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SOME CHANGES IN EASTERN APPLES DURING STORAGE

WRIGHT, R.C., WHITEMAN, T.M. 1 OF 1

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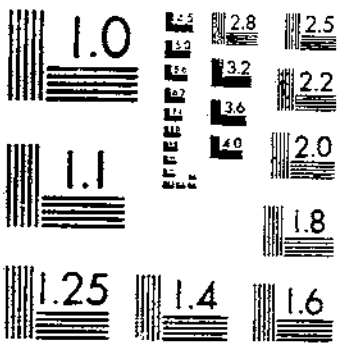

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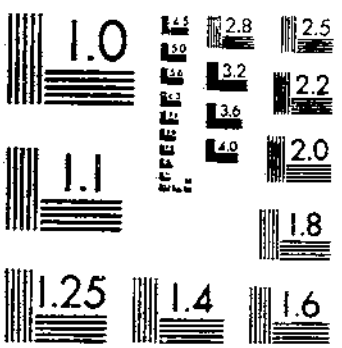

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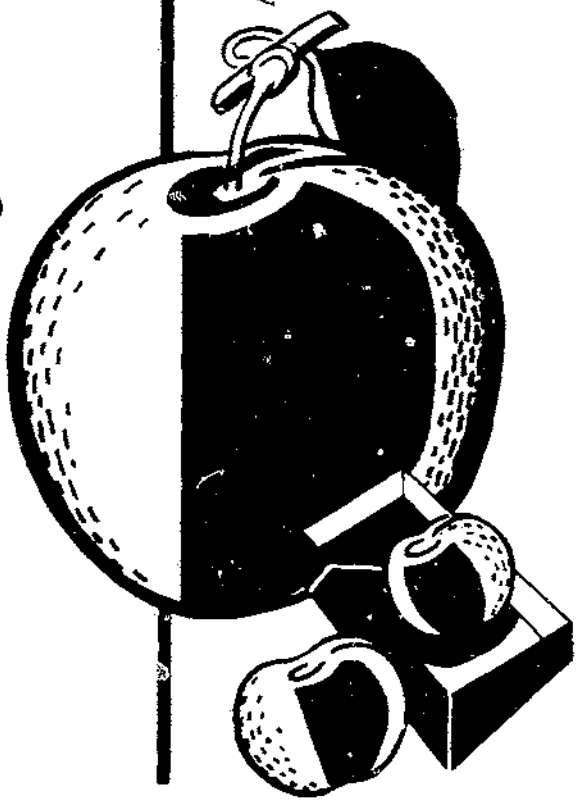

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Some Changes in EASTERN APPLES DURING STORAGE

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Agricultural Marketing Service, Biological Sciences Branch

CONCLUSIONS

In these investigations the length of time the apples could be stored at 31° F. and still retain a comparatively high quality rating after 1 week of simulated marketing conditions at 70° was as follows: Grimes Golden 8 to 9 weeks, Golden Delicious 16 to 18 weeks, Delicious 26 to 28 weeks, and Winesap, Stayman, and York Imperial about 30 weeks.

The flesh of varieties studied softened in storage in the following diminishing order: Stayman, Winesap, Rome Beauty, Golden Delicious, Jonathan, Yellow Newtown, York Imperial, Grimes Golden, and Delicious.

Reducing sugars tended to increase during storage while sucrose increased only during the first 1 or 2 months.

Total sugar increased while acidity decreased during storage.

In general the greatest volume of juice was found after storage in the Winesap, Delicious, Jonathan, Yellow Newtown and York Imperial varieties in the order given. In varieties that tended to become mealy, such as Rome Beauty, Stayman, and Golden Delicious, the juice volume was less.

INTRODUCTION

It is often not realized that apples remain alive even after they are picked from the tree. When left at ordinary room temperatures they pass through their post-harvest life at a comparatively rapid rate, whereas if stored at the usual cold-storage temperature of 31° to 32° F. they go through the same life processes but at a much slower pace. One sometimes hears it said that "cold-storage" apples do not taste as good as apples do shortly after harvest. However, cold storage is necessary to prolong the useful life of the fruit, and to make apples available for consumption at seasons when fresh or tree-ripened apples are not obtainable. In general, the storage life of apples depends upon the variety, storage treatment, state of maturity when harvested, and area in which grown. When all of these conditions are reasonably favorable, apples that have been stored should have nearly the same quality as those that have not been stored but that were ripened soon after removal from the tree.

PART 1.—CHEMICAL AND PHYSICAL CHANGES

For many years investigators have been interested in studying the chemical and physical changes occurring in apples during their development on the tree and subsequently during storage. Sugar and starch development were studied early by Biglow, Gore, and Howard [1] and their results were published in 1905. They reported that during the early growing season sugar was largely in the form of glucose, but as the season advanced sucrose, as well as the reducing sugars, increased.

[1] Biglow, W. D., Gore, H. C., and Howard, B. J. studies on apples. U. S. Dept. Agr. Bur. Chem. Bull. 94. 100 p., 30 fig., 5 pl., bibliographical footnotes. 1905.

Starch likewise increased and reached its maximum about mid-August. After this climax in starch accumulation there was a gradual decrease accompanied by an increase in sucrose. Haynes and Archbald [2] after a critical study of sugar and acid relations in apples during storage suggested that acid is formed as a result of oxidation of one or more of the products that result from inversion of sucrose. They pointed to the coincidence of the death of the apple with the exhaustion of sucrose and acid. Later Kidd and West [3] showed that Bramley's Seedling apples after 250 days of storage showed a loss in total sugar and sucrose, a slight gain in reducing sugar, and a loss in acid as follows:

	Sucrose	Reducing sugar	Total sugar	Acid
Initial quantity (gms.)	3.47	5.91	9.38	1.12
Change after 250 days	−2.15	+0.91	−1.24	−0.56

Magness and Diehl [4] in their observations on physiological changes in apples before and after harvest stated that with the removal of the fruit from the tree certain processes stop while others continue more or less as before. For instance, while further increase in size stops, the change from green to yellow color on the unblushed side of the fruit continues; the red color may increase at ordinary temperatures after picking, but not after the fruit has been placed in cold storage. They noted that softening of the apple continued more rapidly after its removal from the tree than before. There was a distinct difference in rate of softening, however, at different storage temperatures. At 70° F. apples softened 10 to 12 times faster than at 32° and 2 times faster at 36° than at 32°.

Materials and Methods

A study was begun in the fall of 1939 and continued, with some interruptions, into 1950 to obtain additional information on the changes that take place during the storage life of several commercial varieties of apples. Physical and chemical examinations were made monthly on successive sample lots of several varieties during storage at 31° F. and on similar samples after ripening at 70° for approximately 1 week following removal from storage. The object of this procedure was to determine the changes taking place in apples during storage, and how long the apples could be kept in storage and yet allow for a marketing period of at least a week in a temperature of 70° before they became overripe. The varieties studied and number of years each was investigated were as follows:

1. Delicious, four seasons.
2. Golden Delicious, three seasons.
3. Grimes Golden, three seasons.
4. Jonathan, four seasons.
5. Rome Beauty, three seasons.
6. Stayman, three seasons.
7. Winesap, two seasons.
8. Yellow Newtown (mature when picked) three seasons.
9. Yellow Newtown (immature when picked) two seasons.
10. York Imperial, three seasons.

All varieties were harvested at the stage of maturity that was considered best in accordance with local commercial practice. The picking time usually was determined by the

[2] Haynes, D. and Archbald, H. K. Chemical studies in the physiology of apples. X, a quantitative study of chemical changes in stored apples. Ann. Bot. 42, pp. 965–1017. Oct. 1928.

[3] Kidd, F. and West, C. Physiology of fruit. I, changes in the respiratory activity of apples during senescence at different temperatures, Proc. Royal Soc. Series B, Vol. 106, pp. 93–109. 1930.

[4] Magness, J. R. and Diehl, H. C. Physiological studies on apples in storage, Jour. Agr. Res. 27, No. 1, pp. 1–38. 1924.

apparent maturity as indicated by color and tendency to start to drop. Most of the varieties were grown at or near the Plant Industry Station, Beltsville, Md. The Yellow Newtown apples, with the exception of the station-grown mature lot used the last season, were grown near Crozet, Va. For two seasons one lot of these was taken at the time the usual commercial picking was made, termed immature herein as this variety is often harvested so early that its potential quality does not develop. A second lot of these was taken from the same trees a month later. These were still quite green and hard although they had increased in size during the interval. In 1943 the mature lot of Yellow Newtown apples was grown at the Plant Industry Station and no immature fruit was used. The Winesap apples studied came from near Mount Jackson, Va.

The general procedure with each lot of apples was to select about 12 bushels immediately after harvest. These were repacked, with a half pound of shredded oil paper, in bushel baskets having paper linings and pads under the lids and were stored at 31° F. When preparing each lot for storage 50 fruits were set aside as an orchard check sample. This sample was divided into two equal lots, one of which was analyzed immediately; the other was held for 1 week at 70° to ripen and was then analyzed. Two collateral samples of 25 fruits each were removed from the lots in storage at approximately monthly intervals and one analyzed immediately and the other after being held at 70° for about 1 week. Work was terminated each season when too much decay developed to justify further study.

Analytical Procedure

Firmness

Each sample of 25 fruits was washed and thin disks of skin about the size of a dime were removed from 3 equidistant positions around the sides of each fruit. The firmness of the flesh expressed as resistance against applied pressure was then determined with a Magness-Taylor pressure tester equipped with a plunger of $\frac{7}{16}$-inch diameter. An average value expressed in pounds from the 75 readings was thus obtained for each lot.

Tissue Analysis

For tissue analyses a composite sample was made up of two wedge-shaped segments of about ½-inch thickness on the outer edge taken from the sun-exposed and unexposed sides of each of the fruits in the sample. The composite was ground in a food chopper and then homogenized in a laboratory blender. Duplicate 50 gm. aliquots were then taken for carbohydrate determinations and 100 gm. aliquots were dried in a vacuum oven for moisture determinations. During the second and subsequent seasons additional sections were cut from the remainder of each fruit, and juice for additional analytical data was extracted from the composite in a laboratory hydraulic press at a standard pressure of 8,000 pounds per square inch.

Sugars.—After extraction of the homogenized samples in 95-percent alcohol, reducing sugars were determined by the Quisumbing-Thomas method, and cuprous oxide was determined by the volumetric permanganate method. Total sugar was determined in the same manner as for reducing sugars after hydrolysis with hydrochloric acid, and sucrose was calculated by difference.

