

SOBE LOSSES OCCURRING  
WHEN HANDLING AND STORING FROZEN PEAS

by

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SOME LOSSES OCCURRING  
WHEN HANDLING AND STORING FROZEN PEAS

I INTRODUCTION

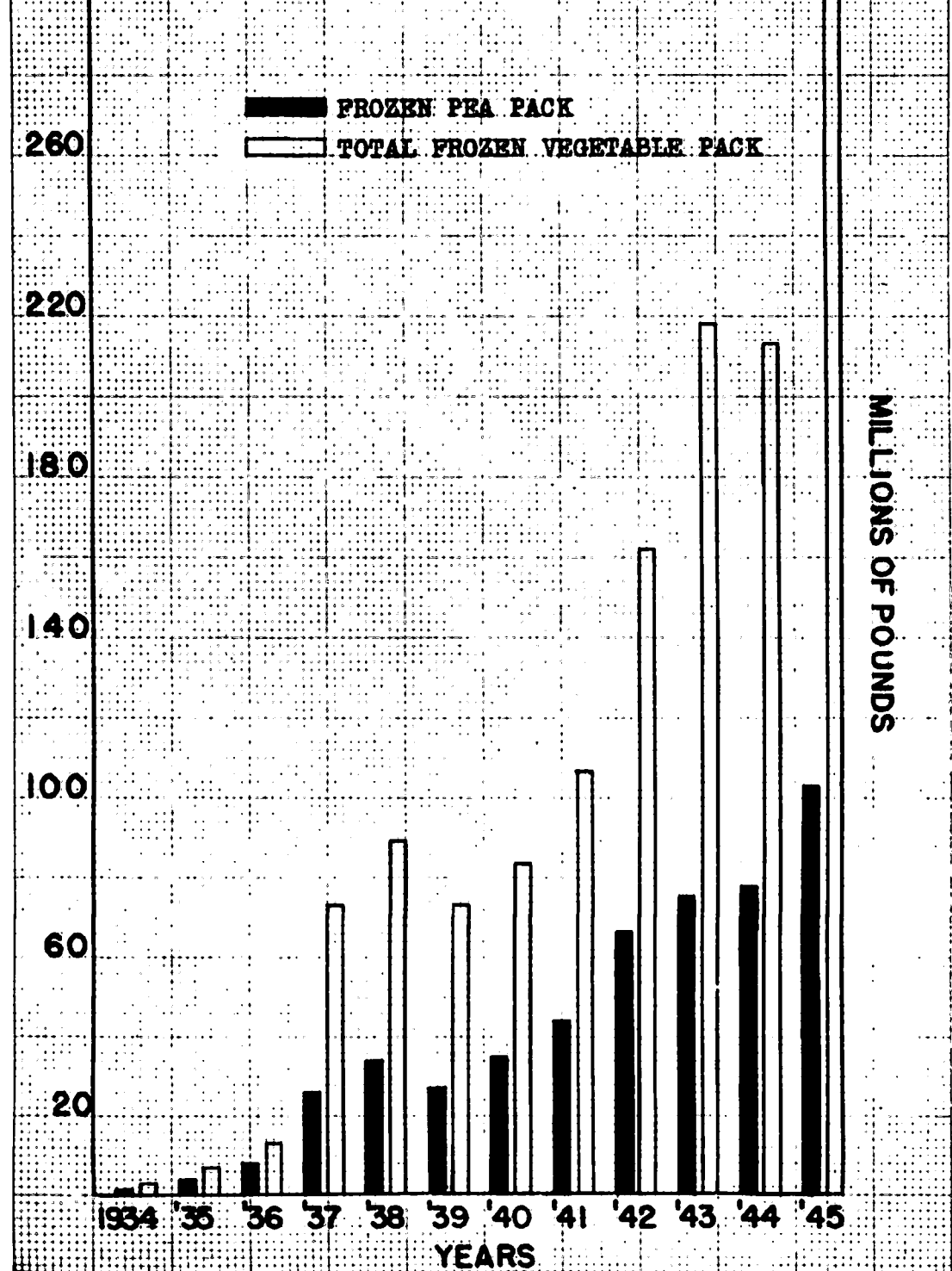
Pea freezing is, by far, the most important segment of the frozen food industry in the United States. Out of 307,977,360 pounds of frozen vegetables packed in 1945, 103,833,553 pounds (21) or approximately 33 percent were peas. A comparison of peas with other frozen vegetables packed in the United States since 1934 is shown in Figure 1.

The pea freezing industry is increasing rapidly. In 1934 Oregon and Washington packed 1,750,000 pounds of peas, which constituted the total U. S. pack. (21) These two states continued to be the sole producers during the 1935 and 1936 seasons. Other sections of the nation entered the industry by 1937, but the Northwest still led the field. Figure II shows the position of the Northwest in frozen pea production for the years 1934 to 1945, when again the Northwest produced over 50 percent of the total national pack. Oregon and Washington can continue to hold the lead in this field only if they maintain the quality of their frozen pea production.

A big problem in the processing of frozen peas is that of balancing the capacity of the plant with the supply of peas available for processing. Usually the field department of a plant makes contracts with the farmers before the planting season starts. Sometimes when the packers receive more orders than they anticipated, contracts are signed

