641 |
| Kuwait | 1,299 | 460 | 920 |
| Liberia | 367 | 16 | 1,139 |
| Libya | 113,776 | 100,395 | 109,373 |
| Mali | 2,170 | 0 | 0 |
| Morocco | 0 | 5,413 | 0 |
| Norway | 4,376 | 5,111 | 7,091 |
| Saudi Arabia | 12,504 | 0 | 3,242 |
| Spain | 0 | 0 | 2,151 |
| Sri Lanka | 0 | 12,500 | 0 |
| Sweden | 0 | 2,681 | 0 |
| Switzerland | 0 | 0 | 1,083 |
| Syria | 24,413 | 22,245 | 15,210 |
| Tunisia | 11,367 | 0 | 11,367 |
| USSR | 0 | 5,641 | 114,759 |
| Yemen, North | 0 | 0 | 7,849 |
| Yemen, South | 0 | 0 | 5,684 |
| Other countries | 2,267 | 1,140 | 2,826 |
| | 281,662 | 270,810 | 351,905 |

**Polish sugar factories for the USSR**[2].—In 1980/81 Poland is to supply three new sugar factories with a capacity of 6000 tonnes of beet per day each. One is for the Ukraine, another for Moldavia and the third for the Russian SFSR.

**Mauritius bulk terminal plan**[3].—Mauritius is expected to grant a mandate shortly for a $50 million loan to be used for a port terminal to facilitate exports of bulk sugar.

**Spanish sugar beet area**[4].—According to the Banco Central, 73,761 hectares were sown to summer sugar beet in 1978/79 and 157,158 hectares sown to winter beet, yielding 2,695,100 and 5,724,600 tonnes of beets, respectively. Spain has a considerable sugar surplus, however, and the area sown to summer beets in 1979/80 has declined sharply to 56,000 hectares.

**New Hungarian sugar factory**[5].—The new sugar factory being built in collaboration with Poland at Hajdusag should be completed in September and ready for operation.

**New Cuban sugar factories**[6].—Three new sugar factories—Central Batalla de las Guásimas in Vertientes, Camagüey, Central Treinta de Noviembre in San Cristóbal, Pinar del Río, and Central Rodas in Cienfuegos—are scheduled for trial runs in the 1979/80 harvest while a fourth factory, Central Cauto Norte, is being built in the Province of Granma and is expected to start operating in the following season. Each of the new factories is reported to be designed to process about 7000 tonnes of cane per day at full capacity and to produce 100,000 tonnes of sugar per season from cane grown on a total area for the four of 67,000 hectares.

**Chile sugar beet area decline**[7].—The area planted to sugar beet in 1978/79 is reported to be 16,190 hectares, which compares with 60,730 ha in 1975/76, 55,425 ha in 1976/77 and 21,510 ha in 1977/78, representing a decline of 73·34% over three years! The main reasons for this very sharp fall in beet area are the low prices on the world market, which is reflected in the price band levels fixed by IANSA in contracts with beet growers, and high interest rates on IANSA loans to farmers. Under such conditions the farmers are discouraged from planting sugar beet as a rotational crop. By implication, when world prices improve to satisfactory levels, farmers will be inclined to increase their area allotted to sugar beet—provided that the sugar factories have not been forced to close down indefinitely in the meantime. The Llanquihue plant, of 8000 tonnes daily processing capacity, has been closed down, but its disposal has not yet been decided[8].

