PRELIMINARY STUDIES ON PROCESSING OF FROZEN PACK GREEN ASPARAGUS

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Thesis

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THESIS

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Introduction

The consumption of fresh, canned and frozen green vegetables has increased markedly in the United States during the past decade. This is particularly true with asparagus where a decided shift from the bleached or white to the more nutritious green asparagus has taken place. In 1938, 112,800 acres of asparagus were harvested in the United States, which was nearly 4000 acres more than was harvested in 1937, and 10,000 acres more than the average for the 1927 to 1936 period (4). The increase in acreage in Michigan is even more striking than the totals for the entire country. In 1921 only 1000 acres were reported for the state, but by 1938 the acreage of bearing asparagus had increased to 2100 acres (4).

This increase in production of asparagus has not lead to a marked increase in the consumption of fresh asparagus. According to figures released by the United States Department of Commerce, the per capita consumption of canned asparagus increased from 0.48 pounds in 1922 to 0.90 pounds in 1927. The per capita consumption of fresh asparagus increased only from 0.40 pounds in 1922 to 0.70 pounds in 1927. Much of this increase has been in the production of frozen pack asparagus. In 1937, 6,259,474 pounds of asparagus were frozen, of which 1,087,724 pounds were packed in the western states and 5,171,750 pounds in the eastern states (3). This would indicate the trend toward freezing green asparagus rather than white.

In the future it is reasonable to expect a great deal more asparagus will be processed in this manner. Commercial methods for processing fruits have been more or less standardized. This in general is not true with vegetables and particularly asparagus, which, due to its high water and protein content, presents some of the most difficult problems

in freezing preservation of all the vegetables frozen packed. This undoubtedly accounts for some of the undesirable packs of frozen pack asparagus on the market.

With the rapid rise of the locker-storage movement in the middle western states and the possibilities of small home freezing units in the future, it is reasonable to expect a demand for authentic processing directions for the locker patrons and the users of small home equipment.

The purpose of this investigation is to determine methods of blanching, packing, freezing, storing and the selection of suitable containers for the production of a satisfactory frozen pack green asparagus.

Review of Literature

A number of investigations have been reported on methods for freezing preservation of green asparagus and closely associated problems. Cruess (10) states that all of the leading varieties are apparently about equal in suitability for freezing storage for the principal varieties vary little in flavor or texture.

Crist and Dye (9) found green asparagus, whether fed fresh, freshly cooked, or canned, where fed in proper amounts, contains sufficient vitamin A to give healthy grown in albino rats. This was not true in the case of bleached asparagus. They concluded from their experiments that the vitamin A content of plant tissue is associated with its greenness. Culpepper and Moon (11) in their investigations found that the canned product was richer and more pleasing to the taste at the tip than at any point below. The flavor and richness did not vary greatly at the tip in stalks of differing heights, but there was considerable variation at the base. They also determined that in stalks 4, 8, 18, and 36 inches tall, the amount of material per stalk which would make a desirable food product appeared to be greatest in the 18 inch stalks.

Cruess (10) comments on the fact that asparagus collapses markedly on freezing and thawing and, therefore, is not particularly attractive in appearance. If quick-frozen, it differs but slightly after cooking from cooked fresh asparagus in flavor, color, appearance, or firmness.

Joslyn and Marsh (23) found blanched vegetables, as a rule, increase in weight upon thawing if frozen in brine. The weight increased with increase in the rate of freezing. Unblanched as well as blanched vegetables, packed without brine, decreased in weight. They also noted

that blanching the asparagus had but little effect on the rate of temperature change, whether packed without liquid, plain, or in brine. They also found that, of the vegetables tested, loss in weight (due to blanching) was greatest for asparagus. Joslyn (21) in other investigations found the drained weights of vegetables depend upon the kind of vegetable and the packing treatment. Loss in weight was greatest for asparagus and spinach. His experiments showed an increase in the loss of weight due to blanching and that blanching in acid tends to toughen vegetables. Cruess (10) suggests that since steam removes less of the water soluble materials than does water, possibly it should be recommended in preference to boiling water for vegetables to be packed without liquid.

Plagge (29) recommends blanching asparagus in boiling water for two minutes, Wiegand (33) two to three minutes in boiling water, and Tressler and Evers (32) suggests that asparagus be scalded in boiling water for two to three minutes. Carlton (8) recommends blanching in boiling water, small stalks three and one-half minutes, large stalks four and one-half minutes. The above investigators did not give any data supporting their recommendations.

Cruess (10) says there is slightly less shrinkage of the asparagus packed in a two per cent salt brine, and that there is practically no difference in appearance or texture between the dry-packed and brine-packed products after cooking the thawed products. Investigations of Joslyn and Marsh (23) showed that the addition of brine to vegetables, to be preserved by freezing, markedly decreased the degree of breakdown in texture. Wiegand (33) reported that vacuumizing was not necessary in all cases, especially where syrups or brines were used in connection with the packing of the fruit or vegetable. Tressler and Evers (32)

citing Diehl, Pentzer, Berry and Asbury, say that airtight or non-airtight containers may be used with brine pack, but the former is preferred. However, with dry pack, airtight containers are desired. The use of unlacquered metal containers is feasible, but asparagus sometimes darkens, due apparently to the rusted condition of the cans caused by concentration of the brine in freezing. Also there is evidence that darkening may arise from other causes in the field. Cruess (10) reports that asparagus sometimes absorbs off flavors and deteriorates in flavor in loose containers, and recommends that airtight containers be used. Carlton (8) also states a preference for airtight containers and suggests that where tin containers are used they be lacquer lined. He also preferred straight side wall containers for the easy removal of the frozen products.

