# PALATABILITY AND ASCORBIC ACID CONTENT OF SELECTED VARIETIES OF FROZEN BAKED KANSAS APPLES

by

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# INTRODUCTION

Precooked frozen foods are rapidly gaining in popularity and availability to the general public. Today more and more precooked foods are finding their way onto the market. California is credited with the first packs about 1940. With experience and increased knowledge, there is an ever-increasing demand from the consumers for high quality products. If frozen precooked foods are to meet the competition of fresh and canned foods, they must meet them with both quality and price. The homemaker must get satisfaction from these foods beyond the convenience of foods easily and quickly prepared. They must meet the approval of the family. Three things in which the consumer is interested are convenience, economy, and nutritive value. To date, very little information is available on the retention of ascorbic acid and palatability of frozen baked apples. More information is desirable on the part of the producer and the consumer. Information in regard to the palatability and nutritive value retained by the different varieties of apples when baked and frozen for various periods of time is necessary to determine their desirability and value to the commercial grower, the processor, and the consumer.

Much fruit is spoiled each year by marketing too early or too late. Every variety of apple has its season when its fitness for use is at a high point. If it is not used at that time, much waste results. If a method of marketing frozen baked apples could be devised whereby the apple might be utilized at

the proper time, not only the reputation of the apple might be saved but also waste and losses could be avoided by the growers, the retailers, and the consumers. It would avoid the possibility of one variety of apple invading the season of another. Also if a method were obtained whereby the homemaker could conveniently package baked apples, it would increase the sales and the consumption of the product. With these things in mind, the present work was begun.

The purpose of this study was to determine the effects of varied periods of frozen storage upon the palatability and ascorbic acid content of the selected varieties of baked Kansas apples.

## REVIEW OF LITERATURE

For centuries, the apple has been accepted widely as one of the world's favorite fruits. It is the dominant fruit in Kansas and in the United States according to Barnett (1944). He stated census reports revealed that the apple comprised one-fourth to one-half of all the fruits consumed in the United States.

Apples are divided into groups according to their seasonal use. The early winter group is probably the most important since it includes such general purpose varieties as Jonathan, Delicious, and Grimes Golden. These are in season from October to February. The Black Twig and Rome Beauty come on the market in November and remain in season until April or May. Among the late winter group, which is in season from December to April or May, are the

Winesap, Ben Davis, Gano, and Stayman. The Winesap is the typical representative of this group.

Each variety should be used during its seasonal period or at its proper degree of ripeness. Overmaturity and overripeness result in a breakdown of cellular tissue and a softening of the flesh. Formerly the pressure of the thumb was used as an indication of ripeness. But for many years the pressure tester has been an aid in measuring maturity and ripeness, as it indicates the firmness of the flesh. Haller (1941) stated that pressure test determinations had not been found to form a reliable index to maturity of apples except to indicate when certain varieties were becoming too soft and overmature for storage, but that they were a fairly accurate guide to the ripeness.

Apples are recognized for their eye and taste appeal as well as for their nutritive value. They are a source of vitamins, minerals, and carbohydrates. Vitamins A, B, C, and G are present in varying amounts.

Generally, at the present time, the apple is not considered a particularly good source of Vitamin C. However, Grant (1947) referred to work done by Holst and Frolich in 1912 in which interest was clearly evident in the Vitamin C content or, as it was known then, the antiscorbutic factor of apples. In that year they fed guinea pigs 30 grams of raw apple daily to supply the antiscorbutic factor in the diet.

Most of the earlier ascorbic acid studies dealt with foods as purchased or harvested rather than in the cooked state.

In recent years, investigators have studied various factors such as locality, season, variety, preparation, and preservation, which affect the ascorbic acid content of foods. Now, these factors are receiving more attention because of their ultimate effect on the palatability and ascorbic acid content of individual foods.

Findings covering the influence and the magnitude of these factors on ascorbic acid content have been summarized by Adams and Smith (1944). More recently, studies have been made of the ascorbic acid content of food as actually served. These include precooked frozen foods as well, since precooked foods have come into prominence follcwing World War II.

To date, very little literature on the factors affecting frozen baked apples has been available. However, investigations were carried out by Lee (1947) on several varieties of apples to determine the palatability of frozen baked apples for a relatively long-time storage. After a storage period of six months at -6° F., six varieties were noted as having an excellent flavor. Rasmussen, Esselen, and Fellers (1948) in working with the McIntosh apple found the frozen baked apples compared favorably with the canned baked apples. There was little or no difference in appearance, texture or flavor.

Many studies have been made concerning the factors which affect the ascorbic acid content of raw and cooked apples. Eheart (1941) studied 19 varieties of Virginia grown apples and found that there was wide variation among different varieties of apples

and among samples of the same variety. It was found that some apples had twice as much ascorbic acid as others from the same lot, which was unexplainable. She found the Albemarle Pippin, among varieties grown in the United States, to be one of the highest in ascorbic acid content. Two of these apples would supply over one-half the day's need for ascorbic acid, or 30 mg. The Black Twig and Winter Banana each supplied one-third of the day's needs. Most varieties would furnish one-sixth to one-fourth of the day's needs if two apples were eaten daily. Todhunter (1936) stated that ascorbic acid did not seem to be related to the pH, total acidity, sugar, ash content or to chromosome number of the same variety. She made a summary of the ascorbic acid content of apples common in the United States and England which showed that they vary from 1.0 to 17.0 mg per 100 grams. An even greater variation, 0.3 to 24.4 mg per 100 grams has been reported for German varieties according to the work of Kessler, as reviewed by Kheart (1941). Smith and Fellers (1934), in working with 21 varieties of Massachusetts grown apples, listed the Ben Davis and the Winesap as very good sources of ascorbic acid while Rome Beauty, Cortland, and Gravenstein were fair and Jonathan poor.

