



THE PALATABILITY AND ASCORBIC
ACID RETENTION OF RED CHERRIES
AND GREEN BEANS PRESERVED
BY HOME METHODS OF CANNING,
FREEZING, DEHYDRATING AND SALTING

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Mei-Po Lou Pian

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THIS IS
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thesis entitled

THE PALATABILITY AND ASCORBIC ACID RETENTION OF
RED CHERRIES AND GREEN BEANS PRESERVED BY HOME METHODS OF
CANNING, FREEZING, DEHYDRATING AND SALTING

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By

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INTRODUCTION

The preservation of foods is of increasing interest in the home and on the farm due to its immeasurable influence on daily life.

Men turned their thoughts at a very early time to devising means of preventing foods from spoiling. They began with the storage of seeds and grains in crude store houses as a protection against birds, animals and the weather. Later the preservative effects of cold, dehydration and salt were discovered and other methods gradually followed as canning and freezing. Drying is probably the oldest method. The ancient Egyptians and Arabs dried figs, dates, grapes and olives. These are mentioned in ancient writing. However, dehydration by carefully controlled conditions of temperature, air-flow and humidity is relatively new. Salting is the next oldest method. Salt preservation is a good method of saving vegetables because the process is simple and inexpensive. In 1809 Nicholas Appert discovered the art of canning. Canning has been the most common method of preserving and storing foods for home use ever since. Artificial freezing is the most recent method. It has been used on a commercial basis since 1930, but has only been recently applied to food for home use.

Both ancient and newer methods are all widely used today. There still is a question as to how fruits and vegetables should be preserved in order to obtain the best product and still retain as much of the vitamins as possible. As there is little experimental work done for the above question it is felt that investigations in this field are needed.

The purpose of this study was to compare the relative merits of home canning, freezing and dehydrating of Montmorency cherries and Landreth Stringless Green Pod Snap beans. Salting was also used for snap beans. The factors evaluated in comparing products preserved by each method were palatability and ascorbic acid retention and the effect of six months storage on these factors. The color change of each product varied to different extent with different methods. For this reason the measurement of color retention is important, and so objective as well as subjective color measurements were made on the products.

LITERATURE REVIEW

Processing Methods

Freezing

Freezing is the use of low temperature to prevent harmful yeast, molds and bacteria from growing. Low temperatures do not sterilize the product. The microorganisms are ready to grow in foods as soon as the temperature becomes favorable. Therefore certain directions for handling and preparation as given by previous investigators should be followed.

Selection of Material: The Extension Service of Michigan State College (1948) recommends Montmorency red cherries as the only desirable variety for freezing. Stringless Green Pod Snap beans is one of the suggested varieties for freezing. All fruits and vegetables used should be of best quality. Freezing retains the goodness but will not increase it in any product.

Preparation and Treatment: Winter (1945) found cherries had better texture and flavor if sweetened before freezing. This may be done by mixing them with dry sugar or by packing in sugar syrup. Cruess et al (1948) reported that sugar had a protective effect in reducing loss of flavor, color and aroma in red cherries during freezing storage. Experiments were made by him to determine the relative effects of syrups of various sugar content on changes of frozen cherries. The results showed syrup of forty degrees Brix was preferred to those of higher and of lower densities. The Bureau of Human Nutrition and Home Economics (1946) advises that green beans should be blanched to

lessen the action of enzymes. Enzymes cause food to lose vitamins as well as flavor and color even after freezing. Blanching also brightens the color and softens vegetables, making them easier to pack. Vegetables after blanching should be chilled immediately. This stops the cooking and cuts down the chance for spoilage organisms to grow.

Freezing and Storage: The Bureau of Human Nutrition and Home Economics (1946) suggests that the packed products should be frozen immediately. Any delay would cause loss of color and flavor. A temperature of -10° F. or below is usually used for freezing. The best result would be obtained when the storage temperature was maintained near 0° F. Winter (1945) found that the difference in products stored at 0° and 5° F. was not great, but every degree above 5° F. shortened the storage period, accelerated the loss of vitamins, and hastened the loss of attractive color in green vegetables. Long-continued storage should not be attempted at any temperature above 10° F. Certain microorganisms were capable of growing at low temperatures but very few grew below 19° F. The lowest limit for growth was believed to be about 14° F.

Cooking: Winter (1945) also suggests that thawing foods are wet foods and are subject to attack by spoilage organisms. Therefore frozen food should remain in the unopened container during thawing or should be cooked promptly after removal from freezing temperature.

Canning

The principle of canning is to heat the foods hot enough and long enough to stop the action of the enzymes and to destroy the spoilage

organisms. The successful use of a canning method depends on the following factors.

Selection of Material: The Bureau of Human Nutrition and Home Economics (1947) advised that fruits and vegetables for canning should be fresh, sound and firm. Griswold (1944) found cherries canned immediately after picking had a redder, more intense color and tasted better than those held four days at 41° F. or those held at 84° F. for 24 hours before canning.

Preparation and Treatment: Green beans should be boiled in boiling water and packed hot with cooking liquid and salt. Sugar should be added to cherries before heating to draw out the juice. The effect of different proportions of syrup was tested by Griswold (1944). As the percentage of sugar increased from zero to 70, scores for the various palatability factors increased at first and then decreased at the highest concentration. The judges preferred fruits canned in 40 or 45 percent syrup. She also showed the objective measurement indicated that sugar syrup prevented the loss of color during canning rather than during storage.

Processing: Griswold (1944) observed that a wide range of processing times, 10 to 45 minutes, resulted in little variation. Cherries processed 10 minutes did not seem spoiled and those processed 45 minutes compared closely with those processed for the standard 25 minutes.

Storage: Gruetzmacher (1948) recommends the storage temperature of 45° to 60° F. for canned jars in dark and dry places.

Dehydration

Dehydration means to remove water. Dehydrated foods have their water content reduced to such a degree that they may be stored indefinitely. The water must be removed in such a way that the highest possible food value of the products is preserved.

