LOSES OF VITAMIN C CONTENT DURING THE
COOKING OF SUMMER SQUASH

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COOKING OF SUMMER SQUASH

THESIS

Presented to the Graduate Council of the North Texas State Teachers College in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

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Paradise, Texas
August, 1941
90821
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CHAPTER I

INTRODUCTION

With the introduction of a chemical method of assay of vitamin C in foodstuffs, much has been written on the ascorbic acid content of vegetables and fruits and the effect of various factors upon it. Mack and Tressler\(^1\) have found that different varieties of peas contain different quantities of ascorbic acid. Tressler\(^2\) and his co-workers report that soils and soil conditions affect the ascorbic acid content more than variety does. They find that on the average spinach leaves grown on upland soils were 50 per cent higher in ascorbic acid content than those grown on muck soil.

That seasons affect the ascorbic acid content of vegetables has been shown by Bessey\(^3\) who reports that spinach grown in the fall has an appreciably higher vitamin C content than that grown in the spring.

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\(^3\)Otto A. Bessey, "Methods of Assay and Dietary Sources of Vitamin C," *Journal of American Medical Association*, CXI (1939), 1295-1298.
Many investigators have shown that maturity also affects the vitamin C content of vegetables. Fellers\(^4\) has found that tomatoes increase in vitamin C content as the fruit ripens, but he also finds that mature green tomatoes may have almost the same vitamin C content as the red ripe tomatoes. Most leafy green and root vegetables contain the greatest concentration of vitamin C during the period of most rapid growth. Sweet corn\(^5\) and green peas\(^6\) show a maximum vitamin C content during the tender stage and the amount decreases as the seeds mature.

Time, temperature, care in handling, and type of product are the important factors in the problem of vitamin C stability during storage.\(^7\)

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\(^4\)C. R. Fellers, *The Effect of Processing in Fruits and Vegetables: A Review*, Bulletin Number 331, Massachusetts State College Agricultural Experiment Station.


\(^7\)Otto A. Bessey, "Methods of Assay and Dietary Sources of Vitamin C," *Journal of American Medical Association*, CXI (1939), 1290-1298.
Freezing causes little or no losses in vitamin C in some vegetables but from 70 to 80 per cent loss may occur in beans, peas or spinach in a few hours through slow thawing. Losses are reduced to a minimum by cooking without preliminary thawing. 8

Other factors affecting the vitamin C content of vegetables and fruits are: presence of metals, 9 crushing or bruising, 10 canning and storing of canned foods, 11 pickling,


10 Dunker, Fellers and Fitzgerald, op. cit.


11 Kohman, Eddy and Gurin, "Canning Tomato Juice Without Vitamin Loss," ibid., XXV (June, 1933), 682.
salting, curing or fermenting, which completely destroys vitamin C,\textsuperscript{12} method of cooking\textsuperscript{13} as well as the length of the cooking period, drying,\textsuperscript{14} presence of oxygen in cooking,\textsuperscript{15} storage and reheating after cooking,\textsuperscript{16} processes

\textsuperscript{12}H. C. Sherman and S. L. Smith, \textit{The Vitamins}, American Chemical Society Monograph, 1931.

\textsuperscript{13}J. E. Richardson, R. Davis and H. L. Mayfield, "Vitamin C in Cooked Potatoes," \textit{Food Research}, II (1937), 85-91.

\textsuperscript{13}Sofia L. Bona and Isabelo Concepcion, "Vitamin C in Philippine Camotes," \textit{Natural and Applied Science Bulletin}, University of the Philippines, VII (Sept., 1940), 415-422.


\textsuperscript{14}Bessey, op. cit.

\textsuperscript{15}Sherman and Smith, op. cit.

\textsuperscript{16}Dunker, Fellers and Fitzgerald, op. cit.


\textsuperscript{16}J. A. Roberts, "Vitamin C in Citrus Juice Beverages," \textit{Food Research}, II (1937), 331.
used in jam making which destroy all vitamin C except in those instances where citrus fruit peelings were used,\textsuperscript{17} manipulations other than actual heating,\textsuperscript{18} and fertilizing.\textsuperscript{19}

Ascorbic acid, as far as nutrition is concerned, is dependent primarily on two things: (1) the natural potency of the particular plant or animal tissue, and (2) the methods used in distributing and processing the plant and animal tissues before their use as a food. For many reasons effort should be made to conserve the vitamin C values of the general supply even though some foods are now recognized as rich antiscorbutic foods. Perhaps a larger percentage

\textsuperscript{17} A. L. Bacharach, P. M. Cook and E. L. Smith, "The Ascorbic Acid Content of Certain Citrus Fruits and Some Manufactured Citrus Products," \textit{Biochemical Journal}, XXII (1934), 1038-1047.