Joslyn and Marsh (23) found, with the possible exception of asparagus, increasing the rate of freezing by using solid carbon dioxide does not appreciably improve the texture of frozen fruits and vegetables which they examined. Woodroof (34), (35) found that fruits and vegetables frozen quickly have a firmer texture after thawing than the same product frozen more slowly. This desired type of freezing was found to be most economically carried out by the "immersion" method of freezing. He also found that very low temperatures (-105° F.) produced objectionable effects, such as alteration in colors. Diehl (1) reports that temperatures nearing -10° F. or lower are unnecessary for satisfactory commercial preservation of most fruits and vegetables. He found some exceptions to this rule, with asparagus, the fresh quality of which seemed to be best retained by rapid freezing at -20° F. or below. Morris and Barker (28) also found

that rapid freezing at -20° F. was helpful in the production of a satisfactory asparagus product. Diehl and Berry (13) working on freezing of fruits and vegetables found that, when packed in brine and frozen at -20° F. or below, asparagus kept its fresh flavor, color, and appearance more nearly intact. Fellers, Young, Isham and Clague (17) state that, "Freezing of asparagus does not cause a loss in the vitamin C content." Fitzgerald (20) says, and Barker and Morris in England state, that freezing affected the permeability of both asparagus and peas, so that solutes leached into the cooking water more readily than from fresh unfrozen vegetables; this increase of permeability was greater the slower the rate of freezing. Fellers, Esselen and Fitzgerald (15) found quick-frozen vegetables to retain a slightly higher percentage of vitamin B, and B_2 (G) than canned vegetables, although both types of food products are good sources of these two water-soluble vitamins.

Diehl and Berry (13) reported a temperature of 15° F. seemed to be the upper limit and most suitable for storing frozen products. They found that a storage temperature of 20° F. might be unsuitable from a physiological rather than a microbiological standpoint. Carlton (8) states vegetables stored at 10° F. have shown a loss in vitamin C, increasing rapidly at 15° F. The deterioration is attended by a loss of color. Investigators (1) found as a result of tests that for most horticultural products, 15° F. or below is best for long-time storage.

Materials and Methods

Asparagus of the Mary Washington variety grown on the Experiment Station plots at East Lansing, Michigan, was used throughout the experiment. This 12-year old bed is being carried on as a fertilizer experiment, this being the ninth crop harvested. The bed is located on soil ranging from sandy loam to a clay loam.

The asparagus was taken from cuttings beginning May 19th and extending through June 14th. Only tip cuts were used, varying in length (none exceeding six inches) to fit the type of container. All asparagus used conformed to U. S. No. 1 grade ranging from three-eighths to three-fourths of an inch in diameter.

The asparagus was cut early in the morning, graded immediately and washed in four to six changes of tap water, depending on the amount of sand adhering to the stalks. The leaf scales were removed from the first few lots but this proved impractical and detracted from the appearance of the product.

After washing, the asparagus was placed in a muslin sugar sack liner and submerged in an enamel lined tub of hot (180° F.) water for five minutes, excepting those lots in which the blanching temperature and time was varied. The tub was of sufficient capacity (15 gals.) to maintain a temperature within one degree. This limited variation was maintained by regulating the flow of live steam into the water through a steam jet. After blanching, the asparagus was submerged quickly in running tap water for 10 minutes which reduced the temperature to 55° - 57° F. After draining, the asparagus was packed, butts first, into No. 2 C-enamel lined tin cans, except those lots in which the types of containers were varied. Two per cent (by weight) salt solution

(cooled to 36°-40° F.) was added to cover the asparagus with the exception of those lots in which the packing method was varied. Head space, one-ninth of the volume of the container, was left to provide for expansion during freezing. The cans were sealed airtight in a hand sealing machine. The samples were frozen in a General Electric commercial condensing unit, type CM (ice cream storage cabinets) at -20° F. for six to eight hours. Those lots used in determining suitable freezing temperatures were subjected to different temperatures. The ice cream cabinets used were of sufficient capacity (20 gals.) to accommodate the rate of heat transfer from the small number of lots put in the cabinet at any one time. The frozen product was then placed in a cold storage room at 0° F. until sampling. Those lots used in storage temperature investigations were held at various temperatures in the ice cream cabinets.

Cooking tests were made on all lots at the end of four months and again at eight months. Samples for the cooking tests were taken from the 0° F. storage and placed in ordinary cold storage, at 40° F., 48 hours before cooking. The samples were taken to the cooking laboratory and given a standard cook by a competent technician. A color chart reading was made on each lot before cooking, using "A Dictionary of Color" by Merz and Paul as a color guide. The thawed asparagus was drained, a 300-gram sample taken and placed in five cups of boiling water to which was added six grams of salt and the whole allowed to cook seven minutes, after coming to a boil. No lid was used on the three-quart white enamel sauce pan. At the end of seven minutes the asparagus was drained and samples were placed before a panel of five judges. The judges scored each lot according to the score sheet found on the following

page. Processing treatment of each lot was unknown to the judges and, after a first practice sampling, no discussion or comparison of ideas was permitted.

