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FRESH MARKET ACCEPTANCE OF TWO TYPES
OF MACHINE HARVESTABLE TOMATOES

John P. Nichols, Chan C. Connolly
and
Robert L. Degner

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PREFACE

The research reported herein was suggested and supported by the Texas Valley Tomato Committee, Pharr, Texas. The tomatoes evaluated were developed by Paul W. Leeper, Associate Professor of the Texas Agricultural Research and Extension Center at Weslaco. His interest in the tomato industry of Texas provided the basic stimulus for this research.

Tomatoes tested were Chico III and advanced breeding line Number 145.

HIGHLIGHTS

- Two tomatoes developed for machine harvesting were evaluated for the fresh market, Chico III and Number 145.
- The evaluation consisted of a 400 family test panel; a 4 week sales period in 13 supermarkets, and trade reaction.
- All evidence indicates that Number 145 is preferred over the Chico III.
- In general, the 400 household consumer panel considered Number 145 superior to the Chico III with respect to general appearance, taste, internal texture, and firmness. Other factors, while not statistically significant, still favor Number 145.
- Sales of the two tomatoes indicate a preference for Number 145. Weekly sales of Number 145 averaged approximately 36 pounds per thousand customers, while the Chico III averaged approximately 28 pounds.
- Sales of Number 145 compare favorably with sales of other types of tomatoes; however, Number 145 usually had a price and display advantage.
- Trade personnel prefer Number 145 to the Chico III primarily because of the puffiness in the Chico III variety.
- Further development of fresh market tomatoes for machine harvesting should incorporate the favorable characteristics of the Number 145 tomato.

Fresh Market Acceptance of Two Types of Machine Harvestable Tomatoes

John P. Nichols, Chan C. Connolly and Robert L. Degner*

INTRODUCTION

The South Texas fresh tomato industry has been declining for many years. In the period immediately following World War II 30,000 to 40,000 acres were planted annually. Currently only about 2,000 to 3,000 acres are utilized for producing fresh tomatoes. The difference between U.S. and Mexican farm labor wage rates has resulted in the transfer of capital previously used to produce fresh tomatoes in South Texas to Mexico. Mexican fresh tomato imports now compete with U.S. fresh tomato production. In 1969, the U.S. imported 449,639,000 pounds of fresh tomatoes 99.2 percent of which were of Mexican origin.^{1/} To re-establish the fresh tomato industry in South Texas a significant reduction in labor requirements for both growing and harvesting is necessary. This has been accomplished in much of the processing tomato industry in the U.S. where over 90 percent of production is now mechanically harvested in California. Development of this capability has been much slower for fresh market tomatoes because of the greater concern for mechanical fruit damage.

*Assistant Professor, Associate Professor and Research Associate, The Agricultural Experiment Station, College Station and Weslaco, Texas.

^{1/} U.S. Department of Agriculture, U.S. Imports of Horticultural Products, FSAM-191-Rev., Washington, D. C. 20250, May 1971, p. 21.

While mechanical harvesting has not yet been adopted in South Texas for fresh tomatoes, a program is underway to develop varieties suitable for machine harvesting. Plant breeders are combining the quality characteristics necessary for the fresh market with the handling characteristics which are required to be compatible with the mechanical harvesting system.

The tomato breeding program has proceeded to the point where several promising lines now exist. The purpose of this study is to evaluate both consumer and market acceptance of two selected fresh tomatoes, Chico III and advanced breeding line Number 145. The Chico III is a pear-type tomato while Number 145 is generally plum-shaped. Both lines are somewhat smaller than the standard round tomatoes usually found in the market. The further development and adoption of these tomatoes for fresh market utilization is dependent upon the reaction of consumers and the trade to these differences and any perceived differences in taste or texture which may exist.

A two phase research effort was designed to evaluate both consumer and market acceptance of the two selected tomatoes. The first phase consisted of consumer evaluations by 400 households and the second phase was an in-store market test of the two tomatoes which involved thirteen supermarkets over a four week period. Each phase of the study is discussed in detail in the following sections.