Starch.—Starch was determined in the residue, after the extraction of sugar, by the action of diluted fresh saliva on 0.5 gm. aliquots.

Juice Analysis

Juice was extracted for each sample from sliced material pressed under uniform conditions and was measured for volume; then specific

gravity, Brix, and pH readings were obtained. Total acidity as malic acid was determined by titration with N/20 sodium hydroxide solution by using a standard pH meter to determine the end point at 8.2.

Astringency of the juice was determined by the official method [5] for determining tannin in tea.

Subjective Observations

Subjective observations were made by the authors at each sampling period on the general maturity as indicated by consideration of texture and flavor while keeping in mind expected varietal characteristics. When varieties were judged to be eating ripe they were rather at the beginning of that stage, and in the case of most varieties, capable of being held considerably longer in storage before becoming unmarketable. Apples in this stage were firm in texture, juicy, not starchy, and considered desirable for eating raw by those who do not prefer a soft mellow fruit. When classed as overripe the fruit was just past the best stage for marketing. Such apples were not necessarily too ripe for eating as they came from storage but they tended to become soft and mealy within a day or two after removal to the 70° F. room. At each inspection the apples were classed as indicated by the pressure tester as hard, firm, firm-ripe, ripe, or overripe in accordance with the terms used in "U. S. Standards for Apples" [6] and as developed by Haller, Lutz, and Mallison [7] to describe the firmness or consistency of the flesh.

Results

The detailed data by varieties from all the tests are shown in tables 13 to 22 of the appendix, and average values for several seasons in tables 1 to 10 of the bulletin.

Firmness and Market Quality

In general it will be seen that firmness at harvest differed from season to season with the same variety, and the fruit also differed by season and variety in firmness when judged to be ripe or overripe.

The Delicious apples in 1940 were firmer and were picked earlier than in the other three seasons (table 13, appendix), as they had colored prematurely on the trees and had begun to drop, necessitating harvest on September 11. At this time the apples tested 17.9 pounds. In 1942, however, the same variety was harvested on September 15 and tested only 14.9 pounds.

The average firmness of the Delicious apples for all seasons when harvested was 16.1 pounds, when rated as eating ripe in storage 14.3, a loss of only 1.8 pounds, and when overripe 13.7 pounds, as shown in table 1. This variety also softened less in storage than the other varieties studied.

There was a wider variation in the picking dates of the Golden Delicious apples than of the Delicious, but the difference in firmness of the apples was less (table 14, appendix). Picking dates ranged from September 20 in 1943 to October 10 in 1940 and pressure tests from 15.4 to 16.6 pounds. The average firmness value of this variety at harvest time was 16.2 pounds, when rated as eating ripe in storage it was 12.8 pounds, a loss of 3.4 pounds, and when overripe in storage 11.5 pounds (table 1). Golden Delicious apples softened more in storage than did Delicious apples.

Grimes Golden apples were harvested at nearly the same date each

[5] Official and tentative methods of analysis of the Association of Official Agricultural Chemists.

[6] United States Standards for Apples. U. S. Dept. Agr., Prod. and Mktg. Adm. 19 pp. 1951.

[7] Haller, M. H., Lutz, J. M., and Mallison, E. D. The relation of firmness to ripeness of eastern-grown apples. U. S. Dept. Agr. Cir. 579, 22 pp. 1941.

year (table 15, appendix). In 2 years the firmness was practically the same (16.3 and 16.5 pounds) whereas in the third year this value was 18.2 pounds. The average firmness at harvest was slightly higher than for Delicious and Golden Delicious (table 1). The amount of softening in storage until eating ripe or overripe was about the same as for Delicious. Grimes Golden apples did not ripen in storage to attain the flavor or color of the orchard checks that were ripened at 70° F. immediately after harvest. The characteristic color of the variety developed fairly well after a month in storage, but when stored longer than this the color that developed on ripening was a mottled greenish yellow.

Jonathan apples were also harvested close to the same date each year (table 16, appendix). The firmness at harvest varied from 14.4 to 16.3 pounds. The average firmness at harvest for this variety was the lowest of all the varieties studied, whereas the average loss in firmness when the apples were eating ripe in storage was 3.3 pounds (table 1).

Rome Beauty apples were harvested October 25 and tested 16.6 pounds the first season whereas during the next two seasons they were harvested on October 8 and tested 19.1 and 19.2 pounds (table 17, appendix). The average firmness at harvest was 18.3 pounds and the average loss in firmness in storage until judged eating ripe was 3.6 pounds. This loss was greater than for Delicious, Golden Delicious, Grimes Golden, or Jonathan, which was to be expected because of greater firmness at time of harvest.

Stayman apples ranged from 16.0 to 19.2 pounds in firmness at harvest and averaged 17.4 pounds, which value was slightly less than for the Rome Beauty variety (table 1 and table 18, appendix). The loss in firmness in storage during ripening was 4.7 pounds. This variety softened more in ripening than any of the other varieties studied, except immature Yellow Newtowns (table 1).

Apples of the Winesap variety were studied only 2 seasons. They were picked on October 22 in 1942 and October 15 the next year and the firmness values were 16.8 and 21.1, respectively (table 19, appendix), averaging 18.9 pounds (table 1). When the apples became eating ripe after 5 months in storage, they had softened to an average of 14.4 pounds, a loss of 4.5 pounds.

Mature Yellow Newtown apples were harvested on October 8, 16, and 26 during the 3-year study, and firmness at harvest was 17.7, 16.1, and 19.4 pounds, respectively (table 20, appendix), averaging 17.7 pounds. Firmness of these apples when eating ripe in storage averaged 15.0 pounds, a loss of only 2.7 pounds (table 1).

Immature Yellow Newtown apples harvested in September tested 20.7 pounds in firmness two seasons (table 21, appendix). When judged eating ripe, although the quality was generally poor, these apples had softened to 16.5 and 14.6 pounds after having been in storage 5 to 6 months. The average loss in firmness during this period was 5.2 pounds (table 1).

York Imperial apples varied from 18.3 to 21.0 pounds in firmness at harvest and from 15.3 to 18.8 pounds when eating ripe in storage (table 22, appendix). They ripened in 31° F. storage in 4 to 4.5 months and lost an average of 2.2 pounds in firmness (table 1).

The data for firmness of all varieties at the monthly sampling periods are averaged for the different years they were studied and are shown in figure 1. This figure and tables 1 and 2 indicate the period when the apples were ripe and overripe both in continuous storage at 31° F. and after they had ripened at 70° for 1 week after storage. When eating ripe in storage the

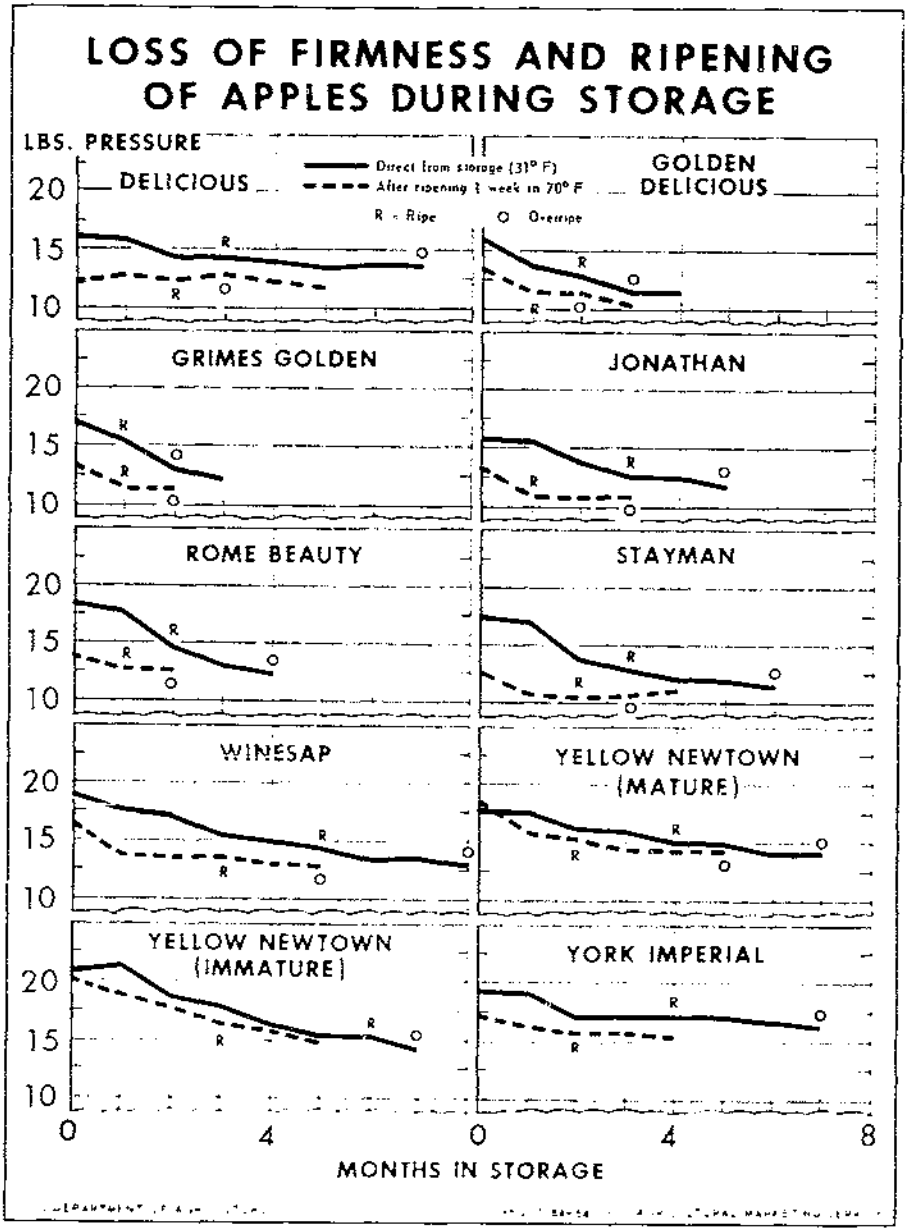

FIGURE 1.—The average firmness of specified varieties as determined at monthly intervals when removed from storage at 31° F. and after holding each removed lot 1 week at 70° is shown; also time when apples became ripe and overripe is indicated.