Selection of Material: Both Stringless Green snap beans and Montmorency cherries are considered by the Georgia Home Food Preservation Committee (1946) as the right varieties that yield nice dehydrated products.

Preparation and Treatment: Green beans should be blanched before dehydrating. The effect of blanching on the drying rates of green beans was studied by Sugihara and Cruess (1941). They concluded that blanching caused an increase in the rate of drying. Crafts (1944, p. 451) summarized the beneficial effects of blanching prior to drying as follows:

- "1. Intercellular air acts as an insulator restricting inward movement of heat and outward movement of moisture. Experience has proved that blanched products dry more quickly than unblanched.

2. Air trapped in drying tissue contains oxygen that may react with ascorbic acid Blanched fruits retain their vitamin C content longer than unblanched

3. Though the change in appearance upon blanching may not be primary importance, it is an index of complete penetration of heat. Such penetration brings about at least two beneficial reactions: first, it inactivates certain enzymes; second, it softens cell walls and improves the texture of the cooked product"

There are some supplementary treatments for cherries to prevent the loss of red color when cherries are dehydrated. Alderman (1945) described the use of 0.05 per cent of sodium bisulfite to soak cherries for 30 seconds prior to dehydration to aid in preserving the color.

Cruess (1942) reported that good quality dehydrated cherries were obtained when cherries were sulfured prior to dehydration.

Processing: According to the suggestion of Bureau of Human Nutrition and Home Economics (1942) the best temperatures of drying fruits and vegetables are between 125° and 160° F. The temperature should be lower with high humidity in the first half of drying to prevent case hardening.

Finished Products: The Bureau (1943) also stated that the dehydrated snap beans should be brittle, greenish black, and the cherries should be leathery but sticky.

Packing and Storing: Dehydrated products should be packed in airtight, moisture-proof glass jars and kept in dark and cool place.

Weigand et al (1945) reported that cherries stored any appreciable time at 95° F. showed marked darkening in color whether sulfured or not.

Rehydration: Alderman (1945) soaked the dehydrated cherries in water for 30 minutes at temperature of 175° to 180° F. and then brought to a boil for three minutes. His result was quite satisfactory.

Salting

Salting draws water from vegetables by the process of osmosis, forming a brine that inhibits the growth of spoilage organisms. Green beans can be salted in two ways: 1, with brine and 2, with dry salt.

Selection of Material: Etchells (1943) reported that salting could be adapted to preserving non-acid vegetables as cabbage, green beans and peas.

Preservation and Treatment: Etchells (1943) found that green beans blanched prior to salting had better flavor and texture than the unblanched lots. Fabian (1943) wrote that blanched beans fermented more readily than unblanched ones.

Processing: Fermentation occurs in brining and salting beans. Loomis (1863, p. 473) explained the fact of fermentation as follows:

"The fermentable sugar present in all fruits and vegetables, which is one of the soluble substances extracted by osmotic action, serves as food for lactic-acid bacteria. The growth of lactic bacteria produces a fermentation. The acid thus formed acts upon the vegetable tissues bringing about the changes in color, taste and texture which mark the pickled state. A scum will form on top of the brine in a day or two and this should be carefully skimmed off daily, as it tends to destroy the acidity, break down the vegetable, and weaken the acid content. The best temperature for curing is between 75° and 85° F., and this will require from 10 days to three weeks. Too low temperature retards fermentation and too high temperature during the period may cause ropy brine and spoilage of the product. When bubbles cease to rise, fermentation is complete."

Repacking: Etchells said that fermented material should be repacked into canning jars and processing in boiling water bath to prevent undesirable changes in the material that might occur if not processed.

Storage: Fabian (1943) recommends to store salted products at room temperature.

Effect of Processing Methods

Ascorbic Acid Retention

Vegetables and fruits are subject to some chemical and physical changes during processing. Ascorbic acid is one of the vitamins affected to a great extent. Previous investigations have shown that

different processing methods have different degrees of effect on ascorbic acid content.

Freezing: Farrell (1942) found the blanched Landreth Stringless Green Pod snap beans lost 33 per cent of their ascorbic acid on freezing. The unblanched ones only retained 10 per cent of their original content of ascorbic acid. Kirk and Tressler (1941) explained that heating caused an inactivation of ascorbic acid oxidase and thus inhibited further oxidation of ascorbic acid. Blanching also resulted in the loss of dissolved air. Hummel (1942) showed that in vegetables blanched at 93° C. for one minute, the oxidase was destroyed and only about 15 per cent of the ascorbic acid was lost. With rapid packing and freezing there was no further appreciable loss. Jenkin, Tressler and Fitzgerald (1938) reported that freshly cooked vegetables and frozen cooked ones had about the same ascorbic acid content, since the cooking time was materially shortened for the frozen food which was blanched prior to freezing. Fitzgerald and Fellers (1938) found the average content of ascorbic acid of frozen green beans was 0.065 milligram per gram of wet basis which was about one half the ascorbic acid of fresh market beans averaging 0.13 milligram per gram. Kirk and Tressler (1941) considered Montmorency cherries as a very poor source of ascorbic acid. They found the average content of ascorbic acid of the raw samples of these cherries was 0.09 milligram per gram. They also described that ascorbic acid content was inversely proportional to the amount of sugar added even when compared on a sugar-free basis. This might be caused by oxidation by air incorporation while stirring in the sugar. Cruess (1948) learned that relatively little loss

occurred in ascorbic acid during freezing if the temperature was at -10° F. or lower, but 16 to 50 per cent of ascorbic acid was lost in the blanching of vegetables and in the cooling of fruits before freezing. McIntosh (1944, p. 145) summarized ways to reduce the loss of ascorbic acid in vegetables processed by freezing as follows:

1. Harvest at optimum maturity and process immediately.
2. Use correct blanching period for each vegetable.
3. Cool quickly after blanching and package.
4. Freeze and hold vegetable at or below -18° C.
5. Frozen vegetable may be defrosted to room temperature before cooking but do not thaw completely or allow them to stand partially defrosted for any length of time.
6. Cook as quickly as possible in a small amount of water.
7. Serve immediately."

