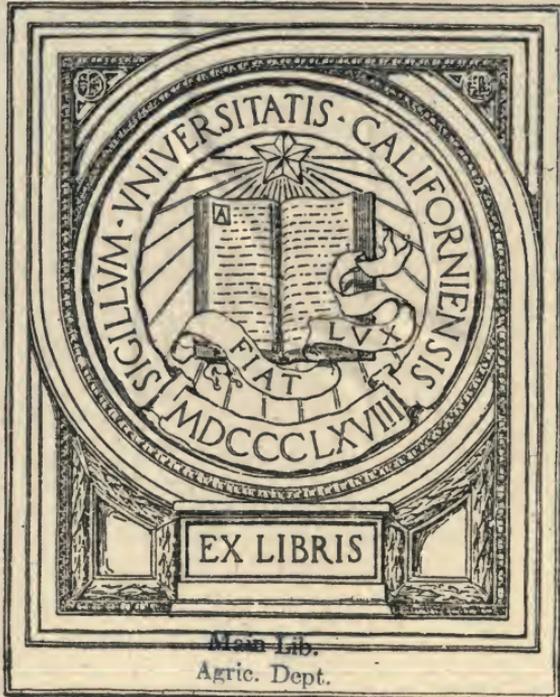


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## THE VALUE OF PEACHES AS VINEGAR STOCK.

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### INTRODUCTION.

The study of the value of peaches as vinegar stock was undertaken to obtain information in regard to the utilization of surplus peaches. It has been carried out on a scale sufficiently large to permit of the results being readily applied to commercial practice. The following subjects have been considered: (1) The composition of peach juice; (2) the fermentation of ground peaches and the composition of the resulting ciders; (3) the preparation and composition of peach vinegar; and (4) the chemical changes accompanying the decay of peaches by *Monilia*, commonly known as "brown rot" (*Sclerotinia fructigena*).

### THE COMPOSITION OF PEACH JUICE.

The peaches were obtained from different localities to determine whether or not marked differences in composition exist between the fruits grown in different sections. Each sample consisted of a six-basket carrier of fruit weighing about 35 pounds.<sup>a</sup> The samples had been picked when market-ripe—that is, when the fruit was fairly well colored and filled out, but still firm. Each lot of peaches (with the exception noted in Table 1) was ground by a rotary high-speed apple grater of the usual form, which readily reduced the peach stones to small pieces without injury to the knife edges. Samples of the juice were then obtained by pressing out small portions of the ground fruit in a cloth, by hand. The analyses given in Table 1 of four lots of Elberta peaches and two samples of Belle (syn. *Belle of Georgia*) indicate that but little variation exists in the composition of the same

<sup>a</sup> Except in the case of sample No. 14, which consisted of two half-bushel baskets of fruit.



variety when obtained from different localities. Previous investigations <sup>a</sup> of the Department show that the tree-ripe peaches are materially richer in sugar than the same fruit picked market-ripe, the average sugar content of three varieties having been found to be 7.50 per cent of the peach pulp in the tree-ripe fruit and 6.04 per cent in the fruit when market-ripe. The juices reported in Table 1, therefore, would probably have been richer in sugar if they had been prepared from tree-ripe instead of from market-ripe fruit. On the other hand the sugar may have become concentrated during the time which elapsed between picking and analysis. The analyses therefore may be considered fairly to represent the composition of peach juices from fruit picked when practically mature.

TABLE 1.—Composition of the unfermented juices of peaches used in the preparation of vinegar stock.

No.	Variety and locality where grown.	Date.	Brix reading corrected to 17.5° C.	Corresponding specific gravity.	Total acids as malic.	Reducing sugars as invert.	Total sugars as invert.	Sucrose.
		1909.			<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
2	Elberta, Fort Valley, Ga <sup>a</sup> . . . . .	July 20	13.17	1.0535	0.71	<sup>b</sup> 7.39	8.60	<sup>b</sup> 1.15
7	Elberta, Richland, Ga . . . . .	July 24	12.83	1.0520	.63	5.34	10.21	4.66
8	Elberta, Baldwin, Ga . . . . .	July 29	14.60	1.0596	.80	4.81	10.87	5.76
14	Elberta, New York . . . . .	Sept. 1	13.37	1.0543	.77	3.10	9.64	6.20
4	Belle (syn. <i>Belle of Georgia</i> ), Fort Valley, Ga.	July 20	13.07	1.0530	.68	<sup>b</sup> 9.23	10.15	<sup>a</sup> .87
5	Belle, Candor, N. C. . . . .	July 22	12.82	1.0520	.79	6.19	9.87	3.50
10	Waddell, Sleepy Creek, W. Va.	Aug. 7	12.55	1.0508	.73	2.21	9.73	7.15
11	Carman, Sleepy Creek, W. Va	Aug. 7	12.85	1.0521	.79	2.55	10.02	7.10
12	Mountain Rose, Boonesboro, Md.	Aug. 14	14.19	1.0578	.85	3.31	10.10	6.45
	Average . . . . .		13.27	1.0539	.75	<sup>c</sup> 3.93	9.91	<sup>c</sup> 5.87

<sup>a</sup> Pulp crushed by hand.

