

Preservation of Apple Cider with Sodium Sorbate*

LARGE QUANTITIES OF FRESH APPLE CIDER (unpasteurized apple juice) are prepared and sold each year in this country, especially during the fall and early winter months. Fresh cider deteriorates within a few days unless yeasts and other microorganisms are inhibited.

Several measures have been used to prolong the shelf life of fresh apple cider. Gore (6) found that apple cider held at 32° F. (0° C.) showed no deterioration in quality for at least 36 days. However, it is usually impractical to maintain such a low temperature during the marketing and distribution of cider. Sodium benzoate has been used extensively to preserve cider. Fellers (3) has reported that a concentration of 0.1% is usually required to inhibit yeast growth. At this concentration sodium benzoate imparts an undesirable flavor to cider (2, 12).

Sorbic acid has been found effective in controlling mold growth on cheese (11) and yeast growth in pickle brines (1, 10). Recently Ferguson and Powrie (4) reported that 0.035% sorbic acid preserved the fresh flavor of apple cider stored at 77° F. (25° C. for 4 to 10 days, and that a combination of sorbic and ascorbic acids increased the period of preservation to 14 days. In the samples treated with sorbic acid, yeast growth was controlled and spoilage was reported to be due to *Acetobacter*. However, these investigations were made on a laboratory-prepared cider with a low initial yeast count and presumably low mold and bacterial counts.

The present study was conducted to determine whether sorbate would be as effective as benzoate in preserving commercial apple cider. The results indicate that sorbate, in the form of sodium sorbate for better solubility, will control yeast and mold growth in cider, but that supplemental measures must be taken to control bacterial growth.

MATERIALS AND METHODS

Representative samplings of cider were obtained from two local processors of fresh apple cider. These plants follow good sanitation practices in handling the apples before and during processing them into cider. The cider equipment was thoroughly cleaned daily. The pressed cider was pumped immediately to storage tanks in a refrigerated room held at 40° F. (4° C.). Samples were obtained from these tanks after the cider had settled for 24 hours. In addition, a sample of cider prepared in the pilot plant of the Eastern Regional Research Laboratory was included for comparison of microbial counts.

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^b One of the laboratories of the Eastern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

Duplicate samples were prepared for each cider treatment tested. The bottles were thoroughly cleaned and sterilized prior to filling and capping.

Sorbic acid (average particle size about 200 microns) and sodium benzoate were added to the cider as solids. Sodium sorbate was added as a 25% solution. After adding the preservatives, the cider was immediately agitated to give proper dispersion.

"Difco" wort agar was used to determine the number of yeasts and molds in the samples, and nutrient agar to determine number of bacteria. The average number of cells found on triplicate plates incubated at 86° F. (30° C.) for 72 hours are reported in the tables. Sorbic acid was determined by the analytical method of Melnick and Luckmann (8).

Taste tests were conducted in conjunction with each of the cider preservation experiments. At each sampling date, cider was evaluated for flavor by a laboratory panel of 5 to 8 judges.

RESULTS AND DISCUSSION

Apple cider prepared under commercial conditions will vary widely in the number of microorganisms per unit volume, depending upon the conditions of the fruit, the daily temperature, and the sanitary conditions of the plant (5, 7). The microorganism population of the commercial ciders used in this experiment was representative of that of other ciders available in this area. Table 1 gives some typical

TABLE 1
Viable cells in commercial and pilot plant cider

Source of sample	Date sample obtained	Average daily temperature	Plate count/ml.	
			Wort	Nutrient
Plant No. 1	9-22-55	70° F.	150,000	460,000
	10-12-55	67° F.	210,000	655,000
	10-20-55	56° F.	160,000	430,000
	11- 8-55	44° F.	225,000 (30 molds)	540,000
	11-22-55	42° F.	110,000 (500 molds)	225,000
	11-29-55	23° F.	155,000	141,000
	12- 9-55	34° F.	113,000	110,000
Plant No. 2	10-30-56	59° F.	460,000	600,000
	11- 8-56	52° F.	480,000	455,000
Pilot-plant	1-24-56	24° F.	6,000	4,800

plate counts for yeasts and molds (wort agar) and for bacteria (nutrient agar) on the two commercial samples and the pilot-plant sample. The much higher microorganism counts for the commercially prepared ciders as compared to those for the pilot-plant sample emphasize the importance of using commercial samples for preservative studies.

As would be expected, the samples contained less

^c Mention of trade name does not imply endorsement by the U. S. Department of Agriculture over similar products not mentioned.

bacteria, generally, at the lower temperatures. Temperature seemed to have no effect on the yeasts and molds.

The comparative effectiveness of sodium benzoate, sodium sorbate, and sorbic acid in protecting the cider against growth of bacteria, yeasts and molds during storage at 70°–75° F. is shown in Table 2.

TABLE 2
Comparison of chemical preservatives for apple cider stored at 70°–75° F. (20°–24° C.)

Additive	Conc. of additive (g./100 ml.)	Days of storage	Plate count/ml.	
			Wort	Nutrient
None	.....	0	113,000	110,000
	.....	7	25,000,000	69,000,000
Sodium benzoate	0.05	7	2,100	320,000
	0.10	7	1,600	3,200
	0.10	14	4,000	1,150,000
	0.10	26	4,300	4,000,000
Sodium sorbate	0.05	7	9,000	736,000
	0.10	7	600	44,000
	0.10	14	8,000,000 ¹	22,600,000
	0.10	26	47,000,000 ¹	60,000,000
Sorbic acid	0.05	7	3,400	710,000
	0.10 ²	....	.....	.....

