CANNING TOMATO VARIETY TRIALS 1963

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Tomato breeders across the United States each year select their outstanding tomato lines for trial. The purpose of this trial is to evaluate the more promising lines for canning, when grown in Virginia. Tomato canners and growers need high-yielding varieties, with good processing characteristics, and which produce a high quality canned product. This trial provides information which will aid in selection for; introduction by tomato breeders, stocking by seedsmen, and production by plantsmen and vegetable growers.

Five numbered lines from the Southern Tomato Exchange Program (STEP) and 3 other varieties were tested against Campbell 146, the leading commercial canning variety of Virginia canners. The canning trials were conducted near Warsaw, which is within an important canning area of Virginia. The canning trial tomatoes were grown adjacent to fresh-market tomato variety trials. The culture was identical until harvesting, which began somewhat later on the canning trial, because a more advanced state of maturity was desired. For information on the fresh market trials, see Virginia Agricultural Experiment Station Research Report 78.

Acknowledgments

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Experiment Description and Production Conditions

Location: V.P.I. Eastern Virginia Research Station, Richmond County, 2 miles north of Warsaw.

Elevation: 140 feet.

Soil: Sassafras sandy loam; pH 6.5.

Previous crop: Small grain.

Plot sizes: One row; records taken on 15 plants.

Plot design: Randomized block.

Replications: Four.

Spacing: Plants 2' apart in row; 5' between rows.

Fertilizer: 5-10-10 applied at the rate of 1,480 lb. per acre. Fourteen days before field setting, broadcast at the rate of 680 lb.; 8 days before setting, placed in rows at the rate of 200 lb.; and 23 days after field setting, sidedressed at the rate of 600 lb. Also 1/2 pint per plant of starter solution (3 lb. 10-52-17 to 100 gals. water) applied at field setting.

Plants: Greenhouse plants grown in peat pots.

Field planting date: April 23.

Cultivation: Frequently enough to control weeds.

Pesticides: Maneb plus Sevin or Malathion as spray; chlordane in starter solution.

Growing conditions: Scanty and erratic distribution of moisture seriously impaired the vigor and probably the yield. Irrigation was not available. See Table 7 for records of precipitation and temperature.

Harvesting and Grading Procedure

Harvest maturity: Firm, red ripe when available

Harvest interval: Weekly.

Grading: According to U. S. Department of Agriculture Grades for Cannery Tomatoes. The fruit was graded into U. S. 1's, 2's, and culls based on color, shape, cracks, and decay. There was no minimum size limit.

Canning Procedure

When: Canning was done the day following harvest.

Preparation: Tomatoes were soaked in fresh water to remove dirt, scalded in 195°F water for 45 seconds; immersed in cold water; cored and peeled.

Filling: About 11 ounces of U. S. No. 1 tomatoes were hand filled into #303 plain can. Firming salt, 25 grain sodium chloride plus calcium sulfate, was added to each can. Cans were topped off with natural juice from peeled, cored U. S. No. 2 tomatoes; about 3/8" headspace was left.

Exhausting: Steam flow can-closing machine.

Processing: Continuous cooker, 12 minutes at boiling.

Cooling: Air stacked in cases.

Miscellaneous Comments on Data Recorded

Only STEP 372, ES-24, and Campbell 146 were in the trials for the second year. New entries this season were STEP 373, STEP 397, STEP 401, STEP 410, Heinz 1350, and Heinz 1370.

Rainfall was most erratic during the 1963 tomato growing season. Less than 3/4" of rain fell from 3 weeks before the first picking until after the fourth picking - a period of about 50 days.

The U. S. Standard for grades of canned tomatoes, effective August 1, 1946, gives the following factors and point value:

I.	Drained weight	20
II.	Wholeness	20
III.	Color	30
IV.	Absence of defects	30
	Total Score	100

Drained weight and defects were not scored in this canning trial, but flavor was added as a factor. Since there is a rather close relationship between wholeness and drained weight*, the following factors and point values were used:

I.	Wholeness	50
II.	Color	35
III.	Flavor	15
	Total Score	100

General Notes on Entries

Fresh tomatoes

Higher than average total marketable yields were produced by Heinz 1370, STEP 410, ES-24, and STEP 401. Lower than average total marketable yields were produced by STEP 372, Heinz 1350, STEP 373, STEP 397, and Campbell 146. Heinz 1370 also produced the highest yield of U. S. No. 1's; there was no significant difference among the other varieties in yield of No. 1's. Step 410 had the highest yield of U. S. No. 2's. Fruit cracking was not a serious problem with any of the entries, probably because of the dry season.