CONSUMER ACCEPTANCE

The first phase of the research project is designed to examine the consumer evaluation of the two varieties. Specifically the objectives of this first phase are as follows:

1. To determine consumer evaluation of the Chico III, 145 and "standard" round tomato in terms of general appearance, taste, internal and external texture, ripeness, internal and external color, size and firmness.
2. To determine the existence of differences in evaluation scores depending on the method of presentation of the product; single stimulus versus double stimulus.

Procedure

A panel of 400 households was selected in the Dallas, Texas metropolitan area. A random cluster sample with twenty clusters was selected, with a total of twenty households designated as members of each cluster. Households directly across the street were used as alternates where needed. A system requiring two call-backs was used to insure maximum possible use of the originally designated households.

The two test tomatoes and one standard "round" tomato were combined in four basic ways which are referred to in this report as treatments. The four treatments are as follows:

- Treatment A: Households received a sample of standard round variety plus a sample of Number 145.
- Treatment B: Households received a sample of standard round variety plus a sample of the Chico III tomato.
- Treatment C: Households received a sample of only Number 145.
- Treatment D: Households received a sample of only the Chico III tomato.

Distribution of the products was made over a three day period in a manner such that each cluster of twenty households received an equal number of each of the four treatments. At the time of placement, evaluation forms for each sample were left with a return envelope for mailing. Each member of the household fourteen years old or older was requested to evaluate individually each of the samples provided.

The evaluation forms contained a nine-point rating scale for each factor evaluated (Tables 1-3). The evaluations were based on the following factors: general appearance, taste, internal texture, skin texture or toughness, ripeness, internal color, skin color, size and firmness. Additional questions were included regarding usage of the tomatoes and demographics of respondents. Telephone calls were made to those households who had not returned their evaluation forms after two weeks in order to stimulate returns.

Results

Alternate Methods of Presentation

Two different methods were used to present the test tomatoes to the panel. One-half of the panel received a sample of one test tomato along with a sample of a standard round tomato. The other half of the panel received only a sample of the test tomatoes.

An analysis of the responses for the two groups is presented in Tables 1 and 2. A chi-square test was used to examine the frequency distributions for the responses of each of the two methods of presentation. In no instance was the calculated chi-square values significant at the .05 level for either Number 145 (Table 1) or Chico III (Table 2).

Table 1. Comparison of Two Methods of Presentation: Mean Rating Scores by Factors for Breeding Line Number 145 Tomato.

EVALUATION FACTOR	DOUBLE STIMULUS	SINGLE STIMULUS	F-VALUE	CHI-SQUARE
<u>General Appearance</u> (1-9; 9 excellent)	6.97	7.28	1.96	7.11
<u>Taste</u> (1-9; 9 excellent)	7.57	7.69	.36	10.70
<u>Internal Texture</u> (1-9; 9 excellent)	7.18	7.45	1.71	8.68
<u>Skin Texture or Toughness</u> (1-9; 1 too tough, 5 just right, 9 too tender)	4.26	4.26	.00017	10.54
<u>Ripeness</u> (1-9; 1 too ripe, 5 just right, 9 not ripe enough)	4.94	5.21	5.35*	13.92
<u>Internal Color</u> (1-9; 1 too red, 5 just right, 9 too green)	5.05	5.13	.80	5.79
<u>Skin Color</u> (1-9; 1 too red, 5 just right, 9 too green)	5.15	5.11	.28	7.35
<u>Size</u> (1-9; 1 too small, 5 just right, 9 too large)	4.51	4.09	10.08**	11.35
<u>Firmness</u> (1-9; 1 too firm, 5 just right, 9 too soft)	5.21	4.90	10.56**	12.27

Source: Consumer Panel; 327 respondents, Dallas, Texas, November, 1970.

*Significant at the .05 level.