average firmness of these apples ranged from 12.4 to 17.2 pounds, the softest being Jonathan and the firmest York Imperial. The average firmness of all varieties when overripe was only about 1.3 pounds less than when they were judged as eating ripe. The time lapse before

TABLE 1.—*The firmness of apples when harvested and when ripe and overripe in continuous storage at 31° F., by varieties*

Variety	Firmness at harvest	When ripe in storage			When overripe in storage		
		Months in storage	Firmness		Months in storage	Firmness	
			On removal	Loss		On removal	Loss
	Pounds	*Number*	*Pounds*	*Pounds*	*Number*	*Pounds*	*Pounds*
Delicious	16.1	3.0	14.3	1.8	7.0	13.7	2.4
Golden Delicious	16.2	2.0	12.8	3.4	3.0	11.5	4.7
Grimes Golden	17.0	1.0	15.4	1.6	2.0	13.1	3.9
Jonathan	15.7	3.0	12.4	3.3	5.0	11.6	4.1
Rome Beauty	18.3	2.0	14.7	3.6	4.0	12.3	6.0
Stayman	17.4	3.0	12.7	4.7	6.0	11.4	6.0
Winesap	18.9	5.0	14.4	4.5	8.0	12.9	6.0
Yellow Newtown:							
Mature	17.7	4.0	15.0	2.7	7.0	14.1	3.6
Immature	20.7	5.0	15.5	5.2	7.0	14.3	6.4
York Imperial	19.4	4.0	17.2	2.2	7.0	16.3	3.1
Average all varieties	17.7		14.4			13.1	

the different varieties became eating ripe in storage varied from 1 to 5 months (excluding the immature Yellow Newtown variety which never became normally ripe (table 1). Arranged in order of increasing time required to ripen, the varieties are: Grimes Golden, 1 month; Golden Delicious and Rome Beauty, 2 months; Delicious, Jonathan, and Stayman, 3 months; Yellow Newtown (mature) and York Imperial, 4 months; and Winesap, 5 months. The time in storage before the different varieties became overripe varied from 2 to 8 months.

The time at which apples should be removed from storage to insure a week's life at 70° F. is an important practical consideration. The storage limits and the firmness measurements for each variety studied are shown in figure 1 and table 2. The varieties can be classed into groups as follows: Golden Delicious, Grimes Golden, and Rome Beauty, which had a life of 1 month in storage and 1 week at a temperature of 70°, and which developed overripeness after 2 months in storage and 1 week at 70°; Stayman and Delicious, 2 months in storage and

TABLE 2.—*The firmness of eating ripe and overripe apples after a given storage period at 31° F. plus an extra week at 70° by varieties*

Variety	Eating ripe				Overripe			
	Months in storage at 31°	Firmness after being in storage at 31° F.			Months in storage at 31°	Firmness after being in storage at 31° F.		
		On removal	Loss	Plus 7 extra days at 70°		On removal	Loss	Plus 7 extra days at 70°
	Number	*Pounds*	*Pounds*	*Pounds*	*Number*	*Pounds*	*Pounds*	*Pounds*
Delicious	2.0	14.3	1.8	12.2	3.0	14.3	1.8	12.9
Golden Delicious	1.0	13.7	2.5	11.3	2.0	12.8	3.4	11.3
Grimes Golden	1.0	15.4	1.6	11.3	2.0	13.1	3.9	11.3
Jonathan	1.0	15.3	.4	10.9	3.0	12.4	3.2	10.8
Rome Beauty	1.0	17.7	1.0	12.7	2.0	14.7	3.6	12.6
Stayman	2.0	13.8	3.6	10.4	3.0	12.7	4.7	10.5
Winesap	3.0	15.4	3.5	13.6	5.0	14.4	4.5	12.9
Yellow Newtown:								
Mature	2.0	16.1	1.6	15.3	5.0	14.9	2.8	14.3
Immature	3.0	15.3	5.4	14.9	6.0			
York Imperial	2.0	17.2	2.2	15.6	5.0	17.2	2.2	
Average all varieties		15.4		12.8		14.0		12.1

overripeness after 3 months; York Imperial, Yellow Newtown (mature) 2 months in storage and overripeness after 5 months of storage. Immature Yellow Newtowns had a minimum of 3 months of storage life and were not overripe until after 6 months when held 1 week at 70°. Softening during the permissible storage period for each variety ranged from 0.4 pound for Jonathan to 3.6 pounds for Stayman and 5.4 pounds for immature Yellow Newtown, and averaged 2.3 pounds for all varieties. When the apples had reached a degree of firmness at which they would become overripe in a week at 70° they averaged about 3.7 pounds less firm than at harvest. It is of further interest to note that apples which rated as prime after a week at 70° averaged 12.8 pounds in firmness and later when considered overripe after a week at 70° they averaged 12.1 pounds, a difference of only 0.7 pound.

Carbohydrate Content

Important characteristics of the taste of apples are sweetness and sourness. In the apples studied, the sugar analyses show an extreme difference of slightly more than 4 percent in total sugar between varieties when harvested (table 3). This difference was reduced during 2 months in storage to about 3 percent. The proportion of reducing sugars and sucrose varied between varieties. Reducing sugar averaged lowest throughout the storage seasons in the Grimes Golden and immature Yellow Newtown apples and was the highest in Golden Delicious. The sucrose content of Grimes Golden was the highest of all varieties, next highest in Stayman, and least in Winesap. There was a trend in most varieties toward an increase in reducing sugars during ripening and an increase in sucrose for the first or second month of storage followed by a decrease. In the lots of fruit that were transferred from storage to room temperature of 70° F. there was, in general, an increase in sugar during this ripening period in the first 2 or 3 lots transferred; but later lots, as the storage season advanced, tended to lose sugar after being transferred. In general, the Golden Delicious and Stayman were highest in total sugar; the Delicious variety was next highest; the Winesap and immature Yellow Newtown were lowest. Total sugars in the Grimes Golden and Jonathan varieties when ripened in 70° temperature after a period in storage were definitely higher than when ripened in continuous storage; in the other varieties these differences were usually slight and in some instances those ripened in 70° contained somewhat less sugar than those ripened in storage.

Starch was determined during two seasons. The amounts found were, of course, higher in the newly harvested apples, varying from less than 1 percent to a little more than 3 percent. The York Imperial and Delicious varieties had the largest amount. Starch disappeared rather rapidly and most varieties after 2 months in storage had little more than a trace. This decrease in starch probably accounted for the early increase in sucrose already noted.

Juice Volume

In the Delicious, Golden Delicious, Rome Beauty, Mature Yellow Newtown, and York Imperial varieties the extractable juice volume increased during the first month of storage (table 4). In the Delicious variety this increase extended to the third month and from there on remained nearly stable to the end of the tests (7 months). The volume in the other varieties tended to decrease in storage from the beginning. The varieties that tended to become mealy as they ripened decreased in juice volume because the fruit cells separated

TABLE 3.—*Average sugar content of apples determined at specified periods of storage at 31° F., by varieties, average of 2 to 4 years*

Variety and months in storage	Percentage sugar content		
	Reducing sugar	Sucrose	Total
Delicious:	*Percent*	*Percent*	*Percent*
At harvest	7.65	2.42	10.07
1 month	7.82	2.71	10.53
2 months	8.56	2.90	11.46
3 months	8.77	2.77	11.54
4 months	9.34	2.55	11.89
5 months	9.73	2.20	11.93
6 months	10.39	1.70	12.09
7 months	9.26	1.30	10.56
Golden Delicious:			
At harvest	9.39	3.04	12.43
1 month	9.30	3.39	12.69
2 months	9.35	3.39	12.74
3 months	9.24	3.17	12.41
4 months	9.50	3.10	12.60
5 months [1]	9.98	3.40	13.38
6 months [1]	10.50	2.74	13.24
Grimes Golden:			
At harvest	6.34	3.57	9.91
1 month	6.55	4.53	11.08
2 months	6.83	4.76	11.59
3 months	6.90	4.38	11.28
4 months [1]	7.83	3.61	11.44
Jonathan:			
At harvest	8.06	2.51	10.57
1 month	8.72	2.60	11.32
2 months	8.75	2.57	11.32
3 months	8.79	2.65	11.44
4 months	8.94	2.43	11.37
5 months	8.83	2.38	11.21
6 months	8.97	2.47	11.44
Rome Beauty:			
At harvest	7.56	3.09	10.65
1 month	7.91	3.86	11.77
2 months	8.01	3.81	11.82
3 months	7.60	3.16	10.76
4 months	7.86	3.20	11.06
5 months	8.66	2.76	11.42
Stayman:			
At harvest	7.75	3.42	11.17
1 month	8.23	4.03	12.26
2 months	8.40	3.81	12.21
Stayman—Continued			
3 months	8.68	4.22	12.90
4 months	7.68	3.74	11.42
5 months	9.09	4.23	13.32
6 months [1]	8.72	3.96	12.68
7 months [1]	8.84	3.40	12.24
Winesap:			
At harvest	8.23	2.39	10.62
1 month	8.53	2.31	10.84
2 months	8.81	2.12	10.93
3 months	8.87	1.82	10.69
4 months	9.10	1.65	10.75
5 months	9.25	1.66	10.91
6 months	9.10	1.56	10.66
7 months	9.18	1.51	10.69
8 months	9.60	1.24	10.84
Yellow Newtown (mature):			
At harvest	7.24	3.31	10.55
1 month	7.24	3.91	11.15
2 months	7.52	3.90	11.42
3 months	7.42	3.78	11.20
4 months	7.73	3.85	11.58
5 months	7.98	3.43	11.41
6 months	8.04	3.09	11.13
7 months	8.15	2.95	11.10
Yellow Newtown (immature):			
At harvest	5.95	2.00	7.95
1 month	6.22	2.39	8.61
2 months	6.77	2.72	9.49
3 months	6.99	2.58	9.57
4 months	7.10	2.34	9.44
5 months	7.24	2.25	9.49
6 months	6.85	2.09	8.94
7 months	7.45	1.93	9.38
York Imperial:			
At harvest	7.26	1.79	9.05
1 month	7.89	2.80	10.69
2 months	8.04	2.95	10.99
3 months	8.00	3.15	11.15
4 months	8.29	3.17	11.46
5 months	8.63	3.10	11.73
6 months	8.52	2.88	11.40

[1] Results from 1 year only.

rather than ruptured under pressure. Little or no diminution in the yield of juice was evident in the Delicious, Jonathan, and York Imperial and possibly the Winesap varieties which did not become mealy. In general, the greatest volume of juice was obtained from the Delicious, Winesap, Jonathan, Yellow Newtown, and York Imperial varieties. Rome Beauty rated the lowest.