**FIGURE I**

**COMPARISON BY YEARS OF FROZEN PEA PACK  
WITH TOTAL FROZEN VEGETABLE PACK IN U.S.**

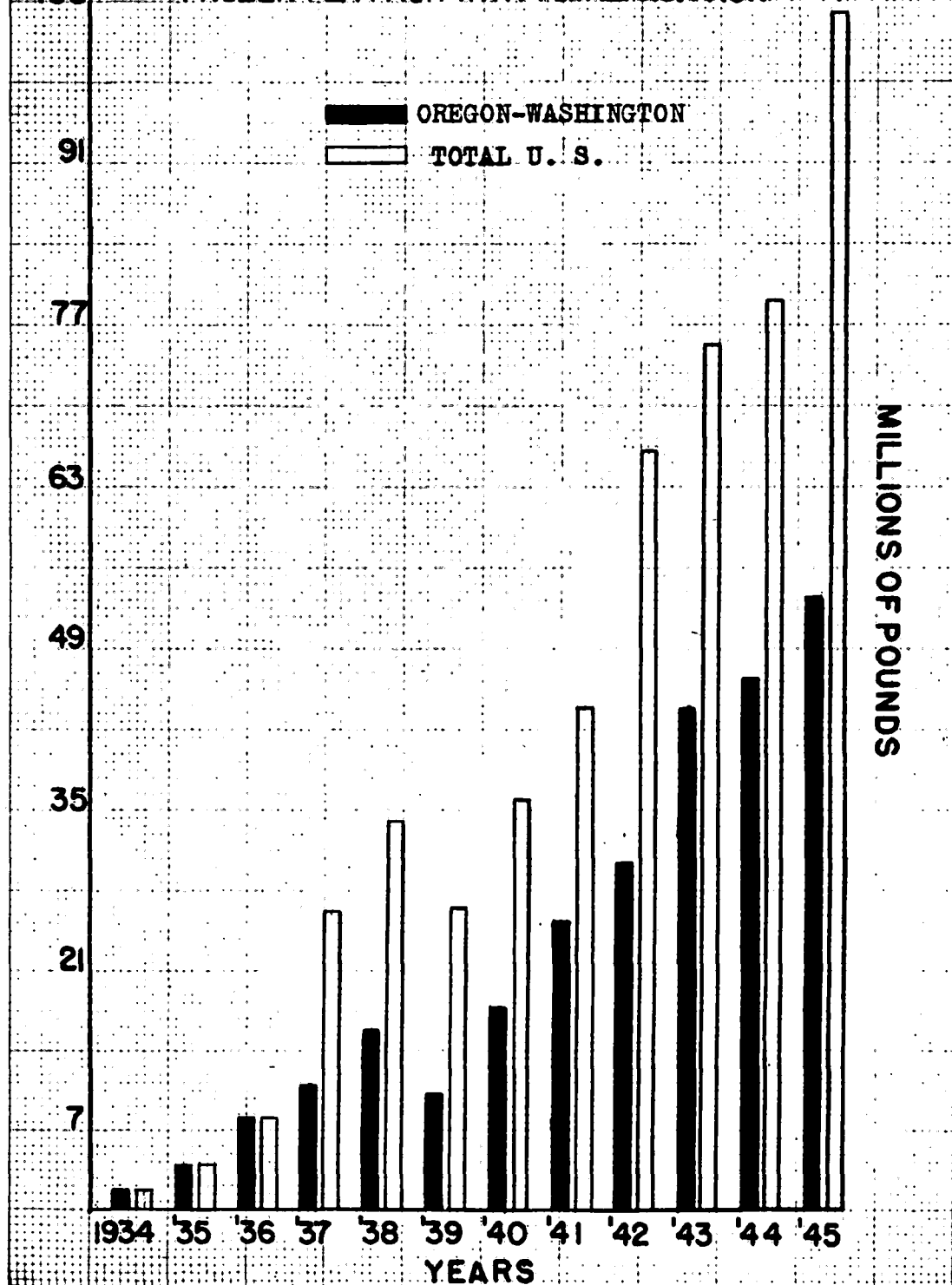


with the farmers for peas in excess of plant capacity. Thus, the management will find itself in a position where the plant is forced to work continuously 20 to 24 hours a day without being able to process the daily intake. In many plants the freezing capacity and the cold storage warehouses are not of adequate capacity; therefore, one plant is often unable to handle the surplus production of its growers and must make provision to handle the excess at other plants where it can be frozen and stored. In some cases, the peas are only cleaned, washed, graded, blanched, cooled, and inspected, then are transported by various methods to another plant for freezing and storage. One common method of handling is to place the peas in wooden field boxes, cooling them with sprays of cold water for 15 minutes, and then shipping to the freezer by truck. Another is to ship them in tank-trucks especially designed for that purpose, half-filled with cold water. The latter method has been questioned because it was felt that much loss of valuable nutrients would occur.

## II. HANDLING THE FROZEN PEAS IN THE PLANT IN EASTERN OREGON

Peas are harvested in the field by a mechanical sweeper which harvests at the rate of two acres per hour. The harvesting is continuous and is carried on at night under artificial light. The vines are thrashed at a central point and the peas are poured into standard field lugs of  $3\frac{1}{4}$  pounds capacity. After this, they are promptly loaded on a truck and transported to the plant within one-half to one and one-half hours.

**FIGURE II**  
**COMPARISON BY YEARS OF OREGON-WASHINGTON**  
**FROZEN PEA PACK WITH TOTAL U.S. PACK**



When peas reach the main plant they are first sample graded (sieve-size grading) to determine the price per ton. In 1946 the price was between \$60 and \$120 per ton according to the size grading. The field boxes with the shelled peas are set on a shaded platform where they can be kept cool and aerated.

When processing starts, the peas are dumped from the lug boxes into a hopper which feeds them onto a vibrating screen with holes three-quarters of an inch in diameter. The peas drop through the screen while foreign matter is removed.

From there, the peas drop onto a goose-neck cup conveyor belt which conveys them to a Monitor cleaner which has two screens. Peas pass through the first screen which has holes three-eighths of an inch in diameter and larger pieces of foreign matter are discarded; chaff and light material are blown out. Small undesirable peas and broken peas drop through the second screen with holes fourteen-sixty-fourths of an inch in diameter.

Peas are syphoned out of the Monitor cleaner into two flumes, through a rod washer, and then into a pump system through which they are carried up to the third floor. There they are discharged into a rod washer to take out split peas and broken peas. Peas are segregated according to their size in a Clover-leaf sieve grader. Only number three, four, and five size peas were used in freezing.

These peas drop from the sieves together (as a mixture) into blanchers and they are water blanched for three and three-fourths minutes at 198° F. They drop from the blanchers into another small

red washer to take out any other broken pieces, and from there onto a black rubber sorting belt. The belt is 18 feet long and about 30 inches wide. Here, women on each side of the belt pick out foreign matter and poor peas.

Peas are inspected as they leave the blancher, and there is no attempt to cook them until after they leave the belt. Half of the peas are usually canned, so they are all inspected before cooling.

Peas to be frozen leave the belt and pass through a flume of cold water to the first floor. Here, half of the peas are stored in tanks of water, later to be processed in another auxiliary freezing plant. The balance is pumped into the freezing department of the main plant. They are then received in a large holding tank full of water and are passed through a red cleaner which removes water and broken pieces. After this, peas drop onto a wire screen which feeds them evenly to a stainless steel mesh belt leading to the freezing tunnel. The peas are frozen loosely in that tunnel at a temperature of  $-15^{\circ}$  to  $-30^{\circ}$  F. depending upon the freezing load. The freezing takes 25 minutes, after which the peas emerge from the tunnel, frozen to the belt and are broken free of the belt by a set of special machine fingers. The frozen peas then drop into a large holding hopper and are fed to the hopper of an automatic carton filler. The filled cartons are automatically fed to an automatic wrapping machine.

As the tunnel capacity in this plant is not sufficient to freeze all the peas intended for freezing, half of them are transported to an auxiliary freezing plant 40 miles away by tank-trucks. The

hauling time is an hour and a quarter. At the cannery there are three big tanks each holding two tons of peas with cold water at 60° F. This reserve of six tons of peas is ready for each tank-truck for shipping. The temperature rises during transportation only 2° F. When the tank-trucks reach their destination with the peas, they are emptied, with flumes of cold water, into big holding tanks. From there they are pumped to a belt freezer and frozen in the same manner as the peas were frozen at the cannery freezer.

### III. THE PROBLEM

The purpose of this research, therefore, was to find out what some of the losses were during blanching, transportation, and during storage for a period of six months. The following samples of peas were taken for investigation: (1) fresh peas from the main plant in Eastern Oregon; (2) peas after blanching and cooling; (3) peas frozen in the same plant; (4) blanched peas from the same lot frozen in an auxiliary plant after they had been transported in a tank-truck more than 40 miles in 75 minutes.

The problem was to determine the loss of moisture, ash, sugar, ascorbic acid (Vitamin C), and beta carotene (Vitamin A) at several stages during the processing operation, transportation, and storage.

### IV. REVIEW OF THE LITERATURE

A review of the literature shows that losses in certain nutritional factors do occur in frozen peas. Pellers and Stopat (8) found

that the ascorbic acid in 15 samples of raw fresh picked peas averaged 35 mg. per 100 grams. The same samples after shipment 21-23 hours later averaged 17 mg. The ascorbic acid content of frozen peas varied from 9-15 mg. with an average of 13 mg. per 100 grams for 13 samples. The loss due to freezing operations was approximately 20 percent.