**Significant at the .01 level.

Table 2. Comparison of Two Methods of Presentation: Mean Rating Scores by Factors, Chico III Variety.

EVALUATION FACTOR	DOUBLE STIMULUS	SINGLE STIMULUS	F-VALUE	CHI-SQUARE
<u>General Appearance</u> (1-9; 9 excellent)	6.39	6.64	1.28	7.40
<u>Taste</u> (1-9; 9 excellent)	6.89	6.74	.44	5.19
<u>Internal Texture</u> (1-9; 9 excellent)	6.72	6.70	.007	3.78
<u>Skin Texture or Toughness</u> (1-9; 1 too tough, 5 just right, 9 too tender)	4.22	3.76	6.32*	11.62
<u>Ripeness</u> (1-9; 1 too ripe, 5 just right, 9 not ripe enough)	5.18	5.04	1.31	12.58
<u>Internal Color</u> (1-9; 1 too red, 5 just right, 9 too green)	5.24	5.12	1.42	5.74
<u>Skin Color</u> (1-9; 1 too red, 5 just right, 9 too green)	5.10	5.03	.57	14.82
<u>Size</u> (1-9; 1 too small, 5 just right, 9 too large)	4.33	4.16	3.84	12.74
<u>Firmness</u> (1-9; 1 too firm, 5 just right, 9 too soft)	4.91	4.76	1.35	9.36

Source: Consumer Panel; 314 respondents, Dallas, Texas, November, 1970.

*Significant at .05 level.

An F-test was employed using standard Analysis of Variance techniques to measure individual factor differences in the two methods of presentation. In general the mean rating scores for the two methods of presentation are not significantly different at the .05 level, although there are some exceptions. For Number 145, ripeness, size and firmness revealed significant differences between the two methods of presentation. For the Chico III only, skin texture was significant different at the .05 level.

Evaluations by both groups of respondents are in close agreement with few significant differences evident. Consequently, the data for the two groups of responses are combined into one aggregate sample.

Data Analysis

The combined analysis of all respondents for the three tomatoes is presented in Table 3. In general the standard round tomato has the lowest rankings while Number 145 has the highest. With a limited supply of fresh round tomatoes in November, the quality level is below normal. The lower quality level is reflected in the ratings given to the standard round variety by the consumer panel.

Chi-square analysis of combined data for all test tomatoes indicate a different frequency distribution for each of the nine factors. Chi-square analysis for the Number 145 and Chico III combined data (eliminating the standard round tomato) reveals that some factors are no longer significant. General appearance, taste, internal texture and firmness still show significantly different distributions. For each of these factors, Number 145 ranks the highest. In fact, on all evaluation factors Number 145 ranks higher than, or equal to, the Chico III variety.

Table 3. Tomato Evaluation Survey: Average Evaluation Scores, by Type of Tomato. All Respondents.^{1/}

EVALUATION FACTOR	ROUND	145 (PLUM TYPE)	CHICO III (PEAR TYPE)	CHI-SQUARE (ALL TOMATOES)	CHI-SQUARE (145 AND CHICO III)
<u>General Appearance</u> (1-9; 9 excellent)	5.7 (3)	7.1 (1)	6.5 (2)	101.28**	25.15**
<u>Taste</u> (1-9; 9 excellent)	6.2 (3)	7.6 (1)	6.8 (2)	91.55**	34.67**
<u>Internal Texture</u> (1-9; 9 excellent)	6.2 (3)	7.3 (1)	6.7 (2)	71.95**	34.00**
<u>Skin Texture or Toughness</u> (1-9; 1 too tough, 5 just right, 9 too tender)	4.5 (1)	4.3 (2)	4.0 (3)	40.88**	12.66
<u>Ripeness</u> (1-9; 1 too ripe, 5 just right, 9 not ripe enough)	5.4 (3)	5.1 (1 [†])	5.1 (1 [†])	81.59**	4.98
<u>Internal Color</u> (1-9; 1 too red, 5 just right, 9 too green)	5.6 (3)	5.1 (1)	5.2 (2)	84.96**	7.13
<u>Skin Color</u> (1-9; 1 too red, 5 just right, 9 too green)	5.7 (3)	5.1 (1 [†])	5.1 (1 [†])	127.16**	8.90
<u>Size</u> (1-9; 1 too small, 5 just right, 9 too large)	4.6 (1)	4.3 (2 [†])	4.3 (2 [†])	30.27*	5.86
<u>Firmness</u> (1-9; 1 too firm, 5 just right, 9 too soft)	5.1 (1 [†])	5.1 (1 [†])	4.8 (3)	61.96**	22.33**