Titratable Acidity

Titratable acidity, calculated as malic acid in the expressed juice, shows considerable variation between varieties as well as within varieties from year to year. Varietal difference is especially noticeable between the Delicious, which was the lowest, and the Jonathan, which was the highest, in acidity of the varieties studied (table 5). Although the average sugar content of the two varieties is practically the same, the low acidity of the Delicious accounts for its sweet taste as compared with the tart, spicy taste of the more acid Jonathan variety. After 3 to 4 months of storage, Delicious and Winesap varieties lost the least acid during ripening whereas Golden Delicious lost the most. In most instances, the apples when ripened at 70° F. following storage were slightly less acid than when ripened at 31°. All differences were slight, however.

TABLE 4.—*Volume of juice per 100 gm. of tissue of different varieties of apples at monthly intervals during storage at 31° F., averages of 2 to 4 years*

Variety	Months in storage							
	0	1	2	3	4	5	6	7
	Ml.	*Ml.*	*Ml.*	*Ml.*	*Ml.*	*Ml.*	*Ml.*	*Ml.*
Delicious	42.3	47.8	50.3	49.7	54.7	54.0	54.0	55.7
Golden Delicious	45.5	48.4	39.6	38.4				
Grimes Golden	49.2	48.9	38.9	21.0				
Jonathan	48.9	47.6	48.2	46.8	48.7	43.6	44.2	
Rome Beauty	33.6	35.4	29.8	27.1				
Stayman	54.7	45.8	45.3	42.9	44.5			
Winesap	60.8	55.4	52.2	52.7	49.6	48.8	48.2	46.1
Yellow Newtown (mature)	49.2	54.5	44.5	46.5	49.1	48.4	44.6	39.9
Yellow Newtown (immature)	46.4	43.6	44.0	44.6	42.5	42.2	42.9	39.5
York Imperial	39.5	47.5	45.5	45.3	44.6	45.3	44.2	42.5

Solids-Acids Ratio

Solids-acid ratio, which is based on the relation of the soluble solids content determined by the Brix hydrometer (table 6) to the acid content of the juice varied largely with the acidity of the different lots. In most varieties, the average ratio of soluble solids to acidity increased during storage (table 7). In the case of the Delicious, Jonathan, and Stayman varieties, the ratio began to decrease during the last month of storage. The ratio was relatively high in those varieties such as Delicious and Golden Delicious which were low in acidity and low in the Jonathan variety which gave a high acid titration. The average acidity of the immature Yellow Newtown apples was slightly less than that of the mature Yellow Newtown whereas the Brix reading for soluble solids of the former was considerably less. The resulting ratio was slightly higher for the mature apples.

Specific Gravity

The juice showed no consistent variations in specific gravity within varieties during storage, but the average values for varieties did vary. The highest approximate average value was found in the juice of the Golden Delicious variety and the lowest in the immature Yellow Newtown as shown in the following tabulation:

Variety	Specific gravity
Delicious	1.054
Golden Delicious	1.066
Grimes Golden	1.052
Jonathan	1.060
Rome Beauty	1.053
Stayman	1.058
Winesap	1.056
Yellow Newtown (mature)	1.049
Yellow Newtown (immature)	1.047
York Imperial	1.058

TABLE 5.—*Acidity (as malic) of different varieties of apples determined at harvest and at monthly intervals during storage at 31° F., averages of 2 or 3 years' results*

Variety	Months in storage					
	0	1	2	3	4	5
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Delicious	0.236	0.219	0.194	0.179	0.162	0.127
Golden Delicious	.412	.345	.309	.267	.202	
Grimes Golden	.530	.448	.393	.400		
Jonathan	.809	.782	.710	.692	.637	.584
Rome Beauty	.456	.405	.358	.332		
Stayman	.502	.491	.471	.404	.393	.384
Winesap	.475	.452	.474	.454	.442	.413
Yellow Newtown (mature)	.615	.575	.553	.512	.496	.468
Yellow Newtown (immature)	.570	.544	.519	.521	.494	.405
York Imperial	.573	.509	.506	.494	.391	.416

TABLE 6.—*Brix hydrometer values as determined in the juice of different varieties of apples at harvest and at monthly intervals during storage at 31° F., averages of 2 to 4 years' results*

Variety	Months in storage							
	0	1	2	3	4	5	6	7
	Degrees	*Degrees*	*Degrees*	*Degrees*	*Degrees*	*Degrees*	*Degrees*	*Degrees*
Delicious	12.89	13.66	13.47	14.16	14.31	13.79	14.13	13.64
Golden Delicious	15.49	15.69	16.34	16.00	16.10			
Grimes Golden	13.00	14.56	14.21					
Jonathan	14.50	15.32	15.20	15.09	15.06	14.39	15.23	
Rome Beauty	14.06	14.26	13.96	14.14				
Stayman	14.31	15.47	15.75	16.20	16.11	15.83		
Winesap	13.88	14.06	14.35	14.03	14.05	13.85	14.60	13.92
Yellow Newtown (mature)	14.30	14.33	15.11	14.82	14.55	14.50	14.67	15.20
Yellow Newtown (immature)	10.51	11.50	12.60	12.92	12.69	12.66	12.20	12.15
York Imperial	12.65	13.66	14.51	14.90	14.83	14.70	14.84	14.80

Total Solids

Values for total solids varied very little during storage and very little between varieties. However, the highest average values were found in the Stayman and the lowest in the immature Yellow Newtown variety (table 8).

Alcohol Soluble Solids

Alcohol soluble solids as determined in the tissue of the different varieties averaged highest in the Golden Delicious and Stayman varieties and lowest in the Yellow Newtown (immature) and York Imperial varieties (table 9). There was a general tendency toward an increase in alcohol soluble solids during storage; Golden Delicious was an exception, however, as the solids in this variety actually decreased. Alcohol soluble solids which, of course, include sugars showed nearly the same relationship between varieties as did total sugar. Two exceptions to this were the York Imperial, which was relatively low in alcohol soluble solids and relatively high in total sugar, and immature Yellow Newtown, which was relatively high in alcohol soluble solids and low in total sugar.

Astringency

The results from determinations for astringents (tannin and non-tannin) were so extremely variable that no definite conclusions or trends seemed evident. In general, total astringents were highest in the Stayman and Winesap, followed by Grimes Golden and immature Yellow Newtown. They were lowest in the York Imperial variety.

TABLE 7.—*Solids-acid ratio as determined in the juice of different varieties of apples at harvest and at monthly intervals during storage at 31° F., averages of 2 to 4 years' results*

Variety	Months in storage							
	0	1	2	3	4	5	6	7
	Ratio	*Ratio*	*Ratio*	*Ratio*	*Ratio*	*Ratio*	*Ratio*	*Ratio*
Delicious	56.44	64.62	74.54	80.18	91.53	117.41	91.68	67.20
Golden Delicious	38.72	46.57	54.84	61.51	82.40			
Grimes Golden	24.33	31.08	37.57	43.84				
Jonathan	18.91	22.80	22.40	22.64	24.45	27.05	24.82	
Rome Beauty	31.86	36.59	39.05	42.68				
Stayman	29.66	32.80	34.10	37.25	41.51	40.20		
Winesap	29.39	31.02	30.46	31.48	32.04	35.97	35.21	33.68
Yellow Newtown (mature)	23.59	25.26	28.10	29.02	30.26	32.09	33.33	34.06
Yellow Newtown (immature)	18.13	21.41	24.40	24.95	25.70	31.76	31.87	34.70
York Imperial	23.12	27.29	20.24	30.35	38.19	35.60	37.36	44.68

TABLE 8.—*Total solids in different varieties of apples as determined at harvest and at monthly intervals during storage at 31° F., averages of 2 to 4 years*

Variety	Months in storage							
	0	1	2	3	4	5	6	7
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Delicious	18.03	16.48	17.08	16.58	17.05	16.97	16.16	17.15
Golden Delicious	17.88	18.02	18.29	17.83	18.16	.....	.....	.....
Grimes Golden	16.63	16.64	16.92	16.96	.....	.....	.....	.....
Jonathan	17.07	17.39	17.27	17.13	17.60	16.95	16.82	.....
Rome Beauty	16.45	16.32	16.02	15.73	16.26	16.09	.....	.....
Stayman	18.30	18.47	18.77	18.67	18.80	18.50	.....	.....
Winesap	16.39	16.33	16.33	16.49	16.11	16.67	16.74	16.59
Yellow Newtown (mature)	17.20	16.98	16.98	17.19	17.16	16.98	16.93	17.03
Yellow Newtown (immature)	14.63	14.61	14.73	14.42	14.71	14.69	14.77	14.51
York Imperial	17.03	17.33	17.48	18.06	17.33	17.72	17.28	17.22

Summary to Part I

Nine varieties of apples were stored during several seasons at 31° F. At monthly intervals samples were removed from storage for inspection and analysis, while similar lots were transferred to a room having a temperature of 70° and held there for a week to determine the ripening changes occurring during this period. Taste and pressure tests for ripeness, tissue analyses to determine carbohydrates and solids, and juice tests for volume, pH, acidity, soluble solids, and astringency were made at each transfer and after holding the fruit at 70°.

The approximate maximum storage periods in which the different varieties were suitable for consumption after storage at 31° F. (before they became overripe), and the maximum periods in which they could be stored at 31° and yet allow a marketing period of a week at 70° before they became overripe are shown in table 10.

These data show that most of the apples studied, if they are to be held at 70° F. for at least a week in the process of marketing after being in cold storage, can be stored for only about one-half the time it would require them to ripen in 31°.