Hortess, Barstern and Mehl (11) indicated that no loss of ascorbic acid other than the uniform slow non-enzymic dehydration was observed in peas blanched one minute then stored for one month at  $-7^{\circ}$  F.

Mehl, Prosser and King (13) found that the average of 10 varieties at different stages of maturity stored for immature peas, 0.336 mg. per g.; for mature peas, 0.272 mg.; and for over-mature peas (8 varieties), 0.205 mg. In general, the larger the peas, the lower was the content of ascorbic acid.

Mehl (5) stated that storage of suitable scalded peas packed without liquid for almost a year at  $-5^{\circ}$  F. had practically no effect on the other extract and carbohydrate content of the peas. He marked changes in the above-mentioned constituents resulted from the scalding of peas by live steam or by hot water when followed by rapid cooling.

Mehl (6) also reported that the scalding of peas, as practiced for frozen-pack material, results in no marked changes in their chemical constituents, other than a slight loss of soluble materials, principally sugars, when the scalding is done in hot water. Scalding with live steam does not incur any losses. Storage of properly prepared garden peas at about  $0^{\circ}$  F. produced no significant chemical changes within a year's storage period.

Diehl, Campbell and Berry (7) said that freezing storage of scalded peas packed without liquid at either  $-20.6^{\circ}$  F. or at  $-6.7^{\circ}$  F. for one year had no significant effect on the dry matter, starch, total sugar, hydrolyzable polysaccharides and other extract.

Jenkins, Tressler and Fitzgerald (10) reported that freshly frozen peas which had been put through the usual commercial steps before freezing had lost from 25 to 30 percent of their content of Vitamin C. The blanching was found to be responsible for approximately one-third of the total loss. Quick freezing did not cause any additional loss of this vitamin. No loss was noted during holding for five months at  $0^{\circ}$  F.

Penton and Tressler (9) in their investigations found that the Vitamin C content of fresh Thomas Laxton peas was reduced about 38 percent during the processes, other than during actual freezing. The fresh peas contained approximately 0.25 mg. ascorbic acid per g., while the cooked frozen peas contained approximately 0.12 mg. per g.

Stimson, Tressler and Maynard (17) found that fresh frozen and fresh peas have approximately the same carotene. About 26 percent of the carotene is lost during 11 month's storage at  $-17.8^{\circ}$  F. Samples of commercially frozen peas on the market contained from 0.12 to 0.23 mg. of ascorbic acid per gram.

Zscheile, Beadle and Kraybill (22) pointed out that blanched peas often showed an increase in total carotene after storage for 6 months, causing apparent gains or negative losses of beta-carotene.

Lee, Gertner and Whitcombe (12) reported that the ascorbic acid content of Thomas Laxton peas to be 0.26 mg. per gram, in blanched peas 0.17 mg., and after storage for 6 months at  $-6^{\circ}$  F. 0.14 mg. per gram. They also found the carotene content of the same fresh peas 4.6%, blanched peas 4.4%, and after storage 6% per gram. The total solids were 22.97 percent for the fresh, 20.49 for blanched, and 19.57 for those stored peas.

Mahoney, Walls, Benter and Scott (14) indicated that the average ascorbic acid content of eight varieties of fresh peas 21.1 mg. per 100 grams net weight, after blanching 17.6 mg., and of the frozen peas after six-months' storage at  $0^{\circ}$  F. 12.3 mg. The retention of ascorbic acid after six-months' storage varied from 46.1 percent to 71.4 percent with an average of 58.4 percent. The moisture content averages 80.25 percent for the fresh peas and 79.76 percent for the stored frozen peas.

Van Duyn, Chase, Retzer and Simpson (20) found that fresh Dark Podded Thomas Laxton peas contained 0.22 mg. of ascorbic acid per gram, after blanching 0.21 mg., blanching and cooling 0.18, and after freezing 0.18 mg. After blanching, the peas retained 85 percent of the original ascorbic acid content; 76 percent after blanching and cooling; 76 percent after quick freezing and 79, 70, and 59, respectively, after one, three, and six months of freezer locker storage.

## V. ANALYTICAL METHODS

### I. Moisture Determination: (Vacuum oven method) (1)

A 12-ounce sample was ground quickly with a food chopper. Duplicate samples were weighed (about 5 grams each) in tared aluminum dishes and were placed into vacuum oven heated to 70° C. in direct contact with metal shelf. Dishes were held for exactly 12 hours at 70° C. at a vacuum of 660 mm. of mercury. (It was found that there was no significant loss after 12 hours.) Lids of drying dishes were half opened. A stream of air, dried in a sulfuric acid tower (about 2 bubbles per second), was allowed to pass through the oven during the whole period of drying. This procedure differs from that of the A.O.A.C. method, primarily in the time required to reach equilibrium in this oven.

After 12 hours, the evacuation was stopped, the oven was brought to atmospheric pressure with dry air and the lids were put on the dishes in the oven. The dishes were transferred to a desiccator charged with calcium chloride and were weighed after they had reached room temperature (after 15 minutes). From the difference between original weight and dried weight, the percentage of moisture was calculated.

### II. Ash Determination: (2)

A 12-ounce sample was ground quickly with a food chopper. Duplicate samples of about two grams each were weighed into porcelain crucibles and were placed in a muffle furnace previously heated to 600° C.

The temperature was maintained at 600° C. for two hours, then the crucibles were transferred to a desiccator and were weighed after they had reached room temperature. From the weight of the original sample and the weight of the ash, the percentage of ash was calculated.

### III. Sugar Determination:

The procedure for the extraction of the sugar was a modified A.O.A.C. method (3) and the determination of the sugar was made with the Somogyi-Shaffer-Hartmann method. (16)

A sample of 100 grams was blended in a Waring blender for five minutes with 200 ml. water. Enough saturated neutral lead acetate solution (50 ml.) was added to the blended peas in a beaker to produce a flocculent precipitate and allowed to stand 15 minutes. Then sufficient powdered potassium oxalate was added to precipitate all the lead, and it was filtered through dry paper.

The filtrate was treated again with a little potassium oxalate to make sure that all the lead had been removed. The filtrate was transferred to volumetric flask and beaker rinsed thoroughly with water, adding rinsing to contents of the flask and made to volume (1000 ml.). 50 ml. of aliquot was transferred to 500 ml. volumetric flask. The pH was adjusted to 4.5 by adding 0.4 ml. of normal hydrochloric acid, and 2 ml. of Invertase solution (prepared by Difco Laboratories Inc., Detroit, Michigan) were added.

After one hour (when all sugars were hydrolyzed) the contents of the flask were made to volume. Total sugars were determined in

duplicates on 5 ml. aliquots, using the Shaffer-Hartmann method with a standard curve established with the reagents used.

#### IV. Ascorbic Acid (Vitamin C) Determination:

The method of Morrell (15) was the basic procedure in this determination. A sample of 100 grams was blended in a Waring blender for two minutes with 200 ml. of 3 percent meta-phosphoric acid, then filtered through dry fluted filter paper, and the first 10 ml. of the filtrate that came through was discarded.

