RESEARCH PROGRESS REPORTS

Fruit and Vegetable Processing and Technology Division

DEPARTMENT OF HORTICULTURE
1827 Neil Avenue
Columbus 10, Ohio

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
Wooster, Ohio
THE OHIO STATE UNIVERSITY
in cooperation with
OHIO COOPERATIVE EXTENSION SERVICE
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EVALUATION OF SNAP BEAN VARIETIES FOR PROCESSING

by

Wilbur A. Gould, J. Fairbrother and W. N. Brown

Fifteen varieties of snap beans, 12 green and 3 wax were grown on the Horticultural Farm at The Ohio State University. Ten of the varieties had been grown in the 1964 season. The 5 different varieties included Resistant Asgrow Valentine, Tenderette, Tendergreen, Topcrop and Surecrop Stringless Wax. The beans were planted in 200 foot rows, 36 inches apart with the seed placed two to three inches apart in the row. The beans were grown under normal commercial practices for this region, which includes overhead spray irrigation. Five varieties were harvested only once (Resistant Asgrow Valentine, Resistant Kinghorn Wax, Surecrop Stringless Wax, Tendergreen and Topcrop), the remainder were harvested twice.

The beans were harvested by hand and transported immediately to the Fruit and Vegetable Processing and Technology Division Pilot Plant. Here they were prepared for canning, freezing and dehydration. Pilot plant equipment was used and this included mechanical snipping and size grading, spray washing, steam blanching and hand packing twelve ounces into number 303 plain tin cans. Two size grades were used, 1-3 and 4-6 cans, the latter were cut into pieces 1 to 1½ inches long, the smaller size grade were packed as whole beans. Blanch time varied from 2½ to 4 minutes depending on sieve size.

The beans were divided by variety and sieve size into two lots as follows:

1. One third for canning.
2. Two thirds for freezing, of which one half was for subsequent dehydration.

The beans for canning 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 for 20 minutes. The beans for freezing were sealed in the cans and frozen without further treatment.

Quality was determined as follows (the results as reported in the following tables are the average values where applicable):

Number of plants - The actual number of plants in 100 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.

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 a one pound field run sample were determined and weighed. The percentage of each sieve size was then calculated.

Pod length - Pod length was determined by evaluating 20 pods as to minimum, maximum, and average length.
Percent by weight seeds - Determined on raw, canned and frozen products and reported in Tables I, II, and III by sieve size. For determining percent by weight seeds, 100 grams of pods for each sieve size was deseeded and the seeds weighed.

The grade for both the canned and frozen products by the respective attributes of quality was determined in accordance with the U.S. Standards for Grades of Canned and the U.S. Standards for Grades of Frozen Snap Beans. The actual score points assigned each of the attributes of quality are recorded by sieve size and harvest for each of the varieties as reported in Tables II and III.

The grade factor "Absence of Defects" was the greatest cause of downgrading of the canned samples from A to B (or lower grade). The major defect was the presence of too many small (less than 3/4 inch) pieces in the can. In commercial operation this could largely be overcome by the use of an additional grading step prior to packing. In this case, all the varieties examined would be acceptable for canning.

The three wax varieties are not recommended for use as a frozen product, due mainly to the poor color of the beans on thawing.

Earliharvest, Greenpod and Tendercrop can be recommended for use as whole or cut frozen beans, while Resistant Asgrow Valentine, Slenderwhite and Tendergreen are recommended for use as whole frozen beans only.
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* Indicates Limiting Rule.
** Indicates Partial Limiting Rule.
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<td>34***</td>
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**Limiting Rules:**

* Samples with these scores may not be of higher grade.

** Samples scoring here for blemished and seriously blemished beans may not be higher than Grade B.

*** Samples scoring here, except of sliced lengthwise, may not be higher than Grade B.
EVALUATION OF TOMATO VARIETIES FOR PROCESSING

by

W. A. Gould, J. R. Geisman, W. D. Bash and J. R. Morley

The 1965 Tomato Variety Trials included 8 varieties of tomatoes which were grown in replicated plots under acceptable commercial practices at the Ohio Agricultural Research and Development Center - Northwest Branch, Hoytville, Ohio. Each variety was harvested 2 times, and following harvest the tomatoes were transported by truck (approximately 100 miles) to Columbus, Ohio for processing.

Quality was determined as follows (the results as reported in the following tables are the average values):

1. Size or average count per 25 pounds. A random sample of 25 pounds of tomatoes were weighed and the total number of tomatoes were determined.

2. Percent total acid as citric. The sample (raw or canned) 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:

\[
\text{% acid as citric} = \frac{(\text{No. ml. of } 0.1 \text{ N NaOH}) (0.0064)}{10 \text{ ml. sample}} \times 100
\]

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

4. Agtron F samples of raw or canned tomato juice were presented to the Agtron F instrument in a standard plastic sample cup. The instrument was standarized, using a black plastic plate (Monsanto Lustrex 11250) as 0, and a red plastic plate (Monsanto Lustrex 11250) as 70. Readings were taken directly.

5. Percent soluble solids. An Abbe 3L refractometer was used for direct determinations of percent soluble solids on raw or canned juice. The instrument was standardized with distilled water and all readings converted to 20°C.

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

7. Grade of Canned Tomato Juice. The grade was determined in accordance with the U.S. Standards for Grades of Canned Tomato Juice.

8. Viscosity. The viscosity was measured using the OOSUC efflux type instrument containing a 5/64" opening and standardized at 23 seconds at 25°C with water. The rate of flow from the instrument was measured with a stop watch and the readings recorded directly.

9. Agtron E. A random sample of 20 raw tomatoes were cut in half and color measured on the Agtron E instrument. The "E" values reported are an average for the 20 tomatoes.

10. Milligrams of vitamin C per 100 grams of tomato juice. Ten 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 - dichorphenol-indophenol indicator solution. Milligrams of vitamin C were determined by the following formula:
Dye factor x ml. of dye x 100 = mgm. Vit. C
\[
\text{100 gms.}
\]

PREPARATION AND PROCESSING

All tomatoes were prepared and processed as either whole tomatoes or tomato juice according to acceptable commercial practices in the OSU Pilot Plant. Variations in process for whole tomatoes were as follows:

Process Code
1. cored, steam scald, and calcium salt only.
2. cored, lye peel, and calcium salt plus 1 gm./303 can citric acid.
3. not cored, lye peel, and calcium salt plus 1 gm./303 can citric acid.
4. cored, steam scald, and calcium salt plus 1 gm./303 can citric acid.

Each lot was filled to 11.5 - 12.0 oz. in No. 303 plain tin cans.

The detailed data are presented in Tables I, II, and III.