\textsuperscript{18} A. Szent-Gyorgyi, "The Identification of Vitamin C," \textit{Biochemical Journal}, XXII (1928), 1387.


\textsuperscript{18} E. Neige Todhunter, "Some Factors Influencing Ascorbic Acid Content of Apples," \textit{Food Research}, I (1936), 435.
of our population than is generally realized do not include citrus fruits, tomatoes, or other potent vitamin C foods in their diets because of economic conditions, lack of nutritional knowledge, or poor food habits. These people necessarily depend on their general food supply for their source of this dietary essential. Bessey says:

The loss of important food qualities, such as flavor and the content of the other vitamins, usually parallels the destruction of vitamin C. In fact, the preservation of vitamin C may well be used as a general index to the care with which certain foods have been processed.17

The general food supply is usually the source of vitamin C for many people, and since squash is a common food in the popular diets of Texans and is so generally grown over the state, this study has a two-fold purpose: (1) to ascertain the amount of vitamin C in the two varieties of squash most commonly used as food in Texas, and (2) to determine the effect of various methods of cooking upon the vitamin C content of these two varieties of squash.

20 Bessey, op. cit.
CHAPTER II

PROCEDURE

The two varieties of squash used in this study were the Early White Bush Scallop or White Patty Pan and the yellow Crookneck. One lot of yellow variety was selected from the local market late in the afternoon of the day on which they were delivered to the market and were kept in a covered enamel container in an electric refrigerator over night and tested the next morning. They were grown in Dallas County.

One lot of the White Bush Variety was purchased from the local market on Tuesday afternoon after they had been delivered early Saturday and had been kept at room temperature. A second lot of this variety was secured and tested in the afternoon of the day they were delivered to the market.

One lot of each variety was gathered from a local garden early in the morning, kept in a covered enamel container in an electric refrigerator, and tested late in the afternoon of the same day.

The yellow squash selected was of medium size—approximately five to the pound in weight—and was prepared for cooking by washing carefully and slicing into slices.
approximately one-half inch in thickness. All were prepared in the same way at the same time, mixed thoroughly to insure uniformity of samples, and divided into one-pound lots for cooking. Each of the one-pound lots of sliced squash was then cooked by boiling rapidly in identical two-quart covered enamel sauce pans. Because Wilmot and Batjer suggest eight to twelve minutes as a desirable time for cooking this squash,\(^1\) the average—ten minutes—was chosen as the cooking time for the first lot. One-half cup of water was used in cooking. The second lot was cooked twenty minutes in one cup of boiling water, and the third lot was cooked thirty minutes in one and one-half cups of boiling water, to see the results of longer periods of cooking. The fourth lot was boiled for three minutes in one-half cup of rapidly boiling water and then sautéed in bacon fat for ten minutes.\(^2\) One squash weighing three and three-fourths ounces was boiled whole for twenty minutes in two cups of boiling water. The fifth lot was boiled in a similar amount of salted boiling water for ten minutes because Fliksen, reviewing the literature concerning vitamin C in

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1 Jennie S. Wilmot and Margaret Q. Batjer, *Food for the Family*, p. 32.

human foods, reports that salt retards the destruction of vitamin C.\textsuperscript{3}

The White Bush squash was prepared for cooking by washing carefully and cutting in one-half inch cubes, mixing thoroughly to insure uniformity of samples, and dividing according to the same methods described for the yellow squash. In addition to those methods of cooking, one white squash weighing three and one-half ounces was boiled whole for five minutes and baked in a moderate oven--350\textdegree F. for twenty minutes without breaking the skin. Another of similar size, weight, and shape was boiled five minutes, a portion of the inside was removed from the stem end, chopped, and returned to the cavity, and then baked at 350\textdegree F. for twenty minutes. This method was adapted from Wilmot and Batjer's\textsuperscript{4} recipe for stuffed squash, but their stuffing was omitted to prevent the introduction of more food material which might add ascorbic acid. The one baked whole after boiling was used for comparison with the broken one for the purpose of determining the destruction of vitamin C caused by cutting the skin and exposing a greater surface to the air. All cooking methods used were selected because they are the ones most commonly used in Texas.

