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CONTENTS

EVALUATION OF TOMATO CULTIVARS FOR PROCESSING

by

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The objective of this study was to determine the suitability of 30 Ohio-grown tomato cultivars for processing and the quality of the canned products. The cultivars included were classified as established and/or new cultivars to Ohio tomato growers.

METHODS

The 1975 processing tomato project included 30 cultivars grown in replicated plots under acceptable commercial practices at the Ohio Agricultural Research and Development Center - Northwestern Branch, Hoytville, Ohio. Each cultivar was machine harvested (with FMC Western Model) with little or no sort on the harvestor and bulk handled. Following harvest the tomatoes were transported by truck (approximately 100 miles) to the Food Processing Pilot Plant at the Ohio State University, Columbus, Ohio for processing. All lots were processed after 24 hours hold following harvest as peeled whole tomatoes.

A. Twenty field run tomatoes were selected and used for objective and subjective quality evaluation.

1. Size was determined by weighing the sample and then calculating the number for a one pound sample. In addition the tomatoes were subjectively classed for shape, fruit surface, core, and firmness and types of defects.

2. Stem scar length, stylar scar length, stem length and wall thickness were determined by measuring the average length in inches.

3. % Red Color was determined by counting the number of tomatoes in the sample that had full red color.

4. E-5 cut surface color was determined on an Agtron E-5 instrument after making a crosswise cut in the tomato and reading the values after standardizing the instrument at 48.

5. The sample was then quartered, extracted in a Food Processing Equipment Co. Laboratory pulper and dearated.

    a. The dearated pulp was presented to the Agtron E-5 instrument in a standard plastic sample cup with the instrument calibrated at 48. The color reading was taken directly and recorded as such.

b. Percent soluble solids. An Abbe refractometer was used for direct determinations of percent soluble solids on raw and canned juice. The instrument was standardized with distilled water and all readings converted to 20°C.

c. pH. The pH was determined by the glass electrode method (Beckman Zeromatic pH Meter) using 10 ml of tomato juice (raw or canned) diluted with 90 ml of distilled water.

d. Percent total acid as citric. The sample used for pH determination was directly titrated using 0.1 normal sodium hydroxide solution to a pH of 8.1. Calculations using the following equation were made:

$$\% \text{ acid} = \frac{(\text{No. of ml of 0.1N NaOH}) \quad (.0064)}{10 \text{ ml sample}} \times 100$$

e. Ascorbic Acid. 10 ml aliquots of tomato juice were diluted with 90 ml of 1% meta phosphoric acid and filtered. A 10 ml aliquot of the filtrate was titrated with 0.2% 2,6-dichlorophenolindophenol indicator solution. Milligrams of Vitamin C were determined by the following formula:

$$\text{Dye factor} \times \text{ml of dye} \times 100 = \frac{\text{mg Vit. C}}{100 \text{ g}}$$

B. The Preparation and Processing of the Tomato.

All tomatoes were prepared for canning by washing, lye peeling (18% caustic soda and Faspeel at 190°F for 20 seconds) and processed as whole tomatoes. Each lot of whole tomatoes was filled to 10.5-11.0 ounces in No. 303 fruit enamel tin cans with a 50-grain salt tablet containing 44½% NaCl, 15% $CaSO_4 \cdot H_2O$, 37% citric acid, and 3.5% Na Bicarbonate.

C. Grades of Canned Tomatoes. The grade was determined in accordance with the U. S. Standards for Grades of Canned Tomatoes.

The results are presented in Table 1.

Table 1. 1975 Tomatoes, Raw & Processed Quality Evaluation

	Chico III	Ohio 2070	0731	0732	0733
Raw					
Fruit Shape	Pear	Globe	Globe	Globe	Pear
Fruit Surface	Smooth	Smooth	Smooth	Smooth	Smooth
Fruit Size	Small	Medium	S - M	S - M	Small
Diameter	1 3/8	2 1/8	1 7/8-2 1/4	1 3/4-2 1/4	1 1/2-2
Length	2 1/4	2 1/4	1 3/8-2 1/8	2-2 1/4	1 7/8-2 1/8
Ct./25 lb	475	75	100	100	125
Stem Scar	-1/4	+1/2	+1/4	-1/4	± 1/4
Stylar Scar	None	+3/8	+1/8	None	±1/8
Firmness	Medium	Medium	Hard	H - M	Medium
% Defects	40	60	50	60	10
Type	Cracks	Large cracks	cracks & scars	radial scars	scars
% Red	80	50	60	sunburn	80
No. Locules	3	6	3	3	3
Thickness, mm	5	6	5	7	5
Size Locules	---	Small	Medium	Medium	Large
Size Core	Small	Small	Small	S - M	Small
E-5 pulp	28	38	43	42	34
halves	36	39	38	37	37
pH	4.4	4.35	4.4	4.5	4.4
Total acids	.32	.30	.35	.39	.33
SS	4.0	3.7	4.4	4.6	4.1
Vit. C	17	19.8	21.3	16.7	17.3
Canned					
Defects	30	30	30	30	30
Drained Wt.	20	19	17	17	17
Color	28	27	26	26	27
Wholeness	20	18	20	19	20
Total score	98	94	93	92	94
Grade	A	A	B	B	A
pH	4.3	4.35	4.1	4.4	4.3
T.A.	.38	.35	.44	.40	.42

Table 1 (cond.)

	0736	07313	CS290	CS309	Campbell 37
Raw					
Fruit Shape	Globe	G - P - O	Globe	Globe	Pear
Fruit Surface	Smooth	Smooth	Smooth	Smooth	Smooth
Fruit Size	Medium	Medium	Small	Medium	Medium
Diameter	1 1/2-2 1/2	1 3/4-3	1 3/4-2 3/4	---	1 1/2
Length	1 1/2-2 1/4	1 7/8-2 1/4	2-2 1/16	---	2-2 3/4
Ct./25 lb	132	100	125	75	200
Stem Scar	+1/4	+1/2	-1/4	+1/2	-1/4
Stylar Scar	+1/8	+1/8	+1/8	+3/8	+3/8
Firmness	Hard	Medium	Hard	Hard	Hard
% Defects	60	10	40	50	10
Type	bruises, rot, cracks	cracks	cracks	cracks	cracks
% Red	60	30	80	70	70
No. Locules	4-6	3-4	6	6-7	4-6
Thickness, mm	3	5	5	5	5
Size Locules	Medium	S - M	Medium	Small	---
Size Core	S - M	Medium	S - M	Small	Medium
E-5 pulp	58	40	26	44	38
halves	57.2	38	20	39	45.8
pH	4.4	4.45	4.35	4.45	4.45
Total acids	.32	.30	.34	.31	.37
SS	4.6	4.1	3.6	3.9	5.1
Vit. C	14.5	24.8	14.2	16.1	12.1
Canned					
Defects	28	30	30	30	28
Drained Wt.	17	20	16	20	17
Color	28	28	28	26	29
Wholeness	19	20	20	19	19
Total Score	92	98	94	95	93
Grade	A	A	B	B	A
pH	4.4	4.3	4.3	4.2	4.1
T.A.	.29	.32	.44	.41	.42

Table 1 (cond.)

	PX7323	PX7328	PX7336	07518	07520
Raw					
Fruit Shape	Globe	Oblong	G - P	Pear	Pear
Fruit Surface	Smooth	Smooth	Smooth	Smooth	Smooth
Fruit Size	---	Small	Small	Small	Small
Diameter	2-2 3/4	1 5/8-1 3/4	1 3/4-1 7/8	1-1 3/8	1 1/2-2 1/2
Length	1 3/4-2 1/8	2-2 1/4	1 3/4-2 1/4	1 1/2-2 3/16	1 1/2-2
Ct./25 lb	100	150	150	250	150
Stem Scar	+1/2	-1/4	-1/4	-1/4	-1/4
Stylar Scar	+3/8	+1/8	+1/8	None	+1/8
Firmness	Medium	Hard	Medium	Hard	Medium
% Defects	70	70	20	20	5
Type	cracks scars	cracks scars	cracks sunburn	cracks rot	cracks
% Red	40	85	80	90	20
No. Locules	4-6	3	2-3	2-3	2-3
Thickness, mm	5	7	5	5	5
Size Locules	Small	Small	Small	Small	---
Size Core	Small	S - M	Medium	Small	M - L
E-5 pulp	36	30	36	38	58
halves	31	35	42.5	39	62
pH	4.4	4.35	4.35	4.3	4.45
Total acids	.26	.28	.28	.35	.25
SS	3.8	4.6	4.9	4.3	4.2
Vit. C	22.8	24.0	14.5	17.3	11.6
Canned					
Defects	30	28	28	30	30
Drained Wt.	20	16	17	20	19
Color	30	30	27	28	26
Wholeness	20	20	20	20	20
Total Score	100	94	92	98	95
Grade	A	B	A	A	B
pH	4.2	4.3	4.45	4.3	4.4
T.A.	.42	.39	.32	.37	.34

Table 1 (cond.)

	07521	07522	07523	07526	07528
Raw					
Fruit Shape	G - P	G - P	Globe	Pear	G - P
Fruit Surface	Smooth	Smooth	Smooth	Smooth	Smooth
Fruit Size	S - M	S - M	M - L	Medium	Medium
Diameter	1 3/4-2 1/4	1 7/8-2	2-2 7/8	1 3/4-2 1/4	1 1/2-2 1/8
Length	1 7/8-2 1/4	1 3/4-2	2-2 3/8	1 7/8-2 1/4	2 1/4
Ct./25 lb	125	125	75	125	75
Stem Scar	-1/4	+1/4	+1/2	+1/4	+1/2
Stylar Scar	+1/8	+1/8	+1/8	+1/8	+1/8
Firmness	S - M	Hard	Hard	Hard	Hard
% Defects	40	40	20	10	60
Types	radial scars	sunburn scars	scars radial	radial	cracks radial scars
% Red	50	60	0	0	60
No. Locules	4	6	6-8	4-6	4-6
Thickness, mm	5	6	7	4	7
Size Locules	Small	Small	Small	Small	Small
Size Core	Small	Small	Small	Medium	Medium
E-5 pulp	38	48	41.5	28	30.5
halves	35.7	42.8	48	40	36
pH	4.4	4.3	4.4	4.35	4.4
Total acids	.30	.35	.25	.33	.37
SS	4.0	3.9	3.7	3.7	4.2
Vit. C	19.2	15.2	27.9	17.2	16.4
Canned					
Defects	30	30	26	29	28
Drained Wt.	19	17	19	19	17
Color	26	30	22	29	29
Wholeness	20	20	20	19	20
Total Score	95	97	87	96	94
Grade	B	A	C	A	A
pH	4.2	4.3	4.25	4.2	4.25
T.A.	.38	.25	.35	.41	.42

Table 1 (cond.)

	07529	07530	07532	07535	07565
Raw					
Fruit Shape	Oblong	Globe	Globe	Globe	Flat
Fruit Surface	Smooth	Smooth	Smooth	Smooth	S - I
Fruit Size	Medium	Medium	Small	Small	M - L
Diameter	1 1/2-1 7/8	2-2 3/8	1 3/4-2 1/2	1 7/8-2 5/8	1 3/4-2 5/8
Length	2 1/8-2 3/8	1 7/8-2	1 3/4-2	1 3/4-2	1 1/2-1 7/8
Ct./25 lb	125	75	200	125	75
Stem Scar	-1/4	+1/2	-1/4	+1/4	+1/4
Stylar Scar	+1/8	1/4 - 3/8	+1/8	+1/8	+3/8
Firmness	Medium	H - M	H-M-S	Hard	Hard
% Defects	---	70	30	40	70
Types	---	scars rot	cracks	cracks scars	stylar rot radial scars sunburn
% Red	70	50	90	90	20
No. Locules	3	4-6	3	4	4
Thickness, mm	8	6	5	5	7
Size Locules	Small	Small	S - M	Small	Small
Size Core	Medium	Medium	Medium	S - M	Small
E-5 pulp	29.5	33.5	39	41	28
halves	39	36	38.6	38	44
pH	4.5	4.4	4.4	4.5	4.6
Total acids	.33	.36	.30	.31	.30
SS	4.7	4.1	4.1	3.9	4.4
Vit. C	17.0	19.2	13.92	22.6	19.5
Canned					
Defects	30	30	30	30	30
Drained Wt.	19	20	17	17	19
Color	28	24	29	30	28
Wholeness	20	20	20	20	20
Total Score	97	94	96	97	97
Grade	A	B	A	A	A
pH	4.3	4.3	4.4	4.3	4.25
T.A.	.42	.38	.33	.37	.42

Table 1 (cond.)

	07572	07578	07580	07581	07584
Raw					
Fruit Shape	Globe	Globe	Oblong	Globe	Pear
Fruit Surface	Smooth	Smooth	Smooth	Smooth	Smooth
Fruit Size	S - M - L	Medium	S - M	Medium	Small
Diameter	1 1/2-2 1/2	1 1/2-2 1/4	1 1/2-1 1/2	1 3/4-2 1/2	1 1/2-1 7/8
Length	1 3/4-2	1 3/4-2 1/2	2-2 3/4	1 3/4-2	1 3/4-1 7/8
Ct./25 lb	100	125	175	100	150
Stem Scar	+1/4	-1/4	+1/4	+1/4	-1/4
Stylar Scar	+3/8	+1/8	+1/8	+1/8	+1/8
Firmness	H-M-P	Medium	M-S	Medium	Medium
% Defects	40	---	20	20	10
Types	cracks stylar rot	---	cracks rot	cracks scars	scars
% Red	80	85	80	90	70
No. Locules	4-6	3	3	5-7	3
Thickness, mm	5	6	4	5	6
Size Locules	---	Medium	Medium	Small	Medium
Size Core	S-M-L	S-M	S-M-L	Small	Medium
E-5 pulp	37	31	46	33	49.5
halves	45	36	48.7	30	46
pH	4.5	4.5	4.4	4.6	4.6
Total acids	.26	.32	.24	.26	.25
SS	4.3	4.0	4.5	4.9	3.8
Vit. C	16.2	15	15.9	22	19.2
Canned					
Defects	28	30	27	30	30
Drained Wt.	20	19	20	19	17
Color	28	28	27	28	30
Wholeness	18	20	20	20	20
Total Score	94	97	94	97	94
Grade	A	A	A	A	A
pH	4.5	4.35	4.55	4.3	4.4
T.A.	.30	.35	.26	.40	.35

USING TOMATO SEEDS

by

J. R. Geisman

One of the residues from the manufacture of tomato juice is the seed. Recent biochemical analysis has shown the tomato seed to contain a high portion (25-30%) of protein. This protein is of excellent quality and should be considered as a source of human food.

By examining tomato seed with the aid of a scanning electron microscope, it was determined that the protein is contained in protein bodies. The body is surrounded by a membrane which would indicate that complex extraction procedures might be necessary to free the protein. However, it was apparent that the bodies were large and pulverizing the seed might simplify the extraction process.

Experimental

Through the cooperation of an Ohio tomato juice manufacturer, an experimental pack of tomato juice with seed particles added was made. Seeds were collected at the discharge end of the extractor. By simple flotation, the skin residue and other particles were separated from the seed. The seed was ground in a Fitzpatrick comminutor equipped with an 0.027 inch screen. Seeds receiving this treatment appeared to be similar to a peanut butter of thin consistency.

The ground tomato seed was filled into 46 oz. cans at the rate of 0.1, 0.2 and 0.4 percent by weight. An untreated lot of the same tomato juice was used as a control.

Samples were brought to the Ohio State University for chemical and physical analysis. Chemical analysis included pH, total acidity and soluble solids. Physical analysis included subjective and objective color, flavor, viscosity and hysterisis.

Results and Discussion

The results of determinations for pH, total acidity, soluble solids and total color are presented in Table 1. From these data it is readily apparent that pH and soluble solids were unaffected by the addition of ground seeds. The total acidity was reduced by the addition but the amount of reduction was unrelated to the concentration of the added seeds. Color was affected in proportion to the additive. The color was noticeably lighter due to the particles added.

Table 1

Analysis of treated and untreated tomato juice for pH, total acidity, soluble solids and total color

Added seeds	pH	% acid	Soluble solids	Total color
0.0%	4.6	.32	5.0	74.48
0.1%	4.6	.28	5.2	71.88
0.2%	4.6	.28	5.0	66.54
0.4%	4.6	.28	5.0	61.74

When samples of the various treatment were evaluated by a trained organoleptic panel for color, flavor and consistency, the results indicated that there was no difference in any of these attributes between untreated juice and juice with 0.1% ground seeds added. However, these samples were scored significantly higher for all attributes than samples containing 0.2 and 0.4% by weight seeds. The samples were rated on a 1 to 10 scale with 10 being excellent and 1 being off.

Samples of each treatment were allowed to settle at room temperature overnight to quantify hysterisis. It was hoped that the added protein would aid in partially eliminating this problem. However, the zone of clear liquid was the same regardless of treatment.

A Brookfield LDF viscosimeter equipped with a No. 1 spindle was used to determine apparent viscosity. The results are shown in Table 2.

Table 2

Apparent viscosity of treated and untreated tomato juice.

% seed added	viscosity at (rpm)			
	60	30	12	6
0.0	38	58	100	143
0.1	43	66	117	162
0.2	44	67	117	185
0.4	47	72	111	156

While these values (Table 2) are not absolute, the data do indicate a slight increase in viscosity with increased amount of ground seeds.