Howe and Robinson (1944-1945) worked with 58 varieties and 33 seedlings and found a range of from 7 to 37 mg ascorbic acid per 100-gram sample. The Cavelle Blanc ranked very high yielding 37 mg per 100 grams. Thus it was superior to the tomato and compared favorably with the orange in ascorbic acid content. From

their results, it was indicated that a high ascorbic acid characteristic might be transmitted from parent to offspring.

Numerous workers have found the amount of ascorbic acid in apples was decreased during storage. The amount lost depended on temperature, time of storage, and on variety. Todhunter (1937), Batchelder (1934), and Batchelder and Overholser (1936) found that no loss or only a small loss occurred at a storage temperature of 32° F. According to Todhunter (1937) a temperature above 32° F. permitted changes in the apple, resulting in lowered ascorbic acid content. Eheart (1941) studied the effect of storage on 16 varieties of apples and found that at 37.9° F. there was a progressive loss of ascorbic acid until on the average, only 66 per cent of the original amount remained after 24 weeks' storage. Storage of 14 varieties at 35.3° F. caused an average decrease to 69 per cent of the original content after 18 weeks of storage. Manville, McMinis, and Chuinard (1936) found that the amount of ascorbic acid lost in storage varied with the kind of apple and that it was less stable in the Jonathan and Winesap. Kohman, Eddy, and Carlson (1924) found that apples held in cold storage from October to March showed a marked deterioration in ascorbic acid content.

It has generally been thought that larger apples are lower in ascorbic acid than smaller ones of the same variety. The explanation has been that since apple peel is higher in ascorbic acid, the smaller apples contain more of the vitamin per unit weight because they contain proportionately more peel. An in-

vestigation made by Batchelder and Overholser (1936) showed that the size of the fruit was an important consideration because the ratio of skin to pulp was higher in small apples than in larger ones and the skin contained a higher concentration of ascorbic acid than did the pulp. Eheart (1941), in a study of 13 varieties, found that the concentration of ascorbic acid in smaller apples was not greater than in the larger apples of the same variety while Fellers, Isham, and Smith (1932) found that in Baldwin apples, the skin contained four times as much ascorbic acid as the contiguous flesh and 6 to 10 times as much as the flesh surrounding the core.

The problem of whether the application of fertilizer to the soil will increase the vitamin value of fruits and vegetables is one which is increasing in importance. Bracewell, Wallace, and Zilva (1930) studied two varieties of apples from trees receiving high nitrogen applications and found no correlation between the ascorbic acid content of the apples and the nitrogen content. Potter and Overholser (1933) found that Winesap apples from trees which had received applications of a complete fertilizer had a greater antiscorbutic value when fed at a 5-gram level than apples from trees which had not received fertilizer treatment. Todhunter (1939) found that Winesap apples from plots receiving added fertilizers of nitrogen, phosphorous and potassium contained no higher content of ascorbic acid than fruit from check plots receiving no added fertilizer.

Tests were made by Fellers, Cleveland, and Clague (1933) on

sprayed and unsprayed fruit to test the toxic effects of arsenic and other compounds on the ascorbic acid content of the fruit. Apples from trees carefully sprayed all season were fully as rich in ascorbic acid as apples from unsprayed trees. In fact, animals receiving the sprayed fruit showed slightly larger gains than those receiving the unsprayed.

It has been found that the ascorbic acid content of the same variety of apple varies when grown in different places. It was reported by Todhunter (1937) that apples grown in Hungary are higher in ascorbic acid than those grown in other countries. Apples grown in southern Germany were found to be higher in ascorbic acid than the same varieties grown in northern Germany according to the work of Kessler, cited by Eheart (1941). In her study on varieties of Virginia apples, Eheart (1941) reported that apples grown in Virginia varied for some varieties from those grown in other states.

The literature indicates that available moisture affects the ascorbic acid content of apples. Todhunter (1939) found that Winesap apples grown where there were 60 acre-inches of water were higher in ascorbic acid than those grown where only 30 acre-inches were available. No difference in ascorbic acid was found for the Rome Beauty apples from the same irrigation plots.

The coloration of apples has been thought to affect the ascorbic acid value. Todhunter (1939) reported a slight tendency for highly colored fruit to contain more ascorbic acid than poorly colored fruit. Kessler's study as reported by Eheart (1941)

showed 30-50 per cent more ascorbic acid on the red side than on the uncolored side of apples. It has been suggested that the greater amount of ascorbic acid on the red side is not due to color but to the greater intensity of light to which it has been exposed, since some of the varieties richest in ascorbic acid are the yellow and green ones.

Batchelder and Overholser (1936), in their investigation of the relation of leaf area to the ascorbic acid content of Winesap and Delicious apples, concluded that leaf area affected the ascorbic acid content of apples only indirectly; i.e., as it affected the size of the fruit produced.