# Australia sugar exports[9]

| | 1978 | 1977 | 1976 |
|---|---|---|---|
| | *tonnes, raw sugar* | | |
| Canada | 308,647 | 620,827 | 437,559 |
| China | 129,549 | 261,752 | 217,429 |
| Japan | 672,000 | 816,564 | 777,625 |
| Korea, South | 260,549 | 288,194 | 177,900 |
| Malaysia | 215,700 | 118,652 | 201,596 |
| New Zealand | 92,263 | 137,307 | 54,924 |
| Singapore | 48,000 | 96,788 | 80,678 |
| UK | 0 | 28,650 | 169,394 |
| USA | 158,160 | 434,234 | 356,068 |
| | 1,884,868 | 2,802,968 | 2,473,173 |

**Italian sugar factory closures**[10].—The S.I.I.Z. company plans to close its Rovigo sugar factory but this step has met with opposition from the trade unions since the labour force would be allocated to other S.I.I.Z. factories and this would involve longer journeys. Closure of the Foligno white sugar factory of Società Generale is also under consideration, after which the Rendina factory in Melfi would be the only one in the company to remain in operation. On the other hand, closure of the Avezzano factory is definite. Saccarifera Abruzzo e Molise S.p.A., which had assumed management of Zuccherificio di Avezzano in the 1978/79 campaign as a result of an official order and had processed the beet supplies at Celano and Avezzano, returned Avezzano to its previous owner, Prince Torlonia, on January 19, and he immediately liquidated the company and closed the factory. The basic beet quota for Avezzano will be officially redistributed to Termoli and Celano factories; thus Celano will acquire both the beet and basic staff of Avezzano and will be the only factory in the Fucino valley. The other Italian sugar companies have declared themselves opposed to the quota distribution.

**USSR sugar purchases from the EEC**[11].—Under the International Sugar Agreement, the USSR is permitted to import only 116,539 tonnes of sugar from non-member countries during 1979 while present sugar prices are below 11 cents/lb. A purchase of 220,000 tonnes from the EEC, a non-member, was recently announced and an ISO spokesman has pointed out that the excess would be deducted from non-member import entitlements for 1980 unless the EEC sugar was not physically imported but instead shipped to other countries to which the USSR has export commitments.

**New Honduras sugar factory**[12].—A new sugar factory, Azucarera Central (Acensa), was opened in January at Marcovia (Choluteca); the venture is jointly owned by Mitsubishi of Japan (45%), the Corporación Nacional de Inversiones (Conadi) (33%), and individual shareholders (22%). The factory is expected to produce 60,000 tonnes of sugar in the 1978/79 season, 110,000 tonnes in 1979/80 and, when operating at full capacity, 150,000 tonnes in 1980/81 or 25% of national output. The total cost of the project was estimated at US $35 million (equivalent).

**New Yugoslavia sugar factory**[13].—A new beet sugar factory has begun operation at Nova Crnja, near Zrenjanin in Vojvodina Province, north of Belgrade. The factory has a daily processing capacity of 4000 tonnes of sugar beets.

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[1] International Sugar Organization; through C. Czarnikow Ltd., *Sugar Review*, 1979, (1431), 52.
[2] *Zuckerind.*, 1979, **104,** 246.
[3] *Reuters Sugar Rpt.*, February 27, 1979.
[4] F. O. Licht, *International Sugar Rpt.*, 1979, **111,** 174.
[5] *Zuckerind.*, 1979, **104,** 245.
[6] F. O. Licht, *International Sugar Rpt.*, 1979, **111,** 180.
[7] *World Sugar J.*, 1979, **1,** (9), 31.
[8] F. O. Licht, *International Sugar Rpt.*, 1979, **111,** 159.
[9] *Queensland Cane Growers' Association Annual Report*, 1978.
[10] *Zuckerind.*, 1979, **104,** 168.
[11] F. O. Licht, *International Sugar Rpt.*, 1979, **111,** 112.
[12] *Bank of London & S. America Review*, 1979, **13,** 171.
[13] F. O. Licht, *International Sugar Rpt.*, 1979, **111,** 116.