Canned tomatoes

Color and flavor ratings averaged best for STEP 397. Heinz 1350 had the best average wholeness. Campbell 146 had the lowest average pH. Percent soluble solids, by refractometer, was highest for STEP 372. There was no statistical difference in ascorbic acid content among entries, but harvests 2 and 3 were higher than 1 and 4. Percent recovery of raw stock was highest with STEP 372.

*Kramer, Amihud, B. A. Twigg, Jane Cooler, F. W. Cooler. (1962). Relation of Factors of Quality to Grades of Canned Tomatoes. Food Technology 16(1): 30-32.

Comments on Individual Entries

(For a comparison of Entries see Tables 1 through 5)

Campbell 146 - This has been the outstanding canning variety in the trial for several years, and is used as the standard or check variety. It was definitely off-type this year, having lower vigor, poorer leaf cover, and abnormal fruit shape. The exceedingly dry weather may have been responsible for this condition. The total marketable yield was only average. Forty-eight percent of the marketable yield was U. S. No. 1. Percent raw stock recovery during peeling, coring, and trimming was below average. The overall score of the canned product was below the group average because of below average color and flavor. The pH and soluble solids were among the lowest.

Heinz 1370 - This was the outstanding variety in the canning trial. During last year's dry growing season it was exceptional; during a wet season it may perform poorly. It had the highest total marketable yield, though not statistically better than ES-24, STEP 410, and STEP 401. This variety produced the largest yield of U. S. No. 1's, with 61% of the total marketable yield in this grade. Percent raw stock recovery was above average, meaning it was rather economical to can. The overall score of the canned product was above average, but it was somewhat lacking in flavor. Soluble solids and pH were among the lowest, probably resulting in the lower flavor score. Total acidity was within the highest group. Its season of ripening is similar to Campbell 146.

ES-24 - The total marketable yield of this variety was among the best, but only 44% of these were U. S. No. 1's. It produced a medium-sized plant with only average foliage cover. Percent raw stock recovery was above average. The overall score of the canned product was below average, mainly because of poor color and flavor. Wholeness was among the best. Soluble solids and pH were among the lowest in the trial.

Heinz 1350 - The total marketable yield of this variety was in the lower third. Only 43% of the total marketable tomatoes were No. 1 grade. This variety produced a small plant with rather sparse leaf cover. The percent raw stock recovered during preparation was about average. The canned product was above average quality, having excellent wholeness and good color, but below-average flavor. The percent soluble solids was rather low, and the 4.4 pH was medium.

STEP 410 - This entry ranked 2nd in total marketable yield and produced only 38% in the U. S. No. 1 grade for canning. The percent raw stock recovered during canning was the lowest in the trial because green shoulders were trimmed off. The fruit size was among the largest in the trial - many of the early fruit were too large to fit in a 303 can. The canned product received the lowest overall score, being deficient in color and lacking wholeness. Flavor was average. This variety ranked highest in pH--its value of 4.49 is dangerously close to the 4.5 limit for low-acid foods. Percent soluble solids was below average and total acidity ranked lowest.

STEP 401 - Total marketable yield was above average, and included in the top

group. It produced the smallest fruit in the trial, and had 48% as U. S. No. 1 grade. Percent raw stock recovery was low. Quality of the canned product was average. It had a rather low pH and soluble solids content. When peeled and canned, a heavy network of external veins detracted from its appearance. An objectionable deep, woody core was characteristic of this variety.

STEP 397 - Though yielding with the average group, this variety was of exceptionally good quality after canning. It ranked 1st in color, 1st in flavor, and 2nd in wholeness - these combined to give it the highest overall score. The pH was moderately high at 4.45; it had the 2nd highest percent soluble solids. Percent recovery of raw stock was a little below average and it was rather difficult to core. It produced many fruit too large for a 303 can.

STEP 373 - The total marketable yield of this variety was average. The percent recovery of raw stock was better than average, and the fruit were relatively easy to core. It was below average in wholeness, but color and flavor were very good. The pH and percent soluble solids were quite high.

STEP 372 - Ranked lowest in total marketable yield. It produced a large vine with good leaf cover. The fruit was quite large but did not present a problem for 303 cans. The percent recovery of raw stock ranked highest in the trial (U. S. 1's - 85%). Quality of the canned product was quite good, but of average color. Flavor was among the best. The pH was average and soluble solids ranked highest in the trial.

General Comments

When comparing yields from the fresh market trial (see Research Report 78, February 1964) with those from the canning trial, there is no consistent trend. With Heinz 1350, yield was similar when harvested at either the fresh state (159 cwt) or the canning ripe stage (165 cwt). Standards for grading were different because the 2 trials were harvested for different markets. It is generally claimed that canning yields are lower, because of the longer period the fruit is on the vine and exposed.

Table 6 shows that there was an overall change in chemical composition of entries as the season and harvest date advanced.