^{1/} Numbers in parenthese are rankings.

[†] Indicates a tie in the ranking for this factor.

**Significant at the .01 level of probability

*Significant at the .05 level of probability

Source: computed from data collected in Dallas, Texas, November, 1970.

The F-test indicates generally the same findings as did the chi-square analysis with the exception of skin texture which does have a significant difference at the .05 level.

Other factors such as family income and age were examined in relation to the evaluation of quality factors. Analysis of the effects of these demographic variables on perceived quality differences does not reveal any significant relationships. The differences between the test tomatoes are generally the same for all income and age groups.

Conclusions

Comparable ratings on general appearance, taste, internal texture, skin texture, ripeness, internal color, skin color, size, and firmness may be obtained from a consumer panel by presenting the test tomatoes to the consumers either with or without a standard round tomato as a check. Few significant differences are observed in the ratings given to the test tomatoes under the two methods of presentation. It is evident that the respondents made independent evaluations of the test tomatoes without being influenced by the check tomato.

Of the two test tomatoes, Number 145 ranks higher than the Chico III in general appearance, taste, internal texture and firmness. The differences between the two test tomatoes for the other factors, while not significant, still favor the Number 145.

MARKET ACCEPTANCE

The second phase of this research project is designed to measure market acceptance of the Chico III and Number 145 tomatoes. The crucial test of any new product is whether or not it is accepted in the market place. The primary objective of the second phase of the study is to determine how well the two new tomatoes sell in typical supermarket produce departments when consumers have a choice of other types of tomatoes commonly available, such as the regular large round tomatoes and cherry tomatoes. Another major objective is to determine trade acceptance of the two test tomatoes.

Procedure

Twelve retail stores of a leading supermarket chain were selected as test stores in the Dallas metropolitan area. The research design consisted of six pairs of stores, which represented a broad range of store sizes with respect to sales volume. The individual stores in each pair were carefully matched on the basis of produce department sales. Within each pair, one store was designated to test market the Chico III tomato and the other store to test market Number 145, so that six stores offered the Chico III and six similar stores offered the Number 145 tomato.

It was planned that the test would be conducted a maximum of eight weeks, subject to an adequate supply of test tomatoes. During the first test week, produce buyers objected to the puffiness of the Chico III tomato. ^{1/}Since the

^{1/}United States Department of Agriculture, United States Standards for Fresh Tomatoes, June 28, 1957 and Amendment effective October 15, 1961, indicates that degree of puffiness is considered in determining the grade of the tomatoes. Increased puffiness causes the grade to decline.

test tomatoes were being offered to consumers on a volume measure rather than weight, i. e., packed in pint plastic containers, buyers took the position that puffiness did not provide consumers with the expected weight compared to typical fresh tomatoes. Puffiness is a characteristic of the Chico III variety, and the seriousness of the problem depends on growing conditions. Puffiness is not associated with the Number 145.

As a consequence of puffiness in the Chico III variety, the cooperating supermarket chain agreed to offer the Chico III variety in the designated six test stores for one full week and subsequently Number 145 in all twelve stores for the balance of the test period. In addition to the designated twelve stores, the cooperating chain allowed audits to be taken in a thirteenth store where Number 145 was also offered.

