THE USE OF NATURALLY OCCURRING TRACERS TO EVALUATE "UNACCOUNTABLE" LOSSES

Mike Fowers, Jackie Olmstead, et al
The Amalgamated Sugar Company
Twin Falls, Idaho

* * * * *

presented at

American Society of Sugar Beet Technologists
27th General Meeting
Anaheim, California

Section F
Factory Operations
Friday, March 5, 1993

ABSTRACT

Chemical substances which occur naturally in the beet may be used as tracers of sucrose in process. The ratios of sucrose as determined by gas chromatography and the concentration of these substances can be determined and followed through out the diffusion and purification process. The ratios also may be correlated to bacterial concentrations and to losses which occur in the beet end.

THE USE OF NATURALLY OCCURRING TRACERS TO EVALUATE "UNACCOUNTABLE" LOSSES

M. Fowers, J. Olmstead, et al.

Introduction

The importance of understanding and reducing the microbial load in the sugar process has been widely discussed. Optimal use of GMP's, temperatures, and biocides can greatly reduce the amount of sucrose lost to microbial degradation. The experiments described in this paper were carried out in an attempt to answer the following questions:

(1) Where in the process is sucrose lost?

(2) How high of a correlation exists between losses and microbial concentrations?

(3) How much of the "unaccountable" losses can be identified with natural tracers?

Natural tracers are chemical constituents which are found in the beet at processing. Those selected for evaluation in this study were betaine, potassium, and chloride. Over 800 samples were taken in this study.

Results

One of The Amalgamated Sugar Company's facilities, Nampa, installed flow meters around the beet end for use in mass balances. The balances seemed to indicate that no sucrose was being lost in the diffuser or purification but rather in the evaporators. Means of evaluating the losses chemically were discussed and three chemical "tracers" were chosen for evaluation. Betaine, potassium, and chloride were chosen due to their inertness in the process. The ratio of gas chromatographic (GC) determined percent sucrose divided by the concentration of the tracers was used to evaluate both the tracer and the location of sugar loss. Since the concentration of the tracer should not change throughout the process any change in the ratio would indicate a change in the sucrose concentration. Samples collected and analyzed included fresh cossettes, mid-tower diffusion juice, diffusion juice (raw juice), pressed pulp water, tailings return, diffuser supply water, thin juice, and thick juice. For this paper only the samples of cossettes, raw juice, thin juice, and thick juice will be discussed. The other samples contained negligible concentrations of sugar and tracers.

Betaine was chosen because of its relatively high concentration and reported inertness through the process. The GC percent sucrose/betaine ratio was plotted against the thermophilic bacteria concentrations and showed an excellent correlation in the cossettes and in the raw juice. Figure 1 is a graph of the ratio-plate count correlation of raw juice in hourly samples taken over a six-hour period. Betaine was rejected as a tracer however because when the ratios between thin and thick juice were compared the thick juice demonstrated a higher ratio. Since sucrose cannot be made in the evaporator this indicated a betaine loss. We theorize that there is some thermal degradation of the betaine in the evaporators.

Potassium was also determined in several sets of samples from two locations. The potassium levels fluctuated throughout the sets of samples. An example of a plot of GC/potassium vs. plate counts is shown in Figure 2. Comparisons of GC/potassium ratios from