The judges' scores for each factor were totalled and averaged, the sample receiving the highest numerical score, under the column "General Rating", being given first preference as described in the presentation of data in the following section.

This experiment was divided into six divisions, each varying in one treatment; otherwise, each lot was handled as has already been desired. Data will be presented according to the treatments listed.

I. Blanching Procedure:

Temperature of Water in Degrees Fahrenheit	Length of Blanch in Minutes
Untreated	0
160	3
160	5
160	10
180	1
180	3
180	5
204	1/2
204	1
204	3
204	5

GRADING CHART FOR VEGETABLES

Cooking laboratory no. _____ Sample no. _____ Kind _____ Date _____

Factor	Phase	7	6	5	4	3	2	1	Remarks
Aroma	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What aroma?
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Slightly Undesirable	Undesirable	Very undesirable	Normal or abnormal?
Color	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Slightly Undesirable	Undesirable	Very undesirable	
General Appearance	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Undesirable	Very undesirable	
Texture		Very desirable	Desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Undesirable	Very undesirable	
Tenderness		Very tender	Tender	Moderately tender	Slightly woody	woody	Very woody	Extremely woody	
Flavor	Intensity	Very pronounced	Pronounced	Moderately pronounced	Slightly pronounced	Perceptible	Slightly perceptible	Imperceptible	What flavor?
	Desirability	Very desirable	Desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Undesirable	Very undesirable	Normal or abnormal?
General Rating		Excellent	Very good	Good	Medium	Fair	Poor	Very poor	

Color: (check one)

1. Natural green
2. Faded green
3. Yellow green
4. Grass green
5. Purple green
6. Grey green
7. Brown green

II. Freezing Tests:

Temperature of Freezing (degrees Fahrenheit)
10
0
-10
-20

III. Storage Temperature Tests:

Temperature of Storage (degrees Fahrenheit)
15
10
0

IV. Asparagus packed in two per cent salt brine in various types of containers:

Unwaxed "Sealright" containers (straight side walls)

Unwaxed "Sealright" containers (sloping side walls)

Waxed paper tubs (snap cover)

Waxed "Nestyle Sealright" container (1 pt.)

Squat quart unwaxed paper container

"Nestyle Sealright" waxed paper container (1 pt. - asparagus cut in one-inch lengths)

No. 2 C-enamel lined tin can (asparagus cut in one-inch sections)

V. Asparagus soaked one-half hour in two per cent salt brine before packing dry in various types of containers:

Unwaxed "Sealright" container (straight side wall)

Unwaxed "Sealright" container (sloping side wall)

Waxed paper tubs (snap cover)

"Nestyle Sealright" waxed paper container (1 pt.)

Squat quart unwaxed paper container

Cellophane bag

Cottage cheese unwaxed paper container

No. 2 C-enamel lined tin can

VI. Asparagus packed dry in various containers:

No. 2 C-enamel lined tin can

Commercially frozen (rectangular paper container)

Commercially canned

Presentation of Data

The Effects of Blanching on Frozen Pack Asparagus:

Numerous authorities have shown that blanching of non-acid vegetables previous to the freezing process is essential to bring out the color and to inhibit enzymatic activity in the finished frozen products. In the investigations here reported, the color of the asparagus, before cooking varied only slightly, ranging from L 4 to L 10, Plate 21 (Merz and Paul's "A Dictionary of Color"). This was true of the various treatments to which the asparagus was subjected. The color of the cooked product resembled that of the fresh very closely except that the commercially canned asparagus was a yellowish green, and the comercially frozen a brownish green, after cooking.

The apparent limpness of the asparagus, due to leakage, was slightly more noticeable after eight months storage than at four months, but little difference was detectable among the various treatments.

Increasing the length of time and the temperature of the blanching up to 204° F. for five minutes, decreased the intensity of the aroma and increased its desirability as is shown in columns 4 and 5 in Table I.

Noticeable differences in color desirability, general appearance, texture, and tenderness, columns 6, 7, 8 and 9 in Table I, did not conform to any particular blanching treatment.

The intensity of the flavor varied slightly, increasing with a decrease in temperature and length of blanch given the asparagus, as shown in column 10 in Table I. The desirability of the flavor, however, showed an increase as the blanching treatment was increased up to 204° F. for five minutes, as shown in column 11 in Table I.

The asparagus which received a blanch of 204° F. for five minutes was given the highest general rating. The commercial packs of canned and frozen asparagus were placed down in the general rating with the underblanched treatments, as shown by the various items in Table I.

Effects of Freezing Temperatures on Frozen Pack Asparagus:

In the freezing tests, asparagus frozen at 10° F., 0° F., -10° F., or -20° F. did not show any appreciable differences after cooking when rated by the judges, as is shown in Table II. That asparagus frozen at 10° F. was given a slightly higher rating than other lots might indicate that temperatures as low as -20° F. are not necessary. However, before definite conclusions may be drawn, further tests should be conducted at the various freezing temperatures. All lots were rated much more desirable than either the commercially canned or frozen samples.