<sup>b</sup> Juice was not expressed from the sample of ground peaches until after yeast had been added. Considerable inversion probably occurred before analysis, owing to the presence of invertase in the yeast, hence the values for reducing sugars are too high and those for sucrose too low. These figures are therefore excluded from the averages.

<sup>c</sup> Average of seven determinations.

In Table 2 the average composition of these juices is compared with analyses of peach juices made by others <sup>b</sup> and with the average composition of apple juice. <sup>c</sup> The peach juices the analyses of which are shown in Table 1 are nearly 2 per cent richer in total sugar than those previously analyzed by others, but are 1 per cent poorer in sugar than average apple juices. Both series of analyses of peach juices show that peaches contain much more sucrose than apples and are also richer in acid.

<sup>a</sup> U. S. Dept. Agr., Bureau of Chemistry Bul. 97, p. 21.

<sup>b</sup> Averaged from the review of literature regarding the composition of peach juices, given in Bul. 97, p. 6.

<sup>c</sup> Compiled analyses by Van Slyke, New York Agr. Exper. Sta. Bul. 258, p. 449.

TABLE 2.—Average composition of peach juices compared with that of juices of American apples.

Data.	Total solids.	Total acids as malic.	Reducing sugars as invert.	Total sugars as invert.	Sucrose.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Average analysis of peach juices from Table 1.....	<i>c</i> 13.27	0.75	<i>f</i> 3.93	9.91	<i>f</i> 5.87
Average analysis of peach juices taken from the literature <i>a</i> .....	<i>d</i> 12.10	<i>e</i> .67	<i>g</i> 2.01	<i>g</i> 8.10	<i>g</i> 5.79
Average analysis of juices of American apples <i>b</i> .....	13.52	.52	7.28	10.91	3.45

*a* Averaged from summary of analyses given in Bureau of Chemistry Bul. 97, p. 6.

*b* From a compilation of analyses by Van Slyke, New York Agr. Exper. Sta. Bul. 258, p. 449.

*c* The corrected Brix reading is here assumed to be equal to the per cent of total solids.

*d* Average of five determinations.

*e* Average of three determinations.

*f* Average of seven determinations.

*g* Average of eight determinations.

### FERMENTATION OF GROUND PEACHES AND COMPOSITION OF THE RESULTING CIDERS.

The freshly ground peaches from which small portions had been taken for preparation of the samples of juice were poured into clean, open-headed, 5-gallon kegs, each keg was covered loosely with an oilcloth, and the pulp allowed to ferment either with or without the addition of a small amount of a vigorous pure culture of yeast. In most cases yeast was used, as it was desired to insure a prompt and rapid fermentation. All of the fermentations were conducted at summer temperatures and were practically completed at the end of three or four days.

The pulps were pressed immediately after fermentation, except in two cases in which the pressing was delayed for ten and eleven days, respectively, on account of the urgency of other work. A powerful handpower press was used. Racks and cloths were employed, following in this respect standard practice in pressing apple and grape juice on a commercial scale. In all cases the ciders flowed readily from the press, the ground peach stones probably assisting to some extent in the drainage of the press cake. The yields of cider were determined in the case of the Waddell and Carman varieties with the following results:

TABLE 3.—Yields of cider from two varieties.

Variety.	Weight of ground fruit fermented.		Loss in weight during fermentation.		Yield of pomace.		Yield of juice by difference.	
	<i>Kg.</i>	<i>Kg.</i>	<i>Per cent.</i>	<i>Kg.</i>	<i>Kg.</i>	<i>Per cent.</i>		
Waddell.....	16.07	0.74	4.61	2.61	12.72	83.0		
Carman.....	16.68	.77	4.62	3.10	12.81	80.5		

High yields of cider were invariably obtained; the composition of these products is given in Table 4.

The analyses show that the usual alcoholic fermentation had occurred in all cases. Rather less alcohol was produced than was expected from the analyses of the juices, but a part of the alcohol was changed to acetic acid during the fermentation, and a portion of the substances reducing the alkaline copper tartrate solution, and hence classed as sugars, was found to be unfermented. The unyeasted samples, Nos. 8 to 14, fermented as rapidly and completely as the others. The proportion of fixed acid became slightly but distinctly less during the alcoholic fermentations. The extent of infection by *Monilia* is also shown in Table 4, and the analyses of the ciders indicate that the lots in which brown rot existed fermented normally.