Canning: Bedford and McGregor (1948) showed that ascorbic acid retention was greater in unblanched canned green beans than in blanched ones. No differences were noticed in palatability and color of the canned beans with and without blanching. Mayfield and Richardson (1939) reported that snap beans in the fresh, raw state were a good source of ascorbic acid. They showed that when the vegetable was boiled for 45 minutes, a 30 to 40 per cent loss of ascorbic acid occurred. Eighty to 85 per cent of the ascorbic acid was lost in canned snap beans which were stored at room temperature for eight months. If beans after cooking were allowed to stand one hour before testing they lost an additional 10 per cent of their ascorbic acid content. They also showed that canning process was no more destructive of ascorbic acid than the process of boiling in an open kettle. When the canned beans had been stored two months at room temperature the total loss of ascorbic acid content was increased to seventy per cent. An additional ten per cent of the original ascorbic acid was lost from three to eight months.

At the end of eight months these beans were found to contain 0.04 milligrams of ascorbic acid per gram on wet basis. Guerrant et al (1946) found the commercially canned Montmorency cherries retained an average of 96 per cent of the original ascorbic acid (dry weight basis), but canned green beans retained only 41 to 60 per cent. Shmidt (1941) reported that canned cherries had a retention of ascorbic acid as high as 90 to 100 per cent. He noted that the greatest loss of ascorbic acid occurred from the time the fruit was plunged into the boiling water to that time when the boiling point was again reached.

Dehydration: Farrell (1942) found dehydration of green beans resulted in almost total destruction of ascorbic acid. Eheart and Sholes (1945) dehydrated two lots of green beans. One lot was blanched before dehydration, the other lot was without blanching. They reported the retention of the dehydrated product of the unblanched lot was 0.01 milligram per gram and that of the blanched lot was 0.21 to 0.27 milligram per gram. They considered that even the blanched lot was a poor source of ascorbic acid after dehydration, since only 6.9 per cent of the amount in the raw beans remained in the dehydrated product. They also described the methods of storage of dehydrated products caused significant differences in retention of ascorbic acid during six months of storage. Dehydrated beans stored in refrigerator in cellophane bags or in fruit jars contained significantly more ascorbic acid, averaging 0.19 and 0.21 milligram per gram dry basis respectively, than beans stored in cellophane bags at room temperature which contained only 0.09 milligram. Cruess (1942) found there was large loss

of ascorbic acid in the drying of fruit unless the fruit was sulfured. He explained that in some fruits such as apples, prunes and berries, oxidation of ascorbic acid was greatly accelerated by ascorbase, an enzyme found in the flesh of these fruits. If the enzyme was destroyed by heat or was held in check by sulfur dioxide or other powerful anti-oxidant, ascorbic acid would be much better retained.

Salting: Peterson, Mack and Athawes (1939) observed about a 50 per cent loss in ascorbic acid during fermentation of shredded cabbage and a further 20 per cent loss in canning. A protection of sauerkraut from air retained the ascorbic acid content. The loss of ascorbic acid in vegetables seems to be associated with the loss of carbon dioxide after fermentation is complete. Hummel (1942) showed when sauerkraut was made of fresh cabbage and fermented quickly it lost little ascorbic acid but as soon as fermentation with its atmosphere of carbon dioxide ceased, a steady decrease in ascorbic acid took place. He concluded that in fermentation ascorbic acid was not destroyed directly by most yeasts or bacteria but was subjected to loss by oxidation. Blum and Fabian (1942) described the green beans that were blanched and then salted lost more ascorbic acid than did unblanched. The losses of ascorbic acid varied from 64 to 86 per cent for whole green beans in unblanched samples and from 66 to 89 per cent in blanched samples. Etchells (1943) reported an average of 15 per cent of ascorbic acid was retained in all lots of salted beans after two months at either room or refrigerator temperature.

Flavor and Texture

Little has been reported by the previous investigators about the effect of various processing methods on the flavor and texture changes of green beans and cherries. Woodroof and Shelor (1948) froze green beans at -15° F. and stored them at -15° , 0° and 15° F. Green beans stored at -15° F. were scored the highest on texture and flavor, those stored at 15° F. received the lowest score. A stale or hay-like flavor developed in those beans stored at 15° and 0° F. by the end of eight months and became much worse by the end of the year. Griswold (1944) noticed a decline in flavor and texture of canned cherries for all variations during the course of seventeen month storage period. The variations were canned cherries stored in dark at room temperature, stored in light at room temperature and kept in cold storage at 50° F. The flavor of cherries stored at 50° F. was rated far ahead of the samples stored at room temperature. There was little difference in the texture of the samples. Alderman (1945) showed that dehydrated red cherries lost the ability to rehydrate satisfactorily after six months' storage. Fabian (1941) found fermentation had no deleterious effect on the flavor and texture of green beans. Etchells (1943) reported that green beans blanched prior to salting possessed better flavor and texture than the unblanched lots.

