CHARACTERIZATION OF WASTE EFFLUENTS FROM A COMMERCIAL PIMIENTO CANNING OPERATION

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ABSTRACT

Characterization of unit effluents from a commercial pimiento canning operation revealed significant patterns of difference in composition and flow rates. The most concentrated effluent occurred in the first stage of the processing operation where the roasted peel was removed by washing. The suspended solids load of this effluent accounted for 69% of the total suspended solids load and 37% of the COD load, but only 18% of the total flow. Segregation and separate treatment of this concentrated effluent is suggested to reduce the total waste load. Another concentrated effluent resulted from the citric acid dip just before the packing and closing area. The flow of the effluent was only 10% of the total, but accounted for 32% of the total dissolved solids and 37% of the total BOD. Two effluents from the grading area accounted for 50% of the total flow and only 10% of the total COD load. Recycling of these dilute effluents to the peel removal operation is suggested. Based on the rate of processing, the total wastes produced from pimiento canning contained 3.2, 60.2, and 35.4 lb. of suspended solids, COD, and BOD, respectively, per ton of raw pimientos. The total waste flow was 4,840 gal. per ton.

There is a shortage of information available on characteristics of effluents from individual unit operations involved in processing of different fruits and vegetables. Compilations of data which characterize the final or composite effluent are readily available but not so for unit effluents *(3, 9)*. Because of lack of information on the separate unit processes and their respective contributions to the total waste load, it should not be surprising that the 1971 survey by the Environmental Protection Agency of wastes from the fruit and vegetable processing industry concluded that "data were generally considered inadequate to make a verifiable determination of effluent limitation guidelines. A second program phase is being initiated to develop additional data to establish guidelines" *(2)*.

Splittstoesser and Downing *(11)* have reported the analyses of several processing effluents, but did not include flow data. Weckel et al. *(12)* investigated canning wastes from peas, corn, beets, potatoes, and carrots, and included effluent composition, flow rates, and total waste loads. Shewfelt and Chipley *(10)* characterized dry bean canning wastes and showed the contributions of separate unit effluents to the total waste load. Likewise, Hang et al. *(4)* have given quantitative data on wastes from sauerkraut manufacture. Mercer et al. *(7)* reported on the characteristics of in-plant waste streams from the processing of peaches and tomatoes. A recent comprehensive survey by the National Canners Association *(8)* summarizes available data on liquid wastes from the fruit and vegetable canning and freezing industry.

A knowledge of the contribution of unit effluents to the total waste load is of current importance to food processors and regulatory agencies alike. When data for the composition and volume of wastes from unit operations are known, the processor can apply process modifications that will minimize the waste load to be treated. Similarly, when the total waste load of different processed products can be defined in terms of the contribution of unit processes, then a scientifically realistic effluent standard can be developed by the regulatory agency and met by the processor.

This study reports data obtained on the composition and flow of liquid wastes from a commercial pimiento canning operation. The pimiento canning industry is located mainly in California and the Southeastern states. The number of actual cases packed in 1971 is reported to be 2,451,000 *(5)*. Industrial sources have estimated the pack for 1972 to be 18,000 tons. Pimientos are grown mainly on small acreage plots, and involve considerable hand labor in processing. Thus, the pimiento industry is an important source of income for many farmers and workers. The large processing plant which cooperated in this study employs approximately 1000 people during the peak of the pimiento season.

EXPERIMENTAL

A flow sheet of the typical unit operations involved in the processing of pimientos is shown in Fig. 1, and includes the waste effluent sampling locations. The first step is the removal of the peel by roasting in a gas flame. The charred peel is then largely removed by the action of two reel washers (effluent A). The pimientos are then placed on a machine for core removal. The cores are handled separately as solid waste. After core removal, the pimientos are conveyed through another set of reel washers (effluent B) before entering the hand grading and cleaning area (effluents C and D). A citric acid dip for pimiento pieces also drains into effluent D. The cleaned pimientos then pass thru a citric acid dip for whole pods and enter the packing and closing area (effluent E). All of the unit effluents (A-E) converge to form the composite pimiento effluent (F) which is passed over a