TABLE I

1965 RAW PRODUCT TOMATO VARIETY EVALUATION
OBJECTIVE QUALITY AND CHEMICAL ANALYSIS

<table>
<thead>
<tr>
<th>Variety</th>
<th>Count/25 lbs.</th>
<th>pH</th>
<th>% Citric Acid</th>
<th>% Soluble Solids</th>
<th>Agtron (F)</th>
<th>mg. Vit. C per 100 gm.</th>
<th>Agtron (E)</th>
<th>Shape*</th>
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<tr>
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<td>0.40</td>
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<td>0.36</td>
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* R = round and O = oblong.
TABLE II

1965 TOMATO VARIETY EVALUATION
GRADE AND OBJECTIVE EVALUATION OF TOMATO JUICE

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<th>pH</th>
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<th>Solids</th>
<th>Color</th>
<th>Inst. (Sec.)</th>
<th>Vit. C (mg/100 g)</th>
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**TABLE III**

**1965 TOMATO VARIETY EVALUATION**
**GRADE AND OBJECTIVE EVALUATION OF WHOLE TOMATOES**

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<td>96.8</td>
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<td>VF 145-21-4</td>
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<td>0.42</td>
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<td>14.8*</td>
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<td>C</td>
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<td>89.8</td>
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<td>4.2</td>
<td>0.60</td>
<td>16.3</td>
<td>19.5</td>
<td>26.0*</td>
<td>91.8</td>
<td>B</td>
</tr>
</tbody>
</table>

* Limiting Rule.
INFLUENCE OF VARIETY ON THE QUALITY OF CANNED APPLE SAUCE

Department of Horticulture
James F. Gallander

The evaluation of apple varieties for processing has been in progress for many years at the Research Center. The objective of this study was to determine the effect of several Ohio grown apple varieties on the quality of canned apple sauce. The varieties included those which are classified as established and new to Ohio apple growers.

Each variety was harvested at optimum picking maturity and delivered to the Department of Horticulture of the Ohio Agricultural Research and Development Center in Wooster for processing. The apples were placed in cold storage for 1 week and then removed for processing. After washing, the apples were machine peeled, cored and sliced, and the slices were immediately placed in a 3% NaCl solution to retard browning. Slices were then flushed with cold water and placed in baskets for pre-cooking, 5 minutes at 212°F. The cooked slices were discharged directly into a pulper with a 0.062 - inch screen. At this point sugar was added to give a soluble solids reading of 20% Brix. Then, the apple sauce was filled at 195°F into no. 303 cans, sealed, inverted and cooled immediately to room temperature.

The apple sauce was evaluated organoleptically for flavor, color and texture by a 10-member taste panel. Each panelist was asked to score the product on a hedonic scale of 1 through 9 (5 and above being acceptable).

The mean values of the three quality attributes for each variety are presented in Table 1. Golden Delicious sauce was rated highest for color and appeared to have a bright golden color. Jonathan was ranked second in color and the other varieties, except Red Delicious and McIntosh, were regarded close. Red Delicious and McIntosh sauces appeared gray and were scored unacceptable by the taste panel.

Table 1. - Effect of Variety on Apple Sauce Quality.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Color Rating</th>
<th>Flavor Rating</th>
<th>Texture Rating</th>
<th>Overall Quality (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jonathan</td>
<td>7.26</td>
<td>6.34</td>
<td>6.74</td>
<td>6.78</td>
</tr>
<tr>
<td>Franklin</td>
<td>5.85</td>
<td>5.37</td>
<td>5.63</td>
<td>5.62</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>3.15</td>
<td>3.52</td>
<td>3.74</td>
<td>3.47</td>
</tr>
<tr>
<td>McIntosh</td>
<td>4.28</td>
<td>5.66</td>
<td>6.29</td>
<td>5.18</td>
</tr>
<tr>
<td>Ruby</td>
<td>6.26</td>
<td>6.18</td>
<td>6.18</td>
<td>6.21</td>
</tr>
<tr>
<td>Stayman Winesap</td>
<td>6.33</td>
<td>6.22</td>
<td>5.67</td>
<td>6.11</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>7.74</td>
<td>6.29</td>
<td>6.63</td>
<td>6.89</td>
</tr>
<tr>
<td>Rome Beauty</td>
<td>6.26</td>
<td>6.03</td>
<td>6.59</td>
<td>6.29</td>
</tr>
<tr>
<td>Melrose</td>
<td>5.93</td>
<td>6.59</td>
<td>6.74</td>
<td>6.42</td>
</tr>
</tbody>
</table>

For flavor Melrose and Jonathan sauces were most preferred. The other varieties in decreasing order for flavor were: Golden Delicious, Stayman Winesap, Ruby, Rome Beauty, McIntosh, Franklin, and Red Delicious. The sauce of Red Delicious was regarded as "flat" and was rated unacceptable.
The sauces which were scored for texture were rather close except Red Delicious. The sauce made from Red Delicious was rated unacceptable by the taste panel. Melrose and Jonathan appeared to have the best texture and were followed by the varieties: Golden Delicious, Rome Beauty, McIntosh, Ruby, Stayman Winesap, Franklin, and Red Delicious.

In summary, the varieties for sauce in this study were ranked as follows: Golden Delicious, Jonathan, Melrose, Rome Beauty, Ruby, Stayman Winesap, Franklin, McIntosh and Red Delicious.
INFLUENCE OF VARIETY AND STORAGE ON THE QUALITY OF CANNED APPLE SLICES

James F. Gallander
Department of Horticulture

This study was initiated to investigate the effect of variety and raw product storage duration on the quality of canned apple slices. Nine apple varieties were included in the study: McIntosh, Franklin, Melrose, Ruby, Rome Beauty, Stayman Winesap, Red Delicious, Golden Delicious, and Jonathan.

Ten bushels of each variety were harvested at what was regarded as optimum maturity. A portion of each variety was immediately processed. The remainder was placed in cold storage (32°F) and processed at storage intervals of 6, 12, and 18 weeks.

Processing Procedure

After peeling and coring, the raw apples were sliced and placed in a 2 percent salt (sodium chloride) solution. Slices were then drained and subjected to 28 inches of vacuum for 10 minutes. The vacuum was broken with steam and the slices removed and flushed with cold water. The slices were then placed in No. 303 cans, covered with boiling water, sealed and processed for 10 minutes at 212°F.

Organoleptic Evaluation

After the canned slices were stored for approximately 6 weeks, they were presented to a taste panel for evaluation as to flavor, color, and texture. Each panelist was asked to score the slices for the three quality attributes on a hedonic scale of 1 to 9 (5 and above being acceptable).

Results and Discussion

Results of the organoleptic evaluation are reported in Tables 1 and 2. The overall quality or the mean value of the combined scores for flavor, color, and texture is presented in Table 1. These results summarize the data in Table 2, which includes the scores for each quality attribute of the various varieties and treatments.

Table 1. Effect of apple storage duration and variety on the overall quality (flavor, color, and texture) of canned slices, 1964 Season

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Harvest</th>
<th>6 Weeks</th>
<th>12 Weeks</th>
<th>18 Weeks</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>McIntosh</td>
<td>4.06</td>
<td>6.52</td>
<td>6.71</td>
<td>6.07</td>
<td>5.84</td>
</tr>
<tr>
<td>Franklin</td>
<td>5.53</td>
<td>5.73</td>
<td>5.41</td>
<td>5.36</td>
<td>5.51</td>
</tr>
<tr>
<td>Jonathan</td>
<td>5.98</td>
<td>6.19</td>
<td>5.56</td>
<td>6.26</td>
<td>6.09</td>
</tr>
<tr>
<td>Red Delicious</td>
<td>5.79</td>
<td>5.61</td>
<td>5.18</td>
<td>4.13</td>
<td>5.18</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>7.21</td>
<td>6.63</td>
<td>6.07</td>
<td>5.64</td>
<td>6.39</td>
</tr>
<tr>
<td>Ruby</td>
<td>6.05</td>
<td>6.15</td>
<td>5.30</td>
<td>3.82</td>
<td>5.33</td>
</tr>
<tr>
<td>Melrose</td>
<td>6.98</td>
<td>6.29</td>
<td>5.60</td>
<td>4.88</td>
<td>5.94</td>
</tr>
<tr>
<td>Stayman Winesap</td>
<td>6.77</td>
<td>7.84</td>
<td>6.86</td>
<td>6.68</td>
<td>7.04</td>
</tr>
</tbody>
</table>
Variety Effect: Four varieties, Golden Delicious, Melrose, Rome Beauty, and Stayman Winesap, were rated highest on the basis of overall quality at harvest time (Table 1). Melrose was best in flavor while Golden Delicious and Stayman Winesap were scored highest in color and texture, respectively (Table 2). McIntosh was unacceptable at harvest for all three quality attributes.