Bracewell, Hoyle, and Zilva (1930) tested a number of English apple varieties for the antiscorbutic factor and found Bramley's Seedling to be the best. In tests of a number of imported varieties, they found that the antiscorbutic activity was greatest soon after harvesting.

All authorities read seem to indicate that cooking caused the greatest loss in ascorbic acid, varying with the method and type of cooking. Not many studies have been made on the effect of cooking on the ascorbic acid content of apples. Kohman, Eddy, and Carlsson(1924) stated that when apple sauce was made, or when apples were baked or canned without special treatment, the ascorbic acid is practically all destroyed. Curran and Tressler (1936) observed a loss of approximately 80 per cent of the ascorbic acid during the baking of the apples. Curran, Tressler, and King (1936) reported a retention of 77 per cent of the

ascorbic acid content of Northern Spy apples when made into unstrained apple sauce and 69 per cent when made into strained sauce. This high retention was not explained. These authors found only 20 per cent ascorbic acid retention in baked apples and apple pie. Experiments made by Eheart (1941) showed that strained apple sauce retained 16.37 per cent of the ascorbic acid in the raw, unpeeled apple while the baked apple retained only 13.43 per cent. The apple sauce contained 0.52 mg per 100 grams and the baked apples 0.67 mg per 100 grams. These losses were large but confirm other reports that much ascorbic acid is lost in cooking.

## EXPERIMENTAL PROCEDURE

All the research for this study was conducted in the Foods Research laboratories of Calvin Hall.

The equipment used included a Magness-Taylor pressure tester, aluminum foil (No. 1001), torsion balances, graduate cylinders, individual pyrex baking dishes, a Frigidaire electric range, freezer lockers, an analytical balance, beakers, flasks, pipettes, funnels, watch glasses, a Waring Blendor, wash bottles, a Klett Summerson photoelectric colorimeter, and Klett tubes.

The apples used were purchased in Doniphan County, Kansas, in early October, 1948, and were stored at 34-36° F. in the regular cold storage room of the Horticulture Department of Kansas State College until January, 1949, when the testing began.

Distilled water was used for all the tests. The sugar and cinnamon were obtained in one lot, and were stored in containers in the experimental laboratories until they were used. Ordering an initial supply large enough to last throughout the study kept the ingredients as uniform as possible.

The work was divided into two series. In Series I, Winesap and Rome Beauty apples were tested for palatability and ascorbic acid content; in Series II, the same tests were used for the Jonathan, Ben Davis, and York Imperial varieties.

The palatability tests were made on the freshly baked apples as well as on those frozen and stored; while the ascorbic acid tests were run on the raw, the freshly baked, and the frozen stored apples. A pressure test was used for each variety to give an indication of tenderness and maturity.

## Pressure Test

Three raw apples of each variety were tested for tenderness by using the fruit pressure tester. This test is one frequently employed commercially. Four tests were made around the periphery, midway between the stem and calyx ends. Three tests each were made at the stem end and at the calyx end.

In making the tests, the skin was removed at the points to be tested by slicing off a somewhat greater diameter than that of the plunger point.

The fruit was held in one hand, and with the other hand the plunger point was directed squarely against the cut surface.

The pressure was gradually increased until the plunger penetrated the apple to the mark indicated.

When this mark was reached, the pressure was released and the reading indicated by the slide was recorded.

The slide was then returned to the zero position and the next test made.

## Apples for Testing

At the beginning of the experimental period in both series, ascorbic acid tests were conducted on raw apples of each variety to serve as controls for the variety tested. All samples were run in duplicate to serve as a check for results obtained.

In Series I, 14 apples each of Winesap and Rome Beauty were prepared and baked for immediate testing. Seven of these were scored for palatability and the remaining seven were tested for ascorbic acid retention.

Forty additional apples each of Jonathan, Ben Davis, and York Imperial were prepared, baked, and placed in storage at 0° F. for further testing. Palatability tests were made on these at intervals of one week, three weeks, six weeks, eight weeks, 10 weeks, 12 weeks, 14 weeks, 15 weeks, and 16 weeks. Determinations for ascorbic acid retention were made after storing for 24 hours, 48 hours, 72 hours, one week, three weeks, six weeks, 10 weeks, 12 weeks, 14 weeks, and 16 weeks.

In Series II, 12 apples of each variety were prepared and baked for immediate testing. Six of these were scored for pala-

tability and the remaining six were scored for ascorbic acid.

Sixteen additional apples of each of the three varieties were prepared, baked, and placed in storage at 0° F. for further testing. Palatability tests were made at intervals of one week, three weeks, six weeks, and 12 weeks; while determinations for ascorbic acid retention were made at intervals of 24 hours, one week, three weeks, and six weeks.

## Preparation and Baking of the Apples

The weight of the uncored apple was taken and recorded. The other ingredients were weighed or measured: sugar, 20 per cent of the uncored weight of the apple; cinnamon, .1 gram; and water 10 ml. Then the aluminum foil (No. 1001), used in wrapping the apple, was weighed. The apple was cored, and the blossom end removed. The weight of the cored apple was taken and recorded. The cored apple was wrapped in foil by placing the apple in the center of the wrap and folding the outside edges firmly around it with the folds overlapping, thus forming a sack-like enclosure with the top partially open. The sugar-cinnamon-water mixture was placed in the cavity of the wrapped apple. The total weight of the packaged apple was taken and recorded. Each packaged apple was placed in an individual pyrex baking dish and baked at 375° F. for 40 minutes. It was removed from the oven and allowed to cool 10 minutes.