Color

Color is one of the properties of fruits and vegetables affected by processing and storage, especially that of highly pigmented food like cherries and green beans. Feaster (1949) found that in ordinary

canning procedure the chlorophyll in beans decomposed partially, resulting in the loss of the characteristic green color. There was also a continuous decomposition of chlorophyll during storage. The rate of color loss was a function of temperature, and storage at low temperature was desirable for maximum color retention. At normal temperature, 21° C. or lower, changes in the color of most processed products were not of great significance. However holding of processed foods at abnormally high temperature was accompanied by loss of the characteristic bright colors of foods and development of dull and darkened shades in the light-colored products. Griswold (1944) described that canned cherries stored in a cool, dark place retained their color well during the long storage period, while the color of samples stored at room temperature became yellower and less intense. Canned cherries stored in the dark retained their color better than those stored in the light. Woodroof and Shelor (1948) froze blanched green beans at -15° F. and stored them at different temperatures. They found color changes of frozen green beans were much greater at the higher temperature. The beans became gray and yellowish at 15° and 0° F.; there were only slight loss of blue and increase in yellow color at -15° F. Lueck et al (1941) established that low oxygen content of food products assisted in retarding formation of undesirable colors. However, Feaster (1949) reported that oxidation was not the only factor influencing the color change during storage. Fabian (1943) found that fermentation of green beans destroyed the chlorophyll content to a great extent; further loss of color on storage was not noted. Alderman (1945) showed that dehydrated red cherries deteriorated in

color, resulting in a reddish brown product; when rehydrated there was a decided loss of red color. He found that the use of 0.05 per cent sodium bisulfite solution to soak the fruits prior to drying helped to preserve the color by preventing bleaching of the anthocyanin pigment upon rehydration and cooking. Anthocyanin is the principal pigment of cherries. Any change of color is the result of change of the anthocyanin pigment.

EXPERIMENTAL PROCEDURE

The Montmorency red cherries and the Landreth Stringless Green Pod snap beans used in this study were grown under the supervision of the Department of Horticulture, Michigan State College. They were picked at a suitable state of maturity for eating and were brought to the laboratory immediately. Ten pounds of cherries were washed and pitted at one time. Twenty pounds of beans were prepared at one time. The remainder was kept under refrigeration until used.

Cherries were processed by three different methods: freezing, canning and dehydration, and green beans were processed by five different methods: freezing, canning, dehydration, brining and dry-salting. Analytical determinations were made on unprocessed, freshly processed and stored samples. The length of time spent in preparation and processing was recorded.

Red Cherries

Unprocessed

The cherries were washed and pitted. Seventy-five grams of sugar were added to 300 grams of cherries. No water was added since the cherries were very juicy. The mixture was boiled for one minute, then chilled before scoring.

Frozen

Three hundred grams of cherries were packed in a one-pint carton with 75 grams of sugar, then frozen at -4° F. (-20° C.). The frozen cherries were held at this temperature until used. They were prepared

for scoring by adding 30 grams of boiling water to the contents of a carton and boiling for three minutes. They were then chilled before serving.

Canned

Seventy-five grams of sugar were added for each 300 grams of pitted cherries. The mixture was brought to a boil and packed into pint jars. The jars were processed fifteen minutes in a boiling water bath, then cooled and stored at room temperature. The jars were refrigerated for two hours before scoring so that all samples would be at the same temperature.

Dehydrated

Fresh pitted cherries were drained 30 minutes, spread one layer deep on 16" by 22" screened trays, and dehydrated at 140° to 167° F. (60° to 75° C.) in a Top-of-the-stove-drier. An electric fan was used to blow toward the top of the dehydrator so as to improve the ventilation. The temperature reached 176° F. (80° C.) for a short time near the end of the dehydration period, at which time the cherries became leathery and sticky. The dehydrated cherries were packed in pint jars and kept at refrigerator temperature of 40° to 44° F. The dried cherries were rehydrated by soaking in water in a double boiler at 140° to 176° F. (60° to 80° C.) for thirty minutes. The amount of water added was figured out in such a way so that it would bring the dried cherries back to the original fresh weight. It was found out in this experiment that 0.15 pound of dehydrated cherries was equivalent to one pound of fresh ones. Seventy-five grams of sugar were added to

each 300 grams of rehydrated cherries and the cherries were placed directly over the flame and boiled vigorously for three minutes. They were then chilled before serving.

Green Beans

Unprocessed

The fresh green beans were washed, snapped and cut into inch pieces. Half teaspoon of salt and one cup of water were added to half pound of these fresh green beans. The mixture was boiled for ten minutes and served hot.

Frozen

Freshly prepared green beans* were blanched for three minutes, two pounds at a time in two gallons of boiling water. They were drained, then cooled promptly in running cold water. Two hundred and fifty grams of blanched beans were packed without salt in each pint package. They were frozen and kept at -4° F. (-20° C.) until used. To prepare for scoring, each package of beans was turned into a saucepan containing three-quarters of a cup of boiling water with half teaspoon of salt. They were boiled for five minutes and served hot.

Canned

Sixteen pounds of freshly prepared beans* were covered with boiling water and boiled for five minutes. They were then packed in pint jars to within half inch of the top and covered with hot cooking liquid. Half teaspoon of salt was added to each pint of beans.

*Freshly prepared beans are beans being washed, snapped and cut into inch pieces.

The jars were closed and processed under ten pounds pressure (240° F.) for twenty minutes. The canned beans were stored at room temperature in a cupboard. They were brought to a boil for ten minutes before being served for scoring.

Dehydrated

Freshly prepared beans* were blanched in steam for twenty minutes and dehydrated at 167° to 185° F. (75° to 85° C.) in a top-of-the-stove drier in the same manner as for dehydrated cherries. The dehydrated beans were packed in pint jars and stored under refrigeration. They were rehydrated by adding three cups of water and half teaspoon of salt to each 60 grams of dried beans. The mixture was covered and brought slowly to a boil, cooked for thirty minutes, and served hot.

Brined

Freshly prepared beans* were blanched, two pounds at a time in two gallons of boiling water, for five minutes. They were drained and cooled promptly in cold water. The blanched beans were packed firmly into a 5-gallon crock. Several layers of clean white cheesecloth were used to cover the beans. Then the top was weighted with a plate and a piece of stone and the crock filled with one and a half gallons of brine. The brine was prepared by mixing half pound of salt and eight ounces of household vinegar to each gallon of water. The beans were stored at room temperature (70° to 80° F.) for two weeks. The scum was removed and cheesecloth changed every other day. At the end of this period, the beans were repacked into pint jars and processed in

*Freshly prepared beans are beans being washed, snipped and cut into inch pieces.

a boiling water bath for twenty-five minutes. They were stored at room temperature in a cupboard. The brined beans were soaked overnight at the rate of one gallon of water for each pound of beans in order to remove the salt. They were then brought to a boil in a small amount of fresh water and served hot.