Conclusions

The principal conclusions based on the results thus far are:

1. The seed was not ground fine enough to allow complete extraction of the protein.
2. The addition of seed increased the protein content but in small quantities had little influence on the overall quality and acceptability of the juice.
3. The research should be continued since the seed is too valuable to be discarded. In future efforts attention will be given to increase the specific surface per unit volume of seeds.
4. If seeds were added to tomato juice a change needs to be made in the standards to allow this practice.

Acknowledgment

The author wishes to express his appreciation to the following for their cooperation in this research. The Hirzel Canning Company, Dr. W. A. Gould, Mrs Ruth Stillabower and Dr. J. L. Blaisdell.

EVALUATION OF SNAP BEAN CULTIVARS FOR PROCESSING

by

W. A. Gould and R. Stillabower

Six varieties of snap beans were grown on the Horticultural Farm at The Ohio State University. The beans were planted in 200 foot rows, 36 inches apart, with the seed placed two to three inches apart in the row depending on seed size.

At harvest, the plants were pulled and the pods removed by hand. They were transported immediately to the Fruit and Vegetable Processing and Technology Pilot Plant. The beans were mechanically snipped, size graded, spray washed, water blanched and twelve ounces were hand packed into R-enamel cans. Two size graders were used, 1-3 and 4-5 sieve sizes, the latter were cut into pieces 1 to 1½ inches long, the smaller size grade packed as whole beans. The beans were blanched, by sizes, using the continuous water blancher set at 175°F for 3 minutes. Both lots were water cooled prior to inspection and filling.

The canned snap beans were covered with boiling distilled water and a thirty-grain sodium chloride tablet was added to the can. The cans were exhausted for four minutes, steam flow closed (at 15 psi) and processed at 240°F and 15 psi for 20 minutes. They were water cooled to 100°F.

Quality was determined as follows:

Number of plants -- The actual number of plants in 50 feet were pulled and counted for each of the harvests.

Yield -- The beans were weighed to determine the gross yield in pounds for the number of plants in 100 foot rows and yield was calculated to ounces/plant.

Number of pods per pound -- The number of pods in a one-pound field run sample was counted.

Percent sieve size -- Sieve size was determined by measuring the diameter of the pod perpendicular to the sutures. The sieve sizes of one-pound field run sample were determined and weighed. The data are shown by count, percentage by count and percentage by weight for each sieve size.

Pod length -- Pod length was determined by evaluating 20 pods as to average length reported in inches.

Percent by weight seeds -- Determined on fresh and canned product and reported by sieve size. For determining percent by weight seeds, 100 grams of pods for each sieve size were deseeded and the seeds weighed.

Texture -- Texture was determined on the GOSUT texturometer. Several pods of each sieve size were used to arrive at the average value. Results are reported directly in GOSUT texturometer values.

Grade -- The grade of the canned product was determined in accordance with the U. S. Standards for Grades of Canned Snap Beans for their respective attributes of quality. The actual score points assigned each of the attributes of quality are recorded by sieve size for each of the cultivars.

TABLE I - SNAP BEAN RAW PRODUCT EVALUATION - 1975

CULTIVAR	HARVEST NO.	NO. PLANTS/100'	YIELD OZ./PLANT	NO. PODS/LB.	SIEVE SIZE	COUNT NO./LB.	COUNT %	% BY WEIGHT	AVE. LENGTH (in.)	GOSUT TEXTURE
Tenderblue	I	155	1.23	111	1	328	27.9	9.3	3.50	2
					2	191	18.9	10.9	3.5	6
					3	102	14.4	15.6	4.5	13
					4	76.8	21.6	31.2	4.75	16
					5	62.4	11.7	20.2	5.0	18
					6	48	5.4	12.5	4.5	25
Tenderblue	II	146	1.74	73	1	192	4.1	1.56	3.75	3
					2	170.4	10.9	4.6	3.5	5
					3	112	9.5	6.2	4.0	11
					4	84	27.4	23.4	4.75	16
					5	60	20.5	25.0	5.0	21
					6	50	27.4	39.0	5.25	23
Tenderblue	III	214	3.57	55	1	128	3.6	1.56	3.5	3
					2	160	9.0	3.1	3.0	7
					3	128	7.2	3.1	4.5	14
					4	76.8	21.8	16.3	5.0	18
					5	56.8	14.5	14.1	5.5	28
					6	38.4	43.6	62.5	6.0	32

TABLE I cont.

Wax 819	I	318	2.18	70	1	224	10.0	3.1	3.75	2
					2	128	2.8	1.56	4.25	9
					3	80	7.1	6.2	4.5	9
					4	66.7	41.4	43.7	4.75	22
					5	60	21.4	25.0	5.5	23
					6	54.8	17.2	21.8	5.0	26
Coloma	I	239	1.23	112	1	384	5.4	1.56	2.0	5
					2	128	1.8	1.56	2.75	7
					3	224	6.3	3.1	2.75	10
					4	121	16.9	14.0	3.5	18
					5	117.8	27.6	26.5	3.25	21
					6	84.6	41.9	56.2	3.75	24
Green Pak	I	309	.90	98	1	562	8.1	3.1	2.5	4
					2	176	11.2	6.2	3.5	8
					3	128	16.3	12.4	4.0	13
					4	101	29.5	28.1	4.0	15
					5	68	17.3	25.0	4.5	21
					6	59	17.3	28.1	4.5	22
Green Pak	II	275	2.00	92	1	512	8.6	1.56	2.5	4
					2	352	11.9	3.1	3.5	10
					3	288	9.7	3.1	3.75	13
					4	92	14.1	14.0	4.0	18
					5	96	16.3	15.6	4.5	19
					6	57.6	39.1	62.5	5.5	21
GP 467	I	178	1.94	89	1	278	13.4	4.6	3.0	4
					2	130	14.6	6.2	3.5	6
					3	90	10.1	6.2	4.0	12
					4	88	24.7	25.0	4.5	18
					5	73.5	16.8	23.4	5.0	18
					6	57.6	20.2	31.2	5.0	24

TABLE I cont.

GP 467	II	115	4.7	76	1	256	10.5	3.1	3.5	3
					2	160	6.5	3.1	4.0	8
					3	116	14.4	9.3	4.5	15
					4	58	18.4	17.1	5.0	18
					5	55.1	25.0	34.3	5.5	22
					6	57	25.0	32.8	5.5	26
Slimgreen	I	217	4.4	94	1	320	5.3	1.56	2.75	3
					2	384	6.4	1.56	3.0	9
					3	176	11.7	6.2	3.75	15
					4	87	31.9	32.8	4.75	19
					5	74.5	22.3	28.1	4.5	22
					6	74.5	22.3	28.1	4.5	25

TABLE II - CANNED PRODUCT EVALUATION - 1975

VARIETY	HARVEST	SIEVE SIZE	U.S.D.A. GRADE FACTORS					
			LIQUOR	COLOR	ABSENCE OF DEFECTS	CHAR-ACTER	TOTAL SCORE	GRADE
Coloma	I	4-6	9	14	33	32	88	B
GP 467	I	1-3	10	15	35	38	98	A
		4-6	9	15	33	34	91	A
	II	4-6	9	13	33	30*	85	C
Green Pak	I	1-3	10	15	35	39	99	A
		4-6	10	15	35	37	97	A
	II	1-3	10	13	35	37	95	A
		4-6	9	13	33	30*	85	C
Slimgreen	I	1-3	10	15	34	39	98	A
		4-6	9	13	33	30*	85	C
Tenderblue	I	1-3	10	15	35	38	98	A
		4-6	9	14	34	36	93	A
	II	1-3	10	15	35	38	98	A
		4-6	9	14	34	36	93	A
	III	1-3	10	15	35	39	99	A
		4-6	10	15	33	35	93	A
Wax 819	I	1-3	10	11*	35	38	94	C
		4-6	10	15	33	36	94	A

*Limiting Rule

FLAME STERILIZATION OF CANNED GREEN BEANS

by

J. R. Mount and W. A. Gould

This study was undertaken to develop a flame sterilization process which would produce a commercially sterile can of green beans with a quality that was as good as or better than that for green beans processed with a conventional type of retort as a cooker. The green beans throughout this study were filled into 303 x 406 R-enamel cans and processed in a flame sterilizer, a still retort or a continuous rotary cooker. The cans and lids used were both 75# base weight.

The flame sterilizer used was the pilot model flame sterilizer manufactured by the Filper Corporation.

Heat Penetration

The heat penetration data were measured using a thermocouple placed into the geometric center of the can of green beans and connected to a continuous recorder. The #1 burner gauges were set to allow the greatest amount of heat penetration while the #2 and #3 burner gauges were set to keep the temperature at either 250°F or 255°F. The process times were determined to produce a sterilizing value of an F_o = 3.5 when the green beans are at the processing temperature. The heat penetration curves for the 250°F and the 255°F flame sterilizer processes for canned green beans are compared as shown in Figure 1 and the heat penetration curves for the 250°F flame sterilizer and still retort processes are compared as shown in Figure 2.

Shelf-Life Study

Seven cultivars of green beans were processed as shown in Figure 3 and 3 separate lots of green beans were processed as shown in Figure 4. After these different lots of green beans were processed they were evaluated for quality with the results shown in Table 1. No significant quality differences were found between the flame sterilized green beans and the still retorted green beans or between the flame sterilized green beans and the continuous rotary cooked green beans except in the liquor scores. The rotary cooked samples are shown to have a significantly larger percentage of solids than the flame sterilized samples and it is most likely due to the longer process time allowing for more breakdown of the green beans.

The color of the green beans from the different processes was also evaluated objectively using an Agtron M-30-A which allowed a large sample to be used in measuring the percent reflectance. The average values for 5 samples from each lot are shown in Figure 5. These values can be compared to the % reflectances found for a frozen sample of green beans with a bright green color. The % reflectance for the samples at the red wavelength were all approximately twice the value found for the frozen sample. The % reflectance at the blue wavelength was approximately the same for the heat processed samples and the frozen sample.

The % reflectance at the green wavelength was approximately 80% of the value of the frozen sample for the heat processed samples except for the flame sterilized sample processed at 255°F which was 90% of the value. This indicates that the high temperature short-time process may have retained more of the green pigments.

Sample cans from each of the lots were microbially analyzed as outlined in AOAC method 41.B01 and all of the samples showed negative growth at incubation temperature for both aerobic and anaerobic microorganisms.

Summary

This study determined that 303 x 406 cans of green beans could be processed on a flame sterilizer, producing commercially sterile cans of green beans which have as good a quality as green beans processed by different thermal process methods.

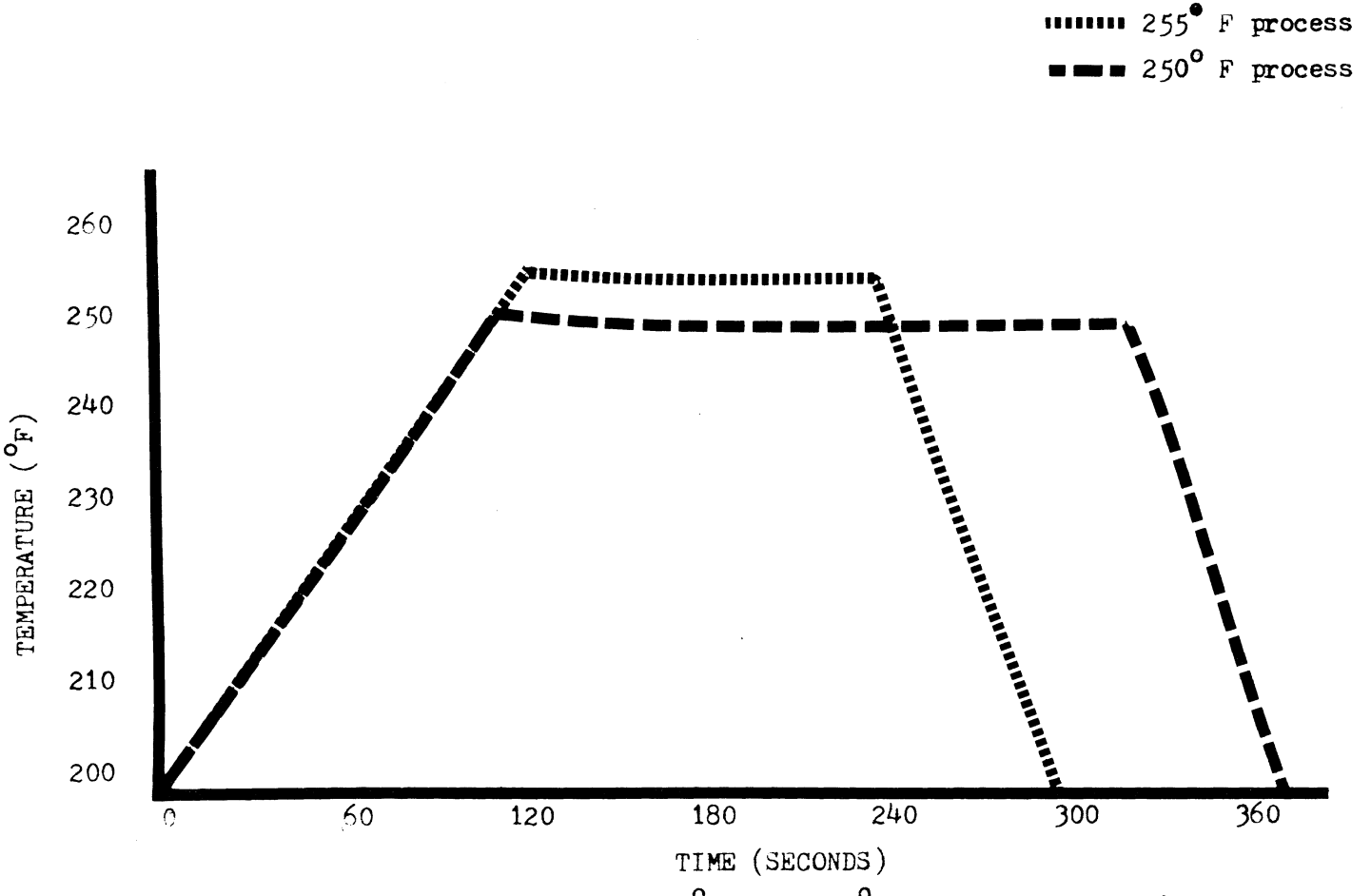

Fig. 1. Heat penetration curves for 250° F and 255° F flame sterilization processes.

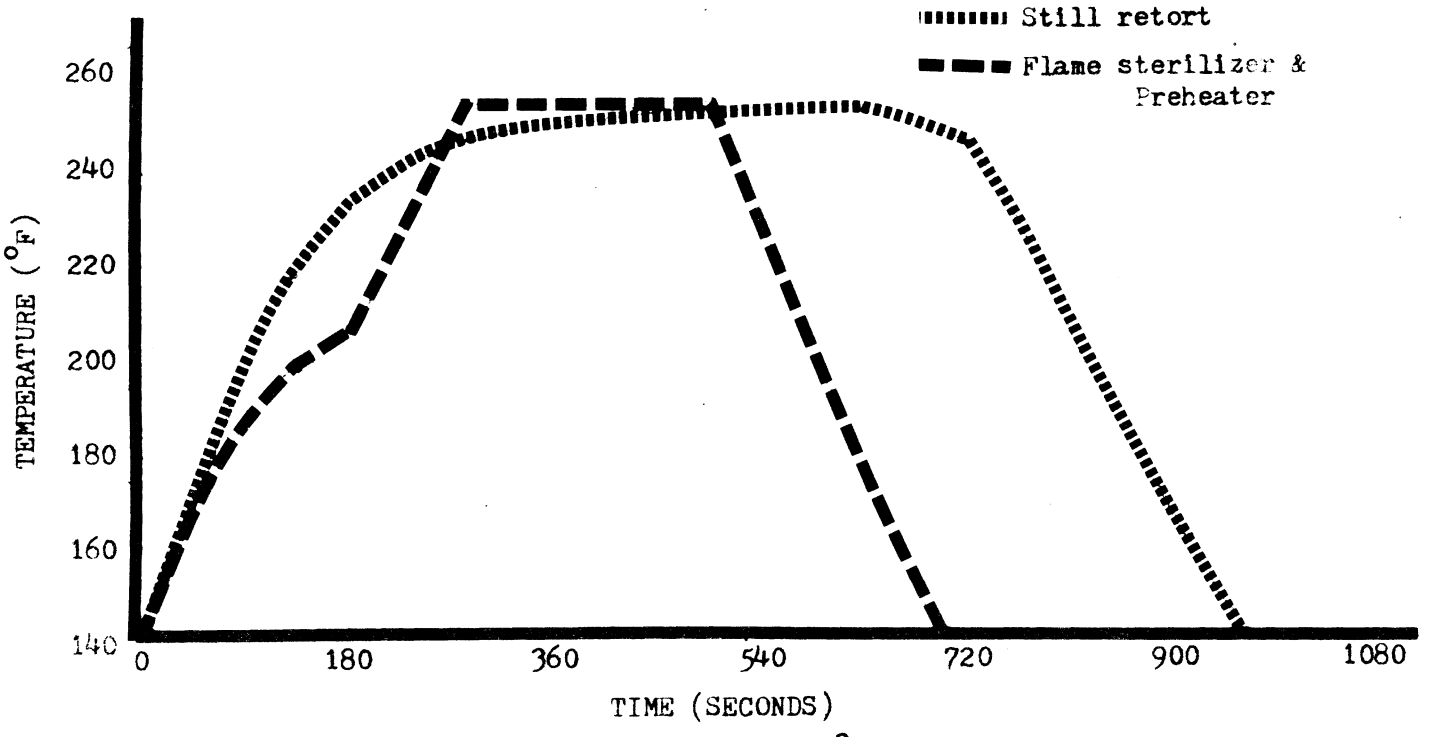

Fig. 2. Heat penetration curves for the 250° F still retort and flame sterilization processes of canned green beans.