## Preparation of Baked Apple for Storage

The package was closed by bringing the edges of the wrap

firmly together at the top and folding the edges over onto the apple until a seal was effected. Next, the package was coded to facilitate handling. Then the baked weight was taken and recorded and the prepared apple placed in storage at 0° F. until ready for testing.

## Palatability Tests

At the designated intervals, duplicate samples of frozen apples were removed from storage and tested for palatability. This was done in the following manner:

The weights of each were taken and recorded. Samples were reheated for 60 minutes in a 375° F. oven and cooled for 10 minutes before weighing. The foil was removed and the apple placed on a small china plate. One-half of each apple was cut for scoring, leaving the remainder in one piece for grading aroma and appearance.

The apples were scored by a palatability committee consisting of seven judges, five members of the staff of the Foods and Nutrition Department, and two graduate students. Form I (Appendix), a modification of the scorecard most commonly used in research projects at Kansas State College, was used. All scores were recorded and tabulated.

## Ascorbic Acid Tests

A modification of the Loeffler-Ponting method was used in analyzing the samples for ascorbic acid content.

Solutions needed for the colorimeter method of ascorbic acid analysis:

Two-six dichlorophenol indophenol dye solution was prepared by weighing ± 10 mg of dye on a watch glass on the analytical balance. The dye was washed and filtered into a 500 ml volumetric flask with hot water and the filter paper again washed with more water. The solution was then cooled and made up to volume. The aqueous solution of the dye changes slowly at low temperatures; therefore it was kept in the refrigerator and fresh solutions were made up approximately every three or four days. If kept longer than three days, the dye solution was restandardized before samples were tested.

A stock solution of 10 per cent metaphosphoric acid made by dissolving 100 grams of metaphosphoric acid pellets in distilled water in a one-liter volumetric flask, and bringing the volume up to 1000 ml, was used in preparing the 1 per cent metaphosphoric acid solution. The ascorbic acid solution for the standardization of the dye was carefully prepared by weighing out exactly 25 mg of crystalline ascorbic acid (Cebione Merck) and dissolving it in a 1 per cent metaphosphoric acid solution. The crystals were brushed through a funnel into a 250 ml volumetric flask containing a small amount of freshly prepared 1 per cent metaphosphoric acid. The funnel was rinsed and the solution was made up to volume.

Standardization of the Dye Solution. To standardize the dye, dilutions of the stock ascorbic acid solution were made so

that there were three solutions having concentrations of 3 micrograms per ml, 4 micrograms per ml, and 5 micrograms per ml. These were prepared by pipetting 3 ml, 4 ml, and 5 ml of the stock solution into each of three 100 ml volumetric flasks and then making these up to volume with 1 per cent metaphosphoric acid.

Ascorbic acid is rendered fairly stable in an acid medium of the proper pH value. One per cent metaphosphoric acid has been found satisfactory for this purpose if the present described method of analysis is employed.

For all standardizations and extractions, care was taken to have all reagents at room temperature.

Method of Standardization. The Klett Summerson photoelectric colorimeter was calibrated to zero with a Klett tube containing 5 cc. of distilled water.

Five ml. of dye solution were pipetted into each of eight Klett colorimeter tubes by means of a 10 ml graduated pipette.

To one of the tubes, five ml of 1 per cent metaphosphoric acid solution were added by means of a five-ml volumetric pipette.

To thoroughly mix these, the tube was quickly inverted three times and placed in the colorimeter.

The reading was taken 15 seconds after the beginning of the addition of the acid.

Checks were run on each.

The reading of the dye plus the acid is referred to as the "blank reading."

Standardization of Ascorbic Acid. The same procedure was followed for each of the ascorbic acid solutions - pipetting five ml of each of the three concentrations of ascorbic acid into the dye rather than the 1 per cent metaphosphoric acid solution.

Checks were run in each case just as in the "blank reading."

To calculate the ascorbic acid factor, the following formula was used:

$$\frac{\text{Concentration of ascorbic acid}}{\text{Blank reading - ascorbic acid reading}} = \text{Ascorbic acid factor}$$

An average of ascorbic acid values for the three concentrations gave the ascorbic acid factor which was used in calculating the amount of ascorbic acid in the sample tested.

## Method of Extraction

Two raw apples of each variety were weighed, cored, reweighed, and macerated in a Waring blendor in approximately 400 ml of 1 per cent metaphosphoric acid for five minutes. The blendor was used in order to have the cellular structure of the tissues well broken down. To prevent frothing, two or three drops of butyl stearate were added to the mixture before the blending started.

After blending, the mixture was quantitatively transferred to a one-liter graduated flask and made up to a volume of 700 or 800 ml, depending on the size of the apple.

Samples were mixed well and a portion was filtered through fluted paper.

Since the filtered samples were quite turbid, it was necessary to filter them a second time. This refiltered sample was used for the ascorbic acid analysis. Seventy-five ml, more or less, were sufficient for running the determinations.