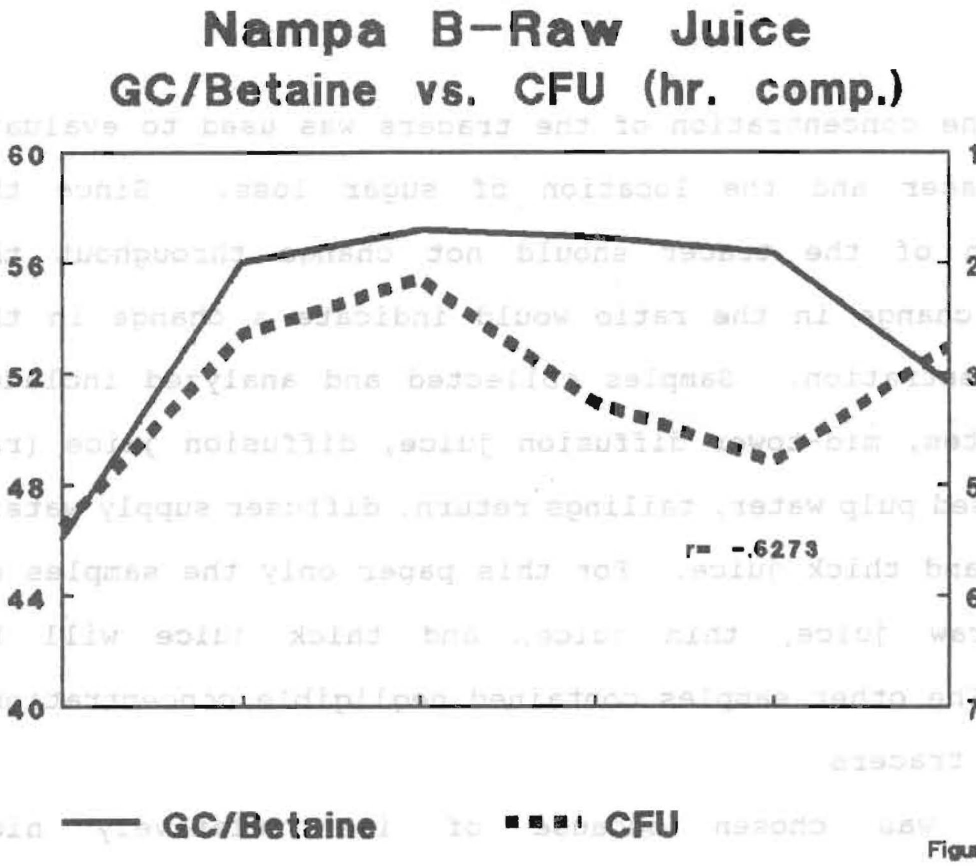

Figure 1

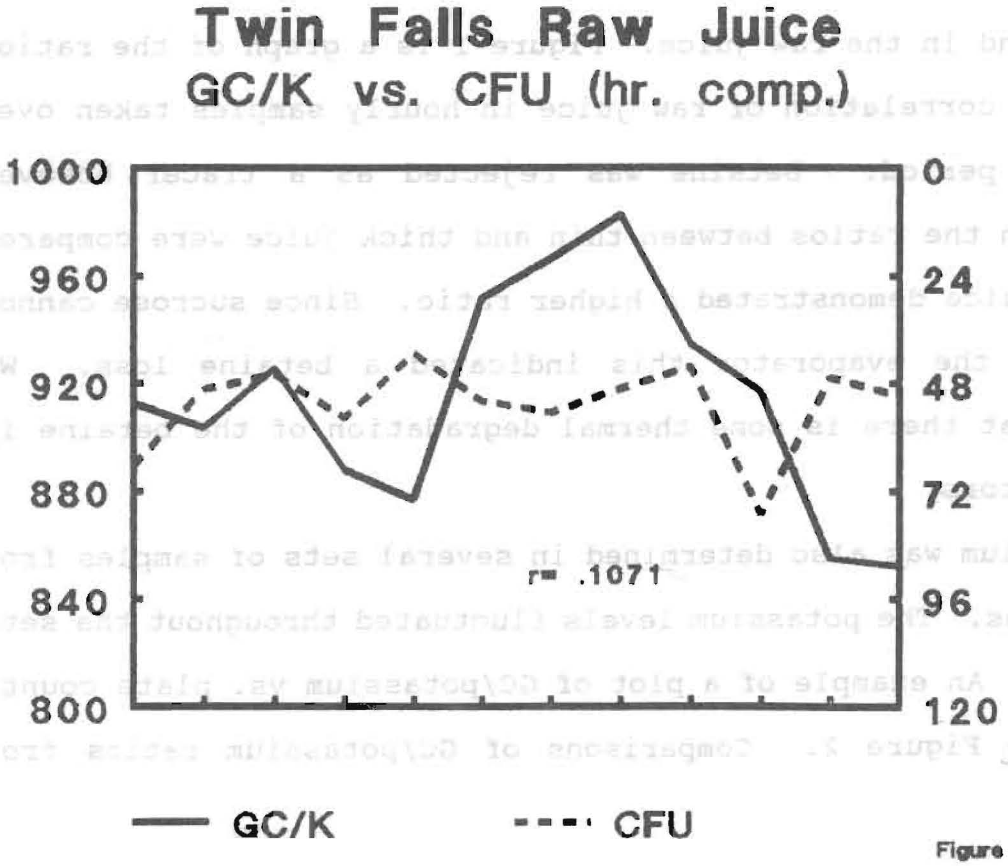

Figure 2

cossettes to thick juice were too erratic to be used for comparisons.