\textsuperscript{3}Margaret A. Boas Fixsen, "Vitamin C Content of Human Foods as Affected by Processes of Cooking and Canning," Nutritional Abstracts and Reviews, VIII (1939), 281-293.

The method of assay used in this study was that described by Bessey and King. A ten-gram portion of the material to be tested was ground in a mortar with acid-washed white sand and 25 cc. of 8 per cent trichloracetic acid until a thin paste was formed. Another portion of the extracting liquid (10 cc.) was used to wash the mortar and was then stirred into the first mixture. The washing and rinsing process was repeated a second time, and the extract was decanted. The material which was being used can be successfully decanted instead of being centrifuged as suggested by King, since it separates quickly and easily from the extract. The decanted extracts were made up to a volume of 50 cc. Ten aliquot parts of the extract were diluted with 40 cc. of distilled water and titrated with a standard 2.6 dichlorophenolindophenol solution until a faint pink end-point was obtained. (About one minute is necessary for the titration.)

The dye solution was standardized with both ascorbic acid and lemon juice, and it was found that lemon juice can be used as effectively as the ascorbic acid.

All analyses were made in triplicate, and the figures herein reported are the average of the three analyses.

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6. Ibid.
CHAPTER III

DISCUSSION

As stated in the procedure, the methods used in cooking the two varieties of squash used in this study were selected because with one exception—the boiling of the whole white squash for twenty minutes—they are the most commonly used methods in Texas. The effect of cooking on the vitamin C content is especially important because in at least two instances outbreaks of scurvy have been reported on diets containing more than adequate amounts of highly, antiscorbutic vegetables.\(^1\) An investigation showed that they were improperly cooked, having been incorporated in meat stews or cooked in large quantities for at least five hours, a period long enough to destroy all the original vitamin C content. In the average Texas home the problem of overcooking vegetables is a serious one, although they are rarely cooked for five hours. When they are not overcooked, they may be allowed to stand an undesirable length of time before they are eaten. Several authors report that storing of cooked food at room temperature for even short periods of time causes a rapid destruction of vitamin

\(^1\) Medical Research Council, Vitamins: A Survey of the Present Knowledge, Special Report, Series Number 167 (1937), 3-5.
C. In institutions and public eating places where vegetables are cooked in large quantities and kept warm for several hours before they are finally served, the total destruction of vitamin C is almost inevitable.

It is evident from the data in Table 1, Samples 1 and 2, that vitamin C is lost during long periods of storage at room temperature. The white Bush squash which had been held in the open market for four days at room temperature contained about 43 per cent less vitamin C (13 mg. per 100 gm. as compared to 23 mg. per 100 gm. in shorter period of storage) than that kept only eight hours, and about 55 per cent less than the garden fresh (13 mg. per 100 gm. as compared to 29 mg. per 100 gm. of garden fresh). This is more than Tressler and his associates reported lost from Lima beans which had been stored four days, and about the same amount which they report as lost from spinach stored three days. However, some of this loss might be due to the badly bruised condition of the squash when it was delivered. Some other investigations definitely show that bruising causes rapid destruction.

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2 Margaret A. Boas Fixsen, "Vitamin C Content of Human Foods as Affected by Processes of Cooking and Canning," Nutrition Abstracts and Reviews, VIII (1939), 281-293.


<table>
<thead>
<tr>
<th>Method of Cooking</th>
<th>Garden Fresh</th>
<th>Open Market Sample 1a</th>
<th>Open Market Sample 2b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg./100 gm.</td>
<td>mg. Lost</td>
<td>Per Cent Loss</td>
</tr>
<tr>
<td>Raw</td>
<td>29</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Boiled 10 minutes</td>
<td>17</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>in salted water</td>
<td>16</td>
<td>11</td>
<td>39</td>
</tr>
<tr>
<td>Boiled 20 minutes (overdone)</td>
<td>14</td>
<td>15</td>
<td>53</td>
</tr>
<tr>
<td>Boiled 30 minutes (overdone)</td>
<td>13</td>
<td>16</td>
<td>56</td>
</tr>
<tr>
<td>Boiled whole 20 minutes (tender)</td>
<td>17</td>
<td>12</td>
<td>43</td>
</tr>
<tr>
<td>Boiled 5 minutes then baked 20 minutes (tender)</td>
<td>10</td>
<td>19</td>
<td>67</td>
</tr>
<tr>
<td>Boiled 5 minutes then stuffed and baked 20 minutes (tender)</td>
<td>9</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>Boiled 3 minutes then sautéed in bacon fat 10 minutes</td>
<td>7</td>
<td>22</td>
<td>76</td>
</tr>
</tbody>
</table>

a Stored in open market at room temperature four days.