When the apples were held in cold storage for 6 weeks, the leading variety for overall quality was Stayman Winesap, followed in decreasing order by Rome Beauty, Golden Delicious, McIntosh, Melrose, Jonathan, Ruby, Franklin, and Red Delicious. Flavor scores in Table 2 show that Stayman Winesap, McIntosh, Golden Delicious and Rome Beauty were best. Stayman Winesap and Rome Beauty received the highest scores for color and texture.

The best varieties at 12 weeks of cold storage were as follows: Stayman Winesap, McIntosh, Rome Beauty, and Golden Delicious. Flavor scores showed that McIntosh was superior. The other varieties were nearly identical, except Ruby and Red Delicious which were unacceptable. For color, Stayman Winesap and Red Delicious were rated highest, with McIntosh, Rome Beauty, and Golden Delicious ranking as the next best varieties. The slices from Melrose were rated unacceptable for color. Stayman Winesap and Melrose were rated higher for texture than the other varieties.

Overall quality of canned slices made from apples held for 18 weeks showed that Stayman Winesap and Jonathan were the most preferred varieties. Stayman Winesap received the highest score for flavor, followed by McIntosh, Jonathan, Franklin and Rome Beauty. Ruby, Melrose, Red Delicious, and Golden Delicious were rated poor for flavor. Color scores showed that Stayman Winesap and Golden Delicious were better than the other varieties. Franklin, Melrose, Red Delicious, and Ruby were not acceptable to the taste panel. Jonathan, McIntosh, Stayman Winesap, and Melrose slices exhibited the highest texture scores, while Ruby was the only variety unacceptable.

Storage Effect: Storage duration, as shown in Tables 1 and 2, affects the quality of canned apple slices. Generally, slices made from apples held for 18 weeks in cold storage received lower scores than those of shorter storage periods. There appeared to be an improvement in texture of canned slices from apples stored for a short period of time. Slices made from apples at harvest were usually tough and rubbery; by short storage, a more ideal firmness and wholeness was obtained. The color scores in Table 2 show that most varieties developed maximum color acceptability at 6 weeks of storage. A further increase in apple storage tended to produce slices with a dull appearance.

Summary

Under the conditions of this study, the varieties for canned apple slices rated on the basis of overall quality are as follows: Stayman Winesap, Golden Delicious, Rome Beauty, Jonathan, Melrose, McIntosh, Franklin, Ruby, and Red Delicious. Canned slices of maximum quality, color, flavor, and texture were usually obtained from apples stores for a short period of time.
Table 2.--Effects of apple storage duration and variety on the flavor, color, and texture of canned slices, 1964 season.

<table>
<thead>
<tr>
<th>Storage Duration</th>
<th>McIntosh</th>
<th>Franklin</th>
<th>Jonathan</th>
<th>Red Delicious</th>
<th>Golden Delicious</th>
<th>Ruby</th>
<th>Melrose</th>
<th>Stayman Winesap</th>
<th>Rome Beauty</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest</td>
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<td><strong>6.42</strong></td>
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<td>6.75</td>
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<td>6 Weeks</td>
<td>6.52</td>
<td>5.33</td>
<td>5.88</td>
<td>5.11</td>
<td>6.15</td>
<td>5.60</td>
<td>5.72</td>
<td>7.26</td>
<td>6.11</td>
<td>6.00</td>
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<tr>
<td>12 Weeks</td>
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<td>5.23</td>
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<td>6.27</td>
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<tr>
<td>18 Weeks</td>
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<td>5.95</td>
<td>6.19</td>
<td><strong>4.49</strong></td>
<td><strong>4.53</strong></td>
<td>5.22</td>
<td>4.96</td>
<td>6.83</td>
<td>5.72</td>
<td>5.57</td>
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<tr>
<td>Average</td>
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<td>5.69</td>
<td>5.60</td>
<td><strong>4.83</strong></td>
<td><strong>5.69</strong></td>
<td>5.40</td>
<td><strong>5.78</strong></td>
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<td>5.95</td>
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L. S. D. 5% Level .. 1.05

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<th>Storage Duration</th>
<th>McIntosh</th>
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<th>Jonathan</th>
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<th>Golden Delicious</th>
<th>Ruby</th>
<th>Melrose</th>
<th>Stayman Winesap</th>
<th>Rome Beauty</th>
<th>Average</th>
</tr>
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<tbody>
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<td>Harvest</td>
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<td>6.86</td>
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<tr>
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<td>5.72</td>
<td>6.91</td>
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<td>7.81</td>
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<td>*</td>
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<td>5.25</td>
<td>6.35</td>
<td>6.11</td>
<td>7.12</td>
<td>5.24</td>
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L. S. D. 5% Level .. 0.90

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<th>Jonathan</th>
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<th>Golden Delicious</th>
<th>Ruby</th>
<th>Melrose</th>
<th>Stayman Winesap</th>
<th>Rome Beauty</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>Harvest</td>
<td>4.27</td>
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<td>5.17</td>
<td><strong>6.65</strong></td>
<td>5.60</td>
<td>5.86</td>
<td>6.38</td>
<td>7.18</td>
<td>5.82</td>
</tr>
<tr>
<td>6 Weeks</td>
<td>5.53</td>
<td>6.12</td>
<td>5.78</td>
<td>4.56</td>
<td>6.12</td>
<td>6.30</td>
<td>5.91</td>
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<td>6.08</td>
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<td>5.87</td>
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<tr>
<td>18 Weeks</td>
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<td>5.64</td>
<td>6.80</td>
<td>5.17</td>
<td><strong>5.88</strong></td>
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<td>*</td>
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<tr>
<td>Average</td>
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<td>5.77</td>
<td>6.05</td>
<td><strong>4.84</strong></td>
<td><strong>6.24</strong></td>
<td>5.36</td>
<td>6.21</td>
<td><strong>6.85</strong></td>
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</tbody>
</table>

L. S. D. 5% Level .. 1.01

* Significance at the 5% level
EFFECT OF VARIETY AND STORAGE DURATION ON THE QUALITY OF FROZEN APPLE PIES

James F. Gallander and Harold Stammer
Department of Horticulture

The main objective of this study was to determine the effect of variety and raw product storage duration on the quality of frozen apple pies. During the 1964 season, nine apple varieties were harvested at what was regarded as an optimum picking maturity. The nine varieties were: McIntosh, Jonathan, Red Delicious, Golden Delicious, Stayman Winesap, Rome Beauty, Ruby, Franklin and Melrose. After harvest, a two-bushel sample of each variety was processed and six bushels were placed in cold storage at 34°F. These apples were removed from storage and processed at the following intervals: 6, 12 and 18 weeks.

Processing Procedure

After machine peeling, coring and slicing, the raw apple slices were trimmed and immediately placed in 3% NaCl solution. Then, the slices were used in a standard pie recipe which the crust and ingredients were essentially the same for each pie as well as the amount of each ingredient. After the pies (9 inches in diameter) were prepared, they were frozen and stored in a freezer at -15°F.