Chlorides are found in lower concentrations in beets than the other tracers but seemed to give the best results. In all cases the ratios decreased from cossettes to raw juice with only small deviations from raw juice to thick juice. Figure 3 illustrates the results of two days of hourly samples of GC/chloride ratios plotted against the microbial titers of the samples.

The correlation of 0.57 is quite good since it is a comparison between a chemical system and a biological system. The question was asked if the sucrose/chloride ratio change in raw juice was due to microbial degradation or changes due to variable incoming beet quality. A plot of the sugar/chloride ratios for cossettes and raw juice is shown on Figure 4.

Good correlations were obtained from sample sets taken in Nampa. Figures 5 and 6 are examples. The high correlations indicate the direct relationship of bacterial concentrations and sucrose lost in the process.

Evaluating the answer to question 1 in the introduction was important in light of the mass balances done at the Nampa factory. A complication at Nampa is that chlorides are added to the system as sodium chloride in the lime kiln. The sodium chloride is used as a flux to reduce clinkers. Since the chloride concentration of the thin juice would be affected calculations were done to correct for the added chloride. Figure 7 summarizes the calculations used. The operators document the amount of salt added per day and so daily averages of percent sucrose/chloride ratios were used in the

Twin Falls Raw Juice
GC/Cl vs. CFU (hr. comp.)

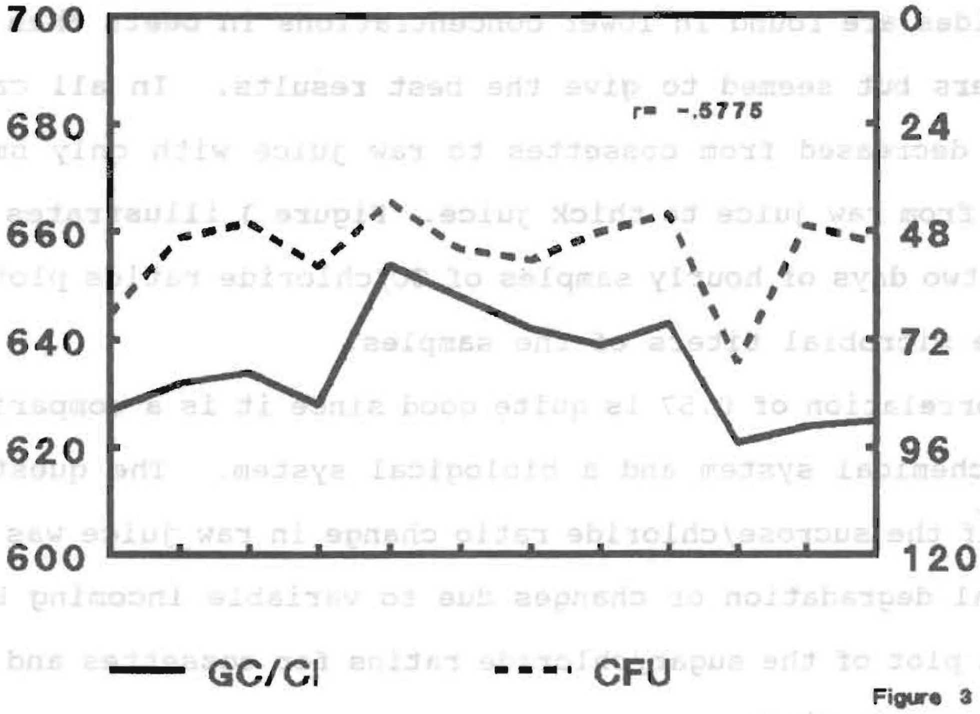

Figure 3

Nampa B GC/Chloride
Cossettes vs. Raw juice (hr. comp.)