# Swaziland sugar statistics[1]

| | 1978 | | 1977 | |
|---|---|---|---|---|
| | *tonnes, raw value* | | | |
| Initial stocks | | 12,714 | | 10,796 |
| Production | | 256,874 | | 238,497 |
| | | 269,588 | | 249,293 |
| Exports: | | | | |
| Canada | 0 | | 27,382 | |
| UK | 130,750 | | 112,994 | |
| USA | 95,443 | | 70,742 | |
| | | 226,193 | | 211,118 |
| Consumption | | 24,925 | | 25,461 |
| Final stocks | | 18,470 | | 12,714 |

**Finland sugar production, 1978/79**[2].—The five sugar factories in Finland sliced 735,279 tonnes of beet to produce 63,255 tonnes of white sugar, 32,128 tonnes of raw sugar, 18,620 tonnes of molasses and 50,195 tonnes of dried beet pulp.

**Czechoslovakia beet sugar production, 1978/79**[3].—According to official sources, 5·2 million tonnes of beets were processed in the 59 sugar factories of the Czech part of the country in the 1978/79 campaign. The quantity processed was 500,000 tonnes less than last year. Sugar content increased, however, to 15·1%. Sugar production in the Czech part of the country did not exceed 600,000 tonnes, white value, 92% of the planned figure. The factories worked at 96·5% of capacity. The campaign in Slovakia ended on November 18 with 1·6 million tonnes of beet processed. Assuming that the extraction rate reached the same level as in the Czech part of the country (11·54%), sugar output will have been around 185,000 tonnes, white value. This would mean a total sugar output in Czechoslovakia in 1978/79 of the order of 785,000 tonnes, white value, which compares with 863,500 tonnes in 1977/78.

**Italy sugar production, 1978/79**[4].—A total of 1,501,192 tonnes of white sugar were produced by the Italian sugar factories in the 1978/79 campaign.

**Turkey sugar expansion**[5].—The Minister of Industry and Technology recently said that he plans to boost sugar production within ten years to 2,000,000 tonnes, against 1978/79 production of slightly more than 1,000,000 tonnes. Actual consumption in calendar year 1977 was 1,053,225 tonnes, white value, and increased to 1,087,436 tonnes in 1978. According to the Minister, Turkey plans to set up 12 new sugar factories by 1989.

**Brazil alcohol production increase plans**[6].—The Brazilian Economic Development Council approved at the beginning of March the utilization of cane equivalent to the production of 4·5 million tonnes of sugar for the production of alcohol. The alcohol production target is 3800 million litres, an increase of 46%, which, if attained, would enable one-fifth of all motor spirit to be derived from domestically produced alcohol. Sugar production has been set at a maximum of 6,600,000 tonnes, tel quel, of which 1,920,000 tonnes will be earmarked for export.

**Nigerian sugar project study**[7].—A Cuban team is conducting a feasibility study on the establishment of a cane sugar industry at Mokwa in Niger State for the production of 100,000 tonnes of sugar per year. The country recently received a $750 million credit to provide finance for its current development plan which includes projects in the sugar industry among others.

**Panama sugar exports, 1978**[8].—Exports of sugar from Panama totalled 126,293 tonnes, raw value, in 1978 against 119,199 tonnes in 1977. In both years all exports went to the USA.

**Swiss sugar beet area expansion**[9].—The Swiss Cantonal Chamber has approved the proposed extension of the country's sugar beet area to 17,000 hectares from the current 13,000 ha. The extra area will allow the sugar factories in Switzerland to satisfy 45% of domestic demand.