¹ Bacteria

² Not completely soluble

With no added preservative the control spoiled in 2 days, as indicated by gas formation. After 7 days the counts on the control cider on both media had reached many millions of cells per milliliter. Usually a count of a few million indicates actual or imminent spoilage.

Table 2 indicates that while all 3 preservatives were effective at the 0.05% level in controlling yeasts and molds for 7 days, they were effective only at the 0.10% level in controlling the bacteria for this period. Many manufacturers would consider a 7-day period of preservation at this temperature to be adequate.

Since the sorbic acid did not dissolve completely in the cider at a concentration of 0.10%, no results are reported for this concentration. In all subsequent tests sodium sorbate was used because of its better solubility.

Beyond the 7-day period, the bacteria overran the samples treated with sodium sorbate, as indicated by the counts on both the wort and the nutrient agar after 14 and 26 days' storage. Sodium benzoate, on the other hand, retarded microbial growth for a longer time, due principally to its ability to control bacterial growth. Although the bacterial counts for the cider treated with sodium benzoate are rather high after 14 and 26 days, these counts are many times higher for the samples treated with sodium sorbate. Sodium benzoate, however, is not a suitable preservative for cider because of its effect on flavor.

Melnick, Luckmann and Gooding (9) have reported that the metabolic destruction of sorbic acid by molds in cheese is directly related to the mold population. York and Vaughn (13) have also reported that bacteria are capable of metabolizing sorbic acid at a pH

of 6.0 or above. The present study indicates that bacteria, when encountered in high numbers, are capable of destroying sorbic acid even at the lower pH's of cider (pH 3.2 to 3.6). In one test, cider containing 0.10% added sodium sorbate was stored 26 days at 73° F. (23° C.). The bacterial count rose to 60,000,000 per ml. and the sorbate concentration fell to 0.046%. A duplicate sample of cider containing 0.100% sodium sorbate plus 0.010% sodium bisulfite showed 39,500 bacteria per ml. at the end of the storage period and analyzed 0.09% sorbate. Therefore, it is apparent that destruction of sodium sorbate occurs under conditions of uncontrolled bacterial growth.

Good bacteriological control was obtained for 14 days at 73° F. (23° C.) by a combination of 0.05% sodium sorbate and 0.010% sodium bisulfite. However, a taste panel found that this concentration of sulfite imparted an objectionable flavor to the cider, and thus it cannot be recommended for cider for beverage use. It may be useful, however, for juices intended for concentrate or other products.

Reducing the storage temperature to 50° F. (10° C.) or below permitted sodium sorbate alone to control bacterial growth, and to maintain its effectiveness against yeasts and molds. Table 3 shows that sodium

TABLE 3
The effect of sodium sorbate on the keeping quality of cider stored at 50° F. (10° C.)

Conc. of sodium sorbate (g./100 ml.)	Days of storage	Plate count/ml.	
		Wort	Nutrient
0	0	460,000	600,000
	9	7,250,000	7,700,000
	48	11,500,000	6,100,000
0.05	9	500,000	540,000
	48	48,000	101,000
	105	960	93,500 ¹
0.10	9	270,000	322,000
	48	21,000	64,000
	105	900	34,100 ¹

¹ Many spore-formers

sorbate effectively controls microbial growths in cider at 50° F. (10° C.) for 105 days. Also at this temperature it was possible to reduce the concentration of sodium sorbate to 0.05%. Concentrations lower than 0.05% gave erratic results in controlling microbial growths.

At a storage temperature of 40° F. (4° C.) (Table 4) untreated cider spoiled in less than 14 days. The bacterial population in the control cider was so low that the yeasts overran the nutrient agar plates. Sodium sorbate and sodium benzoate at 0.05% concentration gave excellent control of all types of microorganisms during the 120-day storage test, although in most cases the counts were lower with sodium benzoate than with sodium sorbate.

Flavor evaluation. Taste-panel evaluation of these samples showed that even at 0.10% concentrations, sorbic acid and sodium sorbate did not impart any

TABLE 4

Comparison of sodium sorbate and sodium benzoate as preservatives for cider stored at 40° F. (4° C.)

Additive	Days of storage	Plate count/ml.	
		Wort	Nutrient
None	0	113,000	110,000
	14	13,100,000	14,100,000 (y)
	26	25,000,000	18,000,000 (y)
	120	26,000,000	19,000,000 (y)
Sodium sorbate, 0.05%	14	39,000	91,000
	26	23,000	47,000
	120	12,000	21,500
Sodium benzoate, 0.05%	14	2,000	220,000
	26	.....	.....
	120	1,400	1,600

(y) = yeast

detectable off-flavors to the cider as did the sodium benzoate.

SUMMARY

Sodium sorbate preserved commercially prepared apple cider for 7 days at 70°–75° F. (21°–24° C.) and for more than 105 days at a storage temperature of 50° (10° C.) or lower. Sodium sorbate imparts no objectionable off-flavor to apple cider as does sodium benzoate.

Sodium sorbate controlled yeasts and molds, but was not effective against bacteria at high storage temperatures. When high bacterial numbers were encountered, sodium sorbate was metabolized and reduced below its effective concentration. Measures which helped to control bacterial growth in cider, such as mild refrigeration or addition of bisulfite, greatly increased the effectiveness of sodium sorbate.

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