Dry Salted

The preliminary treatment for fresh green beans through blanching was the same as for brining. Half pound of salt was evenly mixed with each ten pounds of blanched beans. They were then packed in a container, covered with several layers of cheesecloth and weighted down with a plate and a piece of stone. Eight ounces of household vinegar for each ten pounds of beans were used to cover the beans. The rest of the treatment from weighting down was the same as for brined beans.

Analytical Methods

Analyses were made on samples at different stages: 1) raw, 2) freshly cooked, 3) freshly processed and 4) after storage for two, four and six and a half months. The canned, brined and salted and frozen products were analyzed as stored. The dehydrated products were rehydrated before analyzing. The drained weights for rehydrated, canned and salted products were determined after draining for two minutes in a colander.

Ascorbic Acid

The method of Loeffler and Ponting (1942) was used for the ascorbic acid determinations. One hundred gram samples of both liquids

and solids were used. Samples of frozen products were taken right from the freezer. Samples of canned and salted products were taken from the jars. Samples of dehydrated products were taken as they were first rehydrated. Analyses were made in triplicate.

Moisture

The samples for moisture determination were chopped and dried to constant weight in an oven with forced draft ventilation at a temperature of 158° F. (70° C.) for forty-eight hours. A semi-automatic moisture tester* was used for the moisture determination for the later part of the experiments. The temperature was set at 258° F. (120° C.). Bean samples were dried for two hours and cherry samples for five hours.

Color

The color of the samples of both cherries and beans was measured objectively by the use of Munsell color disc according to the method described by Good (1948). The sample was packed down in the sample cell to avoid large empty areas on the cell surface, some liquid was used to fill the gaps. The colors of the green beans were compared with Munsell color discs: N1 (black), N5 (gray), GY5/8 (green-yellow), and YR6/12 (yellow-red). For red cherries, N1 (black), N5 (gray), R3.8/14 (red) and YR6/12 (yellow-red) were used.

*Brabender Semi-automatic Moisture Tester, manufactured by Brabender Corporation, Rochelle Park, N. J.

Palatability

Samples of each lot of beans and cherries were cooked and scored to determine the palatability. A panel of judges assisted in each test. The products were scored according to the chart shown in Figure I.

Score Card for Frozen Fruits and Vegetables

Date _____

Sample Nos.								
General Appearance								
Color								
Odor								
Flavor								
Texture								
General Conclusion								
Acceptable - Yes or No								

Defects to note particularly:

- 7 - Excellent
6 - Very good
5 - good
4 - medium
3 - fair
2 - poor
1 - very poor

General appearance: undue shrinking, wrinkling, collapsing, sloughing of skins, etc. In purees, undue separation of liquid from solid portion.

Color: fading or darkening, dullness, browning, and other discoloration.

Odor: Oxidized or other unnatural odors, natural odor not pronounced.

Flavor: any foreign or off flavor, too sweet, too sour, or astringent, natural flavor lacking.

Texture: toughness, presence of fibrous material, flabbiness or undue softening, dryness, mealiness.

RESULTS AND DISCUSSION

Comparative Lengths of Time Spent in Processing

Tables 1 and 2 show the time spent in preparing and processing one pound of raw material by the various methods. Drying took almost four and a half times longer than freezing and nearly two and a half times longer than canning for the same amount of raw cherries. A pound of raw cherries took eighteen minutes for washing and pitting and one minute to mix with sugar and package for freezing.

Twenty minutes were required to prepare and pack one pound of raw green beans for freezing. Canning took about twice as long as freezing, and drying three times as long. Both brining and salting required less time than canning but more time than freezing.

Table 1. Average lengths of time spent in preparing and processing red cherries.

(minutes per pound per person)

	Preparation stemming & pitting	Processing	Total
Frozen	18	1	19
Dried	18	70	88
Canned	18	16	34

Table 2. Average lengths of time in preparing and processing green beans.

(minutes per pound per person)

	Preparation snipping & cutting	Processing	Total
Dry salted	17	12	29
Brined	17	11	28
Frozen	17	3	20
Dried	17	44	61
Canned	17	20	37

Yield of Processed Products

Table 3 shows the yield of processed products from the same amount of fresh material. Dehydrated products required the least space to store. Frozen cherries yielded 16 pints (about 50 per cent) more than canned cherries from the same amount of raw material. The frozen ones were not blanched while the canned ones were brought to a boil before packing. This heating process softened the fruit tissue so that they packed more easily and consequently did not take as much space. The same amount of green beans produced 4 pints (about 10 per cent) more as canned than as frozen beans. The beans for freezing and for canning both received a short cooking before packing, so they packed and yielded about the same number of jars from a given weight of vegetable. Blanching causes the shrinkage of the beans and the expulsion of gases from

inside the vegetable tissue. Both brined and dry-salted beans had about the same yield as the canned products.

Table 3. Yield of processed products

Food	Fresh	Frozen	Canned	Dehydrated	Brined	Dry-salted
	lbs.	pints	pints	lbs.	pints	pints
Cherries	30	46	30	4.5		
Green Beans	20	36	40	2	42	42

Palatability Scores

The mean scores for cherries and green beans are shown in Tables 4 and 5. In general, palatability declined with storage. When the flavor is rated low, no matter how high other factors are graded, the general conclusion is also rated low. The color data are related to the scores for odor and flavor showing that a sample which receives a high score for color would probably be scored high for odor and for flavor. The judges consistently preferred the frozen products to the products processed in other ways.