Table 1 - Nine Tomato Varieties or Breeding Lines Tested for Canning at Warsaw, Virginia in 1963.

Entry	Weighted overall Score[1]	Total marketable yield cwt/A (2A)	U.S. No. 1 grade yield cwt/A (2A)	Percent total yield U.S. No. 1 (2D)	Average marketable fruit weight ounces (2A)	Seed Source[3]
Heinz 1370	3.8	229.6 a[2]	140.2 a	61	4.3 cd	4
STEP 410	3.2	227.8 a	87.0 b	38	5.4 abc	2
ES-24	3.5	198.3 ab	88.0 b	44	4.2 d	1
STEP 401	3.8	189.1 ab	91.5 b	48	3.2 e	5
Campbell 146	3.5	179.8 bc	87.0 b	48	5.0 bc	4
STEP 397	4.3	173.0 bc	83.5 b	48	5.9 a	3
STEP 373	4.0	171.6 bc	78.1 b	46	4.0 d	3
Heinz 1350	3.9	164.6 bc	71.1 b	43	4.0 d	4
STEP 372	4.0	135.8 c	61.2 b	45	5.3 ab	3
Average	3.8	185.5	87.5	47	4.6	

(1) See Table 4 for an explanation of factors included in this canned product quality rating.

(2) The letters a, b, c, d, e indicate the statistical significance of each characteristic. For example, data followed by an "a" are significantly different, at a given level of assurance, from those not having an "a"; those followed by a "b" are significantly different from those not having a "b", etc.

(2A) Statistical significance at the 5% level
(2B) Statistical significance at the 1% level
(2C) No statistical significance
(2D) Averages only, no statistics applied.

(3) Seed sources:

1. Eastern States Farmers Exchange
2. Florida - Walter
3. S. E. V. B. L., Charleston, S. C. - Andrews
4. Twilley Seedsmen
5. U.S.D.A. Beltsville, Md. - Webb

Table 2 - Percent Marketable Yield of Total Marketable Yield from Tomatoes Harvested in Canning Trials, 1963.

	Approximate percent of total marketable yield at each harvest			
	7/24	7/30	8/6	8/13
Entry	92*	98*	105*	112*
ES-24	7	16	62	15
Heinz 1370	13	23	58	6
Heinz 1350	28	18	47	7
Campbell 146	16	21	53	10
STEP 372	14	19	52	15
STEP 373	17	18	55	10
STEP 397	20	17	54	9
STEP 401	16	40	33	11
STEP 410	12	12	54	22
Average	16	20	52	12

*Days from field setting on April 23, 1963.

Table 3 - Percent Raw Stock Recovery of U. S. No. 1's and 2's from Entries in Canning Tomato Variety Trials, 1963[1].

U. S. No. 1's

Entry	Entry No.	Date of Harvest 7/24	7/31	8/7	8/14	Variety Average
STEP 372	6	86.9	86.0	84.5	82.7	85.3
STEP 373	7	82.3	82.7	84.3	82.7	83.0
STEP 397	8	84.0	77.3	82.7	69.2	78.3
STEP 401	9	84.8	77.5	80.9	71.4	78.7
STEP 410	10	87.4	79.4	80.5	67.7	78.8
ES-24	11	86.0	81.7	84.3	78.5	82.6
Heinz 1350	12	88.3	81.8	83.8	74.8	82.2
Heinz 1370	13	85.2	81.8	87.1	83.2	84.3
Campbell 146	14	84.8	77.8	85.6	69.7	79.5
Average		85.6	80.7	83.7	75.5	81.4

U. S. No. 2's

STEP 372	6	85.0	80.2	77.7	77.1	80.0
STEP 373	7	86.4	78.8	79.7	78.0	80.7
STEP 397	8	84.8	74.5	68.3	65.7	73.3
STEP 401	9	76.5	69.7	71.2	61.3	69.7
STEP 410	10	73.1	73.0	70.2	56.0	68.1
ES-24	11	77.1	76.3	78.5	70.1	75.5
Heinz 1350	12	73.5	75.2	78.2	67.6	73.6
Heinz 1370	13	73.4	72.8	81.6	71.4	74.8
Campbell 146	14	72.0	70.7	76.5	54.2	68.4
Average		78.0	74.6	75.8	66.8	73.8

(1) Percent recovery is an indication of the weight of peeled, cored, trimmed tomatoes that may be obtained from 100 lbs. of raw stock.

Table 4 - Nine Tomato Varieties Tested for Quality Characteristics of Canned Product, 1963.