b Stored in open market eight eight hours.
of vitamin C. Such losses are due to the breaking down of cell walls and subsequent oxidation of the vitamin.\(^5\)

The data in Table 1 also show that the length of the cooking period definitely affects the vitamin C content of the squash tested. The losses range from 39 per cent to 78 per cent per 100 grams of cooked substance. Fenton,\(^6\) working on Swiss Chard observed that after two minutes' boiling, 10 to 14 per cent of the original vitamin C content was destroyed and 18 to 24 per cent had passed into the cooking water. Halliday and Noble\(^7\) found similar amounts of vitamin C lost in the cooking water of other vegetables. The analyses of the squash samples used in the present study include the liquid in which they were cooked. Only a little free liquid is present due to the use of a minimum amount of water in cooking. About one-eighth cup of water was left in the cooked squash.

There is relatively little difference in the two samples of baked squash. The White Bush squash baked whole had 5 to 10 mg. per 100 gm., while the stuffed, baked squash had 4 to 9 mg. per 100 gm. of cooked material. However, this method

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of cooking destroys a greater amount of vitamin C than does the 10 minute boiling method. Sautéing is the most destructive of all methods used, probably because of a higher cooking temperature, and is therefore the least desirable of all methods of cooking used in this study.

Burrell and Ebright\(^8\) report approximately the same vitamin C value for the White Bush squash as the higher value for market squash in this study. All details concerning storage, cooking, etc., are lacking in their report. The lower value for White Bush squash in this study is known to be due to longer storage and bruising; consequently, there is a need for a definite history of all samples analyzed before the results of analyses become an important part of all the data presented. Investigators using essentially the same method of determination of vitamin C as that used in this study have recorded widely different qualities of ascorbic acid in the same type of vegetable. For example, Floyd and Fraps\(^9\) found from 2 to 6 times as much ascorbic acid in cabbage as that reported by Gould and Tressler.\(^{10}\) The results of the work of Tripp and his

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co-workers\textsuperscript{11} and that of Maclinn\textsuperscript{12} with tomatoes may be cited as further evidence of a wide variance in vitamin C values even in the same variety.

A comparison of the data in Table 1 and Table 2 shows insignificant differences in the vitamin C content of the raw White Bush and the raw Yellow Crookneck squash or in the vitamin C content of the cooked samples of the two varieties. The raw White Bush squash in the garden fresh sample contained 29 mg. net per 100 gm. of squash; the Yellow Crookneck, garden fresh sample, contained 30 mg. of vitamin C per 100 gm. of squash. The two samples boiled 10 minutes contained 17 mg. of vitamin C per 100 gm. of squash each. The content of vitamin C of each variety cooked by other methods was approximately the same in each of the two varieties but decreased from 29 to 29 mg. per 100 gm. of raw squash to 10 to 14 mg. when boiled 20 minutes; to 8 to 13 mg. when boiled 30 minutes; and to 3 to 7 mg. when sauteed.

It is also evident from the data in Table 1 and Table 2 that the addition of salt to the boiling water before the squash is added has little effect on the vitamin C content


of either the White Bush or the Yellow Crookneck squash.

It will be seen by examining the Tables 1 and 2 that the

**TABLE 2**

**A COMPARISON OF THE NUMBER OF MILLIGRAMS OF VITAMIN C IN TWO SAMPLES OF YELLOW CROOKNECK SQUASH AND THE PER CENT LOST BY COOKING A CERTAIN NUMBER OF MINUTES UNDER CERTAIN CONDITIONS**

<table>
<thead>
<tr>
<th>Method of Cooking</th>
<th>Garden Fresh</th>
<th>Open Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg. per 100 gm.</td>
<td>mg. Lost Per Cent</td>
</tr>
<tr>
<td>Raw</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Boiled 10 minutes (tender)</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Boiled 10 minutes in salted water</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Boiled 20 minutes (overcooked)</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Boiled 30 minutes (overcooked)</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Boiled whole 20 minutes</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Boiled 3 minutes sautéed 10 minutes in bacon fat</td>
<td>7</td>
<td>23</td>
</tr>
</tbody>
</table>

White Bush squash boiled 10 minutes without salt has 53 to 61 per cent of the original vitamin C left, while the sample boiled in salted water 10 minutes has 60 to 62 per cent of its original vitamin C. These results do not substantiate
the results of other investigations, as reported by Fixsen,\textsuperscript{13} which found that salt retards the destruction of vitamin C.