The freshly baked apples were removed from the oven, allowed to cool 10 minutes, weighed, the foil removed, and placed in the Waring Blendor to be extracted for ascorbic acid determinations. At stated intervals, duplicate samples of frozen apples were removed from storage, weighed, reheated in a 375° F. oven for 60 minutes, cooled 10 minutes, and reweighed. All weights were recorded and tabulated. The aluminum foil was removed from the reheated sample and ascorbic acid determinations conducted in the same manner as previously stated.

## Analysis of Filtrate

Dilutions were used for most of the raw samples because it was desirable that the ascorbic acid readings fall within the range used for the dye standardization. In all cases, a 25 to 50 dilution proved satisfactory. When dilutions were made, 50 ml volumetric flasks were used. Twenty-five ml of the filtrate were pipetted into the flask and made up to volume with 1 per cent metaphosphoric acid. These diluted solutions were mixed well and were used for the analysis.

The method of analysis was similar to that used for the standardization of the dye. Three tubes were needed for each unknown.

Five ml of distilled water were pipetted into one tube and five ml of dye into each of the other two.

Five ml of the unknown solution were added to the tube containing distilled water.

The tube was inverted three times, and placed in the machine. Thus the machine was set to zero with this blank in the same manner that it was set to zero using distilled water when the dye was standardized. This automatically corrected for turbidity and the normal color of the solution.

Five ml of the unknown were added to each of the other tubes and readings were taken after 15 seconds from the beginning of the addition of acid.

Duplicate readings were always made for ascorbic acid determinations. Greater speed and accuracy were possible the second time.

These readings are referred to as the unknown readings in determining the ascorbic acid content.

The concentration of ascorbic acid in mg per 100 grams of sample was calculated by the following formula:

Dye Blank - Unknown Reading = Corrected Unknown

$$\frac{\text{Ascorbic Acid Factor} \times \text{Corrected Unknown} \times \text{Dilution}}{5(\text{Aliquot Portion})} = \text{mg ascorbic acid per 100 grams of sample.}$$

All ascorbic acid concentrations were recorded and tabulated.

# RESULTS AND DISCUSSION

All data obtained from the five varieties of apples studied were summarized, averaged, and recorded in Tables 1 to 6.

## Pressure Tests

Pressure tests showed a range in firmness (Table 1) which indicated that some varieties were more mature than others. The York Imperial had the highest pressure-test reading while the Jonathan had the lowest.

## Ascorbic Acid

Averages from two tests made on raw apples of each variety indicated quite a range of ascorbic acid content. The fact that the apples were collected from various orchards as they were available instead of all from the same orchard or from the same tree, no doubt had an influence on the ascorbic acid content of the individual apple. The average amount of ascorbic acid found for each variety was as follows:

| | |
|---|---|
| Ben Davis | 5.07 mg per 100 grams |
| Jonathan | 3.28 mg per 100 grams |
| York Imperial | 2.74 mg per 100 grams |
| Winesap | 2.33 mg per 100 grams |
| Rome Beauty | 1.96 mg per 100 grams |

Ben Davis yielded the greatest amount and Rome Beauty the least.

Howe and Robinson (1944 and 1945) showed Jonathan and Ben Davis apples yielded 15-20 mg ascorbic acid per 100 grams of apple. This was a higher yield than that found in the present

study. However, the amounts of ascorbic acid obtained from the five varieties of Kansas apples compared favorably with those listed by Eheart (1941) on Virginia grown varieties. She noted that within a given variety, the ascorbic acid varied from apple to apple, and that sometimes an apple was found with twice as much ascorbic acid as another within the same lot.

All of the apples lost ascorbic acid during baking and storage. The greatest loss occurred during baking. The average loss for each variety was:

| | |
|---|---|
| Winesap | 69.7 per cent |
| Rome Beauty | 74.9 per cent |
| Jonathan | 83.3 per cent |
| Ben Davis | 89.3 per cent |
| York Imperial | 84.6 per cent |

The average loss for all varieties was 80.36 per cent, leaving an average ascorbic acid retention of 19.64 per cent. This is comparable to the 13.43 per cent retention reported by Eheart (1941).

The apples of Series I lost less ascorbic acid in the baking process than did those in Series II (Table 2). This might have been due in part to the overmaturity of the Jonathan and the York Imperial, however, it would not apply to the Ben Davis.

The varieties of Series II retained the remaining ascorbic acid better during storage than did those of Series I.

At the end of the 24-hour storage period, all varieties of both series showed an increase in ascorbic acid content. In Series I, with few exceptions, the ascorbic acid content tended

to decrease with longer storage. The three varieties in Series II showed an increase up to three weeks of storage. These discrepancies could have been due to the variable content of ascorbic acid within the original sample.

At the end of six-weeks' storage, Rome Beauty and Winesap were best in both ascorbic acid content and palatability (Table 3). In Series I the amount of ascorbic acid lost in storage varied with the variety. At the end of 16 weeks' storage, the Winesap had retained .437 mg ascorbic acid per 100 grams of apple while the Rome Beauty showed a retention of .239 mg ascorbic acid per 100 grams. After 16 weeks' storage, the Winesap had lost 38.1 per cent of its ascorbic acid while the Rome Beauty had lost 51.3 per cent (Table 2). In Series I the per cent of ascorbic acid lost at the end of 16 weeks was comparable to that which was lost in Series II at the end of 6 weeks. The loss could have been due to the overmaturity of the apples or to the particular apple chosen for storage.