Effects of Storage Temperatures on Frozen Pack Asparagus:

In these investigations asparagus frozen at -20° F. and stored at 0° F. or 10° F. did not show any consistent differences in the final cooking tests, as indicated in Table III. The lot stored at 15° F. was given a low general rating at the end of four months storage, but due to mechanical difficulties in the refrigeration unit the lot was lost before a second test at the end of the eight months could be given. It was thought that this temperature might have proved too high for storage for long periods. However, all lots were rated considerably better than either the commercially frozen or canned lots, as shown by Table III. Before any definite conclusions may be drawn, further storage tests at each of the temperatures should be made.

TABLE I

RESULTS OF BLANCHING TESTS ON FROZEN PACK ASPARAGUS

*Rating based on numerical values ranging from 1 to 7, i.e., with 1 the lowest and 7 the most desirable.

Blanching Temperature (°F.)	Blanching Time (Min.)	Storage Period (Months	Aroma		Color (desirability)	General Appearance	Texture	Tender-ness	Flavor		General Rating
			Intensity	Desirability					Intensity	Desirability	
Untreated		4	5.4	2.8	2.8	3.2	2.8	3.4	5.8	2.6	1.6
		8	5.5	3.0	3.8	4.3	3.0	3.8	5.5	2.3	2.5
160°	3	4	5.4	2.6	2.6	2.2	3.0	3.0	5.6	1.8	1.6
		8	6.3	1.5	2.8	3.0	2.8	3.8	5.8	2.0	1.8
160°	5	4	5.0	4.0	4.0	4.0	3.6	4.0	4.8	4.4	3.2
		8	5.3	3.8	5.3	4.8	3.5	5.5	5.5	3.5	3.8
160°	10	4	5.2	5.2	6.0	5.8	6.0	5.8	5.2	6.2	6.0
		8	4.3	4.3	4.8	3.8	3.3	6.0	5.5	3.0	3.0
180°	1	4	5.4	4.6	3.8	4.4	4.4	4.6	5.2	3.8	3.2
		8	5.5	2.3	3.8	3.3	3.5	4.0	5.8	2.3	2.3
180°	3	4	4.4	4.0	3.8	4.2	5.6	6.2	5.2	5.0	4.2
		8	5.0	4.5	4.5	2.3	4.0	5.8	4.3	4.3	3.8
180°	5	4	4.4	4.6	4.0	3.8	4.6	5.4	5.4	4.2	3.8
		8	4.8	4.8	4.3	4.3	4.5	5.8	4.8	3.8	3.8
204°	⅓	4	5.2	3.8	3.8	3.6	4.2	4.2	5.2	4.4	3.6
		8	6.0	2.0	1.8	2.3	2.3	5.5	6.0	1.8	1.3
204°	1	4	5.4	3.6	4.6	4.2	5.4	5.6	5.8	5.2	4.2
		8	3.3	4.8	5.0	4.5	3.5	5.5	5.8	2.5	2.5
204°	3	4	4.2	3.8	4.4	3.0	4.8	5.2	4.6	5.2	4.0
		8	4.8	5.3	3.8	3.5	3.0	6.5	4.8	4.8	3.5
204°	5	4	3.4	5.4	3.6	4.0	5.6	6.0	5.4	5.8	5.0
		8	5.0	4.5	5.5	5.3	4.3	6.0	5.3	5.0	4.5
Commercially Canned		4	6.2	2.4	1.6	2.2	5.2	6.2	6.2	2.2	1.8
		8	6.5	1.8	2.3	2.5	3.5	5.8	5.8	2.3	2.0
Commercially Frozen		4	4.2	3.8	3.2	3.0	1.6	1.4	5.2	1.4	1.4
		8	4.5	4.0	4.0	4.0	2.5	2.3	6.5	1.0	1.5

* All samples packed in 2% (by weight) NaCl. brine in No. 2 C-enamel lined tin cans. Frozen at -20°F. and stored at 0°F. (except commercial packs).

TABLE II

RESULTS OF DIFFERENT FREEZING TEMPERATURES ON FROZEN PACK ASPARAGUS

*Rating based on numerical values ranging from 1 to 7, i.e., with 1 the lowest and 7 the most desirable.

Freezing Temperature	Storage Period (Months)	Aroma		Color (desirability)	General Appearance	Texture	Tender-ness	Flavor		General Rating
		Intensity	Desirability					Intensity	Desirability	
	4	4.8	5.0	5.2	5.4	5.4	5.2	5.4	5.2	5.0
10°F.	8	4.3	4.8	5.3	4.8	4.3	6.3	5.3	4.0	4.0
	4	4.4	4.4	4.2	3.4	4.6	4.6	5.2	4.4	3.6
0°F.	8	5.5	3.5	4.0	4.0	3.3	6.5	4.5	4.0	3.5
	4	4.6	5.0	5.4	5.4	4.2	4.4	5.6	4.6	3.6
-10°F.	8	5.3	4.5	5.5	5.5	3.8	5.5	4.5	4.0	4.0
	4	3.8	4.6	5.6	5.0	5.6	5.4	5.2	4.6	4.4
-20°F.	8	4.5	5.3	6.0	5.3	4.5	5.8	5.0	3.5	3.5
Commer-cially Canned	4	6.2	2.4	1.6	2.2	5.2	6.2	6.2	2.2	1.8
	8	6.5	1.8	2.3	2.5	3.5	5.8	5.8	2.3	2.3
Commer-cially Frozen	4	4.2	3.8	3.2	3.0	1.6	1.4	5.6	1.4	1.4
	8	4.5	4.0	4.0	4.0	2.5	2.3	6.5	1.0	1.5

* All samples packed in 2% NaCl brine (by weight) in No. 2 C-enamel lined cans and stored at 0°F., blanched at 180°F. for 5 min. (except commercial packs).