TABLE 4.—*Composition of peach ciders prepared by fermenting peach pulp.*

No.	Description of sample.	Interval of fermentation.	Specific gravity.	Total solids.	Total acid as malic.	Fixed acid as malic.	Volatile acid as acetic.	Alcohol.	Reducing sugars as invert.
2	Elberta; considerable infection by brown rot; yeasted.	<i>Days.</i> 4	1.0114	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
7	Elberta; badly infected by brown rot; yeasted.	3	(a)	4.60	0.82	0.64	0.16	4.12	.57
8	Elberta; considerable infection by brown rot; unyeasted.	4	1.0100	4.94	1.28	.69	.52	4.21	.62
14	Elberta; no infection by brown rot; unyeasted.	10	1.0111	.....	1.27	.61	.58	3.75	.31
4	Belle (syn. <i>Belle of Georgia</i> ); slight infection by brown rot.	4	1.0114	.....	.....	.....	.....	4.34	.38
5	Belle (syn. <i>Belle of Georgia</i> ); slight infection by brown rot; yeasted.	4	1.0132	.....	.83	.....	.....	4.18	.33
10	Waddell; no infection by brown rot; yeasted.	3	1.0076	3.52	.71	.54	.15	4.01	.20
11	Carman; no infection by brown rot; yeasted.	3	1.0080	3.69	.77	.69	.07	4.11	.16
12	Mountain Rose; no brown rot evident, but badly infected by peach yellows.	11	1.0131	.....	.94	.60	.30	3.52	.61
	Averages.	.....	<i>b</i> 1.0107	<i>c</i> 4.19	<i>d</i> .95	<i>e</i> .63	<i>e</i> .30	4.07	.38

<sup>a</sup> Specific gravity not determined; the average specific gravity of the other three fermented Elberta peaches has been used in calculating the results to the percentage basis from the basis of grams per 100 cc, on which they were originally obtained.

<sup>b</sup> Average of eight analyses.

<sup>c</sup> Average of four analyses.

<sup>d</sup> Average of seven analyses.

<sup>e</sup> Average of six analyses.

In Table 5 the composition of the peach ciders is shown in comparison with the analyses of apple ciders taken from the analytical data published by Van Slyke. The peach ciders are much higher in specific gravity, in solids, and in fixed acids than the apple ciders. They are lower in alcohol, but the juices from which the apple ciders were prepared were considerably richer in sugars than average apple juices, containing an average of 13.33 per cent of total sugar expressed as invert, whereas normal apple juice (see Table 2) contains but 10.91 per cent of total sugar.

TABLE 5.—*Comparison of composition of peach and apple ciders (fermented till practically free from sugar).*

Description of sample.	Specific gravity.	Total solids.	Fixed acids as malic.	Volatile acids as acetic.	Alcohol.	Reducing sugar as invert.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Peach ciders.....	1.0107	4.19	0.63	0.30	4.07	0.38
Apple ciders <sup>a</sup> .....	.9932	2.58	.37	.22	6.59	.26

<sup>a</sup> Van Slyke, loc. cit., p. 481; selecting the analyses of ciders of experiments 1-11, inclusive, and 21-29, when the alcohol fermentation was practically complete but before the ciders had become perceptibly acetified.

#### THE PREPARATION AND COMPOSITION OF PEACH VINEGAR.

Three lots of vinegar were prepared from mixed peach ciders whose analyses are given in Table 4, using a small rapid-process generator.<sup>a</sup> Well-flavored vinegars were formed, which, however, did not retain any of the distinctive flavor of the peach. They were clean tasting and free from woody flavors or objectionable after-tastes, but remained persistently turbid. Vinegars prepared under the same conditions from apples would probably have been brilliant.

The average composition of the samples given in Table 6 is compared with that of the apple vinegars given by Van Slyke, the latter having been prepared from the ciders the average analysis of which is presented in Table 5. In comparison with the cider vinegars the peach vinegars are considerably lower in acid. They are richer in solids, which is to be expected, since, as shown in Table 4, peach ciders are high in unfermented solid matter. The total solids probably consist largely of material of a gummy nature and are similar to the unfermentable residues found in vinegar prepared from Kieffer pears<sup>b</sup> and from second pressing ciders.<sup>c</sup>

TABLE 6.—*Composition of peach vinegars and comparison with average analysis of apple vinegar.<sup>d</sup>*

Sample.	Specific gravity.	Solids.	Ash.	Alkalinity of soluble ash as potassium carbonate.	Reducing sugar as invert.	Alcohol.	Volatile acid as acetic.	Fixed acid as malic.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Peach vinegars:								
No. 1.....	1.0161	2.64	0.30	0.19	0.44	0.196	3.89	0.34
No. 2.....	1.0227	3.81	.58	.41	.68	.195	4.78	.068
No. 3.....	1.0231	3.64	.58	.40	.84	.02	5.21	.127
Averages:								
Peach vinegars...	1.0206	3.36	.49	.33	.65	.14	4.62	.13
Apple vinegars...	1.0203	1.99	.34	.....	.....	.09	7.45	.02

<sup>a</sup> J. Ind. Eng. Chem., 1903, 1: 260.

