SANITATION AND WATER USAGE IN THE PROCESSING OF SOUR CHERRIES[1]

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(Received for publication March 22, 1971)

Abstract

Surveys were made of four red sour cherry processing plants to obtain information regarding microbial contamination and water usage. With the exception of some long conveyor belts, no single sites were found to be major sources of contamination and the mean count at most stages was under 50,000 per gram.

The primary sources of waste water were the soak tanks, sprays, and flumes. From 600 to over 800 gal of water were discharged per ton of fruit processed; the BOD per ton ranged from 6 to over 10 lb. The study pointed to the soak tanks and pit flumes as possible areas where waste water generation could be reduced.

Pure waters programs are forcing many members of the food industry to improve their treatment of aqueous wastes that are to be discharged into classified waters. Treatment costs usually are sizeable for fruit and vegetable processors because of the high volume and strength of their wastes. One of the more promising approaches for reduction of these costs is to minimize water consumption and consequently effluent production *(6)*. Although a prerequisite for this is an understanding of the effect of different variables on waste water generation; only a limited number of reports describe in-plant studies dealing with this aspect of fruit and vegetable processing *(2, 4, 7, 10)*.

The purpose of this research was to study water usage and sanitation in the processing of red sour pitted (RSP) cherries. It was felt that the two should be considered together to avoid alterations for reducing waste water that might sacrifice sanitation and thus product quality.

Materials and Methods

Waste water flow rates were measured by two methods. Discharges from various equipment and pipes were estimated by the calibrated container-stop watch procedure in which the time required to fill a container was determined *(3)*. The flow through open channels was calculated on the basis of cross section dimensions and stream velocity. The latter, measured with a cork float and stop watch, was corrected to establish the mean velocity *(5)*.

Samples of waste water and fruit were sealed in one pint polyethylene bags and transported to the laboratory in an insulated ice chest over ice. Bacteriological analyses were performed as soon as the samples reached the laboratory, the same day they were collected. The samples to be analyzed for BOD, total solids, and volatile solids were frozen immediately and stored at −23 C until the tests could be made.

The microbial populations on fruit were determined by blending 22 g in 198 ml of sterile water for 2 min in a Waring blendor. Appropriate decimal dilutions were plated on potato dextrose agar, pH 5.6. Colonies were counted after an incubation of 4 days at 20 C. Water samples were handled similarly except that mechanical blending was omitted.

Standard methods *(1)* were used for determining the BOD, total and volatile solids.

Results and Discussion

During the 1970 processing season 22 surveys were made of the lines of four cherry processors. Three of the plants prepared the fruit for freezing while the fourth was a cannery; all were quite similar with respect to the processing steps that were followed. The general procedure was that the fruit was transported to the factory in water contained in half-ton pallet tanks. After weighing it was transferred to soak tanks where it was held 8 or more hr in 10 C water to effect firming. The soak tanks were part of a closed recirculated-water system in which the water also was pumped through a reservoir containing ice for cooling and through different flumes used for conveying the fruit. Following the soak tanks the cherries were conveyed via flume and belt through the stemmer, size and color graders, an inspection table, and the pitter. They then were ready for canning or freezing.

Microbiology

Microbial counts were made on 120 samples of fruit collected at the different processing stages. The data are presented as geometric means (Table 1) because of the considerable variation in counts from survey-to-survey. In 8 studies of Plant B, for example, the counts on cherries taken from the inspection belt ranged from 6 to 240 × 10^3 per gram.

In general, no specific sites were found to be the primary sources of contamination. This was unexpected since it had been anticipated that certain

[1]Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 1877.

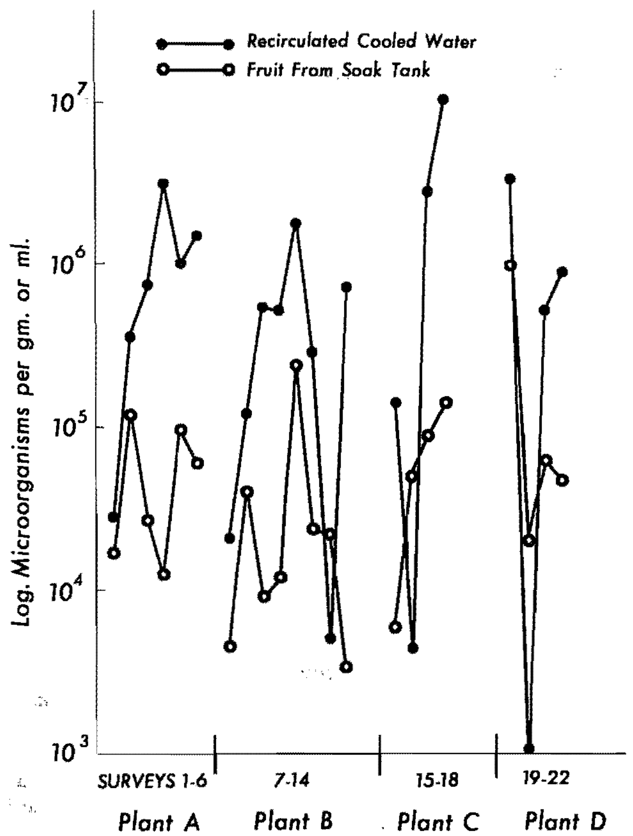

Figure 1. Individual survey results comparing microbial counts of recirculated water with that of fruit from the soak tanks.