Organoleptic Evaluation

After a storage period of 4 to 6 weeks, the pies were baked and presented to an 8-member taste panel for evaluation. Each panelist was asked to score the pies for flavor, color and texture on a hedonic scale of 1 through 9 (9 being the most acceptable). A set of six samples was presented to the taste panel daily, until all varieties and treatments were evaluated.

Results and Discussion

The results of the raw product storage duration and variety effects on the quality of frozen apple pies are presented in Tables 1 and 2. The overall quality (flavor, color and texture) for each variety at the different storage periods is shown in Table 1. The mean scores of each quality attribute for all varieties including the four time intervals are presented in Table 2.
Table 1 -- Effect of Apple Storage Duration and Variety on the Overall Quality (flavor, color and texture) of Frozen Apple Pies, 1964 Season.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Harvest</th>
<th>6 Weeks</th>
<th>12 Weeks</th>
<th>18 Weeks</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>McIntosh</td>
<td>5.70</td>
<td>6.17</td>
<td>5.92</td>
<td>5.23</td>
<td>5.76</td>
</tr>
<tr>
<td>Franklin</td>
<td>4.63</td>
<td>6.39</td>
<td>5.94</td>
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<td>5.55</td>
</tr>
<tr>
<td>Jonathan</td>
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<td>6.19</td>
<td>6.77</td>
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<td>6.26</td>
</tr>
<tr>
<td>Red Delicious</td>
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<td>4.72</td>
<td>5.48</td>
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<td>Golden Delicious</td>
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<td>6.73</td>
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<tr>
<td>Rome Beauty</td>
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<td>Average</td>
<td>5.49</td>
<td>6.02</td>
<td>6.24</td>
<td>5.83</td>
<td></td>
</tr>
</tbody>
</table>

Variety Effect: At harvest, pies made from apple slices of the varieties: Stayman Winesap, Golden Delicious, McIntosh and Jonathan were rated best for overall quality, Table 1. The variety, Stayman Winesap, was scored highest for flavor followed by Jonathan, Melrose and Golden Delicious, Table 2. For color, pies made from varieties: Golden Delicious, Stayman Winesap, McIntosh and Ruby were ranked superior. The texture scores showed that Stayman Winesap, Golden Delicious and Rome Beauty were preferred over all other varieties.

The results of the overall quality of pies made from apples stored for 6 weeks showed that Golden Delicious, Stayman Winesap, Franklin and Rome Beauty were the most acceptable varieties. The varieties: Franklin, Melrose, McIntosh and Jonathan were rated best for flavor. The most preferred varieties for color were: Golden Delicious, Jonathan, Stayman Winesap and Ruby. Texture scores indicated that Franklin was best followed in decreasing order by: Golden Delicious, Rome Beauty and Stayman Winesap.

The overall quality of pies made from apples held in cold storage for 12 weeks indicated that the preferred varieties were: Jonathan, Golden Delicious, Rome Beauty and Ruby. McIntosh, Jonathan, and Franklin pies exhibited the highest flavor scores. Golden Delicious was highly rated for color followed by Jonathan, Ruby and Stayman Winesap. Texture scores for the individual varieties showed that Golden Delicious, Jonathan, Melrose and Stayman Winesap were best.

The results of overall quality for pies made from apples stored at 18 weeks showed that Stayman Winesap ranked highest and the next best varieties were: Jonathan, Ruby and Melrose. Flavor scores for each of the varieties were nearly identical, but Ruby and Melrose were rated highest and Red Delicious lowest. Stayman Winesap was scored the most acceptable variety in color; followed by Golden Delicious, Jonathan and Ruby. Melrose received the highest texture score with Jonathan, Stayman Winesap and Rome Beauty ranking as the next best varieties.
Storage Effect: The quality of pies was improved if processed from apples held for a short storage period rather than from those immediately after harvest, Tables 1 and 2. In addition, those made from apples stored for 18 weeks received lower scores for each quality attribute rather than from storage of 6 and 12 weeks, Table 2. The mean scores of flavor, color and texture for all varieties indicated that apples held for 6 to 12 weeks in cold storage made the best pies.

Summary

The varieties in decreasing order for frozen apple pies based upon the overall quality are as follows: Golden Delicious, Stayman Winesap, Jonathan, Rome Beauty, Melrose, Ruby, McIntosh, Franklin and Red Delicious. Frozen apple pies of maximum quality, flavor, color and texture were usually obtained from apples held in cold storage for a short period of time, 6 to 12 weeks.
Table 2 -- Effects of Apple Storage Duration and Variety on
the Flavor, Color, Texture of Frozen Apple Pies,
1964 Season.

<table>
<thead>
<tr>
<th>Storage Duration</th>
<th>McIntosh</th>
<th>Franklin</th>
<th>Jonathan</th>
<th>Red Delicious</th>
<th>Golden Delicious</th>
<th>Ruby</th>
<th>Melrose</th>
<th>Stayman Winesap</th>
<th>Rome Beauty</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest</td>
<td>5.82</td>
<td>4.64</td>
<td>6.39</td>
<td>5.13</td>
<td>5.90</td>
<td>5.29</td>
<td>5.93</td>
<td>6.84</td>
<td>5.78</td>
<td>5.75</td>
</tr>
<tr>
<td>12 Weeks</td>
<td>7.19</td>
<td>6.81</td>
<td>7.12</td>
<td>5.70</td>
<td>6.58</td>
<td>6.38</td>
<td>6.68</td>
<td>6.79</td>
<td>6.07</td>
<td>6.59</td>
</tr>
<tr>
<td>18 Weeks</td>
<td>6.52</td>
<td>6.18</td>
<td>6.78</td>
<td>5.39</td>
<td>6.16</td>
<td>7.18</td>
<td>7.09</td>
<td>6.36</td>
<td>6.33</td>
<td>6.44</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td>N.S.</td>
<td>N.S.</td>
<td>*</td>
<td>*</td>
<td>N.S.</td>
<td>N.S.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.S.D. 5% Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Harvest          | 6.52     | 5.01     | 6.41     | 5.09          | 7.34            | 6.47 | 5.42    | 7.31           | 5.51        | 6.12    |
| 6 Weeks          | 5.86     | 5.65     | 7.03     | 5.27          | 7.55            | 6.80 | 6.19    | 6.80           | 6.09        | 6.36    |
| 12 Weeks         | 5.40     | 5.80     | 7.16     | 6.31          | 7.53            | 6.92 | 6.28    | 6.14           | 6.24        | 6.15    |
| 18 Weeks         | 4.69     | 5.07     | 6.65     | 4.89          | 7.06            | 6.47 | 5.47    | 7.37           | 5.93        | 5.97    |
| *                |          | N.S.     | N.S.     | *             | N.S.            | N.S. | N.S.    |                |             |         |
| Average          | 5.62     | 5.38     | 6.81     | 5.39          | 7.37            | 6.71 | 5.84    | 6.98           | 5.94        |         |
| L.S.D. 5% Level  |          |          |          |               |                 |      |         | 0.89           |             |         |

| Harvest          | 4.77     | 4.23     | 4.22     | 3.42          | 5.27            | 4.40 | 4.56    | 5.14           | 5.19        | 4.61    |
| 6 Weeks          | 5.95     | 6.18     | 4.98     | 3.66          | 6.22            | 5.65 | 5.17    | 6.01           | 6.14        | 5.58    |
| 12 Weeks         | 5.16     | 5.20     | 6.04     | 4.43          | 6.10            | 5.29 | 5.78    | 5.72           | 4.88        | 5.40    |
| 18 Weeks         | 4.49     | 4.44     | 5.77     | 3.80          | 5.35            | 5.11 | 5.95    | 5.57           | 5.42        | 5.10    |
| *                |          | *        | N.S.     | *             | N.S.            | *    | N.S.    |                |             |         |
| Average          | 5.09     | 5.08     | 5.25     | 3.83          | 5.74            | 5.11 | 5.37    | 5.67           | 5.41        |         |
| L.S.D. 5% Level  |          |          |          |               |                 |      |         | 1.07           |             |         |
SUMMARY OF RESIDUE RESEARCH
by
W. A. Gould and J. R. Geisman

The human dietary chain from seed to consumer is subject to materials added both intentionally and unintentionally. These materials may be helpful to the consumer, or may not have any effect, or may be a potential health hazard. It is important that the effects of processing and storage of foods on these materials be fully understood.