A critical analysis of Table 1 and 2 shows conclusively that the 10-minute boiling period, with or without salt, is the best method to use to prevent vitamin C loss in White Bush and Yellow Crookneck squash. From the standpoint of vitamin C conservation, sautéeing, perhaps the most commonly used method of cooking squash in Texas, is the least desirable of the cooking methods tested here.

If each Texan depending on his general food supply for the 60 mg. minimum vitamin C daily requirement for the adult man or woman\textsuperscript{14} or 75 mg. optimum\textsuperscript{15} vitamin C daily requirement, eats four ounces, or one serving of one-half cup, of garden fresh White Bush or Yellow Crookneck Squash boiled in either salted or unsalted water for not longer than 10 minutes, he gets approximately one-third to one-fourth of his daily requirement of vitamin C. On the other hand, if he eats the same kind of squash which has been sautéeed, it will be necessary for him to eat approximately one and one-half cups to get one-third of his daily requirement of vitamin C.

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\textsuperscript{13} Fixsen, \emph{op. cit.}

\textsuperscript{14} C. G. King, "Physiology of Vitamin C," \textit{Journal American Medical Association}, CXI (1938), 1463-1464.

\textsuperscript{15} National Research Council, Committee on Foods and Nutrition, \textit{Report 1941}. 
CHAPTER IV

SUMMARY

Two varieties of summer squash, Early White Bush and Yellow Crookneck, were used in this study to determine the effect of cooking on their vitamin C content.

The results of the tests using Bessey and King's 2, 6 dichlorophenolindophenol dye titration method of assay were as follows:

1. Garden fresh White Bush squash contains 29 mg. of vitamin C per 100 gm. of raw squash.
2. Market White Bush squash contains 23 mg. per 100 gm. raw weight.
3. Market White Bush squash stored at room temperature for four days contains 13 mg. of vitamin C per 100 gm. raw weight.
4. The difference in vitamin C content of the two varieties of summer squash is negligible.
5. Rapid boiling of squash for 10 minutes destroys 41 per cent of the vitamin C.
6. Boiling squash 10 minutes in salted water causes almost the same vitamin C loss as boiling in unsalted water.
7. Boiling squash 20 minutes causes a loss of 53 per cent of the vitamin C.
8. Boiling squash 30 minutes causes a loss of 56 per cent of the vitamin C.

9. Squash boiled whole for 20 minutes retains approximately the same amount of vitamin C as the cut squash boiled 10 minutes.

10. Whole squash baked 20 minutes at 350°F. after being boiled 5 minutes retains slightly more vitamin C than stuffed squash cooked the same length of time at the same temperature.

11. Squash sautéed 10 minutes in bacon fat after boiling 3 minutes loses approximately 76 per cent of its vitamin C and is the least desirable method of cooking.

12. One serving of four ounces, or one-half cups, of garden fresh squash of either variety boiled not longer than 10 minutes in either variety salted or unsalted water will furnish approximately one-fourth to one-third of the daily requirement of vitamin C for an adult man or woman.
APPENDIX

Directions for Cooking Squash

Boiled squash.--Cut into one-half inch cubes, mix thoroughly to insure uniformity of samples, divide into one-pound lots, and drop into boiling water. Use one-half cup for sample to cook 10 minutes, one cup for sample to cook 20 minutes and one and one-half cups for sample to cook 30 minutes. Use two cups for sample to be boiled whole so water will cover squash. Cover and cook period of time indicated.

Baked squash.--Drop whole squash in two cups boiling water and boil 5 minutes after the water returns to boiling. Bake one squash whole for 20 minutes. Remove a portion of the inside of the squash, including all the seeds, chop, or mash, and return to the cavity. Bake at 350°F. 20 minutes.

Salted squash.--The samples to be cooked in salted water are prepared as the other samples are and dropped into one cup of boiling water to which one teaspoon of salt has been added. Boil 10 minutes.