TABLE III

RESULTS OF DIFFERENT STORAGE TEMPERATURES ON FROZEN PACK ASPARAGUS

*Rating based on numerical values ranging from 1 to 7, i.e., with 1 the lowest and 7 the most desirable.

Storage Temperature	Storage Period (Months)	Aroma		Color (desirability)	General Appearance	Texture	Tender-ness	Flavor		General Rating
		Intensity	Desirability					Intensity	Desirability	
15°F.	4	5.2	3.8	5.8	5.0	4.6	5.6	5.6	4.2	3.6
	8	sample lost due to mechanical difficulties								
10°F.	4	5.0	5.6	5.8	5.4	4.4	4.8	5.6	5.0	4.4
	8	3.8	4.8	4.5	4.3	4.5	5.0	4.5	4.3	4.0
0°F.	4	3.6	4.4	4.4	4.4	6.0	5.8	5.2	5.0	4.4
	8	5.5	1.8	4.8	4.8	4.8	6.0	5.3	2.8	2.5
Commer-cially Canned	4	6.2	2.4	1.6	2.2	5.2	6.2	6.2	2.2	1.8
	8	6.5	1.8	2.3	2.5	3.5	5.8	5.8	2.3	2.0
Commer-cially Frozen	4	4.2	3.8	3.2	3.0	1.6	1.4	5.6	1.4	1.4
	8	4.5	4.0	4.0	4.0	2.5	2.3	6.5	1.0	1.5

* All samples blanched at 180°F. for 5 min. - packed in 2% NaCl brine (by weight) in No. 2 C-enamel lined can: frozen at -20°F. (except commercial packs).

Results of Different Types of Packs in Various Types of Containers:

In these investigations asparagus packed in two per cent salt brine was much superior to asparagus soaked one-half hour in two per cent salt brine and then packed dry, or than that packed dry without any previous flavoring. This is evident by the general ratings given in Tables IV, V and VI. The flavor of brine pack proved to be much superior to the other packs, including the commercially frozen and canned lots. It is evident that when a brine pack is used the effects of various types of containers are reduced markedly.

Unwaxed paper containers when filled with brine did not furnish a desirable type of carton, due to soaking of the paper, resulting in a lack of support. Paper containers with snap covers did not prove satisfactory when brine was used, as the expansion due to freezing stretched the side walls and loosened the covers. Containers with sloping side walls proved difficult to pack, lacking fullness at the large end; therefore the capacity of the container was not used to its fullest extent.

The lot of asparagus packed in the cellophane wrap showed signs of considerable desiccation and the asparagus possessed a peculiar flavor imparted by the wrapper.

When asparagus was packed dry, the superiority of airtight or near-airtight containers was clearly evident, as shown in Table V. Also the ratings given these lots (those packed dry in airtight or near-airtight containers) were higher than that of the commercially frozen lot, as shown in Table VI.

TABLE IV

RESULTS OF FROZEN PACK ASPARAGUS PACKED IN 2% SALT BRINE IN VARIOUS TYPES OF CONTAINERS

*Rating based on numerical values ranging from 1 to 7, i.e., with 1 the lowest and 7 the most desirable.

Type of Containers	Storage Period (Months)	Aroma		Color Desirability	General Appearance	Texture	Tenderness	Flavor		General Rating
		Intensity	Desirability					Intensity	Desirability	
Unwaxed Sealright Container (straight side walls)	4	4.0	4.8	5.4	5.8	4.6	4.6	5.4	4.2	4.2
	8	4.3	4.0	5.3	5.5	4.5	4.8	5.0	4.3	4.0
Unwaxed sealright Containers (sloping side wall)	4	4.2	5.0	4.0	4.4	4.4	4.6	5.2	5.4	4.6
	8	3.8	4.5	3.8	3.8	4.3	5.3	4.3	4.3	3.8
Waxed paper Tubs (snap cover)	4	4.4	5.2	5.6	6.0	5.6	6.0	5.4	6.0	5.6
	8	4.0	3.8	4.8	3.8	4.5	5.3	5.3	3.5	3.5
Waxed Nestyle Sealright container (1 pt.)	4	5.4	5.0	5.0	5.4	6.2	6.6	5.8	5.8	5.0
	8	4.3	4.3	4.8	4.5	3.8	5.3	4.5	4.0	4.3
Squat quart Unwaxed paper container	4	3.8	5.0	4.6	5.4	5.2	5.0	5.0	5.2	4.6
	8	3.8	4.0	3.8	4.5	4.0	4.5	4.8	4.3	4.3
Nestyle Sealright Waxed paper container (1 pt. Asparagus cut in one inch sections)	4	4.2	5.8	5.6	5.4	5.8	5.6	5.0	6.0	5.4
	8	4.3	5.0	4.5	3.8	4.5	6.0	5.0	4.3	4.0
No. 2 C-enamel lined tin can (asparagus cut in 1" sections)	4	4.0	5.4	5.6	4.4	5.2	5.0	5.2	5.6	5.0
	8	3.8	4.3	5.0	4.0	4.0	6.5	5.3	4.3	4.3

*All samples blanched 180°F. for 5 minutes. Frozen at -20°F. and stored at 0°F.