TABLE 1. CHARACTERIZATION OF WASTE EFFLUENTS FROM A COMMERCIAL PIMIENTO CANNING OPERATION

Processing operation	Peel removal (roasting)	Core removal	Grading & cleaning	Grading, cleaning, acid dip for pieces	Acid dip for pods, packing, closing	Composite
Effluent	A	B	C	D	E	F
Total solids, mg/l	2890 ± 675[1]	1574 ± 247	411 ± 65	449 ± 49	5094 ± 1592	1444 ± 131
Fixed solids, mg/l	362 ± 158	177 ± 39	62 ± 42	110 ± 28	567 ± 208	184 ± 64
Volatile solids, mg/l	2501 ± 573	1408 ± 241	358 ± 64	348 ± 61	4602 ± 1505	1243 ± 174
Suspended solids, mg/l	302 ± 55	42 ± 7	32 ± 24	19 ± 21	34 ± 5	73 ± 13
Dissolved solids, mg/l	2584 ± 692	1472 ± 248	379 ± 72	415 ± 48	5057 ± 1586	1359 ± 146
Settleable solids, ml/l	32 ± 6	3.4 ± 0.7	0.2 ± .04	0.2 ± .02	2.8 ± 0.8	6.8 ± 1.5
pH	6.2 ± 0.2	6.0 ± 0.2	6.8 ± 0.4	5.3 ± 0.5	4.1 ± 0.2	5.2 ± 0.3
Total acidity, mg/l[2]	91 ± 21	51 ± 10	16 ± 6	34 ± 10	642 ± 282	82 ± 19
COD, mg/l	3018 ± 837	1548 ± 258	291 ± 27	324 ± 52	4894 ± 1543	1525 ± 182
BOD_5, mg/l	1473 ± 475	866 ± 235	172 ± 24	187 ± 39	3604 ± 1060	816 ± 124
Flow rate, gal/min	152 ± 28	186 ± 16	198 ± 10	237 ± 10	76 ± 22	849[3]
Flow rate, % of total	18	22	23	28	9	100[3]

[1]Standard deviation
[2]Expressed as mg/l $CaCO_3$
[3]Total of A-E flow rates

TABLE 2. THE CONTRIBUTION OF UNIT EFFLUENTS TO THE TOTAL WASTE LOAD OF TOTAL SOLIDS, SUSPENDED SOLIDS, VOLATILE SOLIDS, COD, AND BOD

Unit effluent		Total solids		Suspended solids		Volatile solids		COD		BOD	
		lb./hr	% of total	lb./hr	% of total	lb./hr	% of total	lb./hr	% of total	lb./hr	% of total
Peel removal	A	220	34	23	69	190	33	230	37	112	30
Core removal	B	147	22	4	12	131	23	144	23	81	22
Grading	C	38	6	3	9	33	6	27	4	16	4
Grading & acid Dip	D	53	8	2	6	41	7	38	6	22	6
Citric acid Dip, Packing & closing	E	194	30	1	4	175	31	186	30	137	37
Total, A-E		652	100	33	100	570	100	626	100	368	100

TABLE 3. THE PRODUCTION OF TOTAL SOLIDS, SUSPENDED SOLIDS, VOLATILE SOLIDS, COD, BOD, AND WASTE WATER PER TON OF RAW PIMIENTOS PROCESSED

Effluent		Total solids lb/ton	Suspended solids lb/ton	Volatile solids lb/ton	COD lb/ton	BOD lb/ton	Waste water gal/ton
Peel Removal	A	21.2	2.2	18.3	22.1	10.8	880
Core Removal	B	14.1	0.4	12.6	13.8	7.8	1070
Grading	C	3.6	.3	3.2	2.6	1.5	1080
Grading & Acid Dip	D	5.1	.2	3.9	3.7	2.1	1370
Citric Acid Dip, Packing & Closing	E	18.6	.1	16.8	17.9	13.2	440
Total, A-E		62.7	3.2	54.8	60.2	35.4	4840

20-mesh vibrating screen separator. Cooling water is discharged separately from effluents A-F and was not analyzed in this study.

Composite samples of liquid effluents were taken at each unit operation (A-F) by collecting 600 ml every 30 min over a 2-hr period. Each sample was passed through a 20-mesh screen to remove particulate material. Composite samples were transported to the laboratory and the analyses begun within 15 min of collection. Six replicate composite samples of each unit effluent (A-F), collected on different days during the season, were analyzed in duplicate for the following characteristics: total, fixed, volatile, suspended, dissolved, and settleable solids; pH; total acidity; chemical oxygen demand (COD); and 5-day biochemical oxygen demand (BOD). The methods given by Mercer *(6)* were employed for all analyses except for the BOD, where a method published by the Environmental Protection Agency *(1)* was used to determine dissolved oxygen by the probe method.

Flow rates were determined with a trapezoidal weir which was placed in the rectangular gutters carrying effluents A-D. The base of the weir (b) was 6.5 inches and the sides were cut on a 1:4 slope. The height of water passing over the weir (H) was measured in inches and the flow rate (Q) calculated: $Q = 3.367\ bH^{3/2}$. The flow of effluent E was