The Fischer electrophotometer was set at zero using a tube of distilled water as the reference liquid. Then 1 ml. aliquot of the filtrate was pipetted into another dry clean photometer tube, and 9 ml. sodium-citrate-metaphosphoric acid buffer (pH 3.6) was added, making a total volume of 10 ml. of liquid in the tube. The tube was placed in the photometer and 10 ml. of dye added to it with a rapid delivery pipet; the reading was taken and designated as  $K_1$ . A crystal of ascorbic acid was added to the tube to decolorize the dye completely; the reading was taken and designated  $K_2$ . This reading was taken in order to correct the extraneous color and turbidity introduced by the extract.

Into another matched tube, 10 ml. of buffer solution was added, 10 ml. of dye solution mixed therewith, and the reading taken and called  $D_1$ . This was decolorized with a crystal of ascorbic acid, and the reading  $D_2$  was recorded. The reading  $D_2$  subtracted from the reading  $D_1$  gave the dye factor. This dye factor was determined only once

for the day's use. The amount of ascorbic acid present was calculated from the following equation:

$$\text{Milligrams ascorbic acid in aliquot} = 0.00258 (D_1 - D_2) - (I_1 - I_2)$$

The above ascorbic acid factor for this instrument, using a B525M filter, was 0.00258.

#### V. B-Carotene (Vitamin A) Determination:

The spectrophotometric density determination method of the A.O.A.C. (4) was mainly followed using a Beckman Quartz spectrophotometer. A 12-ounce sample was ground quickly with a food chopper. Duplicate samples about 10 grams each were blended for 5 minutes with 200 ml. of 12 percent of alcoholic potassium hydroxide solution. Then, 100 ml. of petroleum benzine was added to the blended sample into a 500 ml. separatory funnel and shaken for one to two minutes and sediment allowed to settle, whereupon the petroleum layer was separated. The procedure was repeated two more times, each with 25 ml. petroleum benzine, breaking up the residue, which sometimes formed an adherent mass, by shaking with 10-15 ml. of alcohol. After two or three additional extractions with 20 ml. portions of solvent, which usually came colorless, residue was discarded.

Extractions were decanted into the separatory funnel and xanthophyll was removed with 25 ml. portions of 90 percent methanol, shaking two minutes each time. These extractions were continued 6 to 12 times until the methanol was colorless.

The petroleum benzine containing the carotene was washed twice with 50 ml. of water to remove the methanol, then filtered into a 250 ml. volumetric flask through dry filter paper upon which was placed a small amount of anhydrous sodium sulfate, following the A.O.A.C. procedure, and adjusted to volume.

Carotene concentration was determined by using the specific absorption coefficients calculated for  $\beta$ -carotene. Optical density measurements were made for each determination at wave lengths 4500, 4700, and 4800  $\text{\AA}$  U. The average was taken and results were reported in gamma per hundred grams.

## VI. RESULTS

### I. Moisture content:

Moistures were taken on fresh and blanched peas at the main plant and on frozen peas monthly over a period of six months both from the Main and Auxiliary plant. The results are recorded in Table I.

Table I

MOISTURE CONTENT OF PEAS:  
FRESH, BLANCHED AND FROZEN

|                  |              |
|------------------|--------------|
| Fresh (July)     | 73.9 percent |
| Blanched (July ) | 73.6 percent |

#### Changes in Storage 0° F.

| <u>Month</u> | <u>Main Plant</u> | <u>Auxiliary Plant</u> |
|--------------|-------------------|------------------------|
| 0            | 75.1%             | 77.0%                  |
| 1            | 75.1%             | 76.7%                  |
| 2            | 75.2%             | 76.7%                  |
| 3            | 75.0%             | 76.7%                  |
| 4            | 75.1%             | 76.8%                  |
| 5            | 75.4%             | 77.0%                  |
| 6            | 75.3%             | 76.9%                  |

Moisture determinations on the fresh peas show them to have a moisture content of 73.9 percent; after blanching, the moisture content was found to be 73.6 percent, or a loss of 0.3 percent. After freezing, there is a gain of about one percent in the frozen peas taken from the Main plant and two percent in those taken from the Auxiliary plant.

**FIGURE III**  
**MOISTURE CONTENT OF PEAS:**  
**FRESH, BLANCHED & FROZEN**

**SHOWING:**

## 1-BLANCHING LOSS

## 2-TRANSPORTATION GAIN

### 3-FREEZING STORAGE CHANGES



90

80

70

60

莊

# BLANCH

# ERÖFFNUNG

2

2

五

4

•



## STORAGE IN MONTHS

## MAIN PLANT

## AUXILIARY PLANT

• • •

• • •  
• 1

3

199

• • •  
• 1

## II. Ash Content:

The figures recorded in Table II show the number of milligrams of ash per 100 grams, wet basis, in fresh peas, blanched, frozen, and in six-months' storage from the Main plant and the Auxiliary plant.

Table II

### ASH CONTENT OF PEAS FRESH, BLANCHED AND FROZEN

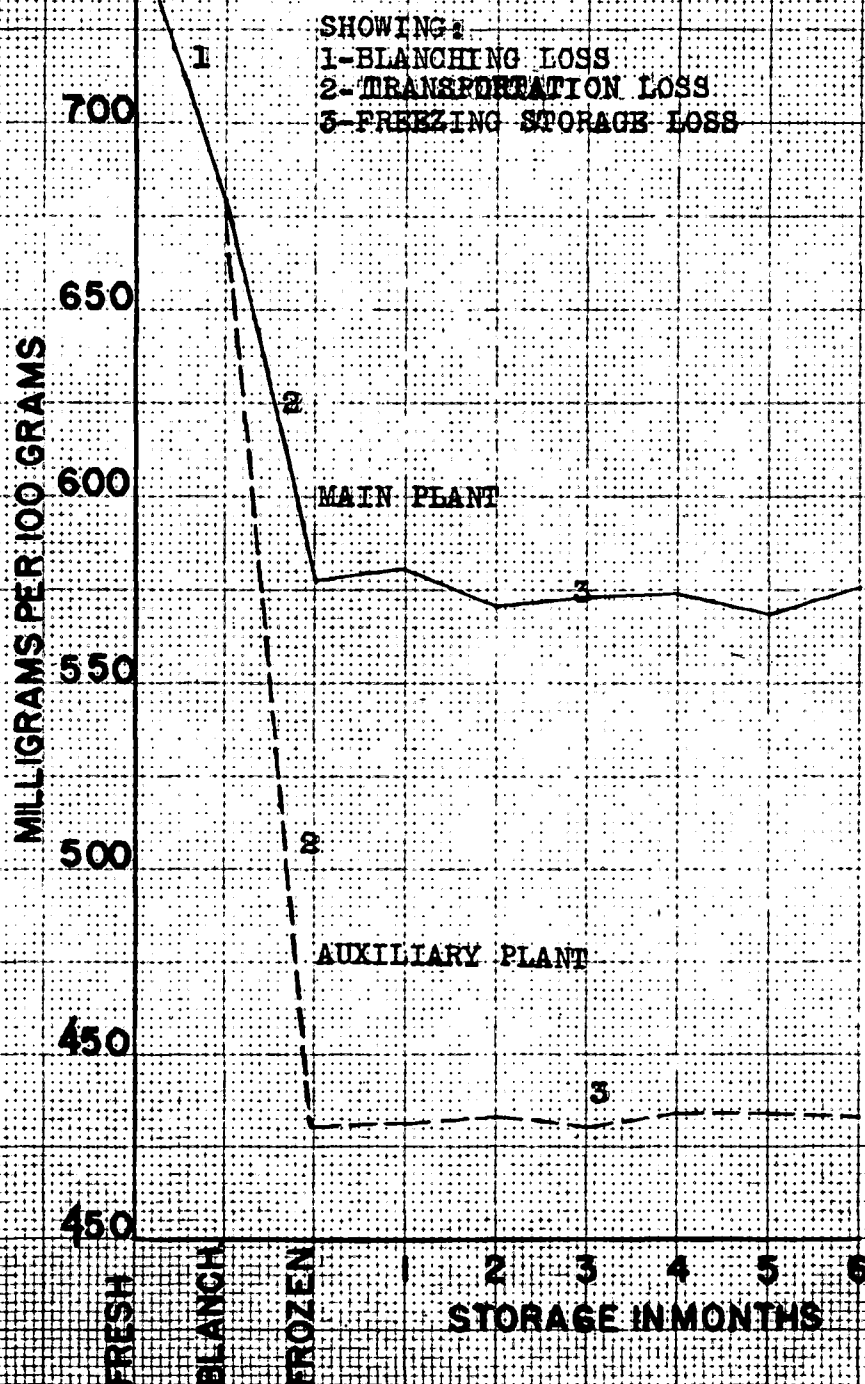
|                                         |                          |
|-----------------------------------------|--------------------------|
| Fresh (July)                            | 752.2 mg./100 grams peas |
| Blanched (July)                         | 679.8 mg./100 grams peas |
| Percentage of ash lost due to blanching | 9.63 percent             |