Sales data were obtained for both test tomatoes for one full week, May 16-22. Sales data for Number 145 and competing fresh tomatoes were obtained from the thirteen stores for three additional weeks, May 23-June 12.

Test stores were visited twice each week. Audits were taken of all fresh tomatoes on Mondays to ascertain weekly sales volume. Display space and prices were recorded on Mondays and Thursdays. Weekly customer transaction count data was also obtained for each store so that sales could be expressed on a "per customer" basis.

Results

Sales Analysis of Test Tomatoes

Sales data from the various stores were measured on a common basis by calculating sales in pounds per thousand customers (Table 4). The stores

Table 4. Sales of Test Tomatoes Per 1,000 Customers,
Week of May 16-22, 1971.^{1/}

Pairs of Stores	Sales Per 1,000 Customers	
	Chico III	Number 145
	(pounds)	
Pair No. : 1	26.62	32.62
2	16.49	28.03
3	21.65	37.57*
4	30.82	47.89
5	47.94*	46.90
6	21.96	23.08
Means	27.58	36.02

^{1/} The paired t statistic for the data in this table is 2.7144 with 5 degrees of freedom. This is statistically significant at the 95 percent level of confidence.

* An asterisk indicates an out-of-stock situation which may have restricted sales of the test tomato.

Source: computed from data collected in store audits in Dallas, Texas.

offering Number 145 sold an average of 36.02 pounds of the test tomato per thousand customers per week, whereas the stores selling the Chico III variety sold 27.58 pounds per thousand customers per week. Sales data analysis using the paired t statistic indicate that the differences in sales per thousand customers per week for the six pairs of stores are statistically significant at the .05 level (Table 4). The sales data were also analyzed on the basis of pounds sold per square foot of display area per thousand customers. No significant differences were observed due in part to the fact that a large amount of variance existed in the display space variable.

Sales of the two test varieties are also expressed as a percentage of total tomato sales in the stores in which they were offered (Table 5). In general, percentage sales of the Number 145 are greater than sales of the Chico III variety. During the first test week, sales of Number 145 represented 36.3 percent of total tomato sales in all six stores, whereas sales of the Chico III variety represented 25.1 percent.

Sales of both varieties represented a sizeable proportion of total tomato sales. However, it should be noted that the two test tomatoes had a substantial price advantage as well as a display space advantage over other types of tomatoes (Table 6). While Number 145 has a significant sales advantage, the test was conducted over a shorter period of time than originally planned. It should be recognized that in a longer test period other factors such as repeat purchases may become important.

Sales of Number 145 Relative to Other Types of Tomatoes

Sales of the Number 145 tomato account for slightly over 30 percent of total tomato sales during the four week test period. The standard large

Table 5. Percentage of Total Tomato Sales - Chico III and Number 145. May 16-22, 1971.

Pairs of Stores	Share of Total Tomato Sales	
	Chico III	Number 145
	(percent)	
Pair No. : 1	28.4	41.7
2	43.0	43.9
3	16.9*	27.0
4	26.3	61.7
5	35.0	30.1*
6	13.8	31.4
TOTALS	25.1	36.3

*An asterisk indicates an out-of-stock situation which may have restricted sales of the test tomato.

Source: computed from data collected in store audits, Dallas, Texas.

Table 6. Mean Price and Display Space by Type of Tomato Package, Week of May 16-22, 1971.

Type of Tomato	Mean Price Per Pound	Mean Display Space	Number of Stores
	(cents)	(square feet)	
Chico III	39.0	5.03	6
Number 145	39.0	4.32	6
Bulk (large round)	49.0	4.13	12
Tube Packed (medium round)	62.0	3.14	12
Cherry Tomatoes	74.0	1.50	8
Plastic Bag (medium round)	43.0	1.70	1

Source: computed from data collected in store audits, Dallas, Texas.

round tomato offered in bulk displays accounts for about 52 percent, and the tube pack tomatoes account for approximately 13 percent of total tomato sales. Cherry tomatoes constitute approximately four percent of total tomato sales, while medium-sized round tomatoes offered in plastic bags account for slightly over one percent (Table 7).