The firmness of apples as determined by the pressure tester at harvest and during ripening in storage was recorded. In general, the Grimes Golden and Delicious varieties had softened the least when ripened in storage. These varieties were followed in order of increasing loss in firmness by York Imperial, mature Yellow Newtown, Jonathan, Golden Delicious, Rome Beauty, Winesap, Stayman, and immature Yellow Newtown. The average firmness of all varieties when harvested was 17.7 pounds; when ripe in storage, 14.4 pounds, and when

TABLE 9.—*Alcohol soluble solids in different varieties of apples as determined at harvest and at monthly intervals during storage at 31° F., averages of 2 to 4 years*

Variety	Months in storage							
	0	1	2	3	4	5	6	7
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Delicious	12.93	12.72	14.03	13.75	14.59	14.39	14.78	15.37
Golden Delicious	16.00	15.87	16.12	15.62	15.75	.....	.....	.....
Grimes Golden	12.17	12.05	13.00	13.40	.....	.....	.....	.....
Jonathan	13.60	14.25	14.27	14.00	13.85	14.37	14.10	.....
Rome Beauty	12.92	13.41	13.32	14.13	13.85	13.50	.....	.....
Stayman	14.13	15.12	15.23	15.59	15.84	15.50	.....	.....
Winesap	13.12	13.82	13.77	13.70	13.62	13.00	13.75	13.5
Yellow Newtown (mature)	13.50	14.01	14.58	14.11	14.51	14.05	13.95	13.7
Yellow Newtown (immature)	9.85	10.05	11.65	11.70	11.70	11.60	11.62	11.97
York Imperial	11.98	13.34	14.18	14.86	14.45	14.22	.....	.....

TABLE 10.—*Maximum time apples were held at 31° F. before becoming overripe in storage, and maximum time they could be stored at 31° allowing also an additional week at 70° before becoming overripe*

Variety	At 31° F.	At 31° F. + 1 week at 70°
Delicious	Up to 7 months	Up to 3 months.
Golden Delicious	Up to 3 months	Up to 2 months.
Grimes Golden	Up to 2 months	Do.
Jonathan	Up to 5 months	Up to 3 months.
Rome Beauty	Up to 4 months	Up to 2 months.
Stayman	Up to 6 months	Up to 3 months.
Winesap	Up to 8 months	Up to 5 months.
Yellow Newtown (mature when harvested)	Up to 7 months	Do.
Yellow Newtown (immature when harvested)	do	Up to 6 months.
York Imperial	do	Up to 5 months.

overripe in storage, 13.1 pounds, showing less than a pound difference in firmness between the ripe and overripe product.

Total sugars tended to increase and acidity decrease in all varieties as they ripened in storage. Reducing sugars tended to increase during storage whereas sucrose increased only during the first 1 or 2 months. Starch varied from 1 to 3 percent at harvest and usually decreased to only a trace after 2 months. Acidity varied greatly between varieties, amounting to 0.69 percent in the Jonathan variety, and only 0.18 in the Delicious when ripened in storage.

In general, the greatest volume of juice occurred in the Winesap, Delicious, Jonathan, Yellow Newtown, and York Imperial varieties during storage; the lowest volume was found in the Rome Beauty. In varieties that tended to become mealy as they ripened, such as Golden Delicious, Stayman, and Rome Beauty, the juice volume decreased because the cells separated rather than ruptured under pressure. In every instance there was a lower volume of juice in apples rated as ripe after a week at 70° F. following storage at 31°, than in those that were rated as ripe in continuous storage.

PART 2.—CHANGES IN EATING QUALITY

After the study of chemical and physical changes in apples during storage as reported in part 1, a project was begun to investigate in greater detail the changes in eating quality; and to determine the maximum safe period that apples can be held in storage and yet allow a reasonable period for distributing or marketing after their removal from storage.

In the work covered in part 1 the authors arbitrarily determined when the different varieties of apples were eating ripe in order to correlate the period required for ripening with changes in firmness, sugar content, acidity, and others. Because of the detailed work involved, samplings were made monthly. It was evident that too much change in eating or cooking quality occurred during sampling intervals as long as a month. Therefore, in the following study sampling periods were made at 2-week intervals when possible and the average ratings of 8 judges were used in determining ripening quality. The ripening periods reported here do not always agree with those given in part 1, but it is believed that as these were derived on a different basis, both results will serve a useful purpose.

Method of Procedure

Seven varieties of apples which included "short," "medium," and "long keepers" were used in this study. These varieties were Delicious, Golden Delicious, Grimes Golden, Jonathan, Stayman, Winesap, and York Imperial. During

the first season (1944) the varieties studied were obtained either from the Plant Industry Station at Beltsville, Md., or from nearby commercial orchards. The approximate blooming date for all varieties was May 1. The picking dates corresponded with the usual commercial picking time for each variety. Thus, Grimes Golden and Jonathan apples were harvested on September 14 and stored the following day. Golden Delicious apples were picked and stored September 23; Delicious, September 25; York Imperial, October 7; Stayman, October 11; and Winesap, October 31.

During the second season (1945) frost following full bloom destroyed most of the crop of apples near Beltsville, but a supply of four varieties was obtained near Kearneysville, W. Va. These varieties included Golden Delicious and Delicious which were picked September 20, stored near Kearneysville at 32° F., then trucked to Beltsville on September 24 and stored; and Stayman and York Imperial which were picked October 8 and 10, stored near Kearneysville at 32°, then trucked to Beltsville on October 17, and again stored.

In 1946 Grimes Golden, Jonathan, and Delicious apples were used. The Grimes Golden variety was obtained at Berryville, Va., as again none of this variety was available at Beltsville. These apples were picked September 11, stored at 36° F. until September 17, when they were trucked to Beltsville and stored. Apples of the Jonathan variety were picked at Beltsville September 17, and stored the following day. Delicious apples were picked at Beltsville on September 18, and stored September 20. Staymans were picked near Kearneysville, W. Va., October 24, and stored at Beltsville the following day.

In 1949, the Grimes Golden variety alone was studied. These apples were obtained from a commercial orchard near the Beltsville station.

The general procedure on arrival at the laboratory was to gently pour the entire lot of each variety of apples over a long work table thus mixing the contents from each original container. All undersized, oversized, or otherwise abnormal or injured fruits were discarded. The required number of standard bushel boxes was then simultaneously filled by successively selecting, at random, fruits of the same approximate sizes for each box. Thus, all the boxes, when filled, contained the same proportion of the different sizes of apples. The boxes were lined, padded, and lidded and about one-half pound of commercial shredded oiled paper was distributed through each while being filled. When packed, each lot of fruit was stored at 31° F. and a relative humidity of 85 to 90 percent.

Depending on the variety and condition, a box lot of each variety was removed from storage at approximately 2-week intervals and taken directly to the holding room which had a temperature of 70° F. Samples of 10 apples each were taken at random for tasting by a panel usually of 8 judges, (1) when the boxes were removed from storage and (2) at 3- or 4-day intervals while the boxes were in the holding room. At the start of the tests a box of each variety was put directly into the room having a temperature of 70°, and also sampled at 3- or 4-day periods. These apples are hereafter referred to as an orchard check. Sampling of each lot in the 70° room was discontinued when the apples had become overripe or an excessive amount of decay had developed.

Each of the samples of 10 apples, after being warmed to room temperature, was cut into segments of approximately equal size. Subsamples constituting a segment from each apple were made up from these

and were given to each judge at his customary place of work to avoid assembled discussion. A simple score sheet, as shown on this page, was provided each judge and he was asked to check 3 items only; texture, taste, and flavor or aroma. Numerical values were assigned to each item on the score sheet, as shown, but these values did not appear on the sheets when the judges received them. Changes in the score sheets after the first season made some differences in certain values, but practically no change in total values. The judges were familiar with apple varieties and were instructed to score each sample on the basis of varietal characteristics and to avoid personal varietal preferences as much as possible. Judges were informed as to the varieties they tasted, but not as to storage treatment. It will be noted that opposite each item under texture, flavor, and taste, the numerical values were arranged to reach a maximum as the fruit ripened to the most desirable characteristic for apples in their prime condition for eating out of hand or for cooking. After reaching this maximum, the values decreased to a point beyond any measure of usability. Thus under "texture" the values increased from "hard" to "firm" to "crisp" and then decreased as the apples became "soft" and "mealy." Taste values were largely a measure of sweetness or sourness and increased from "starchy" to "tart," which represented a pleasant combination of acid and sugar, and then decreased to "sweet" which indicated low acidity. "Flavor" or aroma was a measure of the fullness of the desirable volatile substances characteristic of the variety and present when the fruit is in its prime. The judge was free to check two items if in his judgment the characteristic he wanted to record lay between the terms on the score sheet. In evaluating the scores the values corresponding to the checked items were added together to give the total (taste, texture, flavor) value.

A taste-texture-flavor rating of 65 to 70 represented the minimum acceptable grade in these tests, but in the trade, fruit so rated would ordinarily have a somewhat longer commercial life than is indicated here.

Original Score Sheet Used in Sampling Apples

	Numerical value
Texture (check one or more):	
Hard (too hard to eat out of hand)	15
Firm (nearly eating ripe, but too hard for most persons)	25
Crisp (tender and juicy)	30
Soft (fully ripe, but not overripe)	20
Mealy (overripe)	10
Taste (check one or more):	
Starchy	5
Sour	10
Tart (pleasant combination of acid and sugar)	30
Sweet (low acid)	25
Flavor-aroma:	
Lacking or partially developed	15
Good	35
Flat or insipid	20
Stale or "off"	0

Revised Score Sheet

Texture (check one or more):	
Hard (too hard to eat out of hand)	15
Firm (nearly eating ripe, but too hard for most persons)	25
Crisp (tender and juicy)	30
Soft (fully ripe, but not overripe)	20
Mealy (overripe)	10
Taste (check one or more):	
Starchy	5
Sour	10
Tart (pleasant combination of acid and sugar)	30
Sweet	25
Low sugar-low acid	10
Flavor-aroma (check one or more):	
Lacking	15
Approaching optimum	35
Optimum	40
Past optimum	30
Insipid	10
Stale	0

Results

The results of the work of the different seasons (1944–45, 1945–46, 1946–47, 1949–50) are given in detail in appendix tables 23 to 38. These tables give the averaged values for texture, taste, and flavor,

from the ratings by the individual judges, together with the total values for the different samplings throughout the storage period for each variety. From these tables have been determined, in summary form, the maximum time each variety remained in usable condition while in continuous storage (table 11), and the maximum time each could remain in storage and yet have a period for marketing or distribution in which the apples would be in acceptable condition (table 12).

Quality Development While in Continuous Storage

Consideration was given to the development of quality of the different varieties while in continuous or uninterrupted storage at 31° F. Apples can be held long past their marketable storage period and still appear marketable, but it is not always realized that such fruit may deteriorate seriously in quality a few hours after removal from storage. Such fruit can, however, be used for limited purposes if utilized soon after removal, rather than marketed in the usual way.