### Changes in Storage 0° F.

| Month | Main Plant  |          |              | Auxiliary Plant |          |              |
|-------|-------------|----------|--------------|-----------------|----------|--------------|
|       | Ash Content | Ash Lost | Percent Lost | Ash Content     | Ash Lost | Percent Lost |
| 0     | 578.8 mg    | 173.4 mg | 23.05%       | 430.1 mg        | 322.1 mg | 42.82%       |
| 1     | 580.8 "     | 171.4 "  | 22.79%       | 431.9 "         | 320.3 "  | 42.58%       |
| 2     | 570.9 "     | 181.3 "  | 24.10%       | 433.0 "         | 319.2 "  | 42.46%       |
| 3     | 573.5 "     | 178.7 "  | 23.76%       | 430.6 "         | 321.6 "  | 42.75%       |
| 4     | 573.7 "     | 178.5 "  | 23.73%       | 434.6 "         | 317.6 "  | 42.22%       |
| 5     | 568.8 "     | 183.4 "  | 24.38%       | 434.0 "         | 318.2 "  | 42.30%       |
| 6     | 575.3 "     | 176.9 "  | 23.52%       | 433.2 "         | 319.0 "  | 42.41%       |

These figures show a loss of 9.63 percent of ash due to blanching; a loss of 23.05 percent from the Main plant and a loss of 42.82 percent from the Auxiliary plant.

**FIGURE IV**  
**ASH CONTENT OF PEAS.**  
**FRESH, BLANCHED & FROZEN**



### III. Total Sugar Content:

The figures recorded in Table III show the grams of sugar per 100 grams, wet basis, in fresh peas, blanched, frozen and in six-months' storage from the Main plant and the Auxiliary plant.

Table III

#### TOTAL SUGAR CONTENT OF PEAS FRESH, BLANCHED AND FROZEN

|                             |               |
|-----------------------------|---------------|
| Fresh (July)                | 2.35 grams    |
| Blanched (July)             | 2.00 grams    |
| Sugar lost due to blanching | 14.89 percent |

#### Losses in Storage 0° F.

| Month | Main Plant          |            |              | Auxiliary Plant     |            |              |
|-------|---------------------|------------|--------------|---------------------|------------|--------------|
|       | Total Sugar Content | Sugar Lost | Percent Lost | Total Sugar Content | Sugar Lost | Percent Lost |
| 0     | 1.66 gr.            | 0.69 gr    | 29.36%       | 1.00 gr             | 1.35 gr    | 57.15%       |
| 1     | 1.50 "              | 0.85 "     | 36.17%       | 0.94 "              | 1.41 "     | 60.00%       |
| 2     | 1.56 "              | 0.79 "     | 33.62%       | 0.92 "              | 1.43 "     | 60.95%       |
| 3     | 1.54 "              | 0.81 "     | 34.47%       | 0.94 "              | 1.41 "     | 60.00%       |
| 4     | 1.56 "              | 0.79 "     | 33.62%       | 0.93 "              | 1.42 "     | 60.43%       |
| 5     | 1.52 "              | 0.83 "     | 35.32%       | 0.91 "              | 1.44 "     | 61.28%       |
| 6     | 1.56 "              | 0.79 "     | 33.62%       | 0.94 "              | 1.41 "     | 60.00%       |

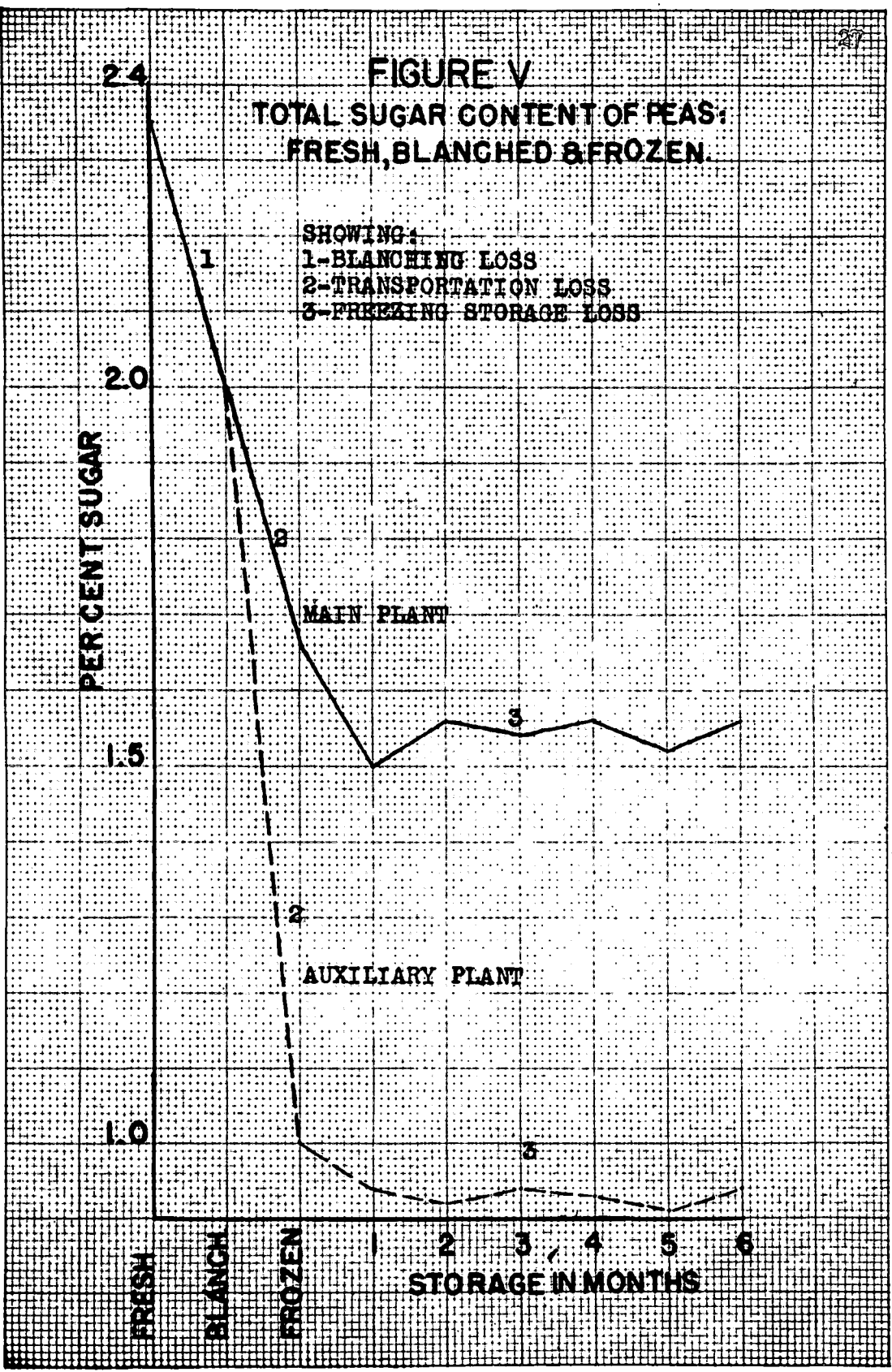
These figures show a loss of 14.89 percent of total sugar content due to blanching, a loss of 29.36 percent in the Main plant and a loss of 57.45 percent in the Auxiliary plant due to leaching in transportation.