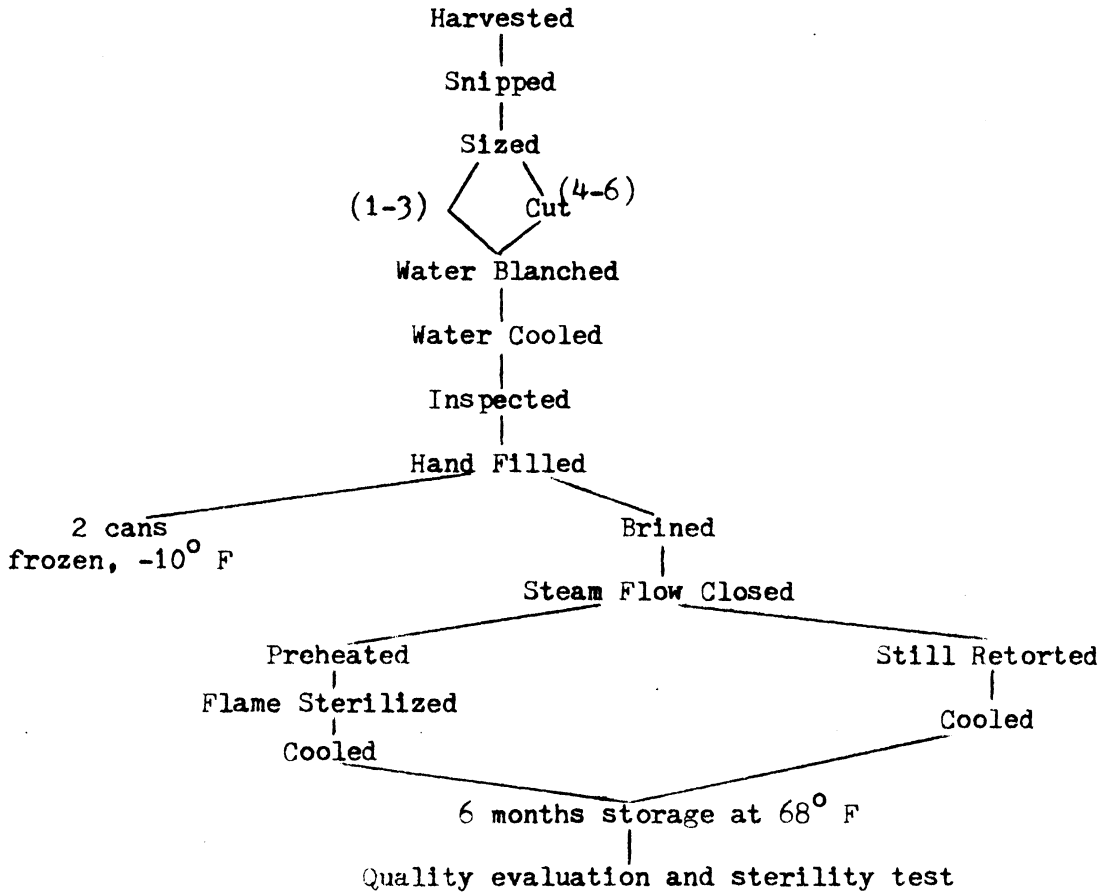

Fig. 3. Flow chart for thermal processing of canned green beans at the Food Processing and Technology Pilot Plant, Department of Horticulture, The Ohio State University, Columbus, Ohio.

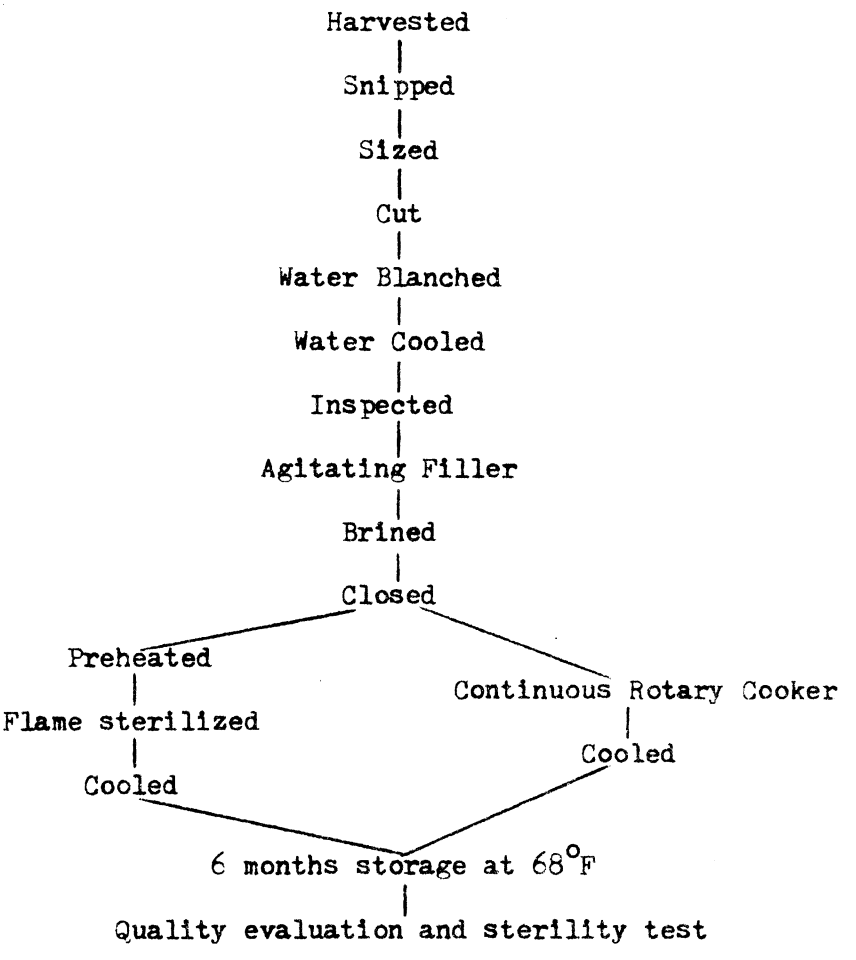

Fig. 4. Flow chart for thermal processing of canned green beans at a commercial canning plant in Ohio.

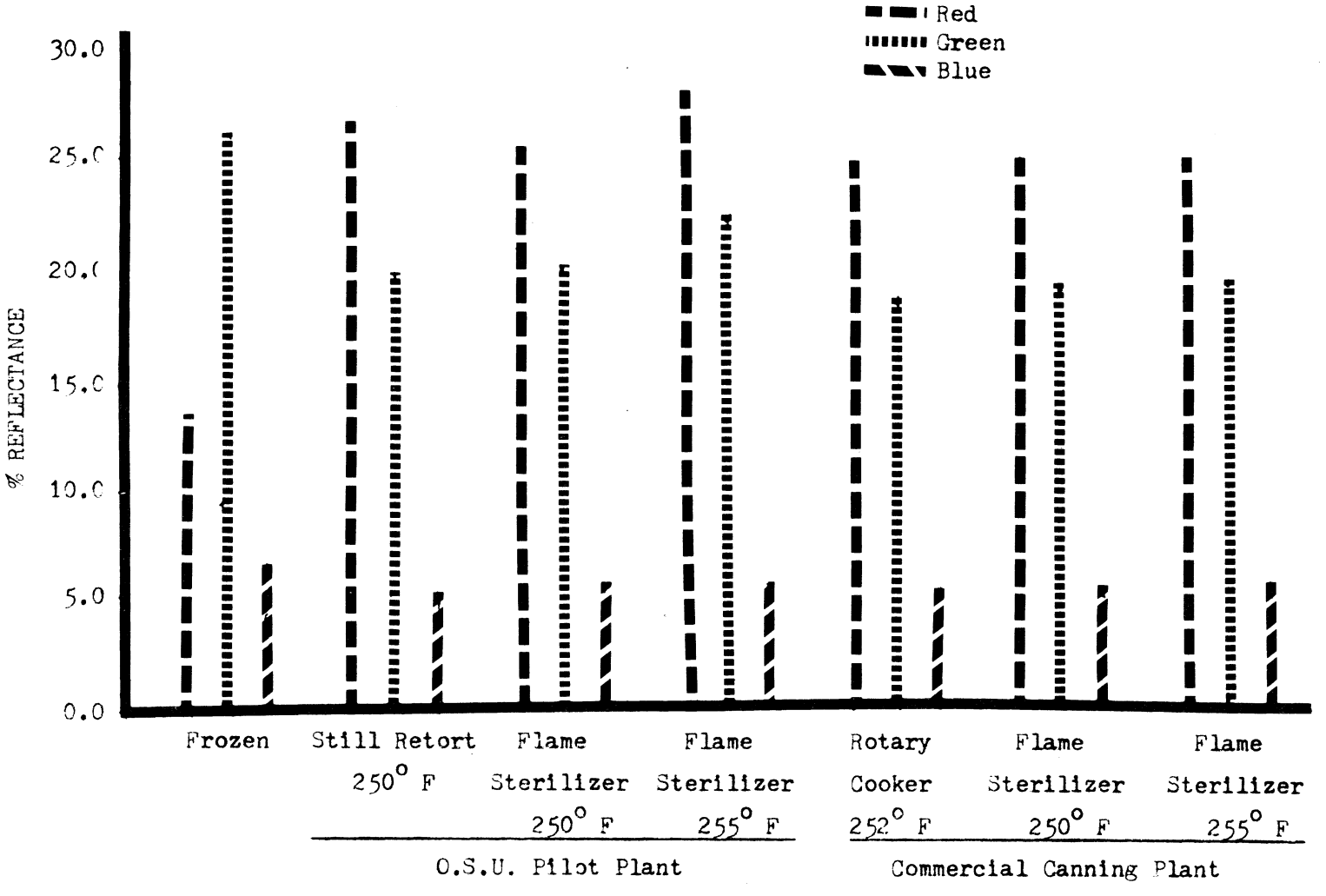

Fig. 5. Average color scores for canned green beans on the Agtron M 30-A

'ABLE 1 Quality evaluation of canned green beans.

VARIETY	PROCESS	SIEVE SIZE	% FIBER	U.S.D.A. GRADE FACTORS LIQUOR	COLOR	ABSENCE OF DEFECTS	CHAR-ACTER	TOTAL SCORE	GRADE
Colorna	I	1-3	.06	10	13	33	37	93	A
		4-6	.15	10	12	33	30*	85	C
		4-6	.23	9	11*	33	27*	80	D
Earliwax	I	1-3	.03	10	15	34	38	97	A
		4-6	.15	10	12	33	31*	86	C
Early Gallatin	I	1-3	.05	10	14	35	39	98	A
		4-6	.08	10	12	35	38	95	A
		4-6	.12	9	11*	32	35*	87	C
GP 467	I	4-6	.12	10	12	35	36	93	A
		4-6	.19	9	13	33	27*	82	D
GP 68-115	I	4-6	.13	10	13	33	36	92	A
Slimgreen	I	4-6	.15	10	15	35	31*	91	C
		4-6	.05	9	12	33	36	90	A
Wondergreen	I	1-3	.05	10	13	35	39	97	A
		4-6	.10	10	13	35	36	94	A
		4-6	.06	10	13	34	36	93	A
average	I		.11	9.8	12.8	33.8	34.5*	90.8	
Colorna	II	1-3	.06	9	14	33	38	94	A
		4-6	.15	10	12	33	30*	85	C
Earliwax	II	1-3	.04	9	15	33	38	95	A
Early Gallatin	II	1-3	.05	10	13	34	39	96	A
		4-6	.08	10	12	32	38	92	A
GP 467	II	4-6	.12	10	13	33	36	92	A
Slimgreen	II	4-6	.14	10	15	34	31*	90	C
Wondergreen	II	1-3	.05	10	13	35	38	96	A
		4-6	.09	10	12	34	36	92	A
average	II		.09	9.8	13.2	33.4	36.0	92.4	

TABLE 1. (continued)

VARIETY	PROCESS	SIEVE SIZE	% FIBER	U.S.D.A. GRADE FACTORS: LIQUOR	COLOR	ABSENCE OF DEFECTS	CHARACTER	TOTAL SCORE	GRADE
Colorna	III	4-6	.21	10	12	34	27*	83	D
Earliwax	III	4-6	.15	10	12	35	31*	88	C
Early Gallatin	III	4-6	.13	10	11*	33	35*	89	C
GP 467	III	4-6	.18	10	13	34	27*	84	D
GP 68-115	III	4-6	.13	10	14	33	36	93	A
Slimgreen	III	4-6	.07	9	12	35	38	94	A
Wondergreen	III	4-6	.06	10	13	34	37	94	A
average	III		.13	9.9	12.4	34	33*	89.3	
Commercial varieties	IV		.07	8	13	35	37	93	A
			.06	7	12	35	36	90	A
			.06	8	14	35	37	94	A
average	IV		.06	7.7	13	35	36.7	92.3	
Commercial varieties	V		.08	10	14	35	36	95	A
			.05	10	13	35	37	95	A
"	VI		.06	9	13	35	37	94	A

* Limiting rule

I Still retort at 250° F in pilot plant

II Flame sterilizer at 250° F in pilot plant

III Flame sterilizer at 255° F in pilot plant

IV Continuous rotary cooker at 252° F in commercial canning plant

V Flame sterilizer at 250° F in commercial canning plant

VI Flame sterilizer at 255° F in commercial canning plant

FLAME STERILIZATION OF CANNED PEAS

by

J. R. Ice, J. R. Mount and W. A. Gould

The objective of this study was to investigate the possibility of using the flame sterilizer to improve the quality of thermally processed peas. The study was divided into two parts, heat penetration determinations of flame sterilized peas and shelf-life comparisons of flame sterilized peas and commercially processed peas.

Heat Penetration

This section of the study was carried out at The Ohio State University Food Processing Pilot Plant. Bulk, commercially frozen peas were thawed and re-blanched for these experiments. Ten to 11 oz of hot peas were filled into 303 x 406 "C" enamel cans. The peas were covered with 200°F water and a 30 grain sodium chloride tablet was added. The cans were steam flow closed at 15 psi using an American Can Company Model 006 can seamer.

The sealed cans of peas were placed into the pilot model preheater to produce consistant initial temperatures (202°-205°F) and then processed on the pilot model flame sterilizer. Both pieces of equipment were supplied by the Filper Corporation of San Ramon, California. The temperature in the canned peas was measured and recorded using a thermocouple inserted into the center of the can that was connected to a continuous recorder. The heat penetration rate is dependent, in part, on the rate of rotation of the container. The heat penetration rate increases as the rotations increase until the centrifugal force causes the can contents to no longer be agitated. It was found, however, that peas processed at rotational rates of 40, 60 and 80 rpm with other conditions being constant had increasingly cloudy brines as the rotational rate increased. Peas processed with a rotational rate less than 40 rpm could possibly have a clearer brine, however, the lowest maintainable setting for the pilot model of the flame sterilizer is 40 rpm and that is therefore the setting used through the entire study.

The gas pressure and flow rate were set at 6.7 psi and 13.0 units respectively for the first burner to produce the best heat penetration rate. The time required for the can of peas to reach temperatures of 250°, 255° and 260°F were determined to be 105, 120 and 135 seconds. The heat penetration curve for a can of peas to reach 255°F when processed on the flame sterilizer is shown in Figure 1. When this curve is compared to a heat penetration curve of a can of peas processed in a still retort, (Figure 2) it is apparent that a can of peas heat more rapidly on a flame sterilizer (approximately 16°F per minute) than in a still retort (approximately 6°F per minute).

