Composition of Certain Beet Diffusion Juices from the 1950 Campaign[1]

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Four years ago the Committee on Processing Problems for the Sugar Beet Industry recommended that determination of composition of processing liquors be undertaken because of its primary importance in the field of sugar beet technology. The committee believed that such knowledge would provide background for evaluation of present processing procedures and enable investigators to predict more precisely the possibilities of new methods for purification of beet diffusion juice.

We have published the results obtained on processing liquors for the 1949 campaign (1, 2)[3]. These results indicate that the present defecation procedure removes only certain colloids (such as pectin) along with citrate, oxalate and phosphate ions. Our attention was then focused on diffusion, because this process offers the first opportunity to achieve any purification in the factory. We have analyzed single samples of diffusion juices taken from nine factories located in all parts of the country to obtain some information on effect of locality of growth on the composition. These results from the 1950 campaign are presented here.

Materials and Methods

The samples were obtained from Manteca and Betteravia, California; Toppenish, Washington; Rupert, Idaho; Sidney, Montana; Brighton, Colorado; Centerfield, Utah; Carrollton, Michigan, and Moorhead, Minnesota. Except for the California samples, they were concentrated *in vacuo* at the factory and preserved with toluene. The two samples from the California factories were treated with toluene and transported directly to the laboratory without concentration. All juices were stored at 3° C. to inhibit microbial action. Before analysis the samples were diluted to approximately 10° Brix and filtered through a bed of filter aid.

Chloride, sulfate, phosphate, oxalate and citrate were determined by published methods on juices that had been treated with a cation exchanger.

The remaining non-amino organic acids were first separated by anion exchange fractionation. Lactic and glycolic acids were determined by eerie ion oxidation (3) ; malic by reaction with 2-7 dihydroxynaphthalene in sulfuric acid and measuring the color in a spectrophotometer (4) ; and pyrrolidone carboxylic acid (PCA) by total nitrogen analysis. In isolated cases, we determined acids by measuring areas on papergrams and comparing them with areas of known amounts of acid, using the chromatographic technique described earlier (5) .

Total nitrogen, amino nitrogen, amide nitrogen and ammonia were determined on the original filtered juices by the usual procedures. Amino acids were adsorbed on a cation exchanger, then eluted with ammonia. They were then analyzed microbiologically. Betaine was analyzed by the reineckate method (6) .

[1] Report of a study made under the Research and Marketing Act of 1946.

[2] Western Regional Research Laboratory, Albany, California; Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[3] Figures in parentheses refer to literature cited.

Results and Discussion

Analyses for the non-amino organic acids are given in Table 1. There is considerable variation from one sample to another except for citric acid. If we consider the known effect of fertilizer, soil composition and light conditions (7) on metabolism of plants, these variations are to be expected.

In addition, glyceric and fumaric have been tentatively identified. These two acids, succinic acid and two other unidentified acids are present in quantities less than 10 mg./liter.

Table 1.—Organic Acids in Diffusion Juice—1950 Campaign, 10% RDS

Factory	mg./liter at 10% RDS					
	Lactic	Glycolic	Malic	PCA	Oxalic	Citric
Betteravia	1,030	215	48	343	645	592
Brighton	82	23	167	104	267	473
Carroll ton	775	92	96	212	221	233
Centerfield	208	88	(260)[1]	374	94	317
Manteca	288	Nil	191	182	771	531
Moorhead	1,610	26	99	425	211	621
Rupert	180	Nil	145	465	Nil	326
Sidney	585	39	112	435	200	744
Toppenish	335	175	(250)i	300	261	702

[1] From paper chromatograms. .

Of the compounds listed in Table 1, lactic acid has the greatest interest. Two years ago we assumed that it is a normal constituent of beets. Since then we have analyzed juice pressed from beets from the Imperial valley, Alvarado and Woodland, California, and detected no lactic acid. Thus if any is present, the amount is less than 50 mg./liter (10% RDS) . The lactic acid present in diffusion juice in the quantities shown in Table 1 may arise during the sampling and concentration. If not, it represents a serious loss of sugar which might be prevented with bactericides or, perhaps, by better sterilization of equipment and beet cossettes.