**FIGURE V**  
**TOTAL SUGAR CONTENT OF PEAS:**  
**FRESH, BLANCHED & FROZEN.**

SHOWING:  
 1-BLANCHING LOSS  
 2-TRANSPORTATION LOSS  
 3-FREEZING STORAGE LOSS

PERCENT SUGAR

FRESH BLANCH FROZEN 1 2 3 4 5 6  
 STORAGE IN MONTHS



#### IV. Ascorbic acid content:

The figures recorded in Table IV show the milligrams of ascorbic acid per 100 grams, wet basis, in fresh peas, blanched, frozen and in six-months' storage from the Main plant and Auxiliary plant.

Table IV

#### ASCORBIC ACID CONTENT OF PEAS FRESH, BLANCHED, AND FROZEN

|                             |               |
|-----------------------------|---------------|
| Fresh (July)                | 21.69 mg.     |
| Blanched (July)             | 12.62 mg.     |
| A. A. lost due to blanching | 41.82 percent |

#### Changes in Storage 0° F.

| Month | Main Plant                  |                          |                 | Auxiliary Plant             |                          |                 |
|-------|-----------------------------|--------------------------|-----------------|-----------------------------|--------------------------|-----------------|
|       | Ascorbic<br>Acid<br>Content | Ascorbic<br>Acid<br>Lost | Percent<br>Lost | Ascorbic<br>Acid<br>Content | Ascorbic<br>Acid<br>Lost | Percent<br>Lost |
| 0     | 10.84 mg                    | 10.85 mg                 | 50.02%          | 6.80 mg                     | 14.89 mg                 | 68.65%          |
| 1     | 9.65 "                      | 12.04 "                  | 55.51%          | 5.92 mg                     | 15.77 "                  | 72.71%          |
| 2     | 8.90 "                      | 12.79 "                  | 58.91%          | 5.30 "                      | 16.39 "                  | 75.56%          |
| 3     | 8.09 "                      | 13.60 "                  | 62.70%          | 4.96 "                      | 16.73 "                  | 77.13%          |
| 4     | 7.59 "                      | 14.10 "                  | 65.01%          | 4.76 "                      | 16.93 "                  | 78.05%          |
| 5     | 7.17 "                      | 14.52 "                  | 66.94%          | 4.43 "                      | 17.26 "                  | 79.58%          |
| 6     | 7.05 "                      | 14.64 "                  | 67.50%          | 4.30 "                      | 17.39 "                  | 80.18%          |

These figures show a loss of 41.82 percent of total ascorbic acid content due to blanching, a loss of 50.02 percent in the Main plant and a loss of 68.65 percent in the Auxiliary plant.