		Organoleptic Evaluations (3)				
Variety	Variety Number	(1A),2 Color	(1A),2 Wholeness	(1A),2 Flavor	(1D),2 Weighted Overall Score*	(1D) Rank
STEP 397	8	4.2 a	4.3 a	4.3 a	4.3	1
STEP 373	7	4.1 a	4.1 a	4.1 a	4.0	2.5
STEP 372	6	3.7 b	4.0 a	4.0 a	4.0	2.5
Heinz 1350	12	3.8 b	3.6 c	3.6 c	3.9	4
STEP 401	9	3.7 b	3.8 abc	3.8 abc	3.8	5.5
Heinz 1370	13	3.8 b	3.4 c	3.4 c	3.8	5.5
Campbell 146	14	3.2 cd	3.4 c	3.4 c	3.5	7.5
ES-24	11	3.0 d	3.6 c	3.6 c	3.5	7.5
STEP 410	10	3.3 c	3.7 abc	3.7 abc	3.2	9
Average		3.6	3.9	3.8	3.7	

(1) The letters a, b, c, d, e indicate the statistical significance of each characteristic. For example, data followed by an "a" are significantly different, at a given level of assurance, from those not having an "a"; those followed by a "b" are significantly different from those not having a "b", etc.

(1A) Statistical significance at the 5% level
(1B) Statistical significance at the 1% level
(1C) No statistical significance
(1D) Averages only, no statistics applied.

(2) Rating: 1 = poor, 5 = excellent.

(3) Rated by 8 trained judges, for each of 4 harvest dates and 2 replications.

*Weighted values - Color 50, Wholeness 35, Flavor 15.

Table 5 - Chemical Attributes of Tomato Varieties for 1963 at Warsaw, Virginia.

Entry	pH (1A)	Percent Acid as Citric (1A)	Brix-Acid Ratio* (1D)	Percent Soluble Solids (1A)
Campbell 146	4.31 a	.41 a	18.1	7.43 cd
Heinz 1370	4.32 a	.42 a	17.1	7.17 d
ES-24	4.36 ab	.40 a	18.3	7.32 d
STEP 401	4.38 abc	.37 b	19.5	7.22 d
Heinz 1350	4.41 abc	.35 bc	20.4	7.13 d
STEP 372	4.42 abc	.36 bc	22.6	8.14 a
STEP 397	4.45 bc	.33 cd	23.6	7.79 ab
STEP 373	4.47 bc	.35 bc	22.1	7.75 bc
STEP 410	4.49 c	.31 d	23.7	7.34 d
Average	4.40	.37	20.6	7.48

(1) The letters a, b, c, d, e indicate the statistical significance of each characteristic. For example, data followed by an "a" are significantly different, at a given level of assurance, from those not having an "a"; those followed by a "b" are significantly different from those not having a "b", etc.

(1A) Statistical significance at the 5% level
(1B) Statistical significance at the 1% level
(1C) No statistical significance
(1D) Averages only, no statistics applied.

*Serum refractometer reading, uncorrected for salts and acids present, divided by percent acid as citric.

Table 6 - Harvest Date Effect on Chemical Characteristics of Nine Tomato Varieties Canned in 1963 at Warsaw.

Harvest Date	pH (1A)	Ascorbic Acid* (1A)
7/23	4.43 a	33.78 b
7/30	4.44 a	42.44 a
8/6	4.37 ab	43.67 a
8/13	4.35 b	32.78 b

(1) The letters a, b, c, d, e indicate the statistical significance of each characteristic. For example, data followed by an "a" are significantly different, at a given level of assurance, from those not having an "a"; those followed by a "b" are significantly different from those not having a "b", etc.

(1A) Statistical significance at the 5% level
(1B) Statistical significance at the 1% level
(1C) No statistical significance
(1D) Averages only, no statistics applied.

*Ascorbic acid, mg/100 ml

Table 7 - Climatological Data in 1963 at the V.P.I. Eastern Virginia Research Station, 2 miles north of Warsaw.

For week ending	Temperature Max.	Temperature Min.	Temperature Avg.	Precipitation* (inches)
Mar. 30	82	38	61	0.22
Apr. 6	92	32	62	0.02
Apr. 13	67	32	51	T
Apr. 20	90	34	64	T
Apr. 27	84	36	58	T
May 4	87	36	58	0.26
May 11	97	46	71	0
May 18	81	37	62	1.40
May 25	85	41	64	0.67
June 1	80	50	67	0.38
June 8	91	59	72	5.80

For week ending	Temperature Max.	Temperature Min.	Temperature Avg.	Precipitation* (inches)
June 15	95	55	75	0.79
June 22	88	51	70	0.25
June 29	94	53	77	0.04
July 6	95	53	77	T
July 13	91	53	72	T
July 20	98	63	81	0.42
July 27	99	61	78	0.03
Aug. 3	98	67	82	0.21
Aug. 10	94	59	78	0.02
Aug. 17	93	52	75	0
Aug. 24	93	63	78	1.40

*Field was not irrigated. T means trace, an amount too small to measure.