## Palatability

In general, the palatability scores for apples in Series I were higher than for those in Series II (Table 4). The Winesap scored highest of all varieties. When it was put in storage, it was in season, of good quality, of uniform size, and apparently at the proper stage of maturity as indicated by the pressure tester. This was not true of some of the other varieties.

At the end of the 16-week storage period, the Winesap was still considered a standard product in aroma, appearance, flavor, and texture and was judged acceptable by every member of the committee.

The Rome Beauty was not as desirable as the Winesap according to the scores of the judges. The Rome Beauty increased in palatability the first week of storage, then decreased, reaching its lowest score at the end of the eighth week. Often the author observed that the sugar in the cavity of the apple was not all melted even after the apple had been reheated. Frequently the comment made by the judges was that the apple appeared underdone. This was understandable as the apples of this variety were very large, the average weight approximating 232.8 grams as compared to the 155.7 grams of the Winesap and the 138.6 grams of the Jonathan (Table 5). Many times the texture of the Rome Beauty was referred to as coarse and grainy. It was interesting to note that after 12 weeks of storage, the Rome Beauty scored the lowest in palatability and at the same time showed the least amount of ascorbic acid retention. However, it appeared acceptable by a majority of the judges up to the end of the 15th week of storage.

The three varieties in Series II all started at slightly different levels of desirability but reached the same level at the end of the third week of storage and showed the same rate of decreasing palatability up to the end of 12 weeks' storage. At that time the Jonathan still was rated standard in aroma and flavor, but appeared inferior in appearance and texture. This was

in accordance with the results of the pressure test which indicated that the flesh of the Jonathan was much less firm than that of any variety tested (Table 1). The Jonathan showed a greater shrinkage than any other variety, which might be another indication of its over-maturity. It retained its shape while it was cooking but upon reheating appeared to shrivel. Preference for this variety was often expressed by members of the committee.

The York Imperial and Ben Davis were not deemed too desirable at any time. The Ben Davis was judged unacceptable at the end of 12 weeks of storage while the York Imperial was not acceptable after six weeks (Table 6). They both were consistently rated as grainy and coarse in texture and lacking in flavor. The sugar often was not melted in the reheated product. They were often reported underdone. At the end of storage, the flesh of both varieties appeared dark and poor in texture with an apparent breakdown of cellular tissue. The undesirability of the Ben Davis was in direct contrast to its high ascorbic acid content (Table 2). However, Tucker (1948) found that high palatability values were not always correlated with high ascorbic acid values, but that palatability was more important in determining the acceptability of the product. The inferior quality of the York Imperial might be explained by the irregularity of size and shape of the apple, the brown areas on the skins, and by the very firm flesh as indicated by the pressure tester. This was in agreement with Barnett's statement (1944) that the cell wall and fibre contained in the flesh of the apple differed from one variety to another.

A characteristic common to all varieties and consistently noted by the judges was the toughness of the skins. This appeared quite objectionable. However, according to Barnett (1944) a tough skin was desirable to hold the shape of the apple after baking. He also stated that apples varied widely in appearance when baked. This too was observed in the present study.

Table 1. Relation of firmness to maturity of apples.

| Pressure tests taken at: | Pressure-test reading of: Winesap | Rome Beauty | Jonathan | Ben Davis | York Imperial |
|---|---|---|---|---|---|
| | | | Pounds | | |
| Center | 6.88 | 5.88 | 4.62 | 6.56 | 10.00 |
| Stem end | 6.93 | 5.87 | 4.68 | 6.91 | 9.42 |
| Calyx end | 7.22 | 5.66 | 4.81 | 6.75 | 9.58 |
| Average | 7.01 | 5.80 | 4.70 | 6.74 | 9.66 |

Table 2. Ascorbic acid changes during baking and storage.

| Variety | Mg ascorbic acid per 100 grams: Raw | Freshly baked | Per cent changed during: Baking | storage: hours: 24 | 48 | 72 | weeks: 1 | 3 | 6 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Series I** | | | | | | | | | | | | | |
| Winesap | 2.33 | .706 | -69.7 | 26.8 | 17.1 | 14.6 | -20.1 | 6.4 | -18.6 | -16.9 | -55.8 | -64.9 | -38.1 |
| Rome Beauty | 1.96 | .491 | -74.9 | 4.7 | -15.1 | -24.6 | -10.4 | -17.9 | 35.0 | 9.8 | -58.0 | -47.3 | -51.3 |
| **Series II** | | | | | | | | | | | | | |
| Jonathan | 3.28 | .547 | -83.3 | 6.0 | - | - | 8.0 | 10.2 | 3.8 | - | - | - | - |
| Ben Davis | 5.07 | .540 | -89.3 | 1.7 | - | - | 6.9 | 5.2 | 3.5 | - | - | - | - |
| York Imperial | 2.74 | .423 | -84.6 | 13.0 | - | - | 18.9 | 22.2 | 24.5 | - | - | - | - |

Table 3. Ascorbic acid content and palatability of apples.