During the entire four week period for all stores, the Number 145 tomato compared favorably with other types of tomatoes in terms of sales per thousand customers. Weekly sales of Number 145 averaged about 31 pounds per thousand customers; bulk, tube, cherry, and plastic-bagged tomatoes averaged approximately 50, 13.4, and 5 pounds respectively (Table 8). While sales of the Number 145 compare favorably with other types of tomatoes, it should be recognized that the test tomatoes in most cases had a substantial price advantage as well as an advantage in display space (Table 9).

The possibility of differences in sales of the test tomatoes, as related to the income level of the store clientele was examined. The stores were separated into two income levels based on census data and current information on the neighborhoods in which each store is located. The analysis of sales of the test tomatoes per thousand customers showed virtually no difference between stores in high and low income neighborhoods. Weekly sales of all test tomatoes in the higher income areas averaged 29.7 pounds per thousand customers while the average was 29.9 pounds per thousand customers in the stores in lower income neighborhoods.

Trade Acceptance of Test Tomatoes

As indicated earlier, a major problem occurred with the Chico III variety which necessitated a change in the original research design. Trade personnel

Table 7. Percent of Total Tomato Sales by Type of Tomato. May 16-
June 12, 1971 (All Stores Offering Number 145).

Type of Tomato	Share of Total Tomato Sales
	(percent)
Number 145	30.1
Bulk (large round)	52.2
Tube Pack (medium round)	12.7
Cherry	3.8
Plastic Bag (medium round)	1.1

Source: computed from data collected in store audits, Dallas, Texas.

Table 8. Mean Sales of Tomatoes per 1,000 Customers
For All Stores, May 16-June 12, 1971.

Type of Tomato	Number of Observations	Sales Per 1,000 Customers (pounds)
Number 145	38	31.2
Bulk (large round)	52	50.6
Tube Packed (medium round)	52	12.7
Cherry	41	4.5
Plastic Bag (medium round)	10	5.2

Source: computed from data collected in store audits, Dallas, Texas.

Table 9. Mean Prices and Display Spaces of Various Types
of Tomatoes for all Stores, May 16-June 12, 1971.

Type of Tomato	Price Per Pound	Size of Display Area
	(cents)	(square feet)
Number 145	39.0	6.00
Bulk (large round)	46.4	4.40
Tube packed (medium round)	61.6	3.10
Cherry	70.5	1.72
Plastic bag (medium round)	43.2	1.45

Source: computed from data collected in store audits, Dallas,,Texas.

involved in produce buying and merchandising operations were dissatisfied with the Chico III variety due to the puffiness which was evident in a high percentage of the Chico III tomatoes. This characteristic was considered serious enough to terminate retail offerings of the Chico III variety after about one week. In general, the Number 145 was well received, with no specific complaints noted, and trade personnel appeared satisfied.

CONCLUSIONS AND IMPLICATIONS

These findings reveal that the Number 145 is preferred over the Chico III. The results from the 400 family test panel indicate that Number 145 is rated significantly higher than the Chico III variety with respect to general appearance, taste, internal texture, and firmness. On other factors, Number 145 is rated higher than or equal to the Chico III variety.

The market acceptance phase of the study also indicates a significant preference for the Number 145 over the Chico III in terms of sales per thousand customers. It is recognized, however, that very limited data is available for the Chico III variety. Trade personnel express a preference for Number 145, primarily because of the puffiness of the Chico III variety.

While the Number 145 tomato is acceptable in the Dallas fresh market, possible variations in demand may exist in other markets. The existence of such variations should be examined by following up commercial shipments to other markets with an evaluation of consumer and trade reaction. With the development of markets for this tomato, having characteristics amenable to machine harvesting, the South Texas fresh tomato industry will be in a position to compete favorably with imports and other producing areas in the United States.