Cherries

The treatments caused differences in general appearance and color. Both freshly canned and frozen cherries were rated higher than the freshly cooked samples. Dried cherries were rated very low. A complete rehydration of dried cherries was impossible. The rehydrated dried cherries looked shrunken and dark, and had lost the characteristic red color of cherries.

Table 4. Average scores for palatability factors of red cherries for different treatments and storage periods.

(maximum possible score = 7)

Treatment	Freshly cooked	Frozen				Dried				Canned			
		F.P.*	Stored			F.P.*	Stored			F.P.*	Stored		
			(months)				(months)				(months)		
			2	4	6½		2	4	6½		2	4	6½
	(1)	(1)	(2)	(1)	(3)	(1)	(1)	(1)	(1)	(1)	(4)	(3)	(5)
General appearance	4.4	5.3	5.5	5.1	4.6	3.9	3.9	3.7	3.0	5.3	4.7	3.5	4.5
Color	5.0	5.4	5.8	5.1	5.1	3.2	3.7	3.7	3.2	5.5	5.2	4.4	4.4
Odor	6.2	6.7	6.0	5.6	6.3	5.2	5.8	5.0	5.2	5.3	5.3	4.4	4.8
Flavor	5.8	6.4	5.8	5.4	5.5	4.7	4.6	4.7	4.8	5.7	4.3	3.5	4.2
Texture	5.6	5.7	5.5	5.5	5.6	4.2	4.5	4.3	3.8	5.5	5.3	3.9	4.9
General conclusion	5.5	6.0	5.3	5.1	5.3	3.8	4.2	4.4	4.1	5.3	4.1	3.4	4.3
Acceptable Yes or No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

* Freshly processed.

- (1) Each number is the average of 12 figures as 4 judges and 3 composites for the experiment.
- (2) Each number is the average of 4 figures as 2 judges and 2 composites for the experiment.
- (3) Each number is the average of 10 figures as 5 judges and 2 composites for the experiment.
- (4) Each number is the average of 9 figures as 3 judges and 3 composites for the experiment.
- (5) Each number is the average of 15 figures as 5 judges and 3 composites for the experiment.

Table 5. Average scores for palatability factors of green beans for different treatments and storage periods.

(maximum possible score = 7)

	Dry-salted												Brined												Frozen												Dried												Canned																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
	** Stored(months)						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* F.C.						** F.P.						* 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* F.C. - freshly cooked

** F.P. - freshly processed

Y⁻ - barely acceptable

- (1) Each number is the average of 8 figures as 4 judges and 2 composites for the experiment.
- (2) Each number is the average of 9 figures as 3 judges and 3 composites for the experiment.
- (3) Each number is the average of 12 figures as 4 judges and 3 composites for the experiment.
- (4) Each number is the average of 6 figures as 3 judges and 2 composites for the experiment.
- (5) Each number is the average of 15 figures as 5 judges and 3 composites for the experiment.
- (6) Each number is the average of 10 figures as 5 judges and 2 composites for the experiment.

The judges made no comments concerning off-odor in any of the samples. Frozen cherries retained most of the characteristic odor while canned and dried cherries kept only a part of the original odor. The odor of freshly frozen cherries was rated the highest but there was a gradual decline in the scores with the lengths of time in storage. The scores of the dried cherries after storage were about the same as the freshly dried.

Frozen cherries received the highest scores for flavor and dried ones the lowest. The judges described the dried cherries as being sour and lacking in characteristic flavor. One of the judges said that they were acceptable as dehydrated cherries. The scores for the flavor of dehydrated cherries changed very little with storage but that for both frozen and canned dropped gradually during the 6-month storage.

The texture of the frozen cherries was most desirable and that of canned was closely comparable with the freshly cooked fruits. Two of the judges commented on the toughness of the dehydrated samples.

The frozen cherries received the highest average score on general conclusion, the canned was close second. The dried cherries received the lowest score. There was a definite decline in all the general scores with the length of time in storage. All the samples were acceptable to all the judges.

Green Beans

Frozen beans retained as much green color as the freshly cooked beans and received the highest scores in color and appearance. Dried beans were rated the poorest. The canned, dry-salted and brined beans

were rated in between and in order as listed. The judges described the dried beans as being dark and brown.

The scores for flavor were highest for frozen beans and lowest for brined and dry-salted beans with canned second and dried third. One of the judges commented frequently on the flatness, saltiness and sourness of the salted beans and suggested that unless the salted vegetable was blended with some other food it was not acceptable.

The salted vegetables were rated higher in texture than the canned ones which in turn were rated higher than the dried beans. Frozen beans received the highest scores in texture.

The poor flavor of the salted beans had a great effect in the general conclusion. They were not acceptable in the freshly processed and 4-month stored and barely acceptable in the rest of the periods.

Frozen beans were most desirable to the judges throughout the entire test period and canned beans second. Dried beans were acceptable as freshly processed, later declined from barely acceptable to not acceptable with storage.

Color Measurement

The results from the objective color tests on the cherries and beans are shown in Tables 6 and 7.

Cherries

The figures for hue of frozen and canned cherries show about the same gradual change from red to yellow-red with increasing time in storage. The dehydrated cherries retained the least amount of red and

Table 6. Munsell color readings of cherries.[#]

		Freshly cooked	Freshly processed	After storage for		
				2 months	4 months	6½ months
Frozen	Hue*	6.5	7.2	7.1	7.8	7.0
	Value**	3.5	3.4	3.4	3.2	2.7
	Chroma***	5.8	7.2	5.2	4.7	4.5
Canned	Hue	6.5	7.1	7.6	8.6	8.9
	Value	3.5	3.1	3.2	3.0	2.7
	Chroma	5.8	6.0	5.3	4.6	4.5
Dehy- drated	Hue	6.5	10.1	10.1	12.4	10.3
	Value	3.5	2.6	3.7	2.6	2.5
	Chroma	5.8	1.6	3.4	2.0	2.1

[#] Each number is the average of 3 replicate samples.