<sup>b</sup> J. Amer. Chem. Soc., 1907, 29: 759.

<sup>c</sup> Ibid., 1906, 28: 202.

<sup>d</sup> Van Slyke, loc. cit., prepared from ciders whose average analysis is given in Table 5.

**CHEMICAL CHANGES ACCOMPANYING THE DECAY OF PEACHES  
BY MONILIA.**

In seasons of heavy crops there are available large quantities of sound, overripe peaches which it will not pay to market as fresh fruit. Particularly is this the case when hot weather causes the fruit to ripen rapidly. It is anticipated that the great bulk of peach vinegar will be made from such fruit, which, while too ripe to ship, is otherwise essentially sound. As before stated, notes were taken when the samples of peaches were ground as to the extent of infection by *Monilia*, and it was found that the alcoholic fermentation was not perceptibly influenced. Two special experiments were undertaken to determine how the presence of a large proportion of rot would affect the value of peaches as vinegar-making material. In each, using Mountain Rose and Elberta, respectively, about a carrier of peaches was inoculated with a pure culture of *Monilia* by Mr. W. M. Scott, pathologist in the Bureau of Plant Industry, and the fruit was allowed to decay for eleven and for ten days. After the sample had thoroughly rotted the fruit was ground, pressed, and the juices analyzed. The composition of these juices is shown in Table 7, contrasted with the analyses of juices from sound fruit of the same lots. The most conspicuous changes were the inversion of sucrose and the loss in total sugars. The inversion of the cane sugar was nearly complete, and the losses in total sugars amounted to 1.18 and 2.47 per cent or to 11.7 and 25.6 per cent of the total sugar in the juices of the sound peaches. Small quantities of alcohol and acetic acid were also formed, probably as a result of fermentation by yeasts and bacteria.

TABLE 7.—*Changes in peach juice due to decay by Monilia.*

Description of sample.	Specific gravity.	Total acid as malic.	Volatile acid as acetic.	Fixed acid as malic.	Reducing sugar as invert.	Total sugar as invert.	Su-crose.	Alco-hol.
		<i>P. ct.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>P. ct.</i>	<i>P. ct.</i>
Juice of sound peaches:								
Mountain Rose.....	1.0578	0.85	.....	.....	3.31	10.10	6.45	.....
Elberta.....	1.0543	.77	.....	.....	3.10	9.64	6.20	.....
Juice of rotted peaches:								
Mountain Rose.....	1.0520	1.02	0.22	0.82	8.52	8.92	.38	0.29
Elberta.....	1.0437	.86	.15	.70	6.94	7.17	.20	.40

Samples of vinegar made in the field from peaches rotted in cribs have been examined by the writer. The juice liberated during decay was collected in barrels and allowed to go to vinegar. These vinegars were generally deficient in acid, many had disagreeable flavors and after-tastes, and they darkened rapidly on exposure to the air. Obviously, vinegars should not be made from peaches of this character.

## SUMMARY.

The most important conclusions to be drawn from this work are, first, that peaches contain sufficient fermentable sugar for use as vinegar stock, and, second, that they can be successfully handled by machinery already in use for making apple cider and vinegar. Other points of interest are as follows: First, but little variation was found in the composition of the same variety of peaches when obtained from different localities. Second, the peach juices analyzed were found to be richer in sugar than those which have been previously analyzed by others, but they were about 1 per cent lower in sugar than average apple juices. They were considerably richer than apples in sucrose and in acid. Third, it was found that the use of pure culture yeasts was not necessary to insure rapid alcoholic fermentation. Fourth, the ciders prepared from peaches were considerably poorer in alcohol than apple ciders on account of the fact that peaches contain less total sugars than apples. Fifth, the presence of brown rot was found not to interfere with the alcoholic fermentation of the ground peaches, but a large proportion of the sugars was wasted by allowing the fruit to rot before fermenting. Sixth, well-flavored vinegars were produced by the use of a small quick-process generator. These vinegars were of acceptable quality, though turbid, and did not possess the distinctive peach flavor.

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