The use of pesticides in production, storage and transportation of foods has increased dramatically during the past decade. Likewise, experiments with nuclear devices have also increased. The literature has revealed a lack of information on the effects of processing on either of these residues in foods. With the above in mind, four projects have been undertaken with the general objective of determining the role of processing in reducing, removing or inactivating residues in processed fruits and vegetables. A synopsis of each project is given below:

Title and Number: Trace Levels of Pesticide Residues in Agricultural Commodities in Marketing Channels. NCM-37 (Hatch 303)

Objectives: The over-all objective is to develop processing procedures for the removal, reduction or detoxification of pesticide residues and conversion products in agricultural commodities with specific objectives:

a. The influence of preparation, washing procedures and processing techniques on stability of pesticides in fruit and vegetables.
b. Modifications of present processing techniques to remove or reduce toxicity of chemical residues in food products.

Current Research: This is a regional project with Ohio conducting experiments in the area of defoliant chemicals used on tomatoes and potatoes. This study involves peeling methods and washing techniques for tomatoes processed whole or as juice. Effect of storage temperatures and times as well as frying temperatures for potatoes made into chips are being evaluated. Both crops were mechanically harvested. The products are being evaluated for quality and residues.

Title and Number: Effects of Selective Herbicides on the Composition and Quality of Tomatoes and Potatoes. SS 1142

Objectives:

1. To determine if 1x and 2x applications of approved herbicides can affect the qualitative and quantitative yields of potatoes and tomatoes.

2. To determine if special handling of the raw product and the processed product can be utilized in an effort to minimize any possible adverse effect of the herbicide used.

3. To utilize the best objective qualitative analyses of the raw product and processed tomato and potato, as related to possible herbicide effects.

4. To utilize radioactive isotope procedures in evaluating the persistence of herbicides in the raw product and processed items, i.e., potato and tomato.
5. To more clearly ascertain the effects of herbicides on the quality of tomatoes and potatoes as fresh vegetables; and also to determine the role of processing in this area.

Current Research: This is a contract project from the U.S.D.A. Experiments have been conducted utilizing mechanically harvested tomatoes and potatoes. Herbicide chemicals were applied at the specified rates. Quality of the raw products was determined and residue assays were made. Variations were made in peeling methods and washing techniques as well as handling practices for tomatoes. Potatoes were stored at different times and temperatures and manufactured into chips. The finished product was analyzed for quality and residues. Samples were also prepared for neutron activation analysis.

Title and Number: Radiochemical Determinations of Pesticides and Food Additives Before, During and After Processing. Hatch 222


Objectives:

1. To determine pesticide and food additive residues on fruits and vegetables during preparation and processing using radioactive tracer techniques.

2. To determine detergent and related chemical compound residues used in washing fruits and vegetables with the aid of radioactive isotopes.

3. To study some of the changes of these chemicals which occur during the unit operations (washing, blanching, chopping, pasteurizing and sterilizing) in processing.

Current Research: This is a federally supported project. Experiments have been conducted using spinach, apples and tomatoes. Insecticides, such as Aldrin and D.D.T., labeled with radiocarbon were applied to the crops. Evaluation of the reduction in activity with time as well as removal due to the unit operations in processing were made. Residues were determined by chemical analysis and scintillation spectroscopy techniques. Autoradiograms were also made to determine whether the material was absorbed or adsorbed.

Title and Number: Effect of Food Processing on Radioactive Fallout. (RF 1502)

Personnel: J. R. Geisman (co-leader), W. A. Gould (co-leader) and Research Assistants.

Objectives:

1. To determine the role of the unit operations involved in the preparation of foods for processing in reducing the contamination from fallout on the crop.

2. To develop a monitoring system to serve as a safety device to the workers in a food processing plant as well as to determine the degree of freedom from contamination of the foods to be processed.

Current Research: This is a grant from the National Institute of Health. Three crops; spinach, tomatoes and potatoes were utilized. Strontium 90 was added to the crops. Autoradiograms were made to determine the depth of penetration of the isotope and the amount, if any, of translocation. Variations in washing techniques and peeling methods were made. Reductions were determined by gas flow beta counting techniques. A comparison of varieties was also made to
determine if differences exist between varieties in absorption of Strontium 90. A conveyor was built with a platform for a monitoring device. Relationships were established between activity of raw and processed products.

In summary, the material above was presented to demonstrate the type of research being carried out in the area of removal of residues. The results of these studies when completed should more clearly define the role of production practices and preparation methods of food for processing.
HANDLING AND HOLDING STUDIES OF MECHANICALLY HARVESTED TOMATOES

by

W. A. Gould, W. D. Bash, and J. R. Geisman

I. Introduction and Background

During the 1965 season, handling and holding practices of mechanically harvested tomatoes and their effects on product quality have been under investigation by the Fruit and Vegetable Processing and Technology Division in cooperation with the Vegetable Crops Division, Department of Horticulture and Forestry, The Ohio State University and The Ohio Agricultural Research and Development Center. The preliminary work on this project originated in 1960 with some pilot plant studies on holding tomatoes in various combinations of chlorine, detergent, and water.

With the interest expressed by the tomato processing industry toward the use of mechanical tomato harvesting, more extensive work was undertaken in the following years. Each year's results were applied to the experimental design for the following year.

Until 1964, two tomato varieties, Eastern States 24 and Heinz 1370 were used for the handling and holding studies. However, for the last two years, only the variety Heinz 1370 which exhibited superior mechanical harvesting characteristics has been used. This has allowed for an intensification of treatments and studies.

The primary objective of this project has been to design a satisfactory handling and holding procedure for mechanically harvested tomatoes. This has entailed the testing of existing containers and on two occasions the development or modification of containers to fulfill the above stated objective. The industry 30 lb. hamper and the 40 and 50 lb. lug boxes were used as the standard containers throughout the project. The new 40 lb. plastic box, the plywood bulk box, the O.S.U. tote box and the O.S.U. Chase tank have been new containers tested and/or developed over the last few years. The tote box has been used for harvesting into and holding the tomatoes in a dry condition as well as being used for dip treatments. For the dipping treatments, the inside of the tote boxes were lined with 4 mil polyethylene. The tote box was filled approximately ½ full (20 gal.) with the dip solution. Tomatoes were harvested directly into the solution and allowed to stand for the desired dipping period. At the end of the time interval the polyethylene was slit through the bottom of the box to allow the solution to drain, thus, allowing the tomatoes to be transported dry. Researchers at the Ohio Agricultural Research and Development Center and The Ohio State University in cooperation with the Chase Foundry Manufacturing Company, Columbus, Ohio designed and adopted a new steel tank for use in handling mechanically harvested tomatoes. The tank was designed primarily for continuous water holding which included harvesting directly into the holding solution. These tanks were first used in 1964 and had the following design features: 500 lb. tomato capacity, interlocking ability for four high stacking, inside rim to prevent spillage during transport and for support of a cover lid, platform skid for easy forklift truck pickup, sloped bottom for easy dumping, and a trip lever for automatic dumping by the lift operator.