Shelf-Life Evaluation

Eight lots of peas, 20 cans per lot, were processed on the pilot plant model flame sterilizer in a commercial plant in Wisconsin. The lots were as follows:

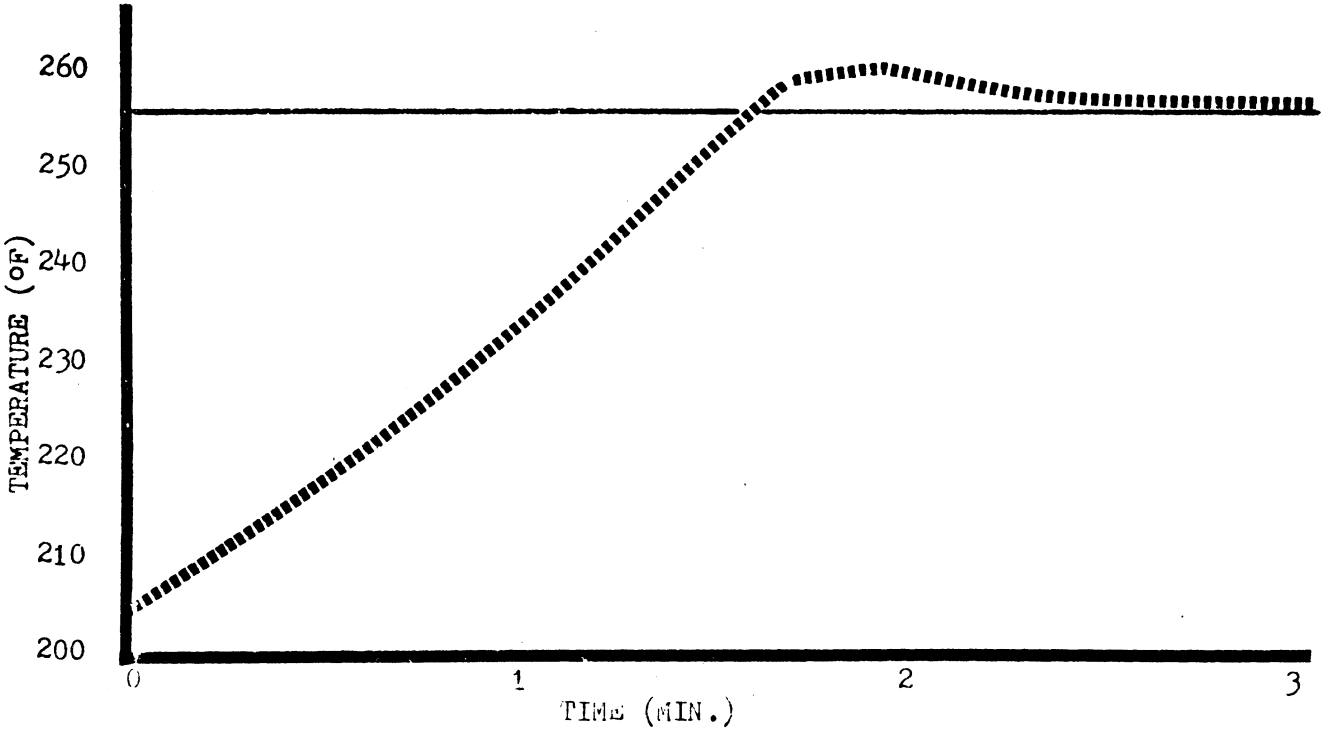

Fig. 1. Heat penetration curve for the flame sterilizer.

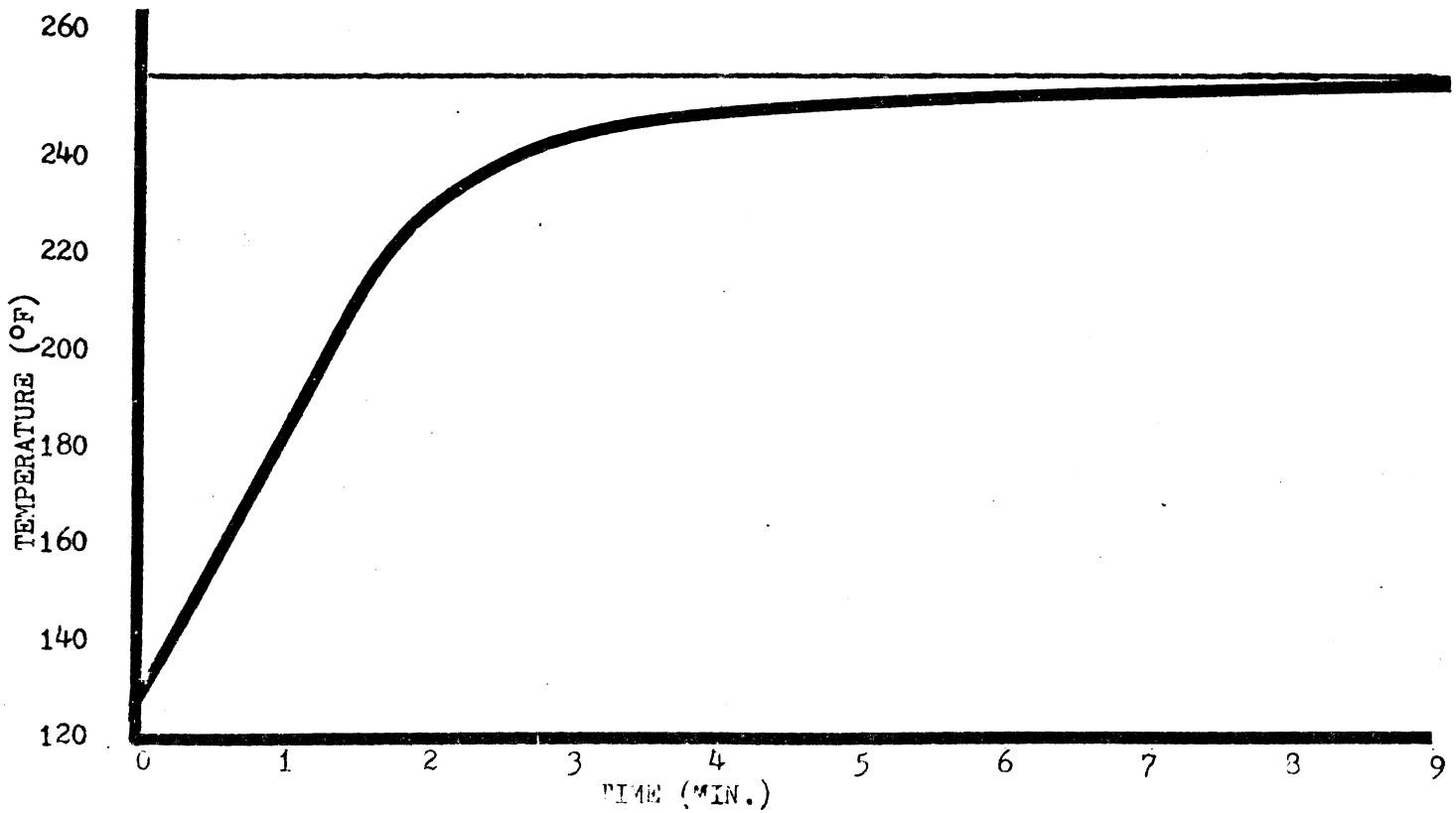

Fig. 2. Heat penetration curve for the still retort.

Lot	Sieve Size	Temperature of Hold (°F)	Time of Hold (min.)
A	2	255	5
B	2	255	9
C	3	255	5
D	3	255	9
E	4	255	5
F	4	255	9
G	3	260	5
H	3	260	9

The cans were taken from the commercial line after closure but prior to processing and then processed on the flame sterilizer. The cans were preheated for 4 minutes at 40 rpm to 200°F. They were held on the first burner for 120 seconds for the 255°F processes and for 135 seconds for the 260°F processes. The hold time was either 5 or 9 minutes which resulted in F_o values of 9.5 or 17.1 for the 255°F processes and F_o values of 18.0 or 32.3 for the 260°F processes. The burner gauge settings were as follows:

	#1 burner	#2 burner	#3 burner
Gas pressure	6.7	4.0	4.0
Gas flow rate	13.0	2.5	2.5

Commercial samples were pulled after processing for 25 minutes in the rotary retort cooker at a retort temperature of 255°F. This time reportedly gave 12½ minutes at 255°F. These samples were compared to the flame sterilized samples to determine if there was any difference in quality.

The samples were stored at room temperature (68°F) for six months and then the cans were opened and the peas were evaluated for color and maturity and the brine for clarity. There was no visual color difference between the commercially processed samples and the flame sterilized samples.

The peas were evaluated for maturity using the procedures established in the FDA standards of quality by determining the alcohol-insoluble solids. There was found to be no difference between the peas processed either on the flame sterilizer or in the rotary retort.

The brine was evaluated for clarity using a spectronic 20 spectrophotometer for reading light transmittance. The light readings were taken at 640 nm as the % change in transmittance before and after a 15 minute settling period. These data indicate the amount of suspended solids in the brine which will settle out and the data show that there is no distinct difference between the pea brines from the two processes. The pea brines were dried to determine the solids content. There was less than 1% difference between flame sterilized pea lots and rotary retorted pea lots except for Lot A (flame sterilized peas approximately 3% less) and Lot B (flame sterilized peas approximately 3% more) again indicating no distinct difference between the two processes.

A microbial analysis was conducted for indication of the presence of aerobic and anaerobic organisms. One can which was known to have been underprocessed was also analyzed for presence of organisms. The only indication of growth was in those media tubes which had been inoculated with brine from the underprocessed can.

FLAME STERILIZATION OF OTHER CANNED PRODUCTS

by

John Mount and W. A. Gould

This study was for the purpose of determining if the quality of several different vegetables varied between cans which were processed on a flame sterilizer and cans processed in a rotary retort.

Diced Carrots

A lot of 24 cans was flame sterilized on the pilot plant model flame sterilizer in a Wisconsin plant. Diced, blanched carrots (3/8 x 3/8 x 3/4" dice) were separated by hand from mixed potatoes and carrots and filled into 303 x 406, C-enamel cans by hand to a fill weight of 11 oz. The carrots were then covered with hot water. The cans were closed and preheated for 3 min. 30 sec. in the pilot plant model preheater. The cans were then flame sterilized with the following process:

257°F process	#1 burner	#2 burner	#3 burner
Gas pressure	6.7	4.2	3.6
Gas flow rate	12.7	3.0	2.8
Time over burner	110 sec	59 sec	58 sec

This process gives a sterilizing value of an $F_0 = 5.4$ and was intended to duplicate the commercial process given to sliced and diced carrots. The rotation rate of the cans of carrots on the flame sterilizer was 40 rpm.

The commercial process calls for an unlimited fill weight, ¼" head space, 100°F fill temperature and a drained weight of 10.5 oz. There were no commercial samples available from the processing plant.

The color and texture of the flame sterilized carrots were found to be very acceptable with a bright orange color and firm texture.

The drained weight of the flame sterilized carrots was 11.25 oz from a fill weight of 11 oz $\pm$ ½ oz. This is a very good drained weight since the processor figures a weight loss of greater than 3%.

Mixed Vegetables

Raw carrots, potatoes, and corn were blanched along with previously frozen peas, green beans and celery. These were mixed together before filling into 303 x 406 cans with the aid of a Solbern filler to 11.2 oz, hot water added and closed without steam. A small amount of saturated salt brine was added to each can prior to filling. The lot of 20 cans were taken from the commercial line in the Wisconsin plant prior to processing and steam preheated for 3 min at 27 rpm. They were processed on the pilot model flame sterilizer as follows:

258°F process	#1 burner	#2 burner	#3 burner
Gas pressure	6.6	3.8	4.1
Gas flow rate	12.7	2.75	2.75
Time over burner	114 sec	96 sec	95 sec

This process gives a sterilizing value, F_o = 7.8 and was intended to duplicate the commercial process.

Commercial samples were removed from the line after processing and compared to the flame sterilized product after 10 months storage. The flame sterilized mixed vegetables compared favorably to the commercial samples with the color of the carrots bright orange and the potatoes whiter and the texture of the vegetables firmer. The drained weight of the flame sterilized cans was 11.4 oz compared to 11.2 oz for the commercial samples.

Red Beets

Three lots of beets were processed on the flame sterilizer in the Wisconsin plant. One lot of whole red beets, 12 cans, and two lots of sliced red beets, 12 cans each. The cans were taken from the commercial line prior to processing and placed on the single-can simulator flame sterilizer with the can rotation at 60 rpm over the single burner. The burner settings were a gas pressure of 7.0 psi and gas flow rate of 12.0 units. The initial temperatures for both lots of sliced beets was 149°F and the cans were held on the burner for 225 sec at which time the temperature was 255°F. The temperature was retained there for 230 sec. The cans were then cooled in a water spray to 100°F. The F_o for this process is 7.3. The initial temperature for the lot of whole beets was 144°F and these cans were held on the burner for 235 sec to achieve an internal temperature of 253°F and held there for 230 sec with a resulting F_o = 7.3.

Commercial samples were taken after processing and compared to the flame sterilized samples after 6 months storage. The color of the flame sterilized beets was bright red (Table 1) and the brine from the beets when read on the Spectronic 20 for % transmittance at 530 nm showed a significant difference at the 1% level of significan.

Table 1 - % Light Transmittance @ 530 nm for Sliced and Whole Beets

Style	Process	% Transmittance
Sliced	Flame sterilized	38.5
Sliced	Rotary retorted	47.6
Whole	Flame sterilized	23.2
Whole	Rotary retorted	29.6

The drained weight of the flame sterilized beets was 10.5 ounces compared to 10.3 for the commercial processed beets. This is not a significant difference at the 5% level of significance.

Potatoes

Whole white potatoes were processed on the flame sterilizer in Wisconsin. One lot of 20 cans at 250°F and one lot of 15 cans at 255°F. The potatoes were one to two inches in diameter, peeled and filled with the Solbern filler and then covered with a brine and closed. Cans were pulled prior to processing and placed on the single burner of the single-can simulator flame sterilizer for 195 seconds for the 250°F process and 202 seconds for the 255°F process. The temperature was then held at 250°F for 410 seconds or at 255°F for 210 seconds. These processes had an $F_0 = 6.8$. The burner gauge settings were a gas pressure of 7.0 psi and a gas flow rate of 12.0 units. The can was rotated at 60 rpm over the burner.

Commercial samples were taken after processing and compared to the flame sterilized potatoes after 6 months storage at 68°F. The flame sterilized potatoes were firmer than the rotary retorted potatoes and had similar color as the commercial sample except for 2 samples at 250°F and 1 sample at 255°F which had several burned potatoes in each can. The potatoes were scorched on the surface where they had pressed against the can wall and not been able to revolve because they were packed too tightly into the can. For flame sterilized whole potatoes the fill weight would possibly have to be reduced to avoid this problem.

The drained weight for the flame sterilized potatoes at 250°F was 12.0 ounces and at 255°F was 12.4 ounces compared to 12.0 ounces for the commercial potatoes. There was no significant difference.

Summary

It is evident that products such as carrots, mixed vegetables and red beets can be flame sterilized with resulting products which have excellent quality. The color and texture of the flame sterilized products are equal to or superior to rotary retorted products.

DETERMINATION OF FACTORS AFFECTING HEAT PENETRATION IN FLAME STERILIZED CANNED WHOLE KERNEL SWEET CORN

by

R. Joseph and W. A. Gould

The flame sterilization project was undertaken because of the potential applications for processing fruits and vegetables in sirup or brine. The principle of flame sterilization is that heat is applied by direct flame contact on the surface of the rotating cans. The large temperature differential between the flame at 1800-2400°F when combined with agitation of the contents, results in a heating curve that is nearly a straight-line with a steep slope on arithmetic graph paper. A laboratory model flame sterilizer, manufactured by Filper Corporation was used for the experimental work for these projects. A sketch of the pilot model flame sterilizer is shown in Figure 1.

This study was undertaken to determine the factors which affect the heat penetration rate of a can of food packed in brine and then standardizing as many of those factors as possible for future studies of canned foods being processed on the flame sterilizer.

Preparation for Processing

Commercially frozen whole kernel corn, tempered in 45°F storage, was further prepared in one of the following ways prior to thermal processing:

1. Hot brine after filling
2. Steam blanch for ½ min and hot brine
3. Steam blanch, hot brine, and exhaust
4. Steam blanch, hot brine, exhaust, and steam-flow closure.

For steam blanching, the tempered corn was spread in a 3/4 to 1 inch layer in a metal wire tray and exposed to free-flowing steam at 212°F for 30 sec. Twelve ounces of the product were filled into standard weight (75 lb) 303 x 406 C-enamel cans. A 30-grain sodium chloride tablet was added, and the cans were filled with hot water at or near 212°F. Exhaust of specified lots was accomplished by 4 min. exposure of the filled cans to atmospheric steam in an A. K. Robbins exhaust box. The headspace was adjusted to either 3/16 or 3/8 inch prior to closure on an American Can Company Model 006 can seamer. Steam-flow closure at 15 psi was used for certain lots.

Heat penetration data were collected for each of the lots by using Ecklund copper-constantan thermocouples inserted in the cans of corn into the geometric center of the cans. The thermocouple was connected to a continuous recording potentiometer to allow for continuous monitoring of can center temperature. The "skin" temperature of the cans was also taken periodically using a pyrometer.

For one lot of corn, a pilot model steam preheater (Figure 2) manufactured by the Filper Corporation, in which the cans were agitated in an atmospheric

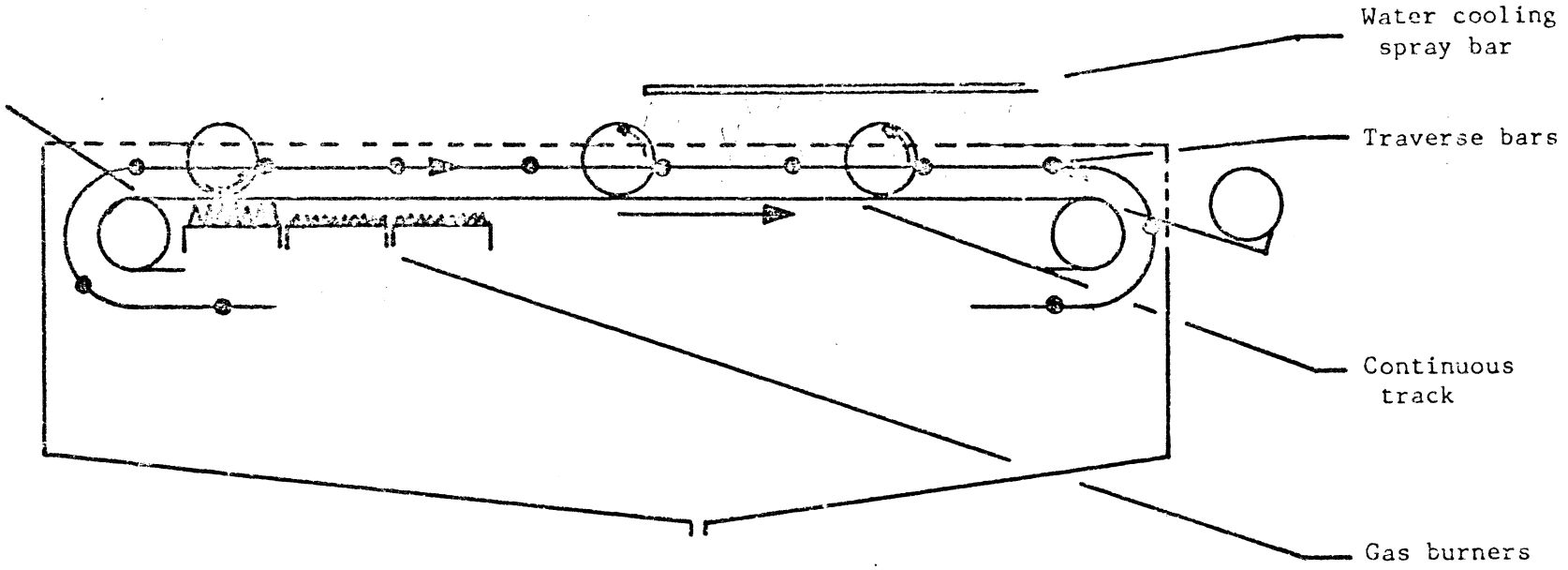

Fig. 1 Sketch of pilot model flame sterilizer.