TABLE V

RESULTS OF FROZEN PACK ASPARAGUS SOAKED ½ HOUR IN 2% SALT BRINE BEFORE PACKING DRY IN VARIOUS TYPES OF CONTAINERS

*Rating based on numerical values ranging from 1 to 7, i.e., with 1 the lowest and 7 the most desirable.

Types of Containers	Storage Period (Months)	Aroma		Color Desirability	General Appearance	Texture	Tenderness	Flavor		General Rating
		Intensity	Desirability					Intensity	Desirability	
Unwaxed sealright Container (straight side walls)	4	4.8	4.4	4.8	4.4	3.6	3.8	5.8	3.4	3.0
	8	4.8	3.5	5.0	4.3	2.8	3.3	5.3	2.5	2.8
Unwaxed sealright Container (sloping side walls	4	4.8	4.2	4.6	4.4	2.2	2.6	5.8	2.2	1.8
	8	4.3	4.0	4.8	4.0	3.8	4.8	5.8	2.3	2.5
Waxed paper Tub (snap cover)	4	3.4	4.2	4.2	5.2	5.2	5.6	5.6	3.6	4.0
	8	4.0	3.8	5.3	4.5	3.3	4.8	5.0	3.0	3.0
Nestyle Sealright Waxed paper container (1 pt.)	4	5.0	4.8	5.8	5.6	5.6	5.8	5.2	5.0	4.8
	8	3.3	4.3	5.0	5.3	4.0	4.8	5.0	2.8	3.3
Squat Quart Unwaxed paper Container	4	4.4	5.6	5.6	5.6	5.8	5.4	5.2	5.4	5.4
	8	4.5	4.3	4.5	3.3	3.8	4.0	5.0	3.8	3.5
Cellophane Bag	4	3.4	5.2	5.0	4.6	3.6	4.4	5.2	4.8	3.6
	8	5.0	2.3	5.0	4.5	3.8	5.0	5.5	2.3	2.3
Cottage cheese Unwaxed paper Container	4	3.8	4.2	6.0	5.4	5.2	5.4	5.6	3.4	3.6
	8	4.5	4.5	5.3	4.8	3.8	4.8	4.8	3.5	3.5
No. 2 C-enamel lined tin can	4	3.6	5.6	5.8	5.8	5.4	5.4	4.8	6.0	5.2
	8	4.5	4.0	5.5	5.3	4.0	5.0	4.8	3.3	3.5

* All samples blanched at 180°F. for 5 minutes. Frozen at -20°F. and stored at 0°F.

TABLE VI

RESULTS OF FROZEN PACK ASPARAGUS PACKED DRY IN VARIOUS TYPES OF CONTAINERS

*Rating based on numerical values ranging from 1 to 7, i.e., with one the lowest and seven the most desirable.

Type of Container	Storage Period (Months)	Aroma		Color (desirability)	General Appearance	Texture	Tenderness	Flavor		Genera Rating
		Intensity	Desirability					Intensity	Desirability	
No. 2 C-enamel lined tin can	4	4.3	3.8	3.8	3.8	3.5	4.0	5.0	2.3	2.3
	8	4.6	5.4	5.0	5.0	3.8	4.2	5.4	3.6	3.2
Commercially canned	4	6.5	1.8	2.3	2.5	3.5	5.8	5.8	2.3	2.0
	8	6.2	2.4	1.6	2.2	5.2	6.2	6.2	2.2	1.8
Commercially Frozen (rectangular)	4	4.5	4.0	4.0	4.0	2.5	2.3	6.5	1.0	1.5
	8	4.2	3.8	3.2	3.0	1.6	1.4	5.6	1.4	1.4

* Samples blanched at 180°F. for 5 minutes. - Frozen at -20°F. and stored at 0°F. (except commercial packs).

Discussion

In view of the fact that asparagus for these experiments was taken from fertilizer test plots, one might possibly question the homogeneity of the chemical composition of the lots. Investigations on the effect of freezing on the vitamin C and A content of green asparagus by Fellers, Young, Isham and Clague (17) show that variation in the amount of potash and nitrogen used in fertilization did not appreciably affect the vitamin C and A content. The antiscorbutic ratings showed asparagus receiving high nitrogen fertilization was slightly better than that from a normal completely fertilized plot, the latter being somewhat better than asparagus grown under high potash fertilization.

It is commonly thought that asparagus becomes tougher as the cutting season progresses. MacGillivray (27) has shown that toughness of the stalks may occur at the beginning of the season as well as near the end or vice versa. He also found that the toughness of the sections of the asparagus did not correlate with the advance of the season. He did find a correlation between the number of days it took to produce a seven-inch spear and the toughness of the stalks, and that as the spears increased in diameter there was a very slight increase in toughness. The asparagus used in these investigations was comparatively uniform in quality throughout the season.