Before the 1964 season, the Ohio Agricultural Research and Development Center purchased an FMC Mobile Western Model Mechanical Tomato Harvester for use at the Northwestern Branch farm. This has been a great asset to the total program since harvesting dates can be controlled by the researchers. It should be pointed out as was stated previously that the objectives of this project are aimed at developing, handling and holding system rather than the evaluation of mechanical harvesters.
During 1965, a total of 23 treatments were used in handling and holding the mechanically harvested tomatoes. These treatments were very similar to those used in 1964. The major change was the expanded use of chlorine dioxide as the bactericidal agent in the holding and dipping solutions. This change was indicated from the preliminary use of this agent in the 1964 study and some intensive laboratory investigation following the season. Following is a complete list of the handling and holding variables used in 1965:

<table>
<thead>
<tr>
<th>Code</th>
<th>Container</th>
<th>Treatment (Harvest &amp; Handling)</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>Hamper</td>
<td>Hand Dry</td>
</tr>
<tr>
<td>121</td>
<td>Hamper</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>221</td>
<td>Midwest Lug</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>321</td>
<td>California Lug</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>421</td>
<td>Plastic Box</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>422</td>
<td>Plastic Box</td>
<td>FMC 3 min. Dip water w/ClO₂ 250 ppm</td>
</tr>
<tr>
<td>423</td>
<td>Plastic Box</td>
<td>FMC 3 min. Dip water w/ClO₂ 500 ppm</td>
</tr>
<tr>
<td>424</td>
<td>Plastic Box</td>
<td>FMC 3 min. Dip water w/ClO₂ 500 ppm-Detergent</td>
</tr>
<tr>
<td>425</td>
<td>Plastic Box</td>
<td>FMC 10 min. Dip water w/ClO₂ 250 ppm</td>
</tr>
<tr>
<td>426</td>
<td>Plastic Box</td>
<td>FMC 10 min. Dip water w/ClO₂ 500 ppm</td>
</tr>
<tr>
<td>427</td>
<td>Plastic Box</td>
<td>FMC 10 min. Dip water w/ClO₂ 500 ppm-Detergent</td>
</tr>
<tr>
<td>521</td>
<td>Tote Box</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>526</td>
<td>Tote Box</td>
<td>FMC 10 min. Dip ClO₂ 500 ppm</td>
</tr>
<tr>
<td>527</td>
<td>Tote Box</td>
<td>FMC 10 min. Dip ClO₂ 500 ppm-Detergent</td>
</tr>
<tr>
<td>621</td>
<td>Plywood Box</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>627</td>
<td>Plywood Box</td>
<td>FMC 10 min. Dip ClO₂ 500 ppm-Detergent</td>
</tr>
<tr>
<td>721</td>
<td>Tank</td>
<td>FMC Dry</td>
</tr>
<tr>
<td>722</td>
<td>Tank</td>
<td>FMC Cl 1000 ppm-Detergent</td>
</tr>
<tr>
<td>723</td>
<td>Tank</td>
<td>FMC ClO₂ 1000 ppm-Detergent</td>
</tr>
<tr>
<td>724</td>
<td>Tank</td>
<td>FMC ClO₂ 500 ppm</td>
</tr>
<tr>
<td>726</td>
<td>Tank</td>
<td>FMC ClO₂ 100 ppm</td>
</tr>
<tr>
<td>727</td>
<td>Tank</td>
<td>FMC ClO₂ 50 ppm</td>
</tr>
<tr>
<td>728</td>
<td>Tank</td>
<td>FMC ClO₂ 100 ppm-Detergent</td>
</tr>
</tbody>
</table>

As soon as possible after harvest, the filled containers were loaded onto a two-ton flat bed truck and transported to The Ohio State University, Department of Horticulture, Processing & Technology Pilot Plant, Columbus. The distance from Hoytville to Columbus is approximately 100 miles. After unloading, the filled containers were held in an open parking lot behind the pilot plant for periods up to 24 hours.

Samples for processing were taken from each of the treatments at 12 and 24 hours after harvest. At each sampling period approximately 50 pounds of tomatoes from the various types of containers were processed as canned tomatoes for subsequent evaluation after storage period. After the 24 hour hold period of the raw product, juice was also manufactured from the tomatoes remaining from each treatment. At each sample period, the lots were sampled for raw product evaluation and bacteriological examination. Each of these areas will be discussed in the following sections of this report.
Bacteriological Spore Counts

Bacteriological aerobic heat resistant spore counts have been one of the areas of primary importance ever since the mechanical tomato harvesting and handling systems evaluation work began in 1960. This area of work has been perpetuated by the concern expressed by some segments of the processing industry in that the increased contact of tomatoes and soil during mechanical harvesting will increase the spore load on the fruit. It is conceivable that spore populations might be increased on damaged fruit, due to the large numbers of spores present in the soil, to the point that washing and present heat processing procedures would not be adequate to properly preserve canned tomatoes or tomato products. This has been the primary reason that chlorine compounds have been incorporated into the dipping and holding solutions as chlorine containing compounds are among the best bacteria control agents.

Up until last year chlorine in the form of sodium hypochlorite had been used in making up all solutions. During 1964, chlorine dioxide was evaluated for the first time. The preliminary results indicated this material to be much more effective in destroying and controlling growth of the soil spore forming bacteria present on the tomatoes after harvest. In the work thus far using sodium hypochlorite, concentrations of 500 ppm of chlorine or above had to be maintained in order to reduce the spore counts to a desirable amount. In order to test the preliminary results, a series of laboratory experiments were developed to evaluate chlorine dioxide and, thus, obtain information that could be used in developing treatments for the 1965 handling and holding studies.

The procedure for pouring, plating, incubating, and counting were the same as those used previously during this study. The major change involved the use of standardized bacterial heat resistant spore suspensions instead of the usual wash water obtained from the harvested tomatoes. The spore suspensions were made from soil samples taken at the Northwestern Branch Farm. Solutions containing the soil samples were plated and the three most common colony types which had appeared in the handling and holding studies were isolated and grown in pure cultures. These cultures were then pasteurized at 170°F for ten minutes in order to kill all vegetative cells. This treatment provided a spore suspension for use in evaluating the effect of chlorine dioxide and its ability to kill and/or control the germination of these spores. The test solutions were made with 10, 25, 50, 100, 200, 300, 500 ppm of chlorine using chlorine dioxide as the chlorine source. In addition, each of these chlorine concentrations were made up with an organic matter content of 0, 0.1, 0.5, 1.0, and 5.0 percent. The organic matter was obtained by adding tomato juice on a volumetric basis.

The standardized spore suspension containing all 3 spore types was pipetted into the test solutions and allowed to remain for 5, 15, 30, and 60 minute exposures before plating. A similar set of test solutions were made using sodium hypochlorite as the chlorine source.