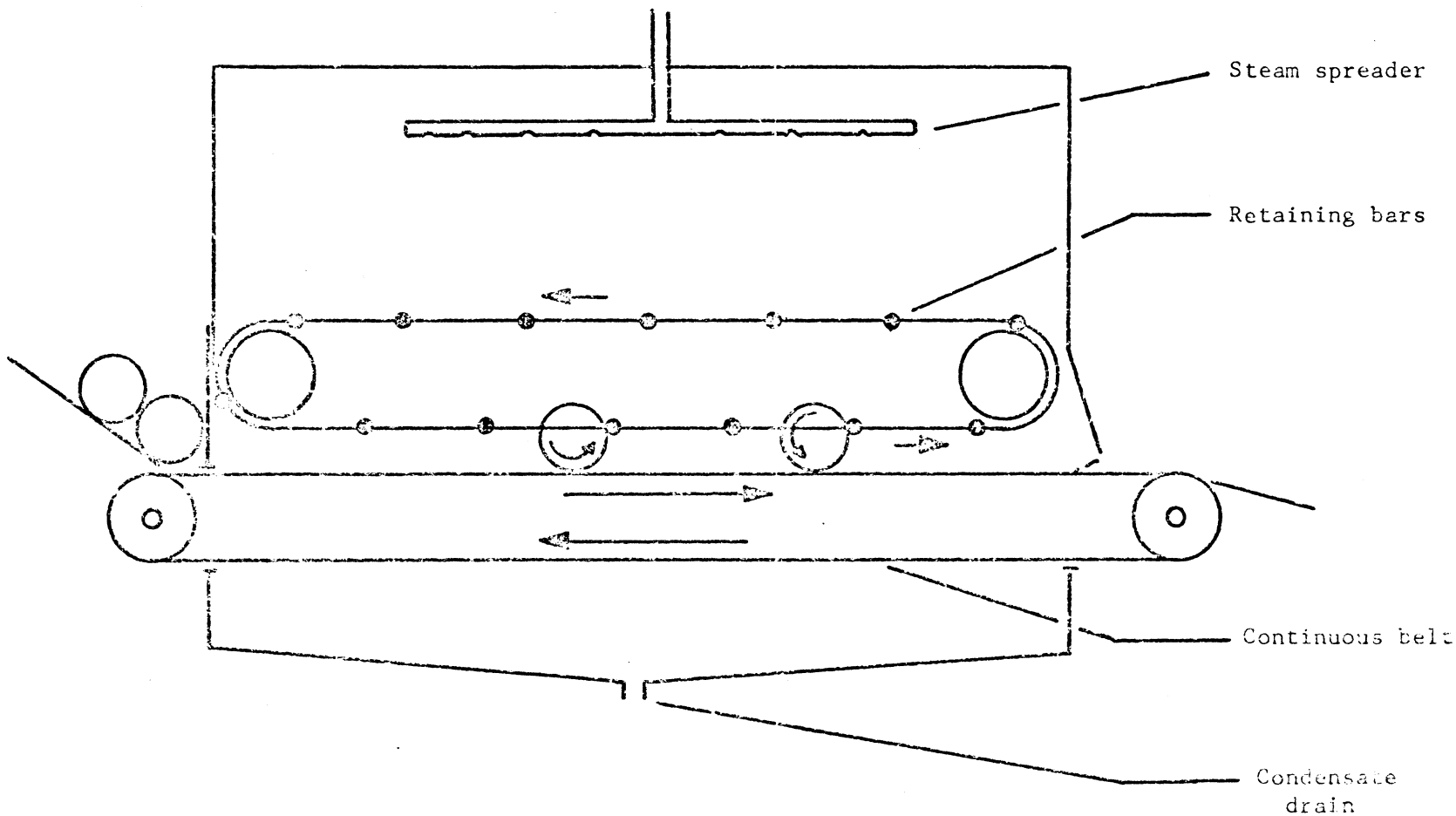

Fig. 2 Sketch of the pilot model steam preheater.

chamber, was used to bring the cans to a temperature of 194°-198°F.

Processing

The different lots were processed with the following variables:

Can rotation rate from 60 rpm to 80 rpm
Process time (time to reach process temperature) from 2½ min to 3½ min.

The heat penetration data were recorded and analyzed in Table 1 for the different process lots. The analysis of the data indicates that the variation given to the different lots did not have a significant influence on the heat penetration rate. The variations are shown to have an effect on the vacuum, the temperature at which cans of whole kernel corn start to buckle and the % of buckled cans as shown in Table 2.

Can Rotation Rate

The influence of the rotation rate of a can of whole kernel corn being processed on a flame sterilizer, on the heat penetration rate was evaluated by varying the rotation rate for different lots of cans being processed at the same flame settings. The burner gauges were set at 7.1 psi gas pressure and 13.9 units flow rate. The can rotation rates were adjusted to 40, 55, 60, or 80 rpm. The can was set to move over the flame in 160 seconds. The data resulting from these tests produced the straight line heating curves as shown in Figure 3.

In order to observe the effects of container rotation rate on the agitation of the product, a glass container of dimensions similar to the 303 x 406 can was filled with blanched, hot, whole kernel corn and topped with hot water at 212°F. Excess water was drained to allow ¼, ½, or 3/4 inch headspace. These glass containers were rotated about the longitudinal axis at 40, 50, 60, 80, and 100 rpm on the moving track of pilot model flame sterilizer. Position of the headspace bubble was photographed and diagrams of those photos are shown in Figure 4.

Sterilizing Values

The sterilizing value of that section of the flame processing curve when the product is at the specified processing temperature can easily be calculated by the formula

(Sterilizing value at T) x (time at T)

This portion of the curve will also produce the greatest portion of the sterilizing value because of rapid heat penetration rate. The contribution of the heating and cooling portions of the flame processing curve are, however, of some importance and interest. The straight line nature of the heating and cooling curves, when plotted on coordinate paper, and the lack of a figure comparable to a retort temperature do not lend flame processing heat penetration curves to analysis by nomogram or formula methods. A computer program was therefore

TABLE 1. Analysis of heating curve slopes for flame processed whole kernel corn samples receiving several pre-processing treatments

Lot Number	1	2	3	4	5	
Can rotation rate (rpm)	60	60	60	80	80	
Headspace (in)	3/16	3/16	3/8	3/16	3/16	
Process time (min)	2½	3½	2½	2½	3½	
Pre-sterilization Treatment	^{o}F/min					$\bar{x}$
Hot brine	27	30	31	37	28	30.6
Blanch-hot brine	28	29	31	27	30	29.0
Blanch-hot brine-exhaust	20	43	40	40	40	27.0
Blanch-hot brine-exhaust-steam flow close	30	24	30	25	26	36.6
$\bar{x}$	26.5	31.5	33.0	32.2	31.0	

Analysis of Variance

Source of Variation	d.f.	Sum of Squares	Mean Square	F	$F_{.05}$
Treatments	3	256.8	85.1	3.01	n.s.
Lots	4	112.7	28.2	0.99	n.s.
Error	12	341.7	28.5		
Total	19	711.2			

TABLE 2. Internal can temperature and vacuum vs. occurrence of buckling in 303 x 406 cans of W K corn[a]

Treatment	Close T (°F)	Vacuum (in) Mean	Vacuum (in) Range	Buckle T[b] (°F)	Per Cent Buckled Cans
Blanch-hot brine-exhaust-steam-flow closure	185-196	16.0	12-20	263-277	5.45
Blanch-hot brine-exhaust	187-194	15.7	13.5-18	260	2.08
Blanch-hot brine	138-169	9.3	5-13	262	2.13
Hot brine	92-120	3.9	0- 8	244-265	25.45

[a]12-oz fill, 9/32 in headspace.

[b]Temperature measured by pyrometer at the point in the process when buckling occurred.

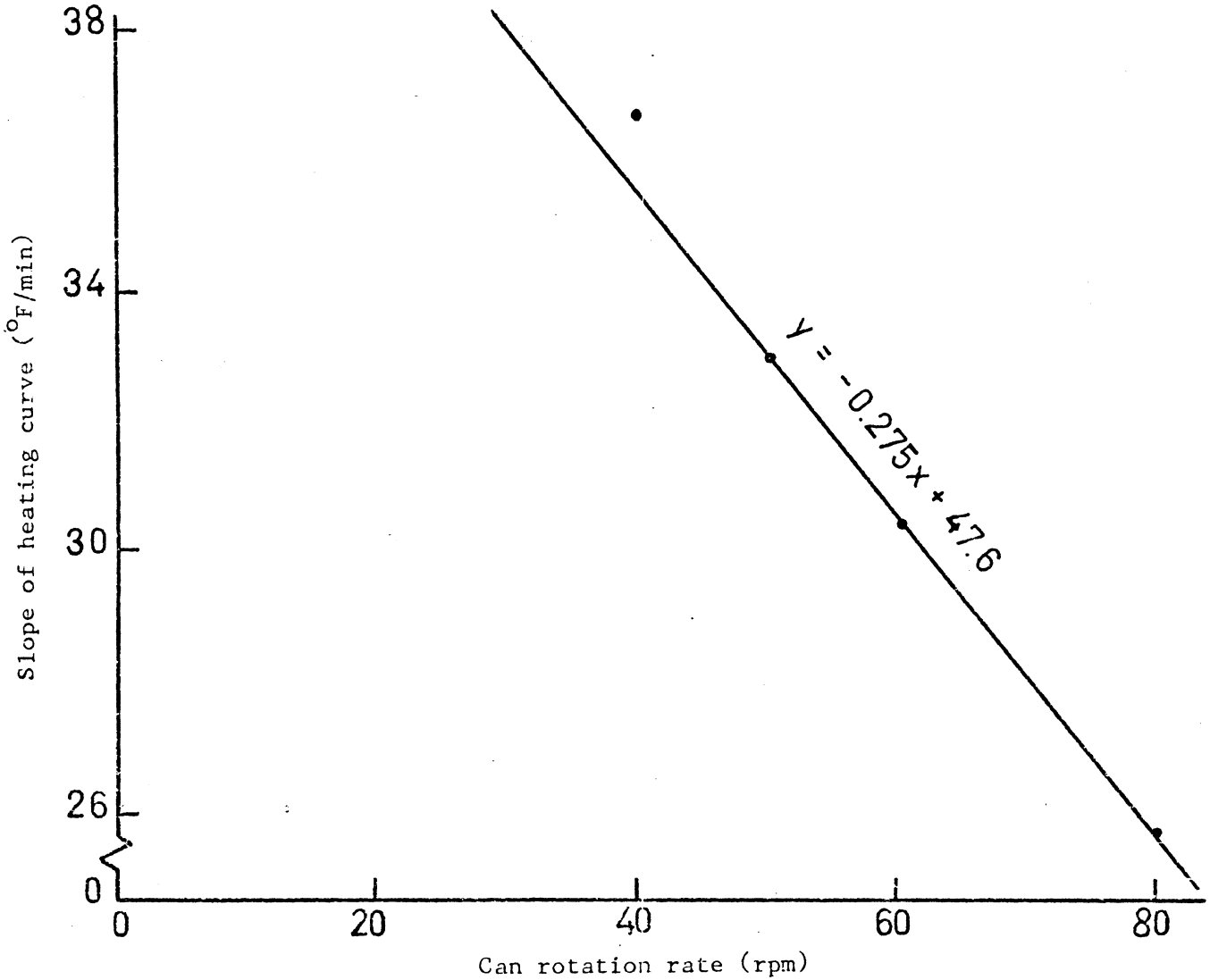

Fig. 3. Heat penetration curve slopes for flame processed whole kernel corn samples at several rotation rates.

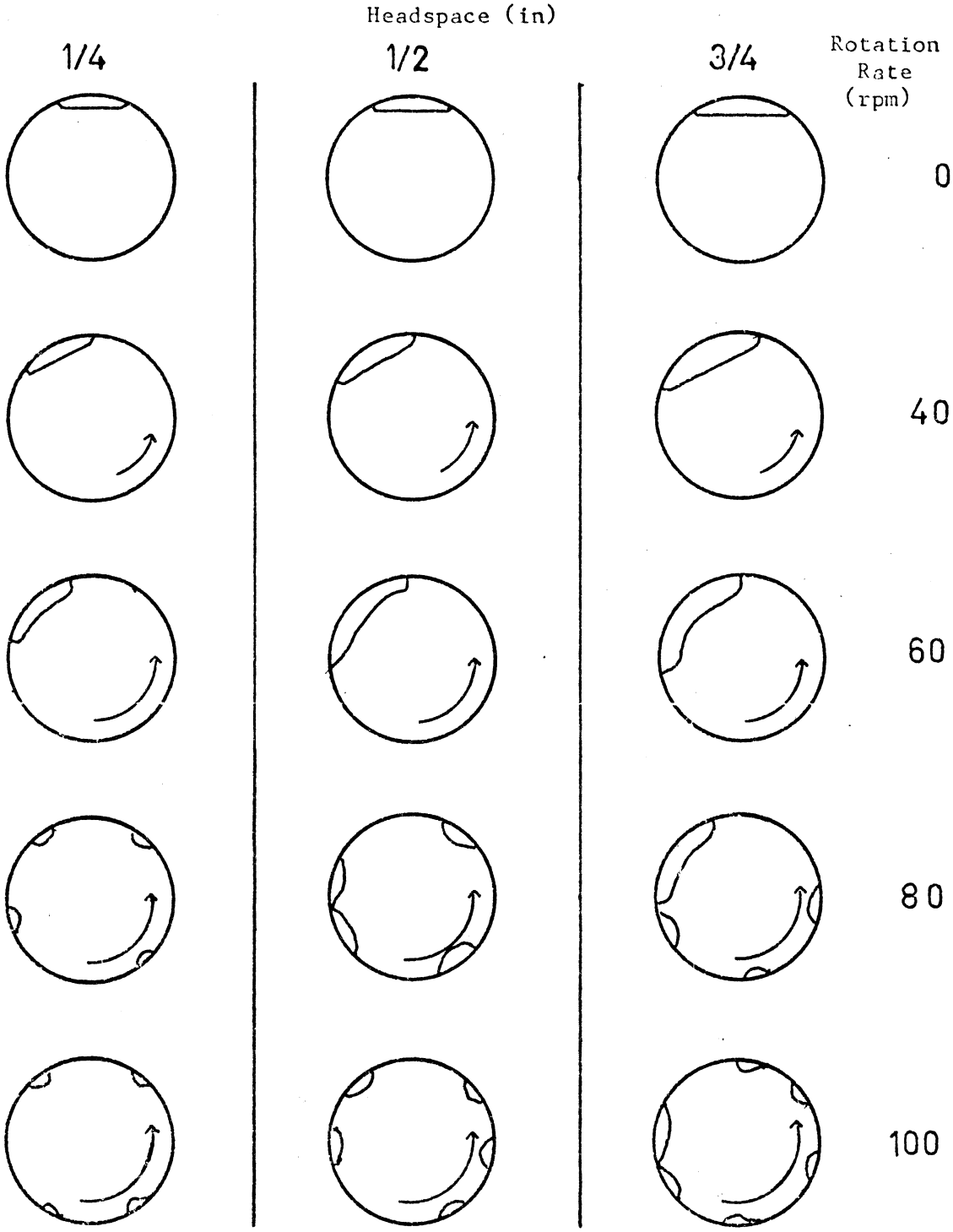

Fig. 4. End view of container illustrating the position of the headspace bubble in 303 x 406 containers of whole kernel corn.

designed to calculate sterilization values by the general method of Bigelow. The contributions of straight line heating and cooling portions of the process curve to total process lethality are presented in Table 3.

Table 3. CALCULATIONS OF STERILIZING VALUES CONTRIBUTED BY HEATING AND COOLING CURVES FOR FLAME STERILIZED PRODUCTS[a,b]

Heating Curve Slope (°F/min)	Final Temperature (°F)				
	240	245	250	255	260
20	.11	.21	.39	.74	1.40
25	.08	.16	.31	.59	1.12
30	.07	.14	.26	.49	.93
35	.06	.12	.22	.42	.80
40	.05	.10	.19	.37	.70
45	.05	.09	.17	.33	.62
50	.04	.08	.16	.29	.56

[a]For straight-line heating and cooling curves, IT = 200°F; z = 18.
[b]Cooling curve contribution to sterilization is found by using the absolute value of the cooling curve slope.