* Hue is the quality that differentiates from gray of the same value. The hue number of red is 5 and yellow-red is 15.

** Value is the lightness of color. The scale begins at 0 (absolute black) to 10 (absolute white).

*** Chroma is the strength of a color, neutral gray being 0, while higher numbers represent stronger colors.

Table 7. Munsell color readings of green beans.[#]

		Freshly cooked	Freshly processed	After storage for		
				2 months	4 months	6½ months
Frozen	Hue*	33.4	34.1	34.3	34.2	33.7
	Value**	4.3	4.1	4.0	3.8	3.8
	Chroma***	5.4	4.5	3.9	3.4	3.5
Canned	Hue	34.0	25.2	25.4	24.7	25.5
	Value	4.6	3.9	4.5	3.8	4.4
	Chroma	5.5	3.2	5.0	3.5	4.6
Dehy- drated	Hue	32.5	23.6	23.6	21.6	23.4
	Value	4.0	2.7	3.0	3.0	3.4
	Chroma	3.8	2.7	1.9	1.9	2.8
Brined	Hue	33.2	25.5	18.3	23.9	25.5
	Value	4.3	3.8	3.3	4.3	4.0
	Chroma	5.4	3.7	2.6	4.2	3.7
Dry- salted	Hue	33.6	26.4	19.0	24.0	24.7
	Value	4.4	3.7	3.4	4.2	3.5
	Chroma	5.5	3.7	3.0	4.2	2.8

Each number is the average of 3 replicates.

* Hue is the quality that differentiates from gray of the same value. The hue number of yellow-red is 15 and green-yellow is 35.

** Value is the lightness of color. The scale begins at 0 (absolute black) to 10 (absolute white).

*** Chroma is the strength of a color, neutral gray being 0, while higher numbers represent stronger colors.

greatest amount of yellow-red. Storage did not have much effect on the hue of dehydrated cherries.

The freshly processed samples of frozen and canned cherries were darker (lower value) than were the freshly cooked cherries. Both frozen and canned cherries became darker with storage. Dehydrated cherries had very low values and no marked change was shown during storage.

The highest chroma was found in freshly frozen cherries, lower in freshly canned and very low in dehydrated ones. Frozen and canned cherries showed a decided decrease in chroma from the first time interval to the last, indicating loss of color with storage. The dehydrated cherries had the lowest chroma, when just processed, then the chroma increased slightly with storage.

Green Beans

All the samples of frozen green beans had higher hue readings than samples processed in other ways. A slight decrease in the greenness of the frozen samples at the end of the storage period was observed. Canned and brined beans contained the next largest amount of green, while the dehydrated and dry-salted beans contained the least amount.

The value figures showed that dehydrated beans were the darkest, the freshly cooked samples were the lightest and the rest were about the same. All the samples, except the frozen and dry-salted ones, had a slight increase in value from the freshly processed stage to the last storage stage. Frozen and dry-salted beans became darker (lower value) during storage.

Freshly cooked beans had the highest chroma, the freshly frozen ones were second, canned and salted third and dehydrated lowest. Dehydrated and brined beans showed little change in chroma, but the other samples showed a decrease, with length of time in storage.

Ascorbic Acid

The results of the ascorbic acid determinations are summarized in Tables 8 and 9. The calculation of dry basis was made from data on percent total solids listed in Tables 10 and 11, Appendix. It is evident that red cherries and snap beans after processed decreased in ascorbic acid content in different degrees with various treatments.

Effect of Freezing

Freezing had less effect on ascorbic acid retention than any of the other methods tested. Both frozen cherries and beans had the least loss of ascorbic acid in comparison with the products processed in other ways.

The retention of ascorbic acid in freshly frozen cherries was 73 percent on wet basis which was higher than that for freshly cooked ones. One reason may be that frozen cherries were not blanched and were packed raw with sugar before packing for freezing. The 27 percent loss of ascorbic acid of the freshly frozen cherries was due to freezing process while the 35 percent loss of ascorbic acid of the freshly cooked samples was due to cooking. This showed that freezing had less effect on ascorbic acid retention in cherries than cooking.

Table 8. Effect of freezing, canning and dehydration on ascorbic acid content of Montmorency cherries.

Product			Ascorbic acid per 100 grams										
			Raw	Freshly cooked		Freshly processed		After storage for					
				%		%		2 months		4 months		6½ months	
				mg.	%R*	mg.	%R*	mg.	%R*	mg.	%R*	mg.	%R*
Frozen	in cartons	wet basis	7.7	5.0	65	5.6	73	4.2	55	3.3	43	3.1	41
		dry basis	58	18	33	26	45	12	21	13	22	13	22
Canned	in liquid in cherries	wet	4.5		4.7		3.0		2.7		2.4		
			7.7	5.7	74	4.7	61	3.2	42	2.6	34	2.3	30
	in jars	basis	7.7	5.0	65	4.7	61	3.1	40	2.6	34	2.3	30
		dry basis	58	19	33	14	24	9	15	9	15	8	14
Dehy- drated	as rehy- drated	wet basis	7.7	5.0	65	**	**	**	**	**	**	**	**
		dry basis	58	18	32	**	**	**	**	**	**	**	**

* %R - % retention.

** No ascorbic acid.

Table 9. Effect of freezing, canning, dehydrating and salting on ascorbic acid content of Landreth Stringless Green Pod Snap beans.

