

SOME CONSIDERATION ON FACTORS GOVERNING THE YIELD OF JELLY MASSECUITES

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It is a matter of common occurrence that recovery figures fluctuate from week to week, with only the general explanation that jellies yielded well or otherwise.

This came to the immediate notice of the writers very forcibly during the course of last season, when it was found that jellies of apparently the same brix and purities gave, after a similar time of crystallisation, yields varying from 1 lb. to 12 lbs. per cubic foot.

With the idea of throwing some light on these variations, the experiments described later were carried out.

An exposure of the methods of boiling in use is here necessary to interpret the results of analysis.

First massecuite boiled off 70 to 80% syrup grain as footing, balance of either wash or first molasses, occasionally of both. Purity 78 to 82.

Second massecuite 30 to 40% syrup grain, followed by first molasses. Purity 69 to 71.

Jelly, blank boilings of second molasses (raw curing): Purity 49 to 51.

All molasses are diluted to approximately 75° brix, heated, skimmed, no chemicals are added and no settling done.

In the case of jellies, however, approximately 3 gallons of milk of lime of about 14 Beaume are drawn in the pan just prior to final tightening.

Group IV. received rather more than this quantity, probably 50% more.

20 tanks of approximately 400 cubic feet were examined.

A sample of jelly representing the whole depth of tank was taken from each tank.

A sub-sample of 500 grams from each was diluted with 5% of water and cured, using a Cyclone laboratory centrifugal; the raw sugar obtained was weighed.

The following (Table I.) is the result of this test, yields being grams of sugar recovered per 500 grams of original jelly. The results are grouped according to yield. Analyses of massecuites refer to figures obtained at time of striking from routine control figures.

TABLE I.

| Group. | Tank No. | Date Boiled. | Time in Tank. Days. | Apparent | | |
|--------|----------|--------------|---------------------|----------|---------|--------|
| | | | | Brix. | Purity. | Yield. |
| I. | 18 | 16/10/32 | 85 | 90.5 | 48.4 | 25 |
| | 19 | 16/10/32 | 85 | 90.0 | 50.9 | 22 |
| | 22 | 17/10/32 | 84 | 90.5 | 48.7 | 18 |
| | 29 | 19/10/32 | 83 | 90.5 | 49.6 | 22 |
| | 16 | 30/11/32 | 62 | 90.0 | 50.6 | 25 |
| | 31 | 6/12/32 | 61 | 91.0 | 51.4 | 18 |
| II. | 12 | 14/10/32 | 88 | 91.5 | 49.9 | 43 |
| | 25 | 18/10/32 | 84 | 90.0 | 49.4 | 45 |
| | 26 | 18/10/32 | 83 | 90.0 | 49.6 | 43 |
| | 15 | 29/11/32 | 64 | 89.0 | 50.6 | 42 |
| | 17 | 30/11/32 | 63 | 89.5 | 52.1 | 45 |
| | 20 | 1/12/32 | 62 | 90.5 | 51.1 | 50 |
| | 30 | 5/12/32 | 61 | 90.0 | 49.1 | 45 |
| III. | 21 | 16/10/32 | 85 | 91.0 | 49.6 | 73 |
| | 11 | 28/11/32 | 64 | 90.5 | 50.8 | 60 |
| | 13 | 29/11/32 | 63 | 90.5 | 50.8 | 70 |
| | 14 | 29/11/32 | 63 | 91.0 | 50.6 | 70 |
| | 23 | 1/12/32 | 62 | 90.5 | 49.1 | 70 |
| | 24 | 2/12/32 | 62 | 90.0 | 50.0 | 70 |
| | 27 | 3/12/32 | 61 | 89.5 | 50.0 | 60 |

It is remarkable that the yield fell in three distinct categories, with little or no transition.

Group I. yielding an average of 21.7 grams.

II. yielding an average of 43.3 grams.

III. yielding an average of 67.6 grams.

It is also remarkable that the yield of Group II. is twice as great as Group I., while Group III. is practically three times as great.

The differences being so marked, it was decided to composite the samples belonging to each group—samples of jellies, sugar and molasses, representing, therefore, six or seven tanks. In addition, a tank of 1,400 cubic feet that had shown signs of froth fermentation was placed as Group IV. It was found necessary to dilute this jelly by 7% for curing, the yield of sugar being 45 grams.