**FIGURE VI**  
**ASCORBIC ACID CONTENT OF PEAS.**  
**FRESH, BLANCHED & FROZEN.**

SHOWING:  
1-BLANCHING LOSS  
2-TRANSPORTATION LOSS  
3-FREEZING STORAGE LOSS

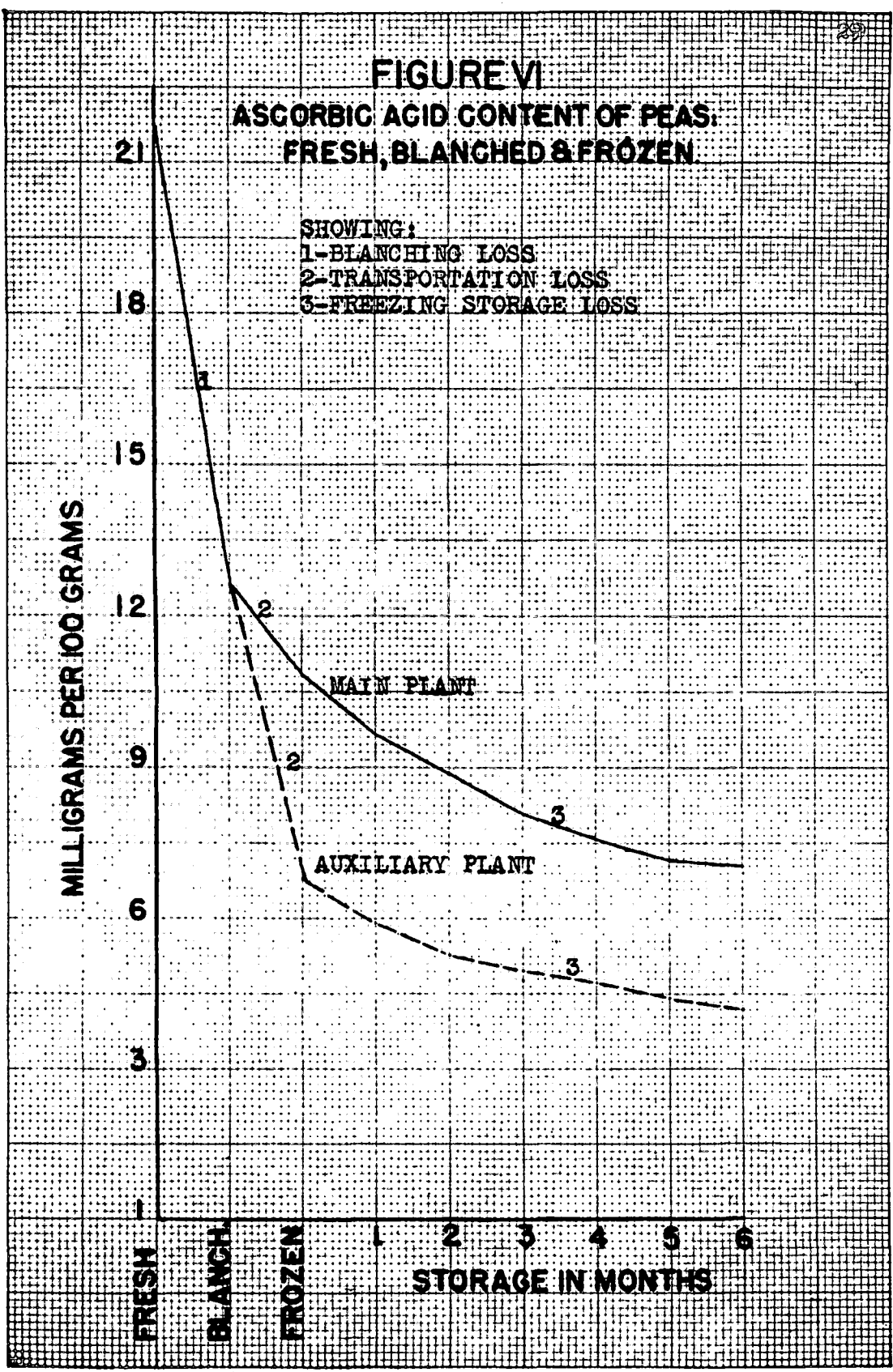
MILLIGRAMS PER 100 GRAMS

FRESH  
BLANCH  
FROZEN

STORAGE IN MONTHS

MAIN PLANT

AUXILIARY PLANT



# V. Beta-Carotene content:

The figures recorded in Table V show the micrograms of Beta-Carotene per 100 grams, wet basis, in fresh peas, blanched and frozen and in six-months' storage from the Main plant and the Auxiliary plant.

Table V

## BETA-CAROTENE CONTENT OF PEAS FRESH, BLANCHED, AND FROZEN

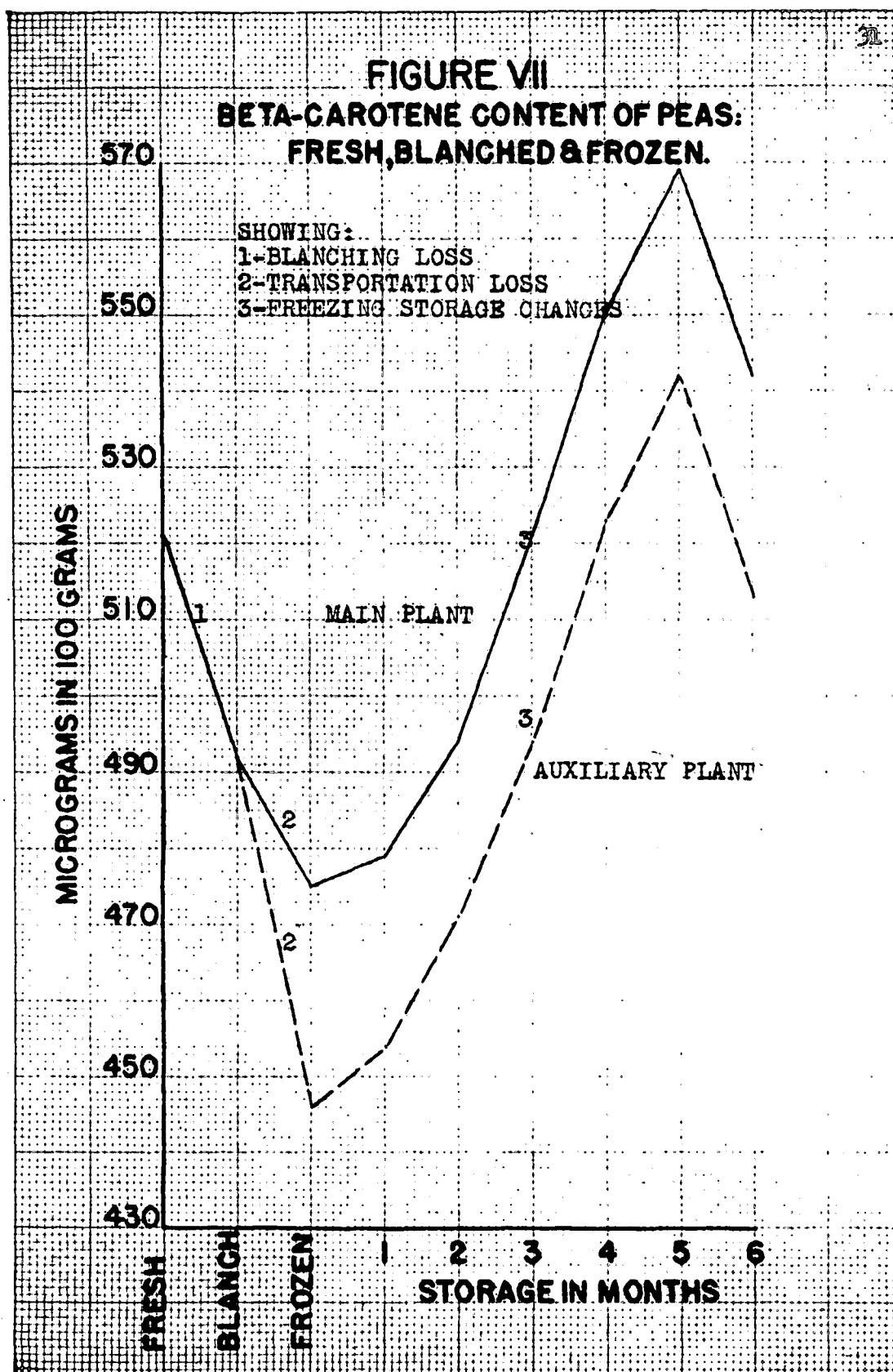
|                                              |                              |
|----------------------------------------------|------------------------------|
| Fresh (July)                                 | 521 $\gamma$ /100 grams peas |
| Blanched (July)                              | 492 $\gamma$ /100 grams peas |
| Beta-Carotene lost due to<br>Blanching (29%) | 5.57% of fresh content       |

### Changes in Storage 0° F.

| Month | <u>Main Plant*</u> |                 |                            | <u>Auxiliary Plant*</u> |                 |                            |
|-------|--------------------|-----------------|----------------------------|-------------------------|-----------------|----------------------------|
|       | Content            | Loss or<br>Gain | Percent<br>Loss or<br>Gain | Content                 | Loss or<br>Gain | Percent<br>Loss or<br>Gain |
| 0     | 475 $\gamma$       | -46 $\gamma$    | -8.83%                     | 446 $\gamma$            | -75 $\gamma$    | -14.40%                    |
| 1     | 479 "              | -42 "           | -8.06%                     | 454 "                   | -67 "           | -12.86%                    |
| 2     | 494 "              | -27 "           | -5.18%                     | 471 "                   | -50 "           | - 9.60%                    |
| 3     | 521 "              | 0.00"           | 0.00%                      | 494 "                   | -27 "           | - 5.18%                    |
| 4     | 550 "              | 29 "            | 5.57%                      | 523 "                   | 2 "             | 0.38%                      |
| 5     | 569 "              | 48 "            | 9.21%                      | 542 "                   | 21 "            | 4.03%                      |
| 6     | 542 "              | 21 "            | 4.03%                      | 513 "                   | - 8 "           | - 1.51%                    |

These figures show a loss of 5.57 percent of the total Beta-Carotene content due to blanching, a loss of 8.83 percent in the Main plant, and a loss of 14.40 percent in the Auxiliary plant.