Table 11 shows the length of time each variety was in continuous storage before a total rating (taste-texture-flavor) of approximately 70 was reached, the storage period during which the fruit retained a rating of 70 or higher, and the highest quality rating reached while in storage. The data show that Delicious apples reached 70 (fair) or higher in from 6 to 10 weeks and remained above this rating for from 14 to 32 weeks. The highest rating reached for this variety was 80. Golden Delicious reached 70 in from 6 to 12 weeks and remained above this rating for 14 to 16 weeks. The maximum recorded quality was 84 and 73. Grimes Golden in 1944 never reached a rating as high as 70 while in storage. In the other two seasons that this variety was studied, the 70 rating was surpassed in 6 weeks and remained above 70 for 14 weeks. The highest ratings for Grimes Golden were 89 and 88. Jonathan apples obtained a rating higher than 70 in 6 to 10 weeks and remained above 70 for 24 to 30 weeks. The highest ratings were 85 and 91. Stayman while in storage surpassed

TABLE 11.—*Development of quality of apples while in continuous storage at 31° F., by varieties*

Variety and season	Weeks in which the rating—		Highest quality reached, and time required	
	70° or above was reached	Remained above 70°	Rating	Weeks
Delicious:	*Number*	*Number*	*Rating*	*Number*
1944–45	8	14	78	12
1945–46	6	32	80	24
1946–47	10	28	80	22
Average	8	25	79	19
Golden Delicious:				
1944–45	6	14	84	8
1945–46	12	16	73	12
Average	9	15	78	10
Grimes Golden:				
1944–45	0	0	53	8
1946–47	6	14	89	6
1949–50	6	14	88	12
Average	4	9	77	9
Jonathan:				
1944–45	6	24	85	10
1946–47	10	30	91	10
Average	8	27	88	10
Stayman:				
1944–45	10	22	78	10
1945–46	8	30	89	14
1946–47	8	24	87	12
Average	9	25	85	12
Winesap:				
1944–45	12	30	73	12
York Imperial:				
1944–45	12	22	79	20
1945–46	16	28	81	24
Average	14	25	80	22

a rating of 70 in 8 to 10 weeks and remained above this point 22 to 30 weeks. The highest ratings were 87 and 89. Winesap apples were variable. The one storage lot reached a rating of 73 in 12 weeks whereas succeeding lots rated below 70 until after 18 weeks of storage. They were again below a rating of 70 until stored 26 weeks at which time they scored 72. York Imperial apples rated above 70 in 12 to 16 weeks and remained above this rating for 22 to 28 weeks. The highest ratings for these lots were 79 and 81.

The results, as will be seen, show that, in general, fruit which ripened at 70° F. after storage had somewhat higher ratings than fruit which ripened in continuous storage at 31°. Jonathan and Stayman had about the same rating for both temperatures.

Marketable Storage Life

Table 12 shows (column 1) the approximate maximum storage period in which the apples were in storage and subsequently retained a total grade (taste-texture-flavor) not lower than 68 to 70 for 6 to 7 days at 70° F. In column 2 of this table the highest quality ratings attained by each variety during ripening at 70° are shown.

Grimes Golden apples, as indicated in table 12, possessed the shortest storage life of the varieties studied. This storage life averaged 9 weeks with extremes of 6 and 10 weeks as the time these apples could be stored and yet allow a week at 70° F. for marketing. The general quality of the 1944 crop was inferior to that in the other 2 years studied. The color of the fruit when stored was a slightly yellowish green. After about 4 weeks of storage these apples still ripened to a fairly good

TABLE 12.—*Summary showing the approximate time apples could be held in storage at 31° F. and still remain in acceptable condition (with a minimum rating of 68 to 70) for at least a week after removal to 70° and highest quality reached during ripening at 70°, by varieties*

Variety and season	Maximum time in storage and remain marketable 1 week at 70° F.	Ripening at 70° F. to highest quality	
		Recorded	Weeks in storage at 31°
	Weeks	*T.T.F. rating*[1]	*Number*
Delicious:			
1944–45	16	81	10
1945–46	20	93	8
1946–47	28	87	10
Average	21	86	9
Golden Delicious:			
1944–45	14	81	2
1945–46	16	86	6
Average	15	83	4
Grimes Golden:			
1944–45	6	78	6
1946–47	10	87	4
1950–51	10	79	10
Average	9	81	7
Jonathan:			
1944–45	18	83	8
1946–47	30	90	10
Average	24	86	9
Stayman:			
1944–45	14	81	6
1945–46	28	92	12
1946–47	20	88	12
Average	21	87	10
Winesap:			
1944–45	22	76	14
York Imperial:			
1944–45	25	87	8
1945–46	25	86	4
Average	25	86	6

[1] Taste-texture-flavor rating.

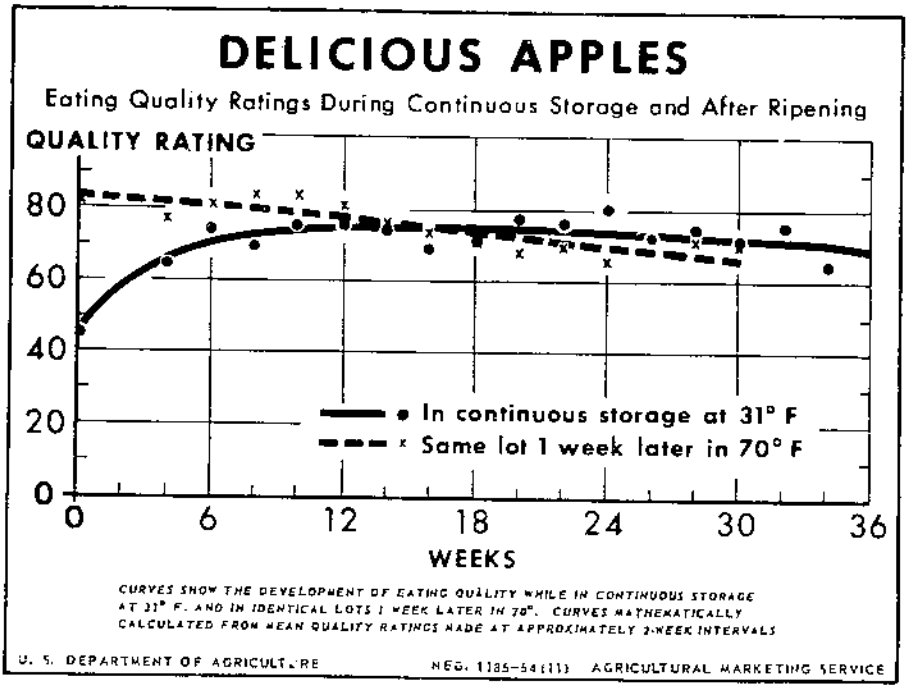

FIGURE 2.

yellow color, but small greenish spots remained on most fruits after ripening. As the time of storage increased, the amount of green remaining on the surface of the apples after ripening increased until finally very little yellow color developed. This deterioration of characteristic ripe color developed somewhat more rapidly than deterioration in the eating quality. Although these apples remained comparatively hard in storage, when they were brought out to ripen, more rapid softening followed by decay occurred in them than in the other varieties. The eating quality of the lots that ripened at 70° after storage at 31° compared favorably with the quality of the orchard checks ripened directly at 70° (tables 28, 29, and 30) up to the maximum time this variety could be held in storage and be marketable a week after removal from storage.

The next variety in order of increased storage life was the Golden Delicious. This variety was stored when the ground color was between green and yellow, but mostly green. An attractive yellow color developed during subsequent ripening. The 1944 lot had a maximum storage life of 14 weeks and the 1945 lot 16 weeks.

Delicious and Stayman apples both showed an average storage life of 21 weeks allowing for the usual 7-day marketing period. The seasonal results were variable for both varieties, ranging from 16 to 28 weeks for the Delicious and 14 to 28 for the Stayman.

Winesap apples were available in only one season during these tests. These kept in marketable condition for 22 weeks. The general quality of these apples as compared with the other varieties was low. There was considerable variation in quality between successive storage lots in spite of the care that was taken

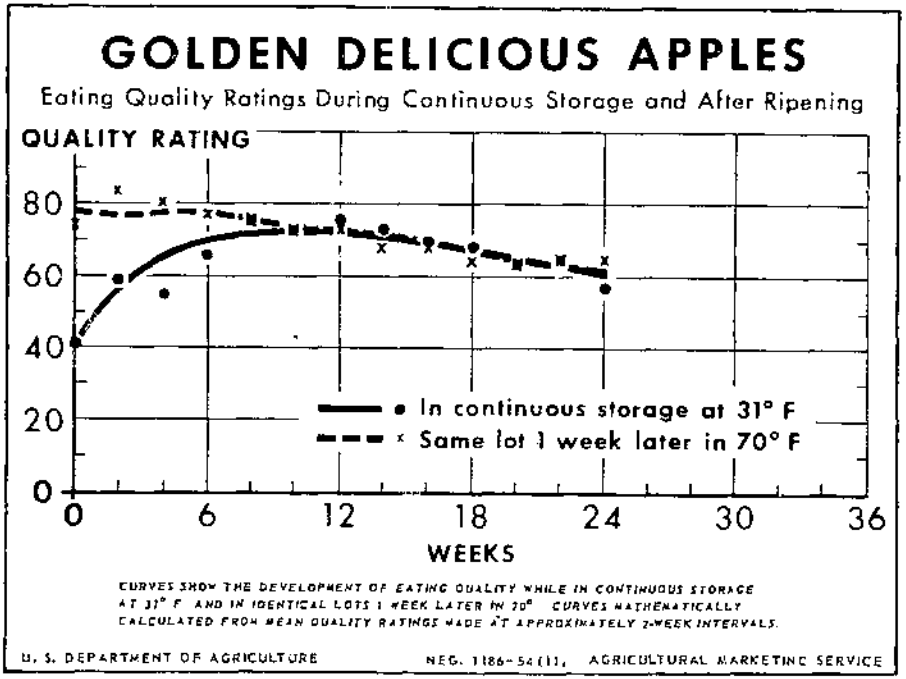

FIGURE 3.

to insure uniformity in making them up.

Jonathan apples showed a wide seasonal variation. For the first year tested they had a marketable storage life of only 18 weeks, but in the next season it was 30 weeks, or an average of 24 weeks for the 2 seasons.