Product			Ascorbic acid per 100 grams										
			Freshly cooked		Freshly processed		After storage for						
			Raw					2 months		4 months		6½ months	
				mg.	%R*	mg.	%R*	mg.	%R	mg.	%R	mg.	%R
Frozen	in cartons	wet basis	25.5	23.4	92	24.5	96	18.6	73	18.2	71	17.9	70
		dry basis	282	332	118	272	96	198	70	215	76	190	67
Canned	in liquid	wet	9.0		11.3		10.0		7.7		8.6		
	in beans		29.5	14.4	48	9.8	33	9.2	31	9.4	32	9.8	33
	in jars	basis	29.5	12.1	41	10.5	36	9.5	32	8.7	29	9.3	32
	in jars		dry basis	241	233	97	256	106	200	83	184	76	192
Dehy- drated	as rehy- drated	wet basis	21.7	18.3	84	**	**	**	**	**	**	**	**
		dry basis	229	396	172	**	**	**	**	**	**	**	**
Dry- salted	in liquid	wet	15.2		3.0		2.8		2.7		2.7		
	in beans		27.5	18.9	69	2.5	9	2.7	10	2.6	9	2.5	9
	in jars	basis	27.5	17.6	64	27	9	2.7	10	2.4	9	2.6	9
	in jars		dry basis	261	283	108	35	13	36	13	31	12	34
Brined	in liquid	wet	21.2		2.8		2.5		2.6		2.6		
	in beans		25.6	23.5	92	3.0	12	3.3	13	2.6	10	2.6	10
	in jars	basis	25.6	23.1	91	2.9	11	2.9	11	2.6	10	2.6	10
	in jars		dry basis	282	332	118	40	14	41	15	37	13	39

* %R - % retention.

** No ascorbic acid.

Freshly frozen beans retained 96 percent of the original ascorbic acid content on wet basis, while freshly cooked beans retained 92 percent which was very close to the former. Frozen beans were blanched before freezing. Freshly cooked beans were cooked in water. The results indicated the similar effects on ascorbic acid retention due to freezing process and cooking.

Frozen cherries and green beans suffered a further loss of 23 and 29 percent of ascorbic acid respectively after half year of storage.

Effect of Canning

The cherries lost 39 percent of their original ascorbic acid on wet basis while the beans lost 44 percent during canning. The freshly cooked cherries retained 65 percent of the original ascorbic acid and the freshly canned retained 61 percent. The retention of freshly cooked beans was 41 percent and that of freshly processed beans was 36 percent. The additional handling in canning in both cases did not cause any marked loss. Cherries lost another 21 percent of ascorbic acid during the first two months' storage and 10 percent till the end of the storage. Two months' storage caused 4 percent loss of ascorbic acid in beans and the later additional four months' storage had no effect on the ascorbic acid content of the canned beans. It showed that the main loss of ascorbic acid during storage of canned products occurred in the first two months.

Effect of Drying

Dehydration of both cherries and beans resulted in total destruction of ascorbic acid. One important factor that caused this total loss is

due to the long exposure of material in the air at high temperature during dehydration.

Effect of Salting

Freshly brined and dry-salted beans retained relatively little amount of the original ascorbic acid. The retention of ascorbic acid in freshly brined beans was 11 percent, and that of freshly dry-salted beans 9 percent of the original content. Fermentation and repacking process caused a great loss of ascorbic acid in beans.

Ascorbic Acid in Liquid Portions

Tables 8 and 9 show that liquid contents of the processed products contained a considerable portion of the ascorbic acid present. The ascorbic acid content tended to become equalized in the solid and liquid parts with time in storage. The ascorbic acid diffused gradually from the fruit and vegetable to the surrounding liquid during storage. The average percentage present in the liquid of the products at the end of storage was around 50 percent in wet basis.

SUMMARY AND CONCLUSIONS

Landreth Stringless Green Pod beans were preserved by home methods of canning, freezing, dehydrating and salting while Montmorency cherries were preserved by canning, freezing and dehydrating. Palatability tests, ascorbic acid determinations and objective color measurements were made on samples at different stages: 1) raw, 2) freshly cooked, 3) freshly processed and 4) after storage for two, four and six and a half months. The results of the tests permit the following conclusions:

1. Freezing gave the best results for palatability factors and ascorbic acid values of both cherries and beans.
2. Canning was rated the second best method in ascorbic acid retention and palatability scores.
3. Dehydration of both cherries and green beans resulted in complete destruction of ascorbic acid, and unfavorable changes of color, flavor and texture.
4. Both brined and salted beans were poor sources of ascorbic acid, but good in texture and fair in other palatability scores.
5. The palatability of processed food declined with storage. Dehydrated, brined and dry-salted beans became unacceptable towards the end of the six and a half months of storage. All other samples were satisfactory throughout the experiment.

6. The color qualities varied with different processing methods and declined with storage. Dehydrated samples had the lowest figures for value (darkest) and chroma (loss of color). Frozen samples had the highest readings for hue (most green of beans and most red of cherries) and chroma (color retention) and had high readings for value next to the freshly cooked. Samples processed in other ways had readings in between for these three qualities.

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APPENDIX

Table 10. Percent Total Solids of Green Beans.

Treatment		Raw	Freshly cooked	Freshly processed	Stored		
					2 months	4 months	6 months
Dry-salted	drained	12.23	10.84	10.94	10.61	10.93	10.38
	liquid	---	2.51	5.18	5.44	6.42	5.75
Brined	drained	9.08	15.05	9.43	9.34	9.31	8.65
	liquid	---	2.58	5.31	5.23	5.27	5.00
Frozen		9.08	15.05	9.02	9.38	8.45	9.40
Dried	drained	9.46	8.64	16.57	16.65	15.67	14.87
	liquid	---	2.65	6.64	6.68	6.74	6.58
Canned	drained	12.23	10.84	7.68	7.82	7.47	7.72
	liquid	---	2.43	2.86	3.32	2.96	3.17

Table 11. Percent Total Solids of Red Cherries.

Treatment		Raw	Freshly cooked	Freshly processed	Stored		
					2 months	4 months	6 months
Frozen		13.19	27.78	21.30	35.29	25.18	23.62
Dried	drained	13.19	27.78	35.83	21.93	38.42	34.52
	liquid	---	26.76	40.62	39.84	41.27	38.71
Canned	drained	13.19	27.78	36.22	35.49	31.17	30.69
	liquid	---	26.76	27.85	30.86	29.75	29.52

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