Geotrichum candidum:
The new FDA indicator of plant sanitation For the food processing industry

by

J. G. Fox and W. A. Gould

Introduction

For nearly fifty years, the Food and Drug Administration has been warning the industry about machinery mold. Beginning with B.J. Howard in 1917, who emphasized that laboratory methods were needed for law enforcement and that machinery mold buildup was an indication of faulty equipment design and inadequate cleaning systems. Again in 1947, Wildman and Clark, both from the Food and Drug Administration, indicated that machinery mold was still a problem in tomato processing plants. They listed twelve different areas in processing plants where machinery mold was encountered including conveyor belts, guide rails, peeling tables, wash tanks, and even the insides of piping. They further developed a method of determining the amount of mold in the finished product. Finally, in the 1970's the Food and Drug Administration adopted a method developed by Cichowicz and Eisenberg, both of the Food and Drug Administration, as official first action for all canned fruits without being masked by large amounts of plant tissue. This action takes place under the auspices of the Good Manufacturing Practices (Part 128 of the Food and Drug Act).

Through the years, this mold has been referred to as Oospora lactis, Oidium lactis, Geotrichum lactis, Geotrichum candidum, and machinery mold. Presently, Geotrichum candidum and machinery mold are the accepted terms most commonly used.

Geotrichum mold is a yeast like fungi that may enter the processing plant with the product even though the raw product condition has not been directly related to machinery mold build-up. It produces various colors but is usually white or gray. It grows over a wide pH range like many fungi, produces septate mycelium and regularly forms arthrospores. This mold will grow partially submerged under liquid and will attach itself to wood, rubber, metal, and concrete. It has a slimy appearance and feel and commonly has a peculiar fetid odor that can be readily detected.

Like all microorganisms, this mold requires a suitable food supply, moisture, and a certain amount of heat. Most tomato processing plants supply food to the organism from broken fruit and fruit deposits on machinery. Water is plentiful and the organism grows well at room temperatures. Specifically, it has been determined that the organism will germinate and grow well in a temperature range of 59 to 108°F.

Methods of Analysis

The official first action method for determining Geotrichum mold in canned vegetables and fruits is very involved and requires equipment not readily found in many tomato processing quality control labs. Basically, the process involves

draining the juice from the contents of the container through a No. 8 sieve. The residue is discarded while the liquid and washings are drained through a No. 16 sieve and drained through a No. 230 sieve with the residue being collected, washed, diluted, and stained. Four 0.5 ml samples are placed on rot fragment slides and all recognizable machinery mold having three or more characteristic hyphael branches are counted. The count obtained is used to determine the number of mold pieces per 500 grams of finished product.

According to the Department of Food Science and Technology at the Oregon State University:

> "Federal and state inspectors say that they are only using machinery mold counts as an "objective" measure of plant conditions which they consider need a higher degree of sanitation. Thus, when in the opinion of the inspector, processing lines are not properly cleaned, not cleaned with sufficient frequency, or if there are violations of the Good Manufacturing Practices that the inspector thinks should be corrected, he may proceed to get machinery mold counts to back up his opinions. He may bring one of the Food and Drug Administration's mobile labs with him and have machinery mold counts within an hour or two after taking samples."

This becomes especially significant when one realizes that given the opportunity mold will grow on any equipment that contains food deposits. Olsen from the National Canners Association, Western Research Laboratory, reports that one part per million of such deposits into a can of product resulted by actual test in machinery mold counts of more than 400.

Since the food and Drug Administration has yet to establish levels of machinery mold counts were a product will be considered contaminated, the food processor must develop sanitation programs that will prevent the mold from growing on the machinery where it may contaminate the finished product.

Progress and Research

A study was conducted to first develop a method for determining the severity of the problem in processing plants. Secondly, alternate methods of preventing and/or destroying the organism both during operation and clean-up, instead of the traditional procedure of physically scrubbing the organism off the machinery.

The first step in solving any specific problem is identifying the location and severity of that problem. Once these critical control points have been established, regular inspections by the quality control personnel can locate potential trouble spots. A requirement that was established for the method to determine mold counts on machinery was that it be relatively simple and quick for the quality control personnel to perform. A swab technique was combined with the staining and counting method of the official Food and Drug Administration method for determining machinery mold counts in vegetable and fruit products. The sampler swabs an established area of equipment surface, one square inch or 6.45 square cm, after which he places the swab into a 10 ml sterile dilutent that contains 5 ml sterile water, 5 ml stabilizer solution (0.5% sodium carboxymethyl cellulose), and 2 drops saturated crystal violet. Four 0.5 ml

samples are pipetted onto rot fragment slides and all Geotrichum mold pieces are counted using the same requirements for identification as the official method at 30-45X. The total count for the four slides is then used to determine the total number of mycelial pieces per square inch or cm of surface area. For ease and accuracy in counting, it was found that diluting the sample was sometimes necessary when more than fifty mycelial pieces were counted on one slide. Also, where heavy growth was reported, the swab was replaced by a scalpel to scrape the mold off the machinery, ensuring a complete sweeping of equipment surface area.

During the 1975 tomato processing season, two processing plants were visited weekly in order to test the method and to ascertain whether a constant growth rate could be established for the mold on machinery.

The two processing plants were chosen on the basis of differences in production levels and unit operations. Flume systems, conveyor belts, equipment framework, and wash tanks were evaluated for machinery mold growth. While Geotrichum mold growth was found on all these pieces of equipment, the rate of growth fluctuated weekly and was unequal between different locations within the same plant. However, it was found that when the mold became easily visible to the naked eye, a growth level of approximately 15,000 mycelial pieces per square inch was present on the machinery surface.

A good quality control program however, requires more than just locating the critical control points and keeping records of samples taken from the machinery surface. Therefore, a study was undertaken to determine different means of stopping the growth of the organism, that is, remove the food source, remove moisture, adjust environmental temperature, and/or the use of anti-mycotic agents.

The first method, removing nutrient supply, entails stopping production, more frequent clean-ups, or equipment designed that does not allow food deposits to accumulate and equipment that is easy to reach during clean-ups. However, none of these methods alone are practical to the processor even with better equipment design because some food deposits will occur, especially in flume systems and soak tanks.

The second method, removal of moisture, is completely unreliable at this time considering the present methods of processing tomatoes. Water is easily available to machinery in most areas of a processing plant where machinery mold is generally found.

The third method, adjusting temperature, shows potential due to the inability of the mold to germinate and grow at temperatures above 108 degrees F. Machinery such as flumes, washing and soaking tanks could be heated by placing steam coils in the bottom of them and the mold would not be capable of growing. However, due to the cost of energy today to processors, this would make the recycling of water within a processing plant even more important. This also would be of assistance in lowering the Drosophila egg and larvae count in the tomatoes as was demonstrated by Gould and Geisman.

The fourth method of preventing growth, anti-mycotic agents, was shown to be effective against slime build-up by Somers when water was chlorinated at a level

of 5 parts per million free residual. At this level, slime build-up was prevented, no off-flavor was imparted to the fruit and no increased corrosion was attributed. The effect of chlorine upon the Geotrichum mold was verified in the Food Processing and Technology laboratory at the Ohio State University with no mold surviving 5 parts per million free residual chlorine for 10 minutes. (See Table 1). This means that in areas where elevated water temperatures are impractical, chlorination can be used to prevent slime build-up. Areas such as flumes, wash tanks, sorting and trim tables could either contain or be sprayed with chlorinated water.

Even with all these precautions, some machinery mold might build up in areas missed by the preceeding actions. For this reason, a study was undertaken to establish the "F" value of the mold at different temperatures so that the processor could completely destroy it during clean-ups. The data indicate that the application of hot water at 200^{o}F will kill 100,000 organisms in 0.36 seconds. Also, by following the data a processor can determine the "kill" time required to destroy the organism at other temperatures below boiling.

Table 1. EFFECT OF CHLORINE UPON Geotrichum candidum (CHLORINE EXPRESSED AS FREE RESIDUAL)

Concentration	Time (Minutes)* 1	2	5	10
Control	+	+	+	+
5 ppm	+	+	-	-
10 ppm	+	+	-	-
15 ppm	+	-	-	-
20 ppm	+	-	-	-

* (+) = Growth
(-) = No Growth

Table 2. NUMBER OF MYCELIAL FRAGMENTS/IN^2 ON DIFFERENT UNIT OPERATIONS

Time in Hours	Unit Operations* A	B	C	D	E	F
3	130	800	105	10	10	110
7	54,500	25,000	---	15	3,650	25
12	55,500	44,000	43,500	---	140,000	775

* A = inside of flumes
B = wood sides to conveyor
C = angle iron framework of inspection table
D = chopper
E = elevator coming out of receiving tank
F = conveyor rollers on inspection table

RECYCLING SPENT PICKLING BRINES

by

J. R. Geisman

Studies on brine recycling were continued to determine if there is a limit to the number times brine can be recycled. Concommitantly, the influence of repeated recycling on product quality was evaluated. Two Ohio pickle processors cooperated in these experiments.

Materials and Methods

Raw cucumbers were obtained from local suppliers at each location. The cukes were size graded and large sizes (#3) were used in the experiments. At one location the raw stock was washed prior to filling into the tanks. At the other cooperator, the cukes were not washed. Each processor's salting technique differed slightly, but if brine recycling is to be used successfully it must be adaptable to various locales and pickling operations. A lot was salted with "fresh" salt to serve as a control.

After curing, samples of the brines were taken for chemical analysis. The salt stock was physically examined for hollow pickles (bloaters).

An additional experiment was conducted to determine whether the readjustment of pH to the acid side (pH 5.7 and 4.6) would aid in reducing bloaters.

Results and Discussion

Examination for cure indicated that the cucumbers placed in recycled brine cured slightly faster than those in fresh brine. The amount of unusable fruit due to bloater formation was less for the recycled brine (35%) than for the fresh brine (46%). The firmness of the treatments was similar.

When the tanks, that had recycled brine with pH adjusted to 5.7 and 4.6 were examined, there was a slight increase in bloater formation in the more acid brine.

Also evaluated in these experiments were tanks that used brine from the fourth and fifth recycle. There was little difference in cure, bloater production or firmness in the multiple recycled brines as compared to fresh salt brine stock.

Conclusions

The principal conclusions drawn from these experiments were:

1. It appears that recycling has a slight influence on curing rate. The use of recycled brine produces completely cured stock in a shorter time than does fresh salt.
2. Adjustment of pH below 7.0 is not worth the extra expense of reagents used.

3. Recycled brine can be used with little affect on finished product quality.
4. Recycling can apparently be continued indefinitely with no adverse effects on quality.

Acknowledgments

The author wishes to express his appreciation for the cooperation of the H. J. Heinz Co. and the H. W. Madison Co. division of the J. M. Smucker Co. in this study.

USES FOR THE OUTER GREEN LEAVES OF CABBAGE

by

J. R. Geisman

It has been known that the darker green leaves on a head of cabbage cannot be fermented into sauerkraut. These leaves become brown during fermentation causing a serious deterioration of product quality from the unattractive color. This makes the outer leaves of cabbage a waste product in the manufacture of sauerkraut. It has been estimated that the amount of waste due to the outer leaves ranges from 25 to 40 per cent of the raw cabbage delivered to the plant. The processor, in the past, has hauled these waste leaves back to fields for land disposal. New regulations in many states combined with a decreasing amount of land available for this purpose has imposed serious limitations on handling the leaves.

This study was undertaken to develop alternatives to land disposal of the outer leaves. Alternatives which allow for recovery of these resources would hopefully change the cash flow from cost to return. It is readily apparent that each sauerkraut processing plant is not exactly the same as the next operation and therefore more than one solution should be found for the problem.

Several alternatives have been suggested and are summarized below:

1. Animal feed. Limited experiments indicate that the outer leaves could be fed to cattle. The economics of this alternative depend on locality. This material cannot be fed to dairy cattle since the sulfur bearing compounds become incorporated into the milk making it unacceptable to many people.

2. Human food. The use of cole slaw has increased in relation to the increase in fast food restaurants. Cole slaw utilizes a mixture of green and white leaves for appearance. With some sorting and cleaning, this market may have potential in certain areas.

3. Land disposal. Where land disposal is permitted and land is available, this provides a means of getting rid of the outer leaves. However, a careful study of the costs and benefits should be made since in most cases this alternative is carried out at the processors expense. The harvesting operation should be evaluated to reduce the amount of outer leaves hauled to the plant if possible.

While the foregoing may present an interim solution, they do not provide the most ideal means for handling the large volume of waste generated. It would seem that methods which utilize a portion or all of the leaves would provide a long term and economical answer. With this in mind research was undertaken to analyze the leaves and seek a means of utilizing the total head.

The cabbage plant contains a legion of chemicals which may be worth extracting. One such sompound is sinigrin, an ingredient in cosmetics. On the basis of laboratory experiments, it is feasible to extract sinigrin from the cabbage leaves. The solvent could be recovered and reused. On the basis of these experiments, a pilot scale evaluation should be conducted to determine the economics of the procedure and the minimum size of operation which would provide

a return to the processor.

As an alternative experiments were conducted on the feasibility of removing the pigment from the leaves. This would allow an increased recovery of product from the same amount of raw material. Potential increases of, at least, 30 per cent by weight could be obtained.

Ascorbic acid was mixed with shredded leaves at concentration of 1.0, 5.0 and 10.0% by weight. The mixture was placed in the dark. Theoretically, chlorophyll would be broken down through reactions with the ascorbic acid. This did occur but required the highest concentration (10%) to accomplish the bleaching of the shreds. At this concentration ascorbic acid would be too costly to use routinely for decolorizing the green leaves. However, it did lead to the conclusion that a less expensive agent could be found. Current investigations are underway to screen various "ripening" agents for the purpose of removing the color from the outer leaves. It is hoped that a suitable agent and a simplified technique for application and control of the process will be found in the near future.

THE DEVELOPMENT OF A FISH SPREAD BY THE UTILIZATION OF FRESHWATER DRUM FROM LAKE ERIE

by

J. D. Morgan and W. A. Gould

Introduction

Currently, the sea only produces approximately 2-3% of the calories consumed by mankind and as the population increases there will have to be more of a harvest of our underutilized fish species.

In Lake Erie, approximately forty per cent of the fish caught are returned to the lake. Most of the species being returned are gizzard, shad, carp, and freshwater drum (Aplodinotus grunniens).

The objective of this study was to develop a base spreadable fish spread to which different flavors could be added, utilizing freshwater drum from Lake Erie.

Materials and Methods

Freshwater drum used in this study were caught by Lake Erie commercial fishermen in the Western basin of Lake Erie. The fish were transported to the Ohio State University Pilot Plant by truck. The round fish were held on melting ice in cardboard containers.

The round fish were first sprayed with cold water to remove the excess slime. Then the fish were headed, gutted, and filleted by hand. The fillets were rinsed and allowed to drain of the excess water. Then, these fillets were packaged in aluminum foil at four pounds of fillets per package and frozen at -18°C.

To prepare the fish spread, frozen blocks of fillets were allowed to thaw until pliable and then placed in a Hobart silent meat cutter with the other constituents of the fish spread. The material was then cut for five minutes. The resulting mixture was placed in a pyrex dish (9x9x$\frac{1}{2}$) and covered with aluminum foil. The mixture was then steamed for 45 minutes (internal temperature 87°C).

Triangle taste panels were conducted on the various components making up the fish spread and also varying amounts of the components. Taste panels were also conducted on varying cutting times, as well as different flavors that were added to the fish spread. A hedonic taste panel was conducted to determine if frozen storage time of the fish fillets affected the color, flavor, and texture of fish spreads.

Taste panel scoring was from 0-10, zero being "off" and ten being "perfect". Taste panels were analyzed by the analysis of variance.

Results and Discussion

It was found that precooking the cut fish resulted in a product of good spreadability but the fish had an extreme weight loss. In a triangle taste panel the panelists did not significantly prefer spread made from "precooked" fish to fish spread made from fish not "precooked".

The best textured fish spread resulted from fish that was cut in the Hobart silent cutter longer than two minutes. In a taste panel the average texture score for fish spread made from fish cut for 4.5 minutes was 7.14 (good). Cutting more than 4.5 minutes did not result in an improved fish spread texture.

The data in Table 1 show the different amounts of the ingredients of the fish spread that were compared by triangle taste panels. Spices, lemon juice, sugar, and onions were eliminated from the spread because the spread was significantly preferred when these ingredients were at the 0.0 g amounts.

Table 1

Amounts of Ingredients Analysed (g)

Vegetable oil	0.0	35.0*	50.0	
Salt	0.0	10.0*	20.0	
Sugar	0.0*	5.0	25.0	
Xanthum gum	0.0	2.5*	10.0	
Starch	0.0	2.5	15.0*	
Onion	0.0*	10.0	20.0	
Pickle relish	0.0	100.0	200.0*	300.0
Ginger	0.0*	.1	.25	
White pepper	0.0*	.25	1.25	

* Amounts that were significantly preferred

Different flavors; worchester, chili, taco, and smoke were added to the base fish spread but data analysis showed no significant preference of one flavor over another. All added flavors resulted in fish spreads that received a "high fair" to "good" rating.