York Imperial apples remained in marketable condition longer than the other varieties studied; 26 weeks was the maximum period for both seasons in which tests were made.

Table 12 also shows the highest quality ratings attained during any ripening period and the time when the specific lots were removed from 31° F. to attain these ratings. It will be noted that these highest quality ratings compared favorably with the maximum ratings of the orchard checks ripened directly at 70°, as shown in tables 23 to 38. Thus, Delicious attained a maximum average quality rating of 86 after 9 weeks of storage, Golden Delicious 85 after 4 weeks, Grimes Golden 81 after 7 weeks, Jonathan 86 after 9 weeks, Stayman 87 after 10 weeks, Winesap 76 after 14 weeks and York Imperial 86 after 6 weeks.

The mathematically developed curves shown in figures 2 to 8 [8] were constructed to illustrate graphically the relation of the eating quality in

[8] The data for these curves were calculated by E. J. Koch, Biometrical Services, Agricultural Research Service, by means of multiple regression techniques. The curve of best fit was determined for each variety when removed from continuous storage and after each lot was ripened 1 week at 70° F. The best fitting curve in most cases was found to be a multiple regression equation using the square root of the number of weeks in storage as one of the independent variables and the logarithm of the number of weeks of storage +1, log (x+1), as the other independent variable. These variables were

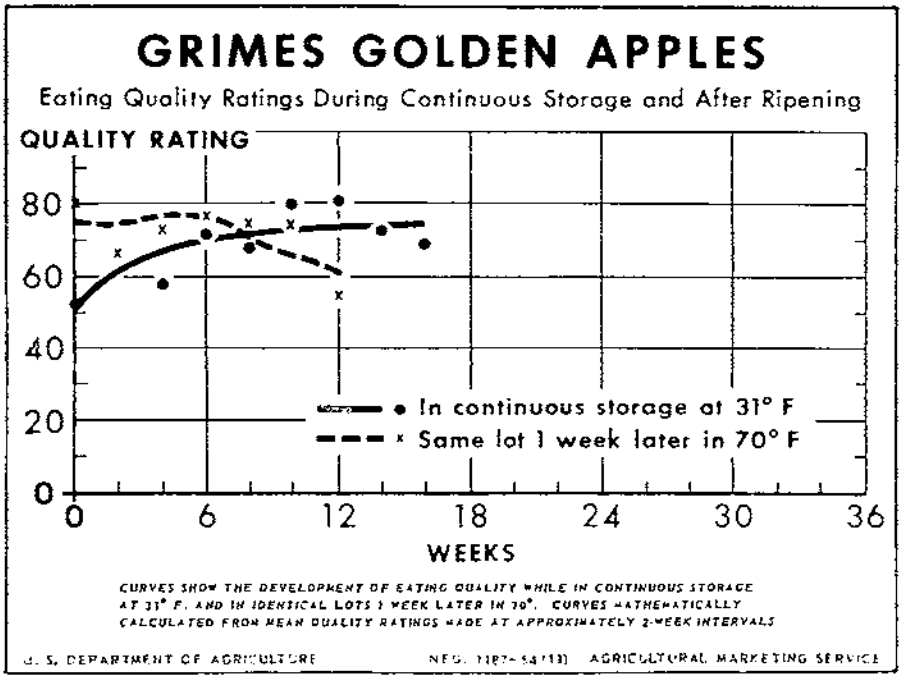

FIGURE 4.

the different varieties of apples at successive periods in continuous storage at 31° F. to that quality in identical sample lots 1 week later after being transferred to a temperature of 70°. These curves show, with one exception (York Imperial) that the orchard check samples attained a higher or nearly higher rating after ripening at 70° than subsequent samples taken from storage and held 1 week at 70°. In all varieties, the quality ratings of the apples ripened directly at 70° diminished until the curves intersected the ratings of the apples held in 31° storage in from 8 to 30 weeks, the length of time depending on whether the varieties were short, intermediate, or long "keepers." At the times when the curves intersected, the apples had ripened sufficiently in 31° temperature that they no longer improved in eating quality when moved to a higher temperature, and from here on they progressively decreased in quality within a week after being removed from storage. The time when the 70° curves show the quality rating to be below 68 to 70 also indicates when the apples in storage will no longer remain in good marketable condition for a week after removal. These periods indicated in figures 2 to 8 do not always coincide with

arrived at by more or less trial and error. The equation of the curve for the Delicious variety in continuous storage for instance, was estimated $y=82.90-10.75\sqrt{x}+28.11 \text{ Log } (x+1)$ where x represents the weeks in storage. The multiple correlation coefficient for this equation is $R=.89$, the coefficient of determination being $R^2=.80$. Because of the peculiarities of these factors in a multiple regression under certain conditions, a dip in the curve appears in the Golden Delicious and Grimes Golden varieties near 2 weeks of storage and little confidence is therefore put in these curves in the intervals from 0 to 4 weeks.

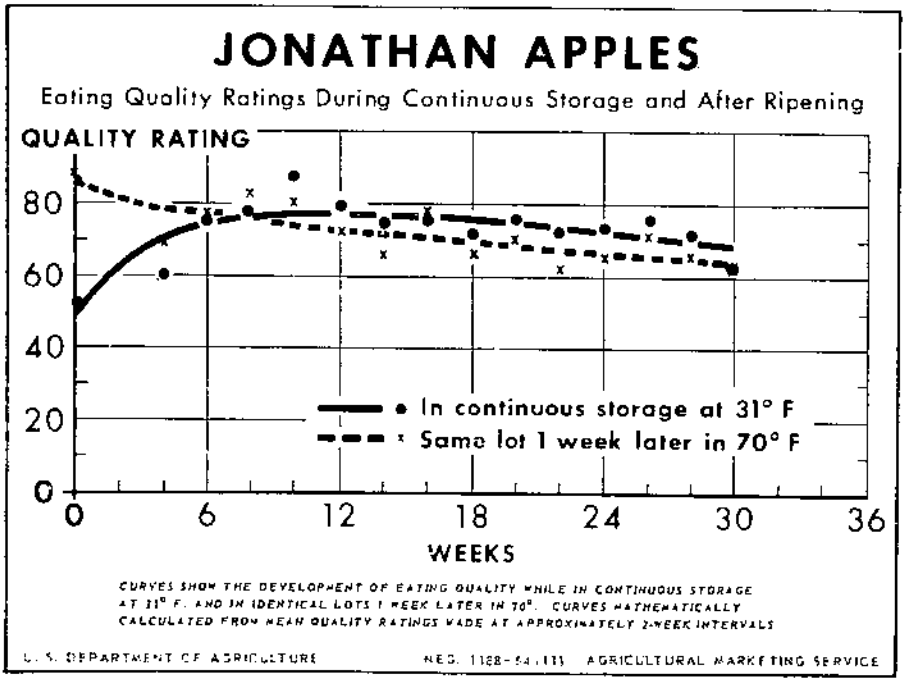

FIGURE 5.

those shown in table 12 which are based on actual mean values, but the mutual relationship is generally close and probably more real.

The curves in figure 7 for York Imperial apples are interesting in that they both show an increase in quality rating to nearly the end of the storage period. This variety ripens slowly and does not attain its highest quality until comparatively late in the storage season. In the studies of this variety, as well as of the others, the tests were concluded when an abnormal amount of decay and internal breakdown indicated that storage for longer periods than those used in the tests would be commercially impracticable.

Summary to Part 2

Seven varieties of apples were stored at 31° F. and at approximately 2-week intervals sample lots were removed from storage. A part was rated as to eating quality by a panel of 6 to 8 judges and a part was transferred to a temperature of 70° for a holding test and periodically rated by the judges.

The purpose of the study was to determine not only the comparative rates of ripening in storage but also how long each variety could be held in storage and yet retain marketable quality at least a week after removal from storage.

APPENDIX

TABLE 13.—*Delicious apples; Condition and composition at harvest and after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Juice analysis										Tissue analysis					
	Maturity	Quality	Firmness [2]	Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Sept. 29, 1939			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Firm to firm ripe	Starchy, poor flavor	15.2										21.11	8.44	2.28	10.72	15.13	2.27
Plus 1 week at 70°	Ripe	Full flavor, sweet, aromatic.	9.8										18.42	8.46	3.22	11.68	15.33	.89
2 months' storage	Firm ripe	Full flavor, sweet, crisp	13.1										19.98	10.10	3.26	13.36	16.82	.60
Plus 1 week at 70°	Firm ripe to ripe	Full flavor	11.7										19.64	10.18	3.34	13.52	17.53	.29
4 months' storage	Firm ripe	Full flavor	12.6										19.93	10.50	2.66	13.16	17.13	.26
Plus 1 week at 70°	Ripe	Slightly overripe	10.4										19.33	10.44	2.24	12.68	16.39	.12
5 months' storage	Firm ripe to ripe	Still full ripe for eating	11.8										19.87	11.18	2.26	13.44	17.07	.17
Plus 1 week at 70°	Ripe	Overripe, flavor gone	9.9										18.81	11.05	2.43	13.48	16.39	.10
6.5 months' storage	Firm ripe	Overripe, poor flavor	13.2										20.38	12.15	1.85	14.00	17.69	.10
Plus 1 week at 70°	Overripe	Soft, mealy, flavorless	9.7										20.62	12.10	1.82	13.92	17.88	.12
Sept. 11, 1940																		
At harvest	Hard to firm	Flavor undeveloped, starchy.	17.9	38.4	3.80	0.279	12.15	43.55	1.048	49.4		49.4	17.63	7.20	2.08	9.28	11.60	3.42
Plus 1 week at 70°	Firm to firm ripe	Flavor undeveloped	14.1	34.5	3.96	.244	13.40	54.92	1.050	67.0	45.9	112.9	16.92	8.26	2.98	11.24	13.20	1.46
1 month storage	Hard to firm	Flavor undeveloped, starchy.	17.1	41.0	3.88	.274	12.95	47.30	1.050	65.2	60.0	125.2	16.36	7.70	2.38	10.08	12.25	1.56
Plus 1 week at 70°	Firm to firm ripe	Almost full flavored	14.4	30.6	3.92	.242	15.07	62.22	1.058	91.7	60.0	151.7	16.77	8.60	3.16	11.76	13.85	.65
2 months' storage	Firm	Flavor undeveloped	15.4	46.7	3.90	.270	13.27	49.09	1.051	56.4	58.3	114.7	16.42	8.30	2.66	10.96	13.20	.92
Plus 1 week at 70°	Firm ripe	Full flavor	13.8	33.3	4.01	.225	13.68	60.90	1.052	54.7	60.0	114.7	16.67	8.72	2.80	11.52	13.80	.38
3 months' storage	Hard to firm	Almost eating ripe, crisp	16.6	48.3	4.01	.211	14.33	68.04	1.055	75.9	44.1	120.0	17.25	9.34	2.66	12.00	14.20	.47
Plus 1 week at 70°	Firm to firm ripe	Full flavor	14.6	41.7	4.20	.172	15.06	87.56	1.058	67.0	47.6	114.6	17.27	9.68	2.88	12.56	14.80	.11
4 months' storage	Hard to firm	Full flavor	16.4	50.5	4.24	.200	14.73	73.61	1.056	65.3	54.7	120.0	17.91	9.46	2.50	11.96	14.15	.44
Plus 1 week at 70°	Firm to firm ripe	Somewhat overripe	14.1	43.3	4.40	.244	14.33	58.75	1.054	61.7	54.7	116.4	16.52	9.34	2.62	11.96	13.55	.22
5 months' storage	Firm	Full flavor	16.0	51.1	4.10	.186	14.41	77.47	1.054	67.0	53.0	120.0	16.67	9.70	2.06	11.76	13.75	-------
Plus 1 week at 70°	Firm ripe	Overripe, mealy	13.7										15.98	9.22	2.18	11.40	13.15	-------
6 months' storage	Firm	Full flavor	15.3	48.9	4.36	.200	14.76	73.80	1.055	74.1	54.7	128.8	16.78	10.90	1.46	12.36	13.85	-------
Plus 1 week at 70°	Firm ripe	Mealy	13.9										17.26	10.70	1.90	12.60	13.75	-------
7 months' storage	Firm	Flavor fair	15.2	51.7	4.17	.158	13.96	88.41	1.052	68.8	58.2	127.0	15.80	10.22	1.26	11.48	13.05	-------