The procedure for sampling the various handling and holding treatments and determining the aerobic spore count was basically the same as that used in previous years. After the 100 mile transport to The Ohio State University pilot plant, bacteriological samples were taken at twelve and twenty-four hour intervals after harvest. Two sampling techniques had to be used since some tomatoes were held continuously in the holding solutions, while the tomatoes that had been dipped and those receiving no solution treatment were in a dry condition at the time of sampling. Sampling procedure for the water tanks was merely to slowly lower and raise an 8 oz. small mouth bottle in the tank until filled. Sampling the dry tomatoes was accomplished by weighing a 4 lb. representative sample of tomatoes and washing in an agitating manner for 2 minutes with 1 lb. of water in a covered plastic container. Samples for analysis were then taken from this wash water.
The National Canners Association recommendation for pasteurizing, diluting, plating, and incubating was closely followed. The procedure is as follows: An aliquot of approximately 30 ml. of the holding solution or wash water was pasteurized in a large screw cap test tube at 180°F for 10 min. Immediately after pasteurization the tube was cooled to room temperature. This pasteurization process killed all vegetative bacterial cells and left only viable spores which could germinate and grow during the incubation period. Aliquots from these tubes were diluted in sterile water blanks to give a range of plating dilutions. Pour plates were made from these dilutions using Tomato Juice Agar (Difco #B389) as the media. The plates were incubated for 48 hours at 98°F and then counted to determine the total aerobic spore content from each plate.
### Table I. AVERAGE SPORE COUNTS FROM CHLORINE DIOXIDE LABORATORY TREATMENTS

<table>
<thead>
<tr>
<th>% Organic Matter</th>
<th>PPM Chlorine</th>
<th>Exposure Duration (min.)</th>
<th>Sodium Hypochlorite</th>
<th>Exposure Duration (min.)</th>
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<tr>
<td></td>
<td>5</td>
<td>15</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
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<td>2.5</td>
<td>1.3</td>
<td>.5</td>
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<tr>
<td>400</td>
<td>4.0</td>
<td>1.0</td>
<td>1.8</td>
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<td>300</td>
<td>3.3</td>
<td>1.3</td>
<td>1.8</td>
<td>2.0</td>
</tr>
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<td>200</td>
<td>4.8</td>
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<td>2.5</td>
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<td>1.3</td>
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<td>66.5</td>
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<td>4.3</td>
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III. QUALITY OF THE PROCESSED PRODUCT

As was the case in previous seasons, samples for processing were taken at specified periods after harvest. At each period, samples were taken randomly from each of the bulk containers from the top to the bottom for determination of sound and damaged fruit. The tomatoes (approximately 50 lb. lot) from each treatment were canned as whole tomatoes using acceptable commercial practices. The tomatoes were packed (12 ounces per can) in #303 plain tin cans, covered with juice, a 30 grain sodium-calcium salt tablet was added, and they were retort processed for 20 minutes at 220°F. At the 24 hours sampling time, juice was also processed from the samples. Following three months storage at room temperature, the tomatoes were graded according to U.S. Standards for Grades of Canned Tomatoes (drained weight, wholeness, color, and absence of defects). In addition, color, vitamin C, pH and total acid were determined before and after canning for each lot. The juice was graded according to U.S. Standards for Grades of Tomato Juice (color, consistency, absence of defects and flavor). The data are reported in Tables II and III.

To determine whether hand or machine harvesting affected the quality of whole canned tomatoes, an evaluation of the finished product was made. The quality attributes selected for three dimensional analysis of variance were: (1) drained weight, (2) wholeness, (3) color, and (4) percent citric acid. The data showed no differences on quality due to harvesting methods.

Effects of handling after harvest were also evaluated using the above criteria.

Dry Treatments

All the dry treatments (lots 121, 221, 321, 421, 521, 621 and 721) were compared to determine whether type of container had any effect on quality of the finished product. There were no differences among the treatments for any of the attributes except for drained weight. For drained weight the interaction of harvest date with hold time was significant at the .05 level. These data indicated that the drained weight decreased with hold time (12 to 24 hrs.) but increased with harvest date (1st harvest to 2nd harvest).

Plastic Box Treatments

Analysis of the plastic box treatments (lots 421, 422, 423, 424, 425, 426, and 427) indicated that the attribute of wholeness was significantly different at the .01 level between harvest dates with the second harvest higher than the first. Also, a highly significant difference in wholeness was found for the interaction between harvest date and hold time. The wholeness of the processed tomatoes decreased with hold time for the first harvest but increased with hold time for the second harvest.

Bulk Wooden Containers

Data for processed tomatoes from the tote box (lot 521, 526 and 527) and the plywood box (lot 621 and 627) handling treatments showed that two attributes were significant. Drained weight was significantly decreased with hold time. Wholeness was affected by treatment with tomatoes from lot 521 being scored significantly higher than those from other treatments. Wholeness was highly significantly decreased from 12 hrs. to 24 hrs. for these treatments but was highly significantly increased from 1st harvest to 2nd harvest. The greatest variation was found within these treatments.
### TABLE II

1965 MECHANICAL HARVEST HANDLING TREATMENT EVALUATION
GRADE AND OBJECTIVE EVALUATION OF WHOLE TOMATOES

Average Values

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x Limiting Rule. Canned tomatoes falling into these classifications may not be graded higher regardless of total score.

xx Special limiting rule. Sample units of canned tomatoes falling into this classification may not be graded higher than U.S. Grade B, regardless of the total score.
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Bulk Tanks

The comparison of the data for tomatoes processed from the bulk tank treatments (lots 721, 722, 723, 724, 726, 727 and 728) showed the total acid take significantly reduced from 12 to 24 hours. Not only were these data significant statistically; but also, biologically. As the total acid was reduced the potential danger of spoilage was increased. The greatest decrease in total acid occurred in the dry tank and the least change occurred in the treatments using detergents.

General Observations

When all treatments were considered together, it was found that there was no effect of handling treatment on color, drained weight or total acid. There was a significant difference in wholeness due to handling treatment. Tomatoes from lot 728 scored lowest (16.2 average) while those from lot 111 were scored highest (18.7 average).

As might be expected, drained weight was highly significantly decreased with hold time. Wholeness scores also were significantly decreased with hold time.

The interaction of harvest date with hold time was significant for drained weight and highly significant for wholeness. Drained weight decreased with hold time more from the second harvest than from the first harvest, while wholeness decreased more on the first harvest than on the second harvest.

Juice

From Table II, it should be noted that regardless of treatment the tomato juice, which was processed after a 24 hour hold time, was grade A. Small differences were noted in the physical and chemical measurements of quality.

RESULTS

1. The laboratory evaluation of the two bactericidal agents sodium hypochlorite and chlorine dioxide indicated chlorine dioxide was definitely more effective in reducing the spore counts under the testing procedure than sodium hypochlorite. The data in Table I show the effect of the two agents on similar spore suspension under identical test procedures. When taking into account the data from the entire test including all treatments, chlorine dioxide was 88 times more effective than sodium hypochlorite in killing and controlling the spore counts. In most treatments, chlorine dioxide at 10 and 25 ppm was as good as or even more effective than the hypochlorite at 400 and 500 ppm. There were a few exceptions at the higher organic matter levels and the low chlorine dioxide contents where the sodium hypochlorite was more effective in controlling the spore counts. This condition only existed at the lower chlorine levels, while at the higher levels the chlorine dioxide was the most effective.

2. The data in Table II show that sodium hypochlorite concentrations of 500 ppm and chlorine dioxide as low as 250 ppm gave satisfactory spore control when used as a 3 minute dip for the 40 pound plastic boxes and as 10 minute dip treatments for the lined wooden tote and plywood boxes. Chlorine dioxide water tank treatments as low as 100 ppm effectively controlled spore counts.

3. When specific treatments in Table II are compared as to effect on holding period it is noted that very good control was maintained throughout the 24 hour period. In some of the previous holding tests where the sodium hypochlorite was used, the degree of control was decreasing by 24 hours and was practically lost by 48 hours.
4. The water tank chlorine dioxide treatments gave the greatest degree of control during the 24 hour hold period. However, the amount of variation between the water tank treatments and the dip treatments was not as effective last year as in some previous years.