TABLE 1. MICROBIAL CONTAMINATION OF CHERRIES DURING THEIR PREPARATION FOR FREEZING.

	Microorganisms/g - geometric mean $\times$ 10^{-3}			
Sampling site	Processing plant A	B	C	D
Receiving station	43	17	20	45
Following soak tank	40	17	44	87
After stemmer	12	35	8.9	19
Following grader	—	10	19	—
Inspection belt	16	20	—	47
After pitter	15	14	78	25
Filler	8.9	12	35	160

equipment such as the pitters would be areas of significant microbial build-up. These results, which differ from our observations of vegetable lines *(8, 9)* are thought to be due to the low pH of cherries, under 4.0, which selects for yeasts as the predominant contaminant. The periodic line clean-ups, usually limited to shutdown periods, appear to have been sufficiently frequent to control the relatively slow growing yeasts.

Plant D used a number of long belts to convey the fruit from pitters to fillers. This is believed to explain the significantly heavier contamination of cherries at this latter stage. Cherries at Plant D were given a thermal process and, therefore, this viable count would not be found in the preserved product.

The microbial populations of the recirculated 10 C wat r that is pumped through the soak tanks and flumes was compared with the level of contamination on fruit taken from the soak tanks (Fig. 1). There was considerable variation in counts; the soak water at Plant B, for example, yielded 5×10^3 to 1.8×10^5 organisms per milliliter. These differences undoubtedly reflected the time that had lapsed since the system had been completely drained and refilled—it was not uncommon for this to be done weekly or at even longer intervals.

It can be seen (Fig. 1) that the concentration of organisms on the fruit paralleled that in the water to only a limited extent and that the number per milliliter of water was almost always higher than the number per gram of fruit. The latter would be expected since most of the organisms on the cherry would be restricted to its surface. The rather poor correlation between microbial densities on the fruit and in the water suggest that other factors have a marked effect on the microbiology of the cherry. It is likely that an important variable was the incidence of surface fractures on the fruit that was cultured.

Waste water

Soak tanks, sprays, and flumes were the main sources of waste water in the four plants (Table 2). The gallons of water and pounds of BOD per ton of cherries shown here probably underestimated the true values because of additional water used for clean-ups, and because the soak tank-flume-cooled water systems were completely drained and refilled periodically. Surprisingly, the different processors could not provide figures as to the volumes of water in these systems.

Total cherry production and water consumption data for the entire processing season, available for Plants A and B, permitted an evaluation of these per-ton figures. Based on seasonal totals, Plant A used 1800 gal of water per ton, a value considerably higher than the 790 gal estimated from in-plant flow measurements. However, this factory completely emptied the water from its soak tanks daily which could account for the difference. The seasonal calculations for Plant B, which emptied its recirculated water weekly, indicated a consumption rate of 780 gal per ton, a figure comparable to the 869 gal in Table 2.

It would appear that the amount of waste water generated in the soak tank-flume operation varied considerably from factory-to-factory. In addition to the frequency that different plants emptied and refilled these systems, considerable variation in wa-

TABLE 2. SOURCES AND PROPERITIES OF WASTE WATER

Plant	effluent source	Av. flow gal/hr	Av. BOD	Strength TS[1]	(ppm) VS[1]	Total/ton of fruit[2] gal	lb BOD
A.	Soak tank	2190	1230	3120	2770		
	Pit flume	1060	2600	5910	5560	790	10.5
B.	Soak tank	1590	137	482	392		
	Spray rinse	1580	334	1020	852		
	Flume	2400	1100	3020	2800		
	Pit flume	3110	1070	2750	2540	869	6.1
C.	Spray rinse	1220	814	2050	1910		
	Flume	781	68	306	219		
	Pit flume	4110	1570	3690	3460	611	7.1
D.	Spray rinse	759	829	2140	1870		
	Flume	4900	1340	3260	2920		
	Pit flume	2810	1120	2710	2420	847	9.6

[1]Total and volatile solids.

[2]Approximate figures based on estimated hourly production and effluent flow at the different discharge points.

ter discharge and make-up rates was observed. Factory A, for example, discharged almost twice as much water per hour as did Plant B although its cherry processing output was only about one-half as great. Plants C and D did not discharge water at this point although some of the discharge from their flumes represented soak tank water.

Our conclusions were that there may be little technological basis for the water management practices presently followed in cherry processing soak systems. It would seem that an ideal approach might be to establish make-up rates and drainage schedules that would keep microbial populations below a certain level. Practical methods for accomplishing this would be difficult, however, without some rapid method for estimating microbial numbers. Our attempts to correlate pH or the optical densities of recirculated water with viable counts were not successful.

All four of the plants were found to use fresh water for the fluming of cherry pits. The amount of waste generated by this practice was sizeable, both as to volume and strength (Table 2). Since the pits were to be discarded as solid waste, here was an area where a significant reduction in waste water could be effected without any threat of reducing product sanitation. Measures that might be adopted include extended recirculation of the flume water or the use of belts or some other means to convey the pits.

ACKNOWLEDGEMENT

John Peck ably assisted in the surveys and waste water analyses.

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