Bisson, Jones and Robbins (7) experiments showed that asparagus deteriorates in quality soon after harvest due to the loss in reducing substances and total sugars, also an increase in fiber under ordinary room temperatures. To avoid these types of deterioration, the asparagus

used in this experiment was cut early in the morning, washed, graded, and trimmed immediately and then placed in cold storage at 32° F. until it was frozen in the low temperature cabinets, which in no case exceeded five hours.

In blanching studies, it was found that lots slightly under-blanched did not lose or vary in color. But with a decrease in blanching time and temperature the intensity and undesirability of the aroma increased greatly and also the desirability of the flavor decreased. These results indicate an incomplete inactivation of the catalase and ascorbic acid oxidase enzymes. These results follow very closely similar results of Joslyn, Bedford and Marsh (22) with artichoke hearts.

Since the highest blanching temperature and the longest blanching time at that temperature used in these studies gave the best quality product, it is reasonable to assume that the upper limits for both temperature and time may not have been reached. Furthermore, the low blanching temperature employed in commercial canning operations (180° F. for 5 minutes) used in the freezing, storage, pack and container studies, may lead to misinterpretations of the data from these phases of the investigation.

Experiments conducted on desirable freezing temperatures did not indicate that severe temperatures of -20° F. or lower are necessary for freezing asparagus. These results do not conform entirely with those of Diehl (1), Carlton (8), Diehl and Berry (13) and Morris and Barker (28). Woodroof (34), (35) pointed out that where the heat transfer is rapid, temperatures below 0° F. have no practical added value.

The results obtained in this study would indicate a justification

of Woodroof's conclusion; however, further experiments should be carried out before definite conclusions are drawn.

Results of this experiment show that storage temperatures of 0° F.-10° F. are entirely satisfactory for a storage period of at least eight months. It appears that a storage temperature of 15° F. is too high. (The flavor and aroma developed an off condition.) These results are in agreement with those of Carlton (8) and Diehl and Berry (13). Through mechanical difficulties this lot was lost before an eight months sampling could be made. Further investigations should be made before reaching definite conclusions.

It is evident that containers with sloping side walls are very unsatisfactory for packing asparagus tips as it is difficult to fill the large end of the container, resulting in a loss in storage space. Enamel lined cans sealed airtight gave the most satisfactory pack since dehydration (due to low humidity in the storage room) was prevented. However, they offer objections as there is a loss in storage space with this type of container.

Unwaxed cartons also gave poor results due to dehydration and lack of support when the brine pack was used.

A two per cent salt brine added to cover the asparagus in the containers gave the most desirable product in all types of containers used. This type of pack improved the quality of the asparagus considerably when non-airtight containers were used. These results are in accord with work of Diehl and Berry (13) and Tressler and Evers (32).

No apparent quality was added to the pack when the asparagus was soaked one-half hour in two per cent salt brine, drained and then packed dry, over that of asparagus packed dry without previous soaking.

Summary

Studies on the blanching, freezing, storing and packing (types of packs and containers) of frozen pack green asparagus are reported.

Blanching temperature of 204° F. for five minutes gave the most satisfactory product. Lower temperatures or shorter blanching periods at the above temperature gave a much less desirable pack.

Freezing temperatures of 10° F., 0° F., -10° F. and -20° F.did not vary consistently. No temperature showed any advantage over the other. The asparagus was frozen satisfactorily in low temperature ice cream cabinets.

The asparagus stored at 0° F. and 10° F. showed no significant differences at the end of four or eight months. At the end of four months an off flavor and strong odor were present in the lot stored at 15° F.

Containers with sloping side walls and unwaxed paper containers were found wholly unsatisfactory for packing asparagus tips. Enamel lined tin cans were found to be the most satisfactory containers. This was particularly true with dry packed asparagus. Waxed paper containers with tight covers compare very well with airtight cans when brine was used. Cellophane bags proved to be unsatisfactory.

A two per cent (by weight) salt brine was found to be superior in quality to a dry pack, or to a pack in which the asparagus was soaked one-half hour in a two per cent salt brine before packing dry. No difference in quality was apparent between the last two packs mentioned.

The above data show certain inconsistencies which should be checked by further studies before definite recommendations for the handling of frozen pack asparagus can be formulated.

Bibliography

1. Quick-Freezing at Zero Degrees Fahrenheit. Food Indust. 5:109. 1933.

2. Quick-Freezing of Asparagus. Ice and Refrigeration 89:215-216. 1935.

3. Western Canner and Packer Yearbook 30:203. 1938.

4. Crop Report for Michigan, U. S. Dept. of Agri. Bureau of Agri. Econ., 1938.

5. Berry, J. A.- Microbiological Studies of Frozen Pack Berries With Special Reference to Effect of Carbonization. Proc. Amer. Soc. Hort. Sci. 32:224-226. 1935.

6. Birdseye, C. and Fitzgerald, G. A. - History and Importance of Quick-Freezing. Indust. Eng. Chem. 24:676. 1932.

7. Bisson, C. S., Jones, H. A., and Robbins, W. W. - Factors Influencing the Quality of Fresh Asparagus After It Is Harvested. Calif. Agr. Exp. Sta. Bul. No. 410, 1926.

8. Carlton, H. - Home Preparation of Fruits and Vegetables For the Freezer-Locker. Univ. of Tenn. Agr. Exp. Sta. Bul. No. 168, 1939.