5. The effect of detergent in the dip or holding solutions was not exhibited as prominently this year as has been in the past. In previous years when sodium hypochlorite was used as the bactericidal agent, the addition of 2500 ppm of detergent greatly reduced the effectiveness of the chlorine and the spore counts increased. However, with the use of the chlorine dioxide this detergent effect appeared to be reduced.

6. When the chlorine containing water tank treatments were used for handling and holding the tomatoes, there was no mold growth and Drosophila fly activity. Thus, eliminating the possibility of contamination.

7. In terms of canned product quality as evaluated by grade, the best treatments were machine harvest into the midwest lug (lot 221) followed by hand harvest into hampers (lot 111).

8. In general, canned product quality as measured by grade was decreased one grade by holding 24 hours. This is primarily due to a decrease in drained weight due to holding. The average difference was approximately ½ ounce.

9. On an average, the wholeness grade factor decreased from the hand harvest in hampers (lot 111) to machine harvest in tanks (lot 728).

10. After 24 hours holding, there are no significant differences among the various treatments on the quality (grade and chemical assay) of the juice.

From the standpoint of bacteriological spore counts and quality differences, the best handling systems are the tank treatments with chlorine dioxide and detergent. As the rate of chlorine dioxide is increased from 50 to 1000 ppm the spore count is reduced.
FLAVOR STUDIES WITH Kraut

by

J. R. Geisman

Research on new sauerkraut products was conducted in three phases this year. Each will be discussed separately.

A series of samples were processed to determine the effect of added sweetening agents on the drained weight of sauerkraut. A standard procedure was used as follows. Twelve ounces of sauerkraut were filled into #303 sauerkraut enameled cans and covered with three ounces of brine with or without added sweetening agents. The acidity of the brine was reduced to 1.0 percent as lactic and the salt content was standardized at 1.3 percent. Sucrose, glucose (corn syrup) or combinations of the two were added to the brine in sufficient quantity to produce 25° Brix. This level was chosen since it was slightly above the detectable level. The combinations of sweetening agents are given in Table 1.

<table>
<thead>
<tr>
<th>Code</th>
<th>Percent Sucrose</th>
<th>Percent Glucose</th>
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<td>0</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
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<td>75</td>
</tr>
<tr>
<td>7</td>
<td>32.5</td>
<td>67.5</td>
</tr>
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</table>

The lots were processed and stored. Samples of each lot were analyzed at 5, 6, 7, 8, 11 and 13 weeks for color, pH, total acid, soluble solids and drained weight.

The results indicated that pH and total acid remained unchanged throughout the storage period. Sucrose alone, as previously reported, produced a slight darkening in the product. All combinations involving glucose had a desirable color and sheen. Soluble solids fluctuated throughout the storage period, but generally tended to decrease until an equilibrium point was reached. This occurred at approximately 10% soluble solids/or 10° Brix. The cut-out brine was approximately 40% of the added brine after equilibrium.

The most interesting aspect of this phase was the effect on drained weight of the kraut shreds. The lot without any sweetening added increased slightly in drained weight until the end of the storage where the average drained weight was 13.9 ounces.
Most of the other samples had this same drained weight after the storage period except for the samples with 75% sucrose/25% glucose added and 32.5% sucrose/67.5% glucose added. These samples had a drained weight of 14.5 ounces after five weeks which did not change throughout the storage period. The samples with 75% sucrose/25% glucose added were preferred for flavor and texture.

These data indicated that the drained weight of kraut without sweetening increased by approximately 16 percent while the drained weight of the kraut sweetened with 75% sucrose/25% glucose increased by 21 percent. Since the minimum drained weight for a #303 can of sauerkraut is 13 ounces, this means that the fill weight could be reduced by at least five percent or to 11.5 ounces when this sweetening formula was used. This would produce at least one extra can per case or an extra case for each 24 cases packed.

Thus not only could the processor have a variety of kraut products, but also would obtain a higher case yield of the product.

Using the basic sweetening formula just described, apple slices of six apple varieties were added to determine which variety was most desirable for use in kraut. The varieties evaluated were Ruby, Stayman Winesap, Melrose, Rome Beauty, Franklin, Jonathan, Golden Delicious and Red Delicious. Canned slices were used. One and one-half ounces of slices were mixed with 12 ounces of kraut and filled into #303 sauerkraut enameled cans. Slices of each variety were divided into two lots; one lot was dipped in a 100 ppm calcium chloride solution prior to mixing, the other lot was not treated. After filling the mixture was covered with three ounces of a 25° Brix (75% sucrose/25% glucose) solution at 1.0 percent acid as lactic and 1.3 percent salt. To each can 0.01 ml. of Orange Oil was added to enhance the apple flavor. The samples were evaluated for pH, total acid as lactic, color, flavor, and texture.

The results indicated that the calcium chloride treatment produced a desirable effect on the texture of the apple slices. The treated slices retained the typical character of apples while the untreated slices were soft.

When flavor evaluations were made, kraut containing apple slices of the Melrose variety was rated the highest. Based on these results, a combination of apple slices and kraut would produce a new product which could be manufactured commercially.

The third aspect of the kraut research was the evaluation of flavoring agents. Several ingredients were utilized both singly and in combination as shown in Table II.

**TABLE II**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Cider</td>
<td>3 oz.</td>
</tr>
<tr>
<td>Cider Concentrated to 25° Brix</td>
<td>3 oz.</td>
</tr>
<tr>
<td>Catsup</td>
<td>2, 4, 6 oz.</td>
</tr>
<tr>
<td>Dill Juice</td>
<td>2, 4 gm.</td>
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<tr>
<td>Sesame Seeds</td>
<td>( \frac{1}{2}, 1, 2 ) gr.</td>
</tr>
<tr>
<td>English Walnuts</td>
<td>( \frac{1}{2} ) oz.</td>
</tr>
<tr>
<td>Concentrated Cider + Smoke</td>
<td>3 oz. + 0.01 cc.</td>
</tr>
<tr>
<td>Smoke + Dill Seed</td>
<td>0.01 cc/ + 1 gr.</td>
</tr>
<tr>
<td>Dill Seed + Mustard Seed</td>
<td>( \frac{1}{2} ) gr. + ( \frac{1}{2} ) gr.</td>
</tr>
<tr>
<td>Egg Whites + Pectin</td>
<td>50 gm. + 50 gm.</td>
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</table>
It should be noted that the egg white and pectin were added to chopped kraut in order to produce an hors d'oeuvres item. Kraut was mixed with these ingredients and allowed to gel. The product was cut into 1\" cubes and fried in deep fat. The laboratory panel rated this product extremely high.

Cider, concentrated cider and catsup were substituted for the brine on kraut. Concentrated cider was rated acceptable. The combinations of concentrated cider plus smoke flavoring and smoke plus dill seed were rated as acceptable by the laboratory panel. The products which rated acceptable will be evaluated further.

In summary, the conclusions drawn from the kraut research this year were as follows:

1. Use of a 75% sucrose/25% glucose sweetening brine for sauerkraut not only enhances the flavor but also increases the drained weight of the kraut shreds.

2. Melrose variety apple slices were most desirable for addition to kraut.

3. A 100 ppm calcium chloride dip treatment enhanced the texture of the apple slices in kraut.

4. Concentrated cider and combinations of concentrated cider plus smoke and smoke plus dill seed have potential for creating new kraut products.
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