| Variety | After baking | After storage of: hours 24 | 48 | 72 | weeks 1 | 3 | 6 | 10 | 12 | 14 | 16 | Av. | Over-all palatability rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mg of ascorbic acid per 100 grams | | | | | | | | | | | | |
| **Series I** | | | | | | | | | | | | | |
| Winesap | .706 | .895 | .827 | .809 | .564 | .751 | .575 | .694 | .312 | .248 | .437 | .611 | Standard |
| Rome Beauty | .491 | .514 | .416 | .370 | .440 | .403 | .663 | .539 | .206 | .259 | .239 | .405 | Standard |
| **Series II** | | | | | | | | | | | | | |
| Jonathan | .547 | .580 | - | - | .591 | .603 | .568 | - | - | - | - | .586 | Very sl. inferior |
| Ben Davis | .540 | .531 | - | - | .577 | .568 | .559 | - | - | - | - | .559 | Very sl. inferior |
| York Imperial | .423 | .478 | - | - | .503 | .517 | .527 | - | - | - | - | .506 | Very sl. inferior |
| Average | .541 | | | | | | | | | | | .534 | |

Table 4. Average scores of palatability committee.

| Factors scored | Varieties | | | | |
|---|---|---|---|---|---|
| | Winesap | Rome Beauty | Jonathan | Ben Davis | York Imperial |
| Aroma | 0 | 0 | 0 | 0 | 0 |
| Appearance | 0 | 0 | -2 | 0 | 0 |
| Flavor | 0 | 0 | 0 | -1 | -2 |
| Texture | 0 | -1 | -2 | -1 | -1 |
| Average | 0 | 0 | -1 | -1 | -1 |

Table 5. Weights of apples tested.

| Sample number | Varieties | | | | |
|---|---|---|---|---|---|
| | Winesap | Rome Beauty | Jonathan | Ben Davis | York Imperial |
| | | | Grams | | |
| 1 | 160.0 | 215.2 | 172.0 | 210.2 | 148.9 |
| 2 | 153.5 | 207.8 | 172.8 | 211.0 | 146.5 |
| 3 | 155.5 | 208.5 | 165.0 | 210.7 | 196.8 |
| 4 | 138.7 | 188.8 | 183.7 | 203.1 | 167.0 |
| 5 | 165.1 | 201.1 | 186.7 | 216.9 | 140.5 |
| 6 | 164.0 | 189.3 | 207.3 | 203.0 | 133.3 |
| 7 | 136.0 | 200.5 | 132.6 | 212.1 | 171.0 |
| 8 | 167.6 | 217.5 | 124.4 | 185.3 | 207.1 |
| 9 | 150.5 | 177.3 | 125.7 | 193.0 | 233.7 |
| 10 | 146.7 | 213.5 | 137.7 | 224.6 | 195.7 |
| 11 | 188.5 | 213.2 | 133.4 | 191.8 | 214.3 |
| 12 | 172.7 | 281.5 | 100.5 | 194.9 | 149.1 |
| 13 | 175.5 | 285.0 | 128.0 | 208.8 | 150.1 |
| 14 | 146.5 | 312.8 | 102.0 | 176.2 | 141.1 |
| 15 | 186.4 | 176.7 | 99.9 | 181.8 | 215.9 |
| 16 | 150.1 | 202.0 | 97.4 | 230.3 | 225.0 |
| 17 | 158.8 | 181.6 | 111.5 | 205.3 | 196.6 |
| 18 | 147.3 | 240.2 | 115.0 | 167.0 | 180.2 |
| 19 | 170.2 | 196.0 | 101.0 | 196.2 | 224.8 |
| 20 | 165.0 | 213.2 | 132.0 | 161.6 | 218.4 |
| 21 | 152.2 | 241.0 | 133.2 | 163.1 | 221.0 |
| 22 | 151.7 | 204.5 | 161.3 | 173.4 | 211.2 |
| 23 | 151.2 | 210.8 | 128.1 | 230.3 | 197.7 |
| 24 | 141.5 | 222.0 | 137.7 | 164.5 | 162.3 |
| 25 | 147.6 | 236.8 | 102.9 | 189.7 | 126.0 |
| 26 | 166.6 | 203.7 | 154.3 | 168.9 | 130.2 |
| 27 | 138.1 | 275.3 | 158.4 | 158.8 | 123.9 |
| 28 | 140.5 | 229.0 | 163.4 | 170.7 | 109.7 |
| 29 | 170.4 | 244.3 | 149.0 | 137.4 | 166.1 |
| 30 | 167.6 | 240.0 | 150.1 | 148.5 | 187.7 |
| 31 | 164.3 | 238.2 | | | |
| 32 | 159.4 | 185.5 | | | |
| 33 | 138.6 | 235.6 | | | |
| 34 | 179.5 | 215.6 | | | |
| 35 | 175.5 | 225.7 | | | |
| 36 | 143.2 | 162.8 | | | |
| 37 | 151.3 | 168.8 | | | |
| 38 | 145.7 | 221.3 | | | |
| 39 | 149.2 | 209.8 | | | |
| 40 | 160.7 | 231.7 | | | |
| 41 | 142.7 | 259.7 | | | |
| 42 | 157.7 | 253.5 | | | |
| 43 | 171.6 | 255.6 | | | |
| 44 | 148.6 | 245.2 | | | |
| 45 | 168.5 | 273.4 | | | |
| 46 | 146.0 | 238.2 | | | |
| 47 | 140.9 | 229.6 | | | |
| 48 | 137.2 | 262.9 | | | |
| 49 | 164.9 | 256.5 | | | |
| 50 | 146.4 | 230.4 | | | |
| 51 | 152.4 | 281.0 | | | |
| 52 | 143.2 | 265.0 | | | |
| 53 | 143.7 | 305.6 | | | |
| 54 | 144.5 | 299.5 | | | |
| 55 | 166.1 | 310.8 | | | |
| 56 | 153.2 | 346.3 | | | |
| Average | 155.7 | 232.8 | 138.9 | 189.6 | 176.4 |