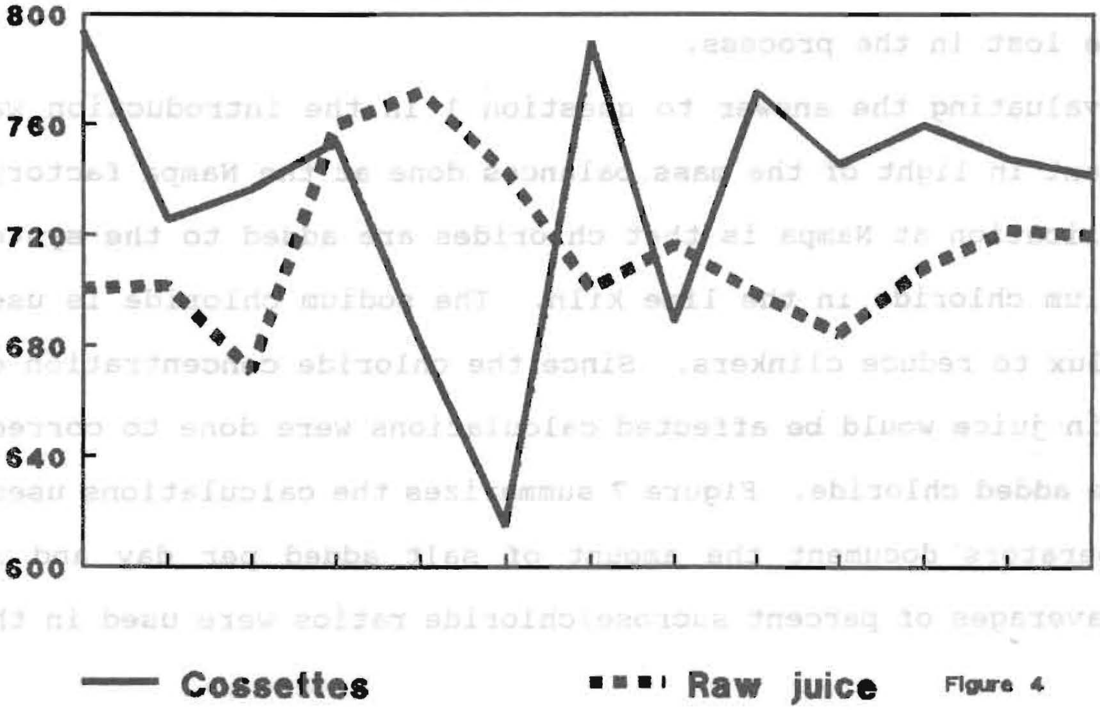

Figure 4

Calculated GC/Cl in Thin Juice

Slice(cossette %sugar-pulp loss)x 2000= lbs sugar

lbs Cl in rj= lbs sugar/ GC/Cl of rj

lbs Cl + Cl added in lime = lbs Cl in Thin juice

Calc. GC/Cl of thin juice = lbs sugar/lbs Cl in tj

Figure 7

GC/Cl Ratios

Cossettes	Raw Juice	Calc.Thin	Thin	Thick
691	662	623	621	614
691	658	620	611	615
673	657	618	619	618
934	895	818	813	856
1170	1104	985	954	956
734	703	653	663	
715	666	625	627	

Figure 8

% Loss on beets

Assume: GC/Cl = lbs sugar/lb Cl

Then: GC/Cl of cossettes/ %sugar = lbs beets/ lb Cl

GC/Cl of coss.- GC/Cl of thin juice = lbs sugar lost/ lb Cl

lbs sugar lost / lbs beets = calc. loss

calc. loss - pulp loss = % loss / beets

Figure 9

% Loss on Beets

Twin Falls

	Calc. Loss	Unacc. loss
	.19	.34
	.46	.21
avg.	.33	.28

Figure 10

% Loss on Beets

Nampa

Calc. Loss	Unacc. loss
.39 .48 (.44)	.43
.06 .58 (.32)	.24
.41	.47
.29 .56 (.43)	.31
.87 .96 (.92)	.96

Figure 11

ACKNOWLEDGEMENTS

Most of the chemical analysis for this paper was done by the Analytical Research group led by Dr. Eugene Rearick. Those who assisted include Diane Patterson, Cheri McKay, Marsha Lambregts, Debora Easterday, and Roxanne Mumm. The authors appreciate their efforts along with the editorial skills of Bev Crothers.