\* All analyses in the table are in terms of Beta-Carotene.



## VII. DISCUSSION

There are many factors governing the condition of the product. The various climatic conditions, variations in soil, agricultural treatments, diseases and insects, different varieties, and stage of maturity have their effect on the quality of the product so that these results may vary from year to year. The characteristics of the district itself are factors which also have an effect on the quality of peas produced.

In some cases the findings recorded in this paper vary with the findings of other investigators and in others agree closely.

The moisture content of the fresh peas found in this investigation was 73.9 percent (Table I), while Lee, Gortner, and Whitcombe (12) reported 77.03 percent, and Mahoney, Walls, Hunter, and Scott (14) reported 80.25 percent. This lower moisture content may be due principally to the fact that this is a dry farming area or that the peas were somewhat over-mature. The blanched peas had 73.6 percent, while Lee, etc. (12) had 79.51 percent, and Mahoney, etc. (14), did not report on blanched peas. The slight loss of weight in our blanching process may be explained as due to the delay in cooling, evaporation having taken place while the peas were warm. The frozen peas from the Main plant show a gain of one percent in moisture, while those taken from the Auxiliary plant show a gain of two percent. Lee, etc. (12) show a gain of 3.40 percent, and Mahoney, etc. (14) a loss of 0.49 percent in the moisture analysis of the frozen peas. These variations may be due to the differences in handling and

processing. During storage the peas from the Main plant and the Auxiliary plant did not show any significant variation in moisture content, which indicates that wrapping paper is very helpful in preventing the loss of moisture.

The ash content of the fresh peas was 752.2 mg. per 100 grams of peas, wet basis (Table II). After blanching, the ash was 679.8 mg. per 100 grams of peas, with a loss of 9.63 percent. The frozen peas from the Main plant showed an ash loss of 23.1 percent and in the Auxiliary, 42.8 percent. This large percentage of ash lost in the Auxiliary plant can be attributed to the tank-truck transportation previously described. In the Main plant the loss raised from 9.63 percent to 23.1 percent, as the peas were pumped for more than 200 feet to the freezing department. During storage the ash content did not show any significant variation. This slight variation in ash content during storage may be due to sampling variations in the individual packages and their moisture contents. A search of the literature revealed no published articles concerning the ash content of peas.

The total sugar content of the fresh peas was 2.35 grams per 100 grams of peas, wet basis (Table III). After blanching the total sugar was 2.00 grams per 100 grams of peas, a loss of 14.9 percent. Diehl (5) stated that no marked changes in the carbohydrate content of peas resulted from scalding by live steam or by hot water when followed by rapid cooling. Diehl (6) also reported that the scalding of peas with hot water resulted in a slight loss of sugars. The loss

here may be slightly high as the blanching period was three and three-fourths minutes, while in commercial practice, the time is usually less than two minutes. The frozen peas from the Main plant showed a loss of 29.4 percent and from the Auxiliary plant, 57.5 percent in total sugars. These high losses are due to the method of handling the peas, as previously described. During storage the total sugar content did not show any significant variation. This slight variation in total sugar may be due to the individual packages and their moisture content. This agrees with the results of Diehl (5,6) and Diehl, Campbell, and Berry (7).

The ascorbic acid content of the fresh peas was 21.69 mg. per 100 grams of peas, wet basis (Table IV). This agrees with the results of other investigators, except for some differences due to variety and state of maturity. After blanching, the ascorbic acid content was 12.62 mg. per 100 grams peas, a loss of 41.8 percent. This loss is higher than all other investigators found and is doubtless due to the longer blanching period of three and three-fourths minutes. The frozen peas from the Main plant showed an ascorbic acid loss of 50.0 percent, and there was a 68.7 percent loss from the Auxiliary plant. These high losses are also due to the method of handling the peas, which has been previously described. During storage there was a uniform slow loss of ascorbic acid, which agrees with the results of all the investigators except Jenkins, Tressler and Fitzgerald (10), who noted no loss during five months of holding the frozen peas at 0° F.

The Beta-carotene content of the fresh peas was 521 $\frac{1}{2}$  per 100 grams of peas, wet basis (Table V). This is higher than other investigators found, as the peas were somewhat over-mature. After blanching, the Beta-carotene content was 492 $\frac{1}{2}$  per 100 grams with a loss of 5.6 percent, which nearly agrees with the results of Lee, Gortner, and Whitcombe (12), but does not agree with Todhunter (18), who states that the blanching period has no effect on carotene content. The frozen peas from the Main plant showed a carotene loss of 8.8 percent and 14.4 percent from the Auxiliary plant. This rise in losses can be attributed to the method of handling the peas, as previously described. During storage the peas showed an increase in carotene, indicating apparent gains or negative losses. This agrees with the results of other investigators. Those apparent gains may be due to a more efficient extraction of the carotene after storage.

#### VIII. SUMMARY AND CONCLUSIONS

1. The moisture content of peas showed a loss of 0.3 percent due to water blanching, but a gain of one percent in the Main plant and two percent from the Auxiliary plant due to their transportation in water.
2. The ash determinations indicated a loss of 9.63 percent due to blanching. That loss increased to 23.1 percent from the Main plant and 42.8 percent from the Auxiliary plant due to transportation in water.

3. Total sugar analyses demonstrated a loss of 14.9 percent due to blanching. This loss was doubled (29.36) from the Main plant and quadrupled (57.45) from the Auxiliary plant.

4. Determinations of ascorbic acid indicated a loss of 41.8 percent due to blanching, 50.00 percent from the Main plant and 68.7 percent from the Auxiliary plant, due again to transportation in water. During storage there was a uniform gradual loss of ascorbic acid. After six-months' storage, this loss was 67.5 percent in packs from the Main plant and 80 percent in packs from the Auxiliary plant.

5. The Beta-carotene data demonstrated a loss of 5.6 percent due to blanching, 8.8 percent loss in the Main plant and 14.4 percent loss in the Auxiliary plant due to transportation in water. During storage the peas showed an increase in Beta-carotene, indicating apparent gains or inadequacy of this standard method for its estimation.

6. The three and three-fourths minutes' water-blanching-time is too long, as indicated by the losses described above. The usual time in commercial practice is less than two minutes.

7. The delay in cooling the peas after blanching is likewise not desirable. It causes excessive losses in vitamin content and flavor of the frozen peas, which are the prerequisites for assuring the appeal of the product. It is advisable to separate the canning peas, so those which will be frozen can be cooled immediately after blanching.

8. The pumping of the product to the freezing department in the Main plant was the direct cause of significant nutritive value losses in the blanched peas. It would be better practice to avoid this system as much as possible.

9. The transportation of the peas to the Auxiliary plant in tank-trucks half-filled with water, as previously described, caused significant losses of the nutritive value of the peas. Undoubtedly, this leaching during transportation also affects the flavor of the product, which will, in turn, affect the public's acceptance of it.

10. Providing the Auxiliary plant with equipment for washing, grading, and blanching is the best method to overcome those losses. It may be more economical than the present set-up and is certainly more economical than using large amounts of ice-snow. Also, it will help in maintaining the high standard of frozen peas in Oregon and Washington, so that those states can continue to hold the lead in this field. Moreover, it is to the best interest of the individual concerns involved to prevent needless losses and to maintain quality in their products.

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