Table 6. Acceptability of baked apples.

| Judges scoring | Variety | Number of apples scored | Times scored | Times scored acceptable | Times scored unacceptable |
|---|---|---|---|---|---|
| 7 | Series I | | | | |
| | Winesap | 25 | 175 | 158 | 17 |
| | Rome Beauty | 25 | 175 | 148 | 27 |
| | Series II | | | | |
| | Jonathan | 14 | 98 | 78 | 20 |
| | Ben Davis | 14 | 98 | 72 | 26 |
| | York Imperial | 14 | 98 | 61 | 37 |

# SUMMARY

The purpose of this study was to determine the effects of varied periods of frozen storage upon the palatability and ascorbic acid content of selected varieties of baked Kansas apples.

Five varieties of apples were used in the study; namely, Winesap, Rome Beauty, Jonathan, Ben Davis, and York Imperial. Pressure tests showed the flesh of some varieties was more firm than others, thus indicating a difference in maturity. Preliminary tests had shown that aluminum foil (1001) could be satisfactorily used for the baking and storing of the baked product.

Ascorbic acid determinations were made on the raw, the freshly baked, and the frozen baked apples. The raw apple was used as the control and served as a basis for comparison with the frozen stored product. For all ascorbic acid determinations, a modification of the Loeffler-Ponting colorimetric method was used. Calculations were made to show milligrams of ascorbic acid per 100 grams of apple.

The ascorbic acid content varied, depending on the variety tested. In the raw samples, the amount ranged from 1.96 to 5.07 mg per 100 grams of apple, with Rome Beauty showing the lowest ascorbic acid value and Ben Davis the highest. Other workers too have found Ben Davis high in comparison with other varieties. The wide variation in ascorbic acid content might have been due to inherent characteristics of that variety. Overmaturity and poor quality might have been influencing factors in the individual

apples, since these characteristics were observed in many of the samples tested.

The amount of ascorbic acid present at the end of storage ranged from .239 to .568 mg per 100 grams. The greatest loss of ascorbic acid was in baking, the amount ranging from 69.7 to 89.3 per cent. The average retention was 19.64 per cent. Some loss was observed during frozen storage. Two varieties tended to show a gradual decrease in ascorbic acid retention while the remaining three varieties showed a decrease only after three weeks.

Palatability tests were made at stated intervals of frozen storage. The freshly baked apple served as the control in each test. As a rule, no decided preference was shown for any one variety. However, at the end of the storage period, the Winesap was the most desirable. Preference for the flavor of the Jonathan was quite generally noted although it often appeared inferior in texture and appearance. The Rome Beauty remained palatable throughout most of the study but the Ben Davis and York Imperial became undesirable toward the end of storage. Both were grainy and coarse in texture and showed a breakdown in cellular tissue. The York Imperial was probably the least desirable.

It would appear from information obtained in the present study that the Winesap, Jonathan, and Rome Beauty ranked above Ben Davis and York Imperial with the latter being the least desirable of the five varieties for a frozen baked product. In general, the results indicated that the Winesap, Rome Beauty,

Jonathan, Ben Davis, and York Imperial apples could be baked, frozen, and satisfactorily stored up to a period of 16 weeks.

A greater number of samples of a given variety, tested at the proper stage of maturity are needed before accurate information concerning the effects of storage on frozen baked apples is known. Additional methods of thawing and reheating should be tried before recommendations can be made as to the best method of handling the frozen product.

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# APPENDIX

Form 1



SCORE CARD

Baked Apples

Date_____

Sample No._____

_____

Name_____

| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Aroma | Use the following numbers as a guide for scoring: | | | | | | | | |
| 2. Appearance<br>Color - clear, not dull or faded<br>Shape - slight or no cracking of skin, having appearance of being soft without flattening of pulp<br>Shriveled | Very Superior | +5 | | | | | | | |
| | Superior | +4 | | | | | | | |
| | Moderately Sup. | +3 | | | | | | | |
| | Slightly Sup. | +2 | | | | | | | |
| | Very sl. sup. | +1 | | | | | | | |
| | Standard | 0 | | | | | | | |
| | Very sl. inferior | -1 | | | | | | | |
| | Sl. inferior | -2 | | | | | | | |
| | Moderately inf. | -3 | | | | | | | |
| | Inferior | -4 | | | | | | | |
| | Very inferior | -5 | | | | | | | |
| 3. Flavor<br>Characteristically apple flavor<br>Pleasingly acid<br>Juice well retained in apple pulp | | | | | | | | | |
| 4. Texture<br>Fine-grained and tender enough to be easily cut | | | | | | | | | |
| Would you consider this an acceptable product to serve at a meal? | | | | | | | | | |
| Comments: | | | | | | | | | |