The following determinations were then made on collective samples:—

| | | |
|------------------|-----------------|--------------------------------|
| <i>Jellies:</i> | Brix. | Apparent; one-fifth dilution. |
| | Purity. | Direct polarisation. |
| | pH | Potentiometric method. |
| <i>Sugar:</i> | | Polarisation. |
| <i>Molasses:</i> | Brix | Apparent; one-fifty dilution. |
| | Sucrose clerget | S.A. Sugar Tech. Assn. method. |
| | Purity clerget. | |
| | Reducing sugar | Lane-Eynon method. |
| | Ash | Carbonated below glowing heat. |
| | Alcohol ppt. | Farnell method. |

Ash extracted with nitric acid and following constituents determined:—

Chlorine Volhard method as modified by Dreschel.

P₂O₅ Atkins method.

Table II. shows the results obtained.

TABLE II.

| GROUP. | YIELD. | MASSECUITES. | | | SUGAR POI. | MOLASSES. | | | | | | | | |
|--------|--------|--------------|---------|------|---------------|-----------|--------------------|-----------------------------------|----------------|----------------------------|--------------------------------|-----------------------|--------------------|---|
| | | Brix. | Purity. | pH. | | Brix. | Clerget Purity. | Re- ducing Sugar % Brix. | Ash % Brix. | Alcohol ppt. % Brix. | Re- ducing Sugar Ash. | Non- Sugar Ash. | Chlorine % Ash. | P ₂ O ₅ % Ash. |
| I. | 21.7 | 88.00 | 50.51 | 6.34 | 78.4 | 83.35 | 48.40 | 10.08 | 10.41 | 7.99 | 0.968 | 3.88 | 17.04 | 0.851 |
| II. | 43.3 | 88.15 | 50.71 | 6.82 | 82.4 | 83.30 | 46.00 | 11.04 | 10.38 | 8.15 | 1.064 | 4.14 | 19.39 | 0.975 |
| III. | 67.6 | 88.85 | 50.03 | 6.38 | 80.2 | 83.35 | 46.33 | 11.21 | 10.57 | 8.31 | 1.064 | 4.02 | 19.52 | 1.601 |
| IV. | 45.0 | 88.75 | 50.36 | 6.57 | 79.0 | 83.95 | 46.40 | 10.24 | 10.52 | 7.91 | 0.974 | 4.12 | 15.13 | 0.816 |

From these figures it is apparent that *brix of masse-cuite* had little effect on yield, except perhaps on Group III., which, however, resulted in inferior and more difficultly-cured sugar.

Reducing sugar.—Concentration was increased by removal of sugar.

Alcohol ppt.—Also seems to have been increased by removal of sugar.

Ash % Brix.—Seems a constant and would therefore indicate the limit of exhaustion.

Non-sugar Ash ratio.—Is also fairly constant, but can only be taken as a measure of exhaustion.

Note.—Group IV. must be interpreted slightly differently, as it had received at boiling a quantity of milk of lime largely in excess of usual.

Ash constituents.—Chlorine concentration increased with yields and also P₂O₅ content.

Chlorine is probably the most persistent of the non-sugars, while P₂O₅ present was probably in combination with Fe and Al, as water extract showed no P₂O₅ by Atkins method; it being revealed only in nitric acid extract.

The fact that chlorine is greater in groups of higher recovery would indicate less added ash.

It is not, however, considered that the added ash is due to milk of lime added to pans, as the solids added amount to less than 0.05% brix.

This, however, could be possible in the case of Group IV., which received probably 50% more than that quantity. It is significant that the yield from this group was not unsatisfactory, although great difficulties were experienced in the curing.

The sum total of these analyses would seem to point that—

- (1) Exhaustion is in a measure directly dependent upon ash concentration.
- (2) Chlorine concentration does not seem to play a great part on exhaustion. This, of course, does not imply that a juice of naturally low chlorine content would not give a higher yield, but rather the reverse—as this constituent, being persistent, would naturally tend to increase ash, with consequent lower recovery.