Analysis of hedonic taste panel data for effect of frozen storage time of the fish fillets versus the color, flavor, and texture of the fish spreads resulted in a significant flavor preference for spreads made from freshwater drum fillets frozen not more than one month. The spread made from fillets frozen for one month had a mean flavor of 9.0, whereas spread made from fillets stored frozen for six months gave a flavor score of 4.4. There was also a color preference for fish spread made from fillets frozen for only one month, which had a mean score of 9.0. Fish spread made from frozen fillets of 12 months storage had a mean color score of 7.8. Texture was not significantly affected by frozen storage time. Table 2 shows the final ingredients and amounts of freshwater drum fish spread based on taste panel data.

Table 2

Formulation of Base Fish Spread

Fish	908.0 g
Pickle relish	200.0 g
Vegetable oil	35.0 g
Food modified starch	15.0 g
Salt	10.0 g
Xanthum gum	2.5 g
Carboxy methyl cellulose	2.5 g
Tripolyphosphate	1.6 g

Summary

Freshwater drum can be made into a spreadable product which results in good texture with a good color. Many different flavors can be added to the spread for preference variation according to the manufacturers taste. The formulation of the fish spread results in a product of good spreadability which can be used on crackers as a snack or on bread as a sandwich.

DEVELOPMENT OF A SAUSAGE PRODUCT FROM LAKE ERIE FRESHWATER DRUM

by

S. Hauck and W. A. Gould

Introduction

The development of a sausage product utilizing freshwater drum may also provide a new outlet for the large amounts of freshwater drum available in Lake Erie.

Materials and Methods

Freshwater drum were purchased from commercial outlets near Lake Erie. Fish were purchased in filleted and/or round form. Round and/or filleted fish were reduced to boneless, skinless flesh by technologists at the Ohio State University Food Processing Pilot Plant. Fillets were then frozen at -18°C for further product development work.

General procedure for freshwater drum sausage was to initially coarse grind fresh or thawed fillets which was then agitated in ice water for 15 minutes. This washed flesh was then drained back to its original weight, placed in a Hobart Silent Cutter with other ingredients and chopped for 5 to 7 minutes. The mixture was stuffed into casing and cooked to an internal temperature of 155°F.

Tomato paste (yielding red color), spices common to emulsion products, and additives for texture or flavor were varied to determine optimums for the various ingredients.

Evaluation was by hedonic scoring, and triangular taste panels, with applicable data subjected to analysis of variance.

Results and Discussion

Analysis of taste panel data showed that 12.5% (based on total weight) tomato paste was preferred. Data also indicated that texture as influenced by "skin" formation was improved by cooking the sausage in steam as opposed to dry oven cooking. Sodium tripolyphosphate (TPP) used to alter internal texture and water retention properties was found to function best when added to the mixture at a minimum level of 0.33%. Based on results of taste panel data the formulation as presented in Table 1 is recommended for manufacture of a fish sausage product.

Table 1

Basic Freshwater Drum Sausage Formulation

Ingredient	Percent (of total weight)
Freshwater drum fillets	85.00
Tomato Paste	12.13
Salt	1.50
Sugar	0.37
Sodium tripolyphosphate	0.25
Smoke, liquid	0.22
Pepper	0.18
Coriander, ground	0.12
Mace, ground	0.09
Sage, ground	0.05
Nutmeg, ground	0.05
Sodium Nitrite	0.02

UTILIZATION OF LAKE ERIE FRESHWATER DRUM FOR FISH STICKS

by

W. Stone and W. A. Gould

Introduction

At the present time, very large amounts of freshwater drum are caught by commercial fishermen, however, a smaller quantity is actually landed due to a relatively limited fresh market. Freshwater drum generally have been considered a low value fish and underutilized.

Materials and Methods

Freshwater drum were purchased from commercial outlets near Lake Erie in either round or filleted form and transported on ice to the Ohio State University Food Processing Pilot Plant in Columbus, Ohio. The drum were then reduced to boneless, skinless fillets, rinsed in cold water, and frozen at -18°C for later use in fish stick development.

Fillets were thawed for use in fish stick development. Fillets were chopped approximately 20 seconds in a Hobart Silent Cutter and mixed with 0, 5, 10, 15, 20, 30, 40, and 45 percent mashed potato (% of total mixture weight), placed in forms, frozen, cut into fish stick sizes, battered and breaded and prefried 1 minute at 385°F. Fish sticks were then refrozen. Preparation for taste panels was by heating for 15 minutes @ 400°F in a conventional oven.

After optimum potato content was determined, 0, 1, 2, 3 percent onion was added to intensify flavor.

All formula variations were subjected to taste panels, followed by statistical analyses of data.

Results and Discussion

Analysis of taste panel data showed members preferred fish sticks containing 10-20% potato. Data also showed that panel members preferred 3.0% onion in fish sticks to other levels evaluated.

Freshwater drum fish sticks (84% drum, 15% potato, 1% salt and 81% drum, 15% potato, 3.0% onion and 1% salt) were evaluated by taste panel with five commercially available fish sticks, some made from minced fish and some of filleted fish. See Table 1.

As can be seen from the data in Table 1, the freshwater drum fish sticks compared very favorably to the commercial samples, scoring as high or higher than the commercial fish sticks. The 15.0% added potato appeared to have its greatest effects on texture and secondly on flavor.

Table 1

Results of Taste Pan Evaluation
Of Freshwater Drum Fish Sticks and
Several Commercial Products

Fish Stick	Mean Scores		
	Flavor	Texture	Odor
X commerical	5.5	6.2	7.1
N 15% potato	$8.1_{xx'yz}$	$8.4_{xx'yvwz}$	7.9
X' commercial	5.2	5.3	7.1
Y commercial	4.4	4.9	7.0
V commercial	5.9_{z}	6.0	8.2
W commercial	$7.2_{xx'yz}$	4.9	8.2
U 3% onion, 15% potato	$7.0_{x'yz}$	$8.2_{xx'yvwz}$	8.5_{y}
Z commercial	4.2	5.6	7.2

Subscripts indicate significant differences between means at the 5% level.

ACIDIFICATION AND THERMAL PROCESSING OF TRIPOLYPHOSPHATE TREATED FRESHWATER DRUM FILLETS

by

T. F. Chin and W. A. Gould

Introduction

Studies were conducted to develop an acidified thermally processed convection pack of freshwater drum fillets treated with tripolyphosphate (TPP). If drum flesh could be acidified and packed in a similarly acidic medium such as tomato sauce, the resulting product could meet the definition of a high acid food as defined by the Food and Drug Administration.

From a processing standpoint, the advantage of a high acid food is the low severity of the thermal process thereby maintaining the product quality. Typical processing times and temperatures for low acid foods like fish are from 60 to more than 120 minutes, depending on the style of pack, at 122°C (252°F). For a convection type product, $F_{250}^{18} = 4$ minutes is considered a minimum to safeguard against Clostridium botulinum (1).

The recommended sterilizing value against butyric acid anaerobes is $F_{250}^{15} = 0.7$ at pH 4.5 (2).

Materials and Methods

Freshwater drum were landed by commercial fishermen during April 1975 and filleted by Ohio State University personnel. Half of the fillets received a 12.5% TPP dip treatment for 3 minutes to decrease cook drip and thaw drip losses. Samples were removed from storage (-18°C) after one month.

Titratable acidity measurements were taken on 10.0 g flesh in 100.0 ml distilled water.

Fillets were acidified by placing 125.0 g frozen fillets into 250.0 ml of 5.0% acetic acid for 23 hours at 4°C (39.2°F).

Titratable acetic acid content was calculated by the formula:

$$\frac{100\ (\text{ml 0.1N NaOH for total sample} - \text{ml 0.1N NaOH for lactic acid})\ 0.06}{10.0\ \text{g sample}}$$

Total acetic acid content was determined by the number of grams of glacial acetic acid needed to acidify 10.0 g of TPP treated flesh to a pH of 4.1 after disintegrating the flesh in a Waring blendor for 15 seconds at low speed.

A heat convection pack was made in 303 x 406 fruit enameled cans using 80.0 g of acidified and TPP treated drum and commercial tomato sauce. The cans

received a steam exhaust preheat for 3 minutes and steam flow closure at 1.05 kg/cm^3 (15.0 psi). The closed cans were immediately treated to a boiling water bath in a still retort and monitored with thermocouples, then water cooled. F values were calculated on a Wang 2200 computer.

Results and Discussion

The pH values for six TPP treated fillets ranged from 7.6 to 8.0 and averaged 7.8. Titratable acidity values were from 0.06 - 0.12% (w/w) as lactic acid and averaged 0.09%.

Acidifying the drum flesh resulted in pH values of 4.0 - 4.1. Titratable acetic acid values were from 3.5 - 4.4% and averaged 4.0%. Virtually all of the dark brown and gray pigmentation had been bleached such that the flesh resembled trout in color.

Titrations with glacial acetic acid revealed that an average of 5.9 and between 5.3 - 6.5 g total acetic acid per 100.0 g flesh was needed to lower pH to 4.1. The average of 5.9 g/100.0 g indicated that after one dip, a 5.0% acetic acid solution will lose 47.0% of its strength in a 1:2 (w/v) fish to solution ratio. Since 5.9 g is total acetic and 4.0 g is titratable, then 15% of the total acid is presumably bound to the TPP treated flesh.

With a level of pH 4.1 and 4.0% titratable acidity the flesh was considered adequate for a low pH - high acid pack pH -- high acid pack when using a commercial tomato sauce.

From an internal temperature of 87.8°F (190°F), an $F_{250}^{18} = 0.21$ was obtained after 71 minutes of processing, assuring destruction of butyric acid anaerobes. If lethality were aimed against B. coagulans, a process time of 182 minutes would be required.

References

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EFFECT OF LIPID AND FATTY ACID COMPOSITION ON KEEPING QUALITY

by

Andrew C. Peng

Lipids are a major constituent of foods. Their presence, quantity, and composition in the food play an important role in organoleptic satisfaction. A small amount of lipid present in the food product makes it more palatable, adds smoothness for mouthfeel, facilitates the utilization of proteins and fat-soluble vitamins, provides the essential fatty acids, and serves as a future energy source for our body needs. Lipids also are involved in cardiovascular physiology so that heart cells deprived of serum lipids lose their ability to beat.

In addition to the nutrition and palatability, lipids are probably the most important source of flavor compounds of the three main food components - lipids, proteins, and carbohydrates, and the most prominent factor affecting keeping quality of foods during storage. The role of lipids has been recognized as flavor precursors; the volatile flavor compounds are derived from free or esterified fatty acids, especially the short chain fatty acids by hydrolysis, and from carbonyl compounds, such as aldehydes, ketones, lactones, etc. by oxidation.

Fresh fruits and vegetables are a part of our main daily diet. Their lipid content even though very low, 0.1 to 1.0%, plays a tremendous role in the storage stability and shelf life, especially of processed fruits and vegetables.

The primary purpose of this research project is to find basic information on lipid content and fatty acid composition from fresh and processed fruits and vegetables during storage from which may lead to some practical application to the food industry later.

Cucumbers were processed as fresh packed pickles, stored at room temperature, and analyzed chemically and organoleptically at 0-, 2-, 4-, 8-, and 12-month intervals.

The results of sensory evaluation revealed a trend of general acceptability that test samples were preferred to the control throughout the entire period of storage. The rating of the control sample increased with storage time. The distribution of total lipids and their classes is presented in Table 1, these data show that total lipids increased after processing, glycolipids were in highest concentration, neutral lipids followed, and phospholipids the least. The changes of major fatty acids from cucumber to pickles stored for 12 months are reported in Table 2. The higher proportion of unsaturated fatty acids may be oxidized during storage and the resulting products may contribute to the flavor changes.

Table 1. Lipid Composition of Cucumber and Pickles (%)

Storage Time	Total Lipids	Neutral Lipids	Glycolipids	Phospholipids
Cucumber	0.14	29.6	60.0	10.4
Pickles				
0-month	0.19	24.7	53.7	21.6
2-month	0.19	25.2	56.4	18.4
4-month	0.19	27.5	53.2	19.3
8-month	0.19	34.6	52.7	12.7
12-month	0.20	39.0	51.1	9.9

Table 2. Changes of Fatty Acids During Storage (%)

Fatty Acid	Total Lipids	Neutral Lipids	Glycolipids	Phospholipids
Palmitic (16:0)	-25.1	+89.4	-44.8	+64.5
Stearic (18:0)	+56.3	+350.0	+17.1	+41.6
Oleic (18:1)	+200.0	+360.0	+75.0	-50.0
Linoleic (18:2)	-9.3	+125.0	+69.2	-50.0
Linolenic (18:3)	-15.7	-12.0	+156.6	-24.1

+: Increasing with storage time
-: Decreasing with storage time

GRAPE LIPIDS

by

P. A. Higgins and A. C. Peng

Grapes have long been an important economic crop in Ohio, and many different grape cultivars have been planted and cultivated during the past 150 years. The Concord grape, Vitis labrusca var. Concord, is the most prevalent grape cultivar grown within the State of Ohio. It accounts for approximately 75% of the annual Ohio grape crop.

Many aspects of the chemical composition of grapes, particularly vinifera grapes, have been investigated. The oil of the seeds has been examined carefully and thoroughly and the cuticular wax coating on the berry was studied extensively. But no published information is available on the lipid composition of the edible portion of the grape berry - skin and pulp. Since lipids account for a source of the volatile compounds which are responsible for the characteristic flavor, this study was designed to investigate the crude lipid content and classes, and fatty acid composition. The results may be useful and helpful to the grape juice and wine industry for possible product improvement.

The Concord grape skin contained 0.32% of total lipids, whereas the pulp only had 0.10%. The lipids isolated from both components showed that glycolipids were the predominant fraction, neutral lipids the next, and phospholipids the lowest. This finding agrees with the general pattern of plant lipids, especially photosynthetic green plants. The main fatty acids found in different lipid components are pelargonic (9:0), tetradecadienoic (14:2), palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), linolenic (18:3), arachidic (20:0), behenic (22:0), and lignoceric (24:0) acids. Their distribution is as follows:

Skin portion: 0.32%

Neutral lipids, 40.4%	18:0*	16.5%
	16:0	15.2%
	20:0	14.5%
	9:0	7.2%
	14:2	5.8%
Glycolipids, 53.3%	18:3	46.2%
	9:0	22.1%
	24:0	6.6%
	16:0	6.0%
Phospholipids, 6.3%	16:0	30.4%
	18:3	10.6%
	18:2	9.5%
	9:0	7.3%
	18:1	5.9%
	18:0	5.3%

*Carbon numbers/number of double bonds.

Pulp portion: 0.10%

Neutral lipids, 26.0%	16:0	23.4%
	18:0	10.3%
	9:0	6.3%
	14:2	6.1%
Glycolipids, 65.6%	18:3	33.4%
	9:0	22.1%
	16:0	11.9%
Phospholipids, 8.4%	16:0	22.1%
	18:2	12.1%
	18:1	8.5%
	22:0	6.3%
	18:0	6.1%

The presence of pelargonic (9:0) and tetradecadienoic (14:2) acids are quite different from other plant lipids.

THE EFFECT OF MATURATION ON THE LIPID CONTENT OF 'CONCORD' GRAPES

by

John A. Bauman and James F. Gallander

Lipids play a definite and important role in many foods by contributing to the palatability (2) and nutritional value. Upon the breakdown of lipids into fatty acids the resulting compounds cause characteristic odors and bacteriostatic effects if present in high concentrations (1). However, if the concentration of fatty acids is low, stimulatory effects for bacterial growth may occur. Such factors could be important in production of wine and other grape products.

Changes in the concentration of chemical constituents in grapes during maturation have received much attention (3). However, little has been reported concerning the lipid content as the grape matures.

The most important measurement of grape maturity is the °Brix, or total soluble solids which increase during maturation. While this is not specific, the majority of the soluble solids, about 95%, are sugars.

Materials and Methods

'Concord' grape samples were collected from different areas of Ohio, Northern and Southern Central Ohio. Four fruit samples were taken from each vineyard at four different maturities (°Brix). Collection of samples began at veraison and were completed at peak maturity. Samples were analyzed for pH, Brix, percent total acidity, and lipid content. The berries for lipid analysis were cut from the grape clusters and frozen until used. Lipids were extracted from the 'Concord' grapes, minus the seeds, with chloroform-methanol (2:1 v/v) and their neutral and polar lipid classes were separated by silicic acid column chromatography.

Results and Discussion

The Brix values, amount of crude lipid/fresh weight, and the percent neutral and polar lipid for two vineyards are listed in Table 1.

TABLE 1.--Brix, Percent Crude Lipid, and Percent Neutral and Polar Lipids of 'Concord' Grapes Collected from Two Ohio Vineyard Locations.

Vineyard Location	°Brix	Crude Lipid/ Fr. Wt. %	Neutral Lipid %	Polar Lipid %
Southern Central Vineyard	10.6	0.26	56.0	44.0
	12.9	0.21	60.4	39.6
	14.9	0.21	44.0	56.0
	16.0	0.21	68.6	31.4
Northern Vineyard	10.2	0.20	48.7	51.3
	11.2	0.18	63.8	36.2
	14.7	0.20	59.4	40.6
	15.3	0.20	65.8	34.2

The °Brix of the 'Concord' grape samples at all vineyard locations increased during maturation. In general, the crude lipids extracted from the 'Concord' grapes were more abundant at the first sampling maturity. The amount of crude lipid decreased as the grape matured. The percent neutral and polar lipids fluctuated during the maturation process. However, the neutral lipid content was higher than the polar at peak maturity.