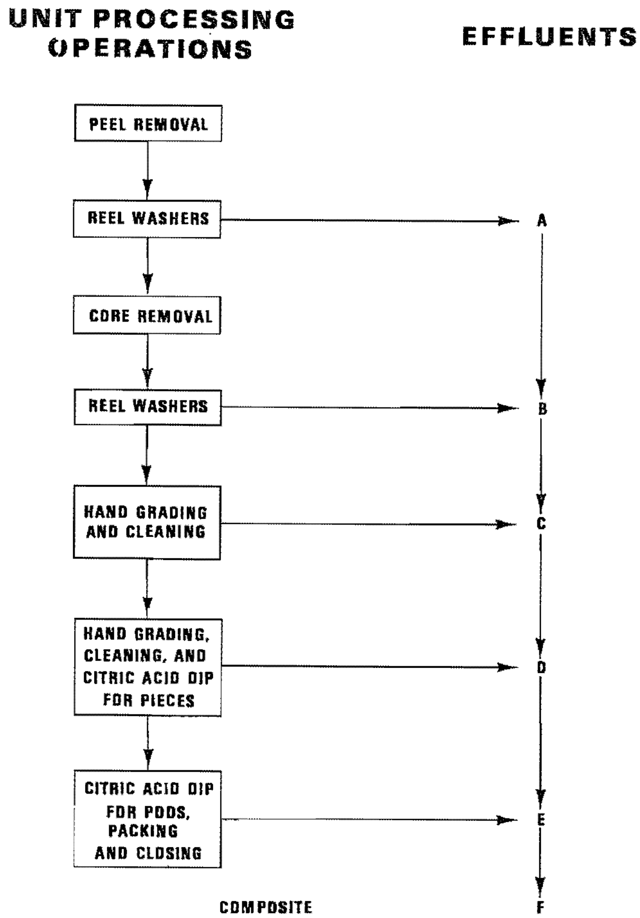

Figure 1. Flow diagram of unit processing operations and effluents in a commercial pimiento cannery.

estimated by a floating block method described by Mercer *(6)*. The flow of cooling water was estimated by plant personnel to be 12,000 gal/hr.

RESULTS AND DISCUSSION

The distributions of the various solids fractions in the pimiento effluents are shown in Table 1. The values listed are the averages and standard deviations for six replicates. The high standard deviation values reflect the day-to-day variations in the unit effluent composition. Differences in rates of processing, in raw products from different growers, and from early and late season pimientos are included in the variations.

The effluent from the peel removal operation (A) contained a considerable amount of charred peel which contributed to the solids load, especially the suspended solids concentration which was 302 mg/liter. The effluent from the core removal area (B) contained only 42 mg/liter suspended solids but was relatively high in dissolved solids (1472 mg/liter) because of soluble materials from the interior of the pimiento. The effluents from the grading area (C-D) were generally low in solids. Also, the strength of these wastes was more variable as shown by the high standard deviation values, particularly those of suspended solids. The total solids concentration of the effluent from the citric acid dip, packing, and closing area (E) was 5,094 mg/liter, of which 5057 mg/liter was dissolved solids. The total acidity of this effluent was also high due to the citric acid which drained off the product after the dip.

The average values obtained for pH, total acidity, COD, and BOD are also shown in Table 1. The effluents from the peel removal operation (A), core removal area (B), citric acid dip, packing, and closing area (E), and the composite (F) had relatively high concentrations of degradable solids as shown by the COD values: 3,018, 1,548, 4,984, and 1,525 mg/liter, respectfully. For these same effluents, the BOD values were 1,473, 866, 3,604, and 816 mg/liter, respectfully.

The results obtained by expressing the BOD as a percentage of the COD shows the uniqueness of the effluent containing the citric acid (E). The BOD of this effluent was 74% of the COD value. The BOD values for the other effluents ranged from 49 - 59% of the COD values.

The average flow rates for the unit effluents are given in Table 1 and are also expressed as a percentage of the total. The total flow of the five individual effluents was 849 gal/min, and the contributions of unit effluents A-E to this total were 18, 22, 23, 28, and 9%, respectfully.

Table 2 shows the individual waste load (lb./hr) and the percent of the total waste load (sum of A-E) contributed by each unit effluent. The effluent from the peel removal operation (A) contained 34% of the total solids load, 69% of suspended solids, 33% of the volatile solids, 37% of the COD, and 30% of the BOD waste load. However, these wastes were contained in only 18% of the total flow. It is possible that the processor could reduce the waste load from this unit operation by process modification. Segregation of this effluent for separate treatment could significantly reduce the total waste load.

The effluent from the core removal operation (B) contained 23% of the COD and accounted for 22% of the total flow. Effluent C from the grading area contained only 4% of the COD in 22% of the total flow. Effluent D was likewise dilute and contained 6% of the COD in 28% of the total flow. Effluents C and D could possibly be recycled for use in the peel removal operation which would produce a concentrated effluent that could be segregated and treated separately to reduce the total waste load.

The effluent from the citric acid dip, packing, and closing area is another example of a concentrated, low volume effluent. It contained 37% of the total BOD load in only 10% of the total flow. Over 99% of its total solids load was found in the dissolved solids fraction and was readily biodegradable as indicated by the comparatively high BOD: COD ratio (0.74).

Table 3 shows the pounds of waste materials generated per ton of raw product processed. The total production of total solids, suspended solids, volatile solids, COD, and BOD was 62.7, 3.2, 54.8, 60.2, and 35.4 lb./ton of raw pimientos, respectively. The total flow of waste water was 4840 gal/ton. The flow of cooling water which was discharged separately from processing wastes was approximately 1,000 gal/ton.

A survey of the waste loads from several fruits and vegetables *(8)* reported the suspended solids and BOD load from snap beans to be 4 and 30 lb./ton, respectively. Corresponding values for peas were 10 and 50 lb./ton, respectively. The total waste water produced was 4,500 gal/ton of snap beans and 5,000 gal/ton of peas *(8)*. The results of this study indicated that the production of wastes from pimientos was similar in amount to that from snap beans and peas.

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