Sautéed squash.--Wash one pound of tender squash and cut crosswise in slices about one-half inch thick. Do not pare. Drop into one cup of boiling water and boil 3 minutes. Sauté 10 minutes in bacon fat or any other cooking fat.
TABLE 3
MILLIGRAM CALCULATIONS FOR 2, 6 DICHLORPHENOLINDOPHENOL TITRATIONS
OF EXTRACTS OF EARLY WHITE BUSH AND
YELLOW CROCKNECK SQUASH

<table>
<thead>
<tr>
<th>Variety, Source and Method of Cooking</th>
<th>Aliquot Number</th>
<th>Total ml. Dye Used</th>
<th>ml. Correction for Acid</th>
<th>Corrected ml. Value Per Aliquot</th>
<th>Average No. ml. Used Per Aliquot</th>
<th>Calculated mg. Ascorbic Acid Recovered Per 100 gm.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Bush A. Garden fresh Raw</td>
<td>1</td>
<td>.66</td>
<td>.02</td>
<td>.64</td>
<td>.64</td>
<td>28.60</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.66</td>
<td>.02</td>
<td>.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.66</td>
<td>.02</td>
<td>.64</td>
<td>.64</td>
<td></td>
</tr>
<tr>
<td>Boiled 10 minutes</td>
<td>1</td>
<td>.40</td>
<td>.02</td>
<td>.38</td>
<td>.38</td>
<td>17.10</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.40</td>
<td>.02</td>
<td>.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.40</td>
<td>.02</td>
<td>.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiled 10 minutes in salted water</td>
<td>1</td>
<td>.40</td>
<td>.02</td>
<td>.38</td>
<td>.38</td>
<td>17.60</td>
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<tr>
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<td>2</td>
<td>.40</td>
<td>.02</td>
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<tr>
<td></td>
<td>3</td>
<td>.40</td>
<td>.02</td>
<td>.38</td>
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<tr>
<td>Boiled 20 minutes</td>
<td>1</td>
<td>.34</td>
<td>.02</td>
<td>.32</td>
<td>.32</td>
<td>13.50</td>
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<tr>
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<td>2</td>
<td>.32</td>
<td>.02</td>
<td>.30</td>
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<tr>
<td></td>
<td>3</td>
<td>.30</td>
<td>.02</td>
<td>.28</td>
<td>.30</td>
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</tr>
<tr>
<td>Boiled 30 minutes</td>
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<td>.32</td>
<td>.02</td>
<td>.30</td>
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<tr>
<td></td>
<td>2</td>
<td>.30</td>
<td>.02</td>
<td>.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.30</td>
<td>.02</td>
<td>.28</td>
<td>.29</td>
<td></td>
</tr>
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<td>.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**TABLE 3--Continued**

<table>
<thead>
<tr>
<th>Variety, Source and Method of Cooking</th>
<th>Aliquot Number</th>
<th>Total ml. Dye Used</th>
<th>Ml. Correction for Acid</th>
<th>Corrected ml. Value Per Aliquot</th>
<th>Average No. ml. Used Per Aliquot</th>
<th>Calculated mg. Ascorbic Acid Recovered Per 100 mg.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiled 20 minutes (whole)</td>
<td>1</td>
<td>.30</td>
<td>.02</td>
<td>.28</td>
<td>.28</td>
<td>12.60</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.30</td>
<td>.02</td>
<td>.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.30</td>
<td>.02</td>
<td>.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiled 3 minutes, sauteed 10 minutes</td>
<td>1</td>
<td>.16</td>
<td>.02</td>
<td>.14</td>
<td>.14</td>
<td>6.30</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.18</td>
<td>.02</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.14</td>
<td>.02</td>
<td>.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*To get this value multiply the average number of ml. used per aliquot by .9 (the number of ml. of dye indicator solution used in standardizing) and then by 50 gm. as each aliquot was 2 gm.*
Preparation and Standardization of the Indicator Solution

To prepare the indicator solution dissolve 0.10 gm. of the dry dye with successive portions of warm water, cool, add water to make the volume 200 cc., and filter. Although the dry dye is quite stable, aqueous solutions of the dye change slowly and should be discarded after five days.

Ascorbic acid was used for the standardizing reagent. Twenty-five milligrams of ascorbic acid was dissolved in warm water, filtered and titrated with the dye solution to a permanent faint pink. The value of the dye solution was calculated in this way: The average number of ml. used in three titrations was found to be 27.9. Since 25 mg. of ascorbic acid was used in the determination, each ml. of dye represents .9 mg. of vitamin C.
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