# Holland sugar imports and exports[10]

| | 1978 | 1977 |
|---|---|---|
| *Imports* | *—tonnes, telq uel—* | |
| Austria | 1,000 | — |
| Belgium/Luxembourg | 39,278 | 60,142 |
| Czechoslovakia | 750 | — |
| Finland | — | 2,500 |
| Germany, West | 68 | 4,068 |
| Surinam | 3,124 | 2,187 |
| Other countries | 727 | 1,089 |
| | 44,947 | 69,986 |
| *Exports* | | |
| Algeria | 3,000 | 80 |
| Bahrain | 1 | 10,751 |
| Belgium/Luxembourg | 9,515 | 6,506 |
| Cameroun | 500 | — |
| Cape Verde Is. | — | 650 |
| China | 22,300 | — |
| Cyprus | 1,000 | 100 |
| Djibouti | 500 | — |
| Egypt | 500 | — |
| Germany, West | 10,764 | 1,933 |
| Ghana | 500 | 1 |
| Iran | 23,012 | 1,005 |
| Iraq | 1 | 12,001 |
| Israel | 7,568 | 4,058 |
| Ivory Coast | 4,200 | — |
| Kenya | — | 600 |
| Korea, North | 9,163 | — |
| Kuwait | 900 | 2,000 |
| Lebanon | — | 15,175 |
| Malta | 1,213 | 1,857 |
| Mauritania | — | 1,170 |
| Morocco | — | 550 |
| Nigeria | 19,632 | 33,020 |
| Oman | 600 | 2,500 |
| Papua | — | 519 |
| Saudi Arabia | 123 | 4,816 |
| Sri Lanka | 11,866 | — |
| Sudan | 9,950 | 4,583 |
| Surinam | 110 | 2,501 |
| Tanzania | — | 2,001 |
| Tunisia | 36,550 | 11,050 |
| UK | 37,722 | 20,963 |
| United Arab Emirates | 1,502 | 1,000 |
| USSR | — | 30,551 |
| Venezuela | 15,000 | — |
| Yemen, North | — | 21,551 |
| Yemen, South | 3,000 | — |
| Other countries | 1,342 | 1,163 |
| | 232,034 | 194,655 |

**Chile sugar company difficulties**[11].—According to press reports, low sugar prices are forcing the Chilean state-owned sugar company, Industria Azucarera Nacional S.A. (IANSA), into bankruptcy. The critical situation of the Chilean sugar industry has forced the closure of IANSA's Llanquihue factory and has five other plants operating at only one-third capacity. The beet area contracted to IANSA has been falling steadily since the 1975/76 season when 60,000 hectares were contracted. The area fell to 55,400 ha in 1976/77, 21,300 ha in 1977/78, 16,100 ha in 1978/79 and is expected to drop below 14,000 ha in 1979/80. Sugar production fell from 121,488 tonnes, white value, in 1978 to 91,500 tonnes in 1979.

1 International Sugar Organization; through C. Czarnikow Ltd., *Sugar Review*, 1979, (1431), 53.
2 *Zuckerind.*, 1979, **104**, 167.
3 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 82.
4 *Zuckerind.*, 1979, **104**, 168.
5 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 134.
6 C. Czarnikow Ltd., *Sugar Review*, 1979, (1430), 47.
7 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 138.
8 *I.S.O. Stat. Bull.*, 1979, **38**, (2), 79.
9 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 174.
10 C. Czarnikow Ltd., *Sugar Review*, 1979, (1433), 63.
11 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 238.

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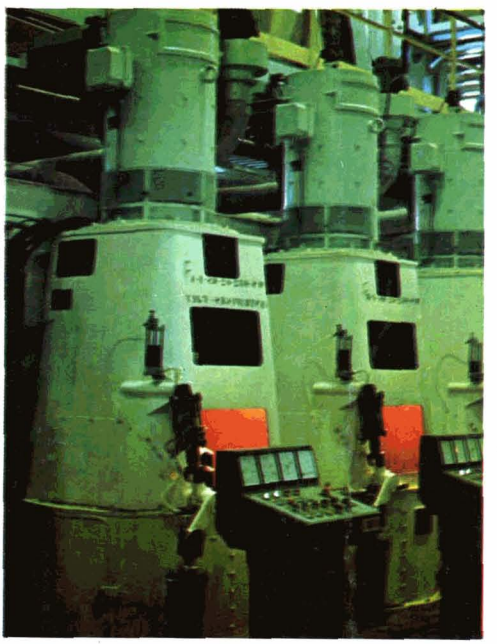

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