- (3) Alcohol precipitate concentration is increased by exhaustion—this probably within limits.
- (4) Considerable research is necessary on non-sugar constituents of sugar products before any definite conclusions can be drawn.
- (5) At the present state of knowledge all increase in ash concentration must be carefully guarded against.

At some future time it is intended to determine the following other ash constituents of these same molasses:—

Magnesium, silicate, sulphate, potassium, sodium, and calcium,

to try and trace the diluent, which at present is suspected to be lime.

We are indebted to Dr. E. P. Hedley, of the Natal Sugar Experiment Station, for the potentiometric determination of the hydrogen ion concentrations.

—E—

Mr. FOSTER: I notice from the table of results the ash ratio is about 10.5%. Does Mr. Bechard consider that an indication of exhaustion?

Mr. BECHARD: I am inclined to think so. That is the general figure we got. As long as we get a figure about 10.3 to 10.5 we get a fairly good yield. If it drops below that the yield is generally very low.

Mr. PEARCE: I think the whole trouble with your massecuite is entrained air. Once you get air into it you cannot do anything with the mixture. At Illovo we heat to 93° and have no trouble, but in tanks into which air gets we have trouble.

Mr. BECHARD: The general content of the massecuites are very indicative of the results we got.

Mr. RAULT: I am really sorry this paper was read at the last stage of the Congress, because no doubt it interests all of us who have been in the factory; at some time or other we have met the same difficulties, the same strange happenings, that Mr. Bechard reports. At Mount Edgecombe we have the carbonatation process and clarify our juices in a more vigorous way; we may not be strictly comparable with defecation mills, but nevertheless our experience has been more or less identical with Mr. Bechard's. One gets different yields from massecuite boiled jellies, boiled to nearly the same consistency and having the same composition, and there is no apparent explanation even after making many minute analyses. Mr. Bechard has done quite a lot of work in giving these figures, and it looks as if probably something in the nature of colloids would be the reason for affecting these yields. So far we have not developed a technique that would quickly test the colloidal matter.

I must at the same time express surprise at the trend of our sugar boiling technique in South Africa, because if you read through the reports from other sugar lands you find they do not favour jelly boiling, and we seem to have gone back. In Java, I do not think they boil jelly at all. I remember corresponding with Princen Geerligs years ago, and he stated that by stopping jelly boiling they put up their recovery by 0.5.

Mr. BECHARD: I think Mr. Viger has quite a bit to say about the advisability of boiling jellies as against third massecuite, say. The reason why we probably boil jellies in sulphitation factories is the difficulty of crystallisation in a very dense medium or in a very viscous medium. I have been told of cases where syrup would not grain and they had to drop it back into the tanks.

CHAIRMAN: I quite agree with what Mr. Rault says, and I think that jellies should become things of the past. It is up to us to find a way out of the trouble and eliminate it, but I do not want to continue this discussion any further. I have an apology to make to Mr. Bechard for not working in his paper earlier in our programme; but those of you who have dealt with meetings of this kind probably appreciate the difficulty of keeping to a correct time-table. I would suggest that we ask Mr. Bechard to continue this work and at the next Congress give us a continuation paper on a subject which is of great interest to all of us. I ask you to accord to him a very hearty vote of thanks for his paper. (Applause.)

—E—

CHAIRMAN: We have come to the end of the Congress, and I have very few words to say; it is a very tiring job to be President at a Congress. This is the seventh Congress of the Association, and I think it has been a very successful one. I am sure you will agree we have had more people here than in past years. We have had many interesting papers discussed, and in retiring from the position of President I wish to extend my thanks to all individuals and Committees who have assisted me so greatly in the past two years in making the job an easy one. I wish you all the very best, and I am sure that in the coming years the Association will advance and our work will get better and better. Gentlemen, I thank you. (Loud applause.)

Mr. MOBERLY: I would like to propose a very hearty vote of thanks to Mr. Dymond for the very able way in which he has conducted the meetings, and not only for that but for the very able way in which he has held the reins of this Association during the past two years. As a member of the Committee during that time I know the work he has done is not only shown here but has been right through the two years. I ask you to give a very hearty vote of thanks to Mr. Dymond. (Loud applause.)