Summary

The crude lipids of the 'Concord' grape decreased as the fruit matured. The neutral and polar fractions of the 'Concord' samples from two vineyard locations yielded an uninterpretable pattern. More neutral lipid was present at peak maturity than polar.

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STABILITY OF ASCORBIC ACID IN FORTIFIED APPLE JUICE

by

M. I. Mahmoud and W. A. Gould

Introduction

There is a need for improved nutrition in many segments of the population. Food Manufacturers, aware of this need, are evaluating their products to determine how nutritional improvements can be made. Apple juice contains little or no ascorbic acid unless enriched. Since it is used interchangeably with high ascorbic acid juices in the diet, the enrichment of apple juice with ascorbic acid has a sound nutritional basis and become accepted as common practice. A study has been undertaken to determine the influence of time, temperature of storage and fortification level on the retention of ascorbic acid in apple juice.

Method

Two cultivars of apples, Jonathan and Grimes Golden, were blended together at the rate of 1:1. The apples were sorted, washed, rinsed and ground in a hammer mill. The juice was extracted in a hydraulic press by the rack-and-cloth method. It was then pasteurized at 205°F for 30 seconds. The pasteurized juice was filled from an eight gallon bowl to which was added 0, 50, 75, 100 or 125 ml of a solution of 90 gram ascorbic acid in one liter of pasteurized apple juice. The added solutions increased the ascorbic acid content by 0, 30, 45, 60 or 75 mg ascorbic acid per 100 ml juice. The juice was then filled into No. 303 cans, sealed, coded and cooled. Each fortification level was divided into 5 lots to be stored at 32, 50, 68, 86 and 104°F. Samples of the processed juice were analyzed for ascorbic acid content after 0, 3, 6, 9 and 12 months of storage.

Ascorbic acid was determined spectrocolorimetrically using the following reagents: 4-methoxy-2-nitroanaline, 0.2% sodium nitrite, ethanol and 0.5% oxalic acid. The solution was made alkaline by the addition of 10% sodium hydroxide which forms a reddish-violet compound with the reaction mixture. The absorbance was measured at 570 nm. Ascorbic acid concentration of apple juice was read from a standard curve. Titratable acidity, soluble solids, pH and vacuum were also determined.

Results

Percent retention of ascorbic acid in apple juice stored for 12 months at the five temperatures employed is presented in Table 1.

The retention of ascorbic acid in apple juice stored at refrigeration temperatures was excellent. The highest retention was found in juices stored at 32°F where it ranged from 79 to 84 percent, while juices held at 50°F retained from 71 to 77 percent of the initial level of ascorbic acid.

Storage at room temperature (68°F) resulted in decreased ascorbic acid retention which ranged from 63 to 68 percent. When apple juice was maintained

at elevated temperatures, the retention of ascorbic acid suffered dramatically. At the end of 12 months storage, juices stored at 86°F retained from 33 to 44 percent of their ascorbic acid content, whereas those juices stored at 104°F retained from 19 to 33 percent of ascorbic acid at the end of 6 months storage.

It was also noticed that increasing the initial level of ascorbic acid content decreased the percent retention. Higher percent retention values were found in juices containing initial levels of ascorbic acid of 30 and 45 mg/100 ml juice.

The rate of loss of ascorbic acid was also calculated and it was found that raising the storage temperature from 32 to 68°F doubled the rate of ascorbic acid loss while increasing the temperature from 68 to 104°F quadrupled the rate of ascorbic acid loss.

Evaluation of the data with respect to kinetics of ascorbic acid loss in apple juice is being continued along with the influence of time, temperature and fortification level on titratable acidity, soluble solids, pH, vacuum and Brix: acid ratio.

Table 1. Percent Retention of Ascorbic Acid in Fortified Apple Juice

Fortification Level	Temp. of Storage °F	Storage Time (months) 3	6	9	12
0	32	100	67	0	0
	50	100	67	0	0
	68	67	0	0	0
	86	67	0	0	0
	104	0	0	0	0
30	32	98	96	93	84
	50	93	88	86	77
	68	84	79	77	68
	86	82	74	56	44
	104	77	33	-	-
45	32	97	92	88	83
	50	91	85	80	74
	68	81	79	75	65
	86	80	71	59	41
	104	67	29	0	0
60	32	98	89	91	81
	50	93	87	80	73
	68	82	81	73	64
	86	83	70	57	38
	104	66	23	0	0

Table 1. (cond)

Fortification Level	Temp. of Storage °F	Storage Time (months) 3	6	9	12
75	32	91	88	84	79
	50	86	81	80	71
	68	77	76	72	63
	86	77	63	50	33
	104	61	19	-	-

WINE DEACIDIFICATION WITH MIXED CULTURES OF SCHIZOSACCHAROMYCES pombe AND SACCHAROMYCES cerevisiae

by

J. F. Gallander and J. F. Stetson

Grapes grown in Ohio are usually high in acidity, and some means must be employed by wineries to reduce wine acidity to a desirable level (tartness). Results of previous investigations have shown that grape musts inoculated with Schizosaccharomyces pombe reduced wine acidity. This yeast has the stability to ferment malic acid, a major acid in grapes, during alcoholic fermentation. Although this yeast has the ability to reduce wine acidity, recent studies indicated that an over-deacidification may result in using Schizosaccharomyces pombe in place of the common wine yeast Saccharomyces cerevisiae var. ellipsoideus.

A study was initiated to determine the effectiveness of reducing wine acidity by mixed yeast cultures of Sch. pombe and Sac. cerevisiae.

Procedure

Grapes from the varieties Baco Noir and Concord were harvested at maturity from the OARDC Southern Branch near Ripley. After the grapes were destemmed and crushed, the musts were analyzed for soluble solids and treated with 100 ppm of sulfur dioxide in the form of potassium metabisulfite. From the soluble solids reading, the amount of sugar needed to bring the original soluble solids content of each variety to 21% was calculated. The required amount of sugar was added and dissolved in the crushed grapes.

Six hours after the sulfur dioxide treatment, the must of each variety was divided into 7 lots. Two lots were used as control samples and were inoculated with active yeast cultures of Sch. pombe and Sac. cerevisiae. The other 5 lots were also inoculated with Sch. pombe. However, these lots were re-inoculated with Sac. cerevisiae at 1, 2, 3, 4, and 6 days after the initial inoculation.

The fermenting crushed grapes were stirred twice daily and were pressed 4 days after the initial yeast inoculation. Then, the fermenting juice was transferred to glass carboys. All carboys were equipped with water seals, and were placed in 65°F. storage for fermentation. The fermentations were essentially completed in 4 weeks, and the wines were racked at this time to clean glass carboys. After additional rackings, the wines were placed in cold storage (30°F) for approximately 3 weeks to precipitate the excess tartrates. The wines were racked again, bottled and placed back in to 65°F storage. After 1 month storage, they were analyzed for composition and quality.

Results and Discussion

The results of the chemical analyses of the wines fermented with the two yeasts are shown in Table 1. Wines fermented by Sch. pombe were lower in total acidity than the Sch.-fermented wines. The greatest amount of deacidification occurred in the Baco Noir wines. The Sac.-fermented wine contained 1.06% total acidity while the Sch.-fermented wine was 0.51%. The Sch. fermentation also brought about an increase in pH through the loss in total acidity, mainly malic acid. The Sch. yeast metabolized most of the malic acid in the wines. For both varietal wines, the malic acid content was reduced to approximately 0.125%. The reduction in total acidity

of the mixed culture wines was related to the time of the Sac. cerevisiae inoculation. The greatest loss in total acidity occurred when the Sac. inoculation was delayed to 6 days. The delay of inoculating with Sac. cerevisiae at 4 days appears to be best in reducing wine acidity to the proper level. Later inoculations would tend to over-deacidify the wines.

TABLE 1.--Composition of Two Varietal Wines Fermented by Mixed Yeast Cultures of Schizosaccharomyces pombe and Saccharomyces cerevisiae.

Yeast Treatment	pH	Total Acidity %	Total Tartrates g/100 ml	Total Malates g/100 ml
		Baco Noir		
Sac. (control)	3.36	1.06	0.16	0.50
Sch.-Sac. (1 day)	3.57	0.75	0.16	0.33
Sch.-Sac.(2 days)	3.57	0.81	0.14	0.35
Sch.-Sac.(3 days)	3.57	0.70	0.15	0.34
Sch.-Sac.(4 days)	3.71	0.66	0.16	0.27
Sch.-Sac.(6 days)	3.80	0.56	0.12	0.21
Sch. (control)	3.90	0.51	0.14	0.13
		Concord		
Sac. (control)	3.22	0.98	0.32	0.37
Sch.-Sac.(1 day)	3.40	0.64	0.28	0.20
Sch.-Sac.(2 days)	3.45	0.63	0.28	0.16
Sch.-Sac.(3 days)	3.46	0.63	0.30	0.16
Sch.-Sac.(4 days)	3.46	0.62	0.28	0.17
Sch.-Sac.(6 days)	3.46	0.61	0.30	0.15
Sch. (control)	3.54	0.56	0.28	0.12

THE EFFECT OF BACTERIAL INOCULUM ON MALO-LACTIC FERMENTATION IN WINES

by

J. F. Gallander and J. F. Stetson

Since Ohio wines are generally made from grapes high in total acidity, malo-lactic fermentation may be a desirable means of lowering wine acidity to a more acceptable level, less tartness. Malo-lactic fermentation is the bacterial conversion of malic acid to lactic acid and carbon dioxide in wine. This fermentation is caused by certain lactic acid bacteria and occurs after the alcoholic fermentation. Investigations of malo-lactic fermentation have reported that many factors influence this fermentation in wines. Some of the major factors include: temperature, aeration, alcohol content, time of racking, pH, and sulfur dioxide. Consequently, efforts to induce this secondary fermentation have proven unpredictable in many cases in Ohio wines.

The purpose of this study was to determine the effectiveness of encouraging malo-lactic fermentation in wines by varying the bacterial inoculum.

Materials and Methods

A strain of Leuconostoc oenos was used to inoculate wines. This particular strain, ML-34, was obtained from R.E. Kunkee of the University of California, Davis.

The strain was grown in growth medium and transferred to sterilized grape juice (pH 4.5) containing 0.05 percent yeast extract. After 5 days, this bacterial culture was used for inoculating the wines at rates of 0.5, 1.0 and 2.0 percent.

Grapes from the variety "Chancellor" (Seibel 7053) were harvested at peak maturity. After the grapes were destemmed and crushed, the must was analyzed for pH, total acidity, and Brix (Table 1).

From the Brix reading, an amount of sugar was added to the must to bring the original Brix content to 20.0° Brix. Then the must was treated with 50 ppm of sulfur dioxide. After 3 hours, a 1 percent active yeast starter (Montrachet #522) was added to the must, and the fermenting grapes were stirred twice daily.

When the Brix reading dropped to approximately 10° Brix, the must was pressed and divided into four lots. One lot with no bacterial inoculation was used as a control. The other three lots were inoculated with 0.5, 1.0 and 2.0 percent bacteria. All wines were fermented in glass carboys equipped with "water seals" and placed in 65°F storage. The wines were fermented to dryness, racked, and stored to capacity in glass containers. After malo-lactic fermentation, the wines were racked again and placed in cold storage (30°F) for 3 weeks. Then, the wines were racked, 25 ppm sulfur dioxide added, bottled, and stored at 65°F. Chemical analyses of the wines were performed about 1 month after bottling.

TABLE 1.--Composition of Must and Malo-Lactic Wines from the Variety Chancellor.

Sample	pH	°Brix	Total Acidity %	Malic Acid g/100 ml	Days to Complete M-L Fermentation
Must	3.10	16.9	0.93	---	---
Control*	3.60	----	0.76	0.15	---
Control**	3.67	----	0.61	0.03	101
0.5% Inoculum	3.69	----	0.58	0.01	58
1.0% Inoculum	3.67	----	0.61	0.01	51
2.0% Inoculum	3.68	----	0.62	0.01	45

* Sample taken before M-L fermentation.
** Sample taken after M-L fermentation (natural).

Results and Discussion

Wines resulting from malo-lactic fermentation contained only trace amounts of malic acid (Table 1). Malo-lactic fermentation was induced in all wines inoculated with bacteria. This fermentation was also present in the control wine, but was found to be slower than in the inoculated wines. For example, the natural malo-lactic fermentation was completed in 101 days; whereas, the wines fermented with Leuconostoc oenos at 0.5, 1.0 and 2.0% inoculum occurred in 45, 51, and 58 days, respectively.

The malo-lactic fermentation brought about an increase in pH through the loss in acidity, conversion of malic to lactic acid and carbon dioxide. The titratable acidities of the bacteria-inoculated wines and control wines at the end of malo-lactic fermentation were substantially lower than the initial values. This loss in acidity reduced the tartness of the wines to a more acceptable level.

These results emphasized the importance of bacterial inoculation for the stimulation of malo-lactic fermentation.

CONCENTRATIONS OF TARTARIC AND MALIC ACIDS OF SEVERAL WINE VARIETIES GROWN IN OHIO

by

J. F. Gallander and J. F. Stetson

The major acids in grapes are malic and tartaric acids. The concentrations of these acids and their relative amounts in the fruit vary with variety, location, season, maturity and cultural conditions. These acids decrease during maturation with malic acid generally decreasing at a faster rate than tartaric acid. In addition, malic acid is usually found in high concentrations when grapes are grown in cool regions. This is the main reason that many grapes grown in Ohio and eastern United States are relatively high in total acidity. If these acidic grapes are used for making wines, some method during the vinification process must be applied to reduce the acidity to an acceptable level. One important method of reducing wine acidity is the process of malo-lactic fermentation. Malo-lactic fermentation is the bacterial conversion of malic acid to lactic acid with the liberation of carbon dioxide. This method reduces wine acidity to approximately one-half of the percentage of malic acid present in the wine.

Since excessively acidic grapes contain high amounts of malic acid, this investigation was made to determine the relative concentrations of malic acid in five grape varieties grown under Ohio conditions. This information should serve as a basis for determining the desirability of malo-lactic fermentation in wines made from these varieties.

Materials and Methods

Each variety was harvested at maturity and transported to the OARDC Department of Horticulture in Wooster for analysis. After the grapes were stemmed, crushed, and pressed, a representative juice sample was obtained and analyzed as follows:

1. Total Soluble Solids: The soluble solids content was determined by using an Abbe refractometer.

2. pH: The pH was determined by the glass electrode method (Corning Digital 112 Research pH Meter).

3. Total Acids: A 10-ml juice sample was titrated with a 0.1 normal sodium hydroxide solution to a pH of 8.2. The percent total acids was calculated as tartaric.

4. Tartrates: The tartaric acid was determined by using the vandate method.

5. Malates: The l-malic acid content of the juice was determined enzymatically with malic dehydrogenase.

TABLE 1.--Total Soluble Solids, pH, Total Acidity, Total Tartrates, Total Malates and Tartrate-Malate Ratio of Several Wine Varieties Grown in Ohio.

Year	Soluble Solids %	pH	Total Acidity %	Total Tartrates g/100 ml	Total Malates g/100 ml	Tartrate/ Malate Ratio
			Catawba			
1971	16.9	3.08	0.94	0.65	0.48	1.35
1972	16.6	3.16	0.85	0.43	0.33	1.30
1973	17.6	3.11	1.03	0.75	0.50	1.50
1974	17.5	3.13	0.89	0.64	0.44	1.45
Average	17.2	3.12	0.93	0.62	0.44	1.40
			Baco Noir			
1971	16.9	3.15	1.39	0.74	0.83	0.89
1973	17.4	3.04	1.44	0.65	0.84	0.79
1974	16.2	3.05	1.35	0.65	0.79	0.63
Average	16.8	3.08	1.39	0.68	0.82	0.77
			De Chaunac			
1971	18.3	3.06	1.19	0.71	0.84	0.84
1972	16.2	3.20	0.86	0.53	0.37	1.43
1973	18.8	3.43	0.97	0.70	0.52	1.34
1974	18.6	3.27	0.86	0.57	0.46	1.23
Average	18.0	3.24	0.97	0.63	0.55	1.21
			Villard blanc			
1971	13.6	2.93	1.03	0.79	0.30	2.63
1972	16.5	3.08	0.99	0.63	0.37	1.70
1973	15.6	3.05	1.05	0.65	0.55	1.18
1974	19.0	3.03	0.99	0.69	0.39	1.76
Average	16.2	3.02	1.01	0.69	0.40	1.82
			Vidal 256			
1971	15.6	3.06	1.02	0.74	0.31	2.38
1972	17.6	3.08	0.92	0.63	0.37	1.70
1973	17.6	3.17	0.98	0.85	0.55	1.54
1974	16.4	3.09	1.11	0.61	0.55	1.10
Average	16.8	3.10	1.01	0.71	0.46	1.68

Results and Discussion

Total acidity, pH, total soluble solids, and concentrations of tartrates and malates in fruits of the various grape varieties are given in Table 1. These results showed differences in the total acidity, pH, and total soluble solids in the various varieties and between seasons. Also, this table indicates that there was considerable variation in the levels of tartrates and malates, depending on

variety and season. The ratio of total tartrate to total malate ranged from 0.63 to 2.63 for Baco Noir and Villard blanc, respectively. Catawba, Villard blanc and Vidal 256 were classified as low-malate varieties while De Chaunac was a moderately high malate variety. Baco Noir was the only grape classified as high-malate variety. Since this variety is relatively high in malic acid, wine from Baco Noir would certainly benefit by a malo-lactic fermentation. This secondary fermentation may also be desirable for wines made from De Chaunac in certain seasons.

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