9. Crist, J. W. and Dye, M. - The Association of Vitamin A With Greenness In Plant Tissue. II. The Vitamin A Content of Asparagus. Rept. Jour. of Biol. Chem. 81: No. 3. 1929.

10. Cruess, W. V. - Commercial Fruit and Vegetable Products, pp. 688-715. 1938. McGraw-Hill Publishing Co., N. Y.

11. Culpepper, C. W. and Moon, H. H. - Composition of the Developing Asparagus Shoot In Relation To Its Use As A Food Product and As A Material For Canning. U. S. Dept. of Agri. Tech. Bul. 462, 1935.

12. Diehl, H. C. - A Physiological View of Freezing Preservation. Indust. Eng. Chem. 24:661-665. 1932.

13. Diehl, H. C. and Berry, J. A. - The Temperature Factor In the Freezing Preservation of Fruits and Vegetables. Proc. Amer. Soc. for Hort. Sci. 29:287. 1932.

14. Fellers, C. R. - The Effect of Processing on Vitamins In Fruits and Vegetables - A Review. Mass. Agr. Exp. Sta. Bul. No. 338, 1936.

15. Fellers, C. R., Esselen, W. B. and Fitzgerald, G. A. - The Vitamin B_1 and Vitamin B_2 (G) Content of Vegetables. Influence of Quick-Freezing and Canning on Vitamins B_1 and B_2 (G). Quick Frozen Foods 1: No. 8, pp. 24-25, 1939.

16. Fellers, C. R. and Isham, P. D. - Effect of Storage, Freezing and Canning on the Nutritive Value of Vegetable Products. Rept. from Ann. Rpt. of Vegetable Growers Association of America, 1935.

17. Fellers, C. R., Young, R. E., Isham, P. D. and Clague, J. A. - Effects of Fertilization, Freezing, Cooking and Canning on the Vitamin C and A Content of Asparagus. Proc. Amer. Soc. for Hort. Sci. 31:145-151, 1934.

18. Fenton, Faith andTressler, D. K. - Losses of Vitamin C During Commercial Freezing, Defrosting and Cooking of Frosted Peas. Food Res. No. 4, 3:409-416. 1938.

19. Fisher, A. R. - Progress in the Quick Freezing Methods. Quick Frozen Foods, No. 5, 1:11. 1938.

20. Fitzgerald, G. A. - The Effects of Freezing on the Vitamin Content of Vegetables - A Review Quick Frozen Foods, No. 3, 1:44-49. 1938.

21. Joslyn, M. A. - Preservation of Fruits and Vegetables by Freezing Storage. Calif. Agr. Exp. Sta. Circ. Bul. 320, 1930.

22. Joslyn, M. A., Beford, C. L., and Marsh, G. L. - Enzyme Activity in Frozen Vegetables - Artichoke Hearts. Quick Frozen Foods, No. 3, 1:10-14, 1938.

23. Joslyn, M. A. and Marsh, G. L. - Changes Occurring During Freezing, Storage and Thawing of Fruits and Vegetables. Calif. Agr. Exp. Sta. Bul. 551, 1933.

24. Kohman, E. F. - Freezing of Fruits and Vegetables. Ice and Refrigeration 76:115-116. 1929.

25. Lockhead, A. G. and Jones, A. H. - Studies of Numbers and Types of Microogranisms in Frozen Vegetables and Fruit. Food Res. 1:29-41, 1936.

26. Lockhead, A. G. and Jones, A. H. - Types of Bacteria Surviving in Frozen Pack Vegetables. Food Res. No. 3, 3:299-306, 1938.

27. MacGillivray, J. H. - Seasonal Variation in the Tenderness of Asparagus. Proc. Amer. Soc. for Hort. Sci. 30:558-560, 1933.

28. Morris, F. N. and Barker, J. - Food Invest. Bd. Rpt. pp. 162-163, 1934.

29. Plagge, H. H. - Preservation of Fruits and Vegetables in Refrigerated Food Compartments by Freezing. Quick Frozen Foods , No. 6, 1:12-13, 1939.

30. Tanner, F. W. and Oglesby, E. W. - Influence of Temperature on Growth and Toxin Production by Clostridium Botulinum. Food Res. 1:481-495, 1936.

31. Tressler, D. K. - Preventing Changes in Stored Frozen Foods. Food Indust. 5:410, 1933.

32. Tressler, D. K. and Evers, C. F. - The Freezing Preservation of Fruits, Fruit Juices and Vegetables. The Avi. Publ. Co. New York, 1936.

33. Wiegand, E. H. - Experimental Results on the Preservation of Fruits and Vegetables by Freezing. Oreg. Agr. Exp. Sta. Circ. No. 122, 1937.

34. Woodroof, J. G. - Microscopic Studies of Frozen Fruits and Vegetables. Ga. Agr. Exp. Sta. Bul. 201, 1938.

35. Woodroof, J. G. - Comparing Methods of Freezing Fruits and Vegetables. Quick Frozen Foods, No. 4, 1:18-19, 1938.

36. Woodroof, J. G. - Some Effects of Preservation by Freezing on Quality of Fruits and Vegetables. Proc. Amer. Soc. for Hort. Sci. 28:507-509, 1931.

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