Table 2.—Inorganic and Total Acids in Diffuson Juice:—1950 Campaign, 10% RDS

Factory	mg,./liter					
	Chloride	Sulfate	Phosphate	Total Acid[1]	Total Acid Accounted for[1]	Recovery %
Betteravia	606	292	651	87.6	85.3	97
Brighton	341	262	386	47.2	45.1	96
Carrollton	223	211	436	52.4	46.0	88
Centerfield	392	300	174	49.5	40.2	81
Manteca	365	174	618	62.6	66.9	107
Moorhead	283	126	331	69.6	58.5	84
Rupert	186	147	305	44.0	30.8	70
Sidney	142	160	434	62.3	49.3	79
Toppenish	187	142	369	75.0	49.0	65

[1] meq./l.

Analyses of inorganic anions are listed in Table 2. Except for chloride ion, the results are about the same as for the juices reported earlier (1) . Total accounted-for acid in the juices treated with cation exchange resin is generally about 80 percent or greater, except for juices from Rupert and Toppenish. Nitrate ion could account for a major portion of the unidentified acidic components.

Table 3. —Nitrogen and Acid Alcohol Insolubles for Diffusion Juice. 1950 Campaign at 10% RDS.

	Nitrogen—mg./liter					
Factory	Total	Amino	Amide	Ammonia	Betaine	Acid Alcohol Insolubles[1]
Betteravia	761	345	63		164	0.12
Brighton	362	107	26		109	0.43
Carrollton	461	126	26		157	0.24
Centerfield	461	118	24		175	0.24
Manteca	660	289	81		173	10.5
Moorhead	778	299	65		197	1.3
Rupert	445	100	15		151	0.31
Sidney	488	112	15		174	9.6
Toppenish	652	278	79			0.44

[1] g./liter

Table 3 shows the nitrogen analyses. The California, Washington and Minnesota juices are much higher in nitrogen than the others. The difference between total nitrogen and the sum of amino, amide and ammonia nitrogen is nearly constant, and indicates that betaine and purine bodies are not greatly influenced by the environmental growing conditions of the beets. The betaine analyses tend to confirm this assumption.

Xable 4.—Amino Acids Manteca Diffusion Juice—1950 Campaign at 10% RDS (Microbiological Assay).

	mg./liter				
Alanine	67	Isolucine	62	Proline	22
Arginine	11	Leucine	49	Serine	82
Aspartic	125	Lysine	16	Threonine	39
Glutamic	182	Phenylalanine	9	Tyrosine	37
Glycine	13	Methionine	9	Valine	45
Histidine	6				

The high values for alcohol-insoluble material for juices from Manteca and Sidney are due to the presence of dextran as proved by periodate oxidation and by hydrolysis to glucose. A period of several months had lapsed before this analysis was run and either leuconostoc or enzymes from it could have split the sucrose and synthesized dextran.

Table 5.—Amino Acids in Diffusion Juice—1950 Campaign at 10% RDS (Microbiological Assay).

	mg./liter		
Factory	Glutamic	Aspartic	Leucine
Betteravia	247	157	51
Brighton	56	48	18
Carrollton	105	76	21
Centerfield	119	94	28
Manteca	182	125	49
Moorhead	417	184	86
Rupert	44	73	22
Sidney	56	73	34
Toppenish	273	173	45

A fairly complete analysis of amino acids in Manteca diffusion juice is summarized in Table 4. Aspartic and glutamic acids are the predominant amino acids. The analyses for these two and leucine in all the diffusion juices are shown in Table 5. This table emphasizes the fact that the Rocky Mountain region and Michigan yield sugar beets low in amino acids compared to the rest of the country.

In 1951 cossettes and diffusion juices from two factories in the high-nitrogen and two in the low-nitrogen areas were analyzed. This project was undertaken to determine more exactly how much purification is accomplished by present diffusion methods. Results will be reported next year.

Summary

Analyses of sugar beet diffusion juices from nine factories are presented. Variation among most of the constituents is manifold but beet juice from the Rocky Mountain States and Michigan is low in nitrogen compared to that obtained from Minnesota and along the Pacific coast.

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