Sept. 25, 1941																	
At harvest	Hard to firm	Flavor undeveloped, starchy.	16.6	40.0	3.87	.180	13.40	70.76	1.050	44.1	40.6	84.7	16.49	8.21	2.49	10.70	12.60
Plus 1 week at 70°	Firm ripe	Prime for eating, aromatic.	12.9	23.8	3.94	.180	14.70	79.25		45.9	31.7	77.6	17.45	8.65	3.67	12.32	14.20
1 month storage	Firm	Flavor slightly undeveloped, starchy.	15.4	52.0	4.10	.189	15.10	79.52	1.056	49.4	37.0	86.4	16.75	8.69	3.03	11.72	13.45
Plus 1 week at 70°	Firm ripe to ripe	Mostly good quality, a few somewhat soft.	11.5	30.6	4.13	.168	14.60	92.27	1.054	37.0	38.9	75.9	17.03	9.12	3.24	12.36	14.10
2 months' storage	Firm to firm ripe	Eating ripe, aroma not fully developed.	14.4	49.5	4.13	.147	14.30	96.74	1.053	49.4	44.1	93.5	16.19	8.59	3.19	11.78	13.75
Plus 1 week at 70°	Firm ripe to ripe	Somewhat overripe	11.9	37.2	4.17	.158	14.80	93.54	1.052	42.3	49.4	91.7	16.69	9.07	3.07	12.14	13.85
3 months' storage	Firm to firm ripe	Full flavor	15.0	45.5	4.22	.168	14.80	87.83	1.056	52.9	35.5	88.2	16.92	9.04	3.22	12.26	14.10
Plus 1 week at 70°	Firm ripe	Soft but not mealy, some overripe.	12.9	46.0	4.35	.126	14.00	111.00	1.052	60.0	35.3	95.3	15.93	8.93	2.49	11.42	13.25
4 months' storage	do	Full flavor, crisp	13.5	51.7	4.30	.127	14.50	114.28	1.056	54.7	35.3	90.0	16.37	9.45	2.71	12.16	14.15
5 months' storage	do	Full flavor, still crisp	13.4	51.1	4.41	.105	13.90	131.62	1.053	49.4	28.2	77.6	16.30	10.00	2.52	12.52	13.55
Sept. 15, 1942																	
At harvest	Firm to firm ripe	Flavor undeveloped, starchy.	14.9	48.5	3.98	.239	13.13	55.01	1.048	58.2	33.5	91.7	16.91	6.75	2.85	9.60	12.40
Plus 1 week at 70°	Firm ripe	Eating ripe, full flavor and aroma.	12.6	39.5	4.00	.200	12.90	64.47	1.048	38.8	38.8	77.6	15.96	7.11	2.99	10.10	12.65
1 month storage	Firm to firm ripe	Flavor undeveloped	14.6	50.5	4.00	.193	12.94	67.05	1.046	35.3	37.0	72.3	16.35	7.07	2.73	9.80	12.45
Plus 1 week at 70°	Firm ripe	Prime for eating	12.1	36.7	3.92	.232	13.57	58.57	1.050	37.0	35.3	72.3	16.38	7.46	2.96	10.42	13.05
2 months' storage	Firm	Almost eating ripe, flavor fair.	14.2	54.8	4.55	.165	12.85	77.88	1.048	30.0	40.6	70.6	15.75	7.28	2.48	9.76	12.35
Plus 1 week at 70°	Firm ripe to ripe	Prime for eating	11.5	45.0	4.12	.172	13.13	76.34	1.049	31.8	40.6	72.3	15.54	7.43	2.67	10.10	12.85
3 months' storage	Firm ripe	Eating ripe, flavor good	13.0	55.2	4.22	.158	13.37	84.67	1.051	38.8	47.6	86.4	15.56	7.94	2.42	10.36	12.95
Plus 1 week at 70°	Firm ripe to ripe	Overripe, flavor lacking	11.3	39.7	4.79	.091	13.29	145.56	1.050	35.3	44.1	79.4	15.52	7.89	2.33	10.22	12.60
4 months' storage	Firm ripe	Prime for eating	13.0	61.8	4.31	.158	13.60	86.70	1.051	49.4	40.6	90.0	15.79	7.97	2.33	10.30	12.95
5 months' storage	do	do	13.0	59.8	4.96	.091	13.07	143.15	1.052	44.1	44.1	88.2	15.04	8.03	1.97	10.00	13.20
6 months' storage	do	do	12.0	58.3	4.60	.123	13.50	109.57	1.052				15.54	8.11	1.79	9.90	12.90
7 months' storage	do	Flavor good, almost overripe.	12.2	59.8	4.76	.091	13.33	146.00	1.052	24.7	58.2	82.9	15.26	8.30	1.34	9.64	
8 months' storage	do	Flavor good, almost overripe.	12.2	61.1	4.70	.088	13.40	152.80	1.050	39.0	39.0	78.0	15.26	8.24	1.58	9.82	

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates resistance of the tissue to applied pressure.

TABLE 14.—*Golden Delicious apples: Condition and composition at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis									Tissue analysis						
	Maturity	Quality		Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Oct. 10, 1940			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Firm	Starchy, underripe	15.4	46.7	3.48	0.495	16.52	33.38	1.062	45.9	77.6	123.5	19.24	9.84	3.64	13.48	16.25	0.44
Plus 1 week at 70°	Firm to firm ripe	Almost eating ripe	13.2	34.4	3.69	.432	17.79	41.21	1.070	52.9	84.7	137.6	20.27	10.24	4.40	14.64	17.40	.15
1 month storage	do	do	13.7	44.9	3.67	.386	16.43	42.56	1.064	37.0	68.8	105.8	19.20	9.42	4.14	13.56	15.80	.35
Plus 1 week at 70°	Ripe	Prime for eating, juicy	10.9	22.8	3.87	.361	17.47	48.39	1.066	44.1	65.3	109.4	19.32	9.78	4.18	13.96	16.55	.23
2 months' storage	Firm ripe	Prime for eating	12.9	35.0	3.77	.354	17.57	49.66	1.070	44.1	63.5	107.6	19.18	9.82	4.14	13.96	16.55	.25
Plus 1 week at 70°	Firm ripe to ripe	Slightly mealy, flavor fair.	11.3	31.1	3.97	.344	17.44	50.70	1.070	47.6	52.9	100.5	19.47	9.40	4.48	13.88	16.25	.17
3 months' storage	do	Good flavor	11.5	30.2	3.80	.305	17.38	56.91	1.068	61.7	63.5	125.2	19.00	9.72	3.88	13.60	16.25	.04
Plus 1 week at 70°	Ripe	Mealy, flavor fair	10.4										19.24	9.42	4.06	13.48	16.70	.01
4 months' storage	Firm ripe	Flavor fair	12.0		4.07	.211	17.77	84.38	1.070	31.8	63.5	125.3	19.76	10.09	3.71	13.80	16.60	.03
Plus 1 week at 70°	Firm ripe to ripe	Poor flavor, soft	11.0										19.64	9.92	3.88	13.80	16.60	.02
5 months' storage	do	Mealy, flavor fair	11.4	28.5	4.15	.168	17.47	103.68	1.065	22.0	61.8	84.7	18.96	9.96	3.40	13.36	15.80	
6 months' storage	do	Poor flavor, mealy	11.0										18.60	10.50	2.74	13.24	16.00	
Sept. 30, 1941																		
At harvest	Hard to firm	Flavor undeveloped, starchy.	16.6	41.7	3.62	.326	15.40	47.58	1.060	37.1	42.3	79.4	17.78	9.79	3.47	13.26	15.25	
Plus 1 week at 70°	Firm	Flavor fully developed, sweet.	14.4	36.7	3.73	.323	16.10	51.28	1.063	49.4	40.6	90.0	18.63	10.32	3.68	14.00	16.35	
1 month storage	Firm	Fair, slightly starchy	14.8	54.4	3.82	.270	15.60	58.45	1.060	37.1	33.5	70.6	17.82	9.75	3.69	13.44	15.95	
Plus 1 week at 70°	Firm ripe to ripe	Full flavor	11.5	38.9	3.96	.242	15.60	65.40	1.060	38.8	33.5	72.3	17.56	9.00	3.60	12.60	14.55	
2 months' storage	Firm	Fully eating ripe	14.3	38.7	3.96	.242	16.80	70.48	1.065	56.4	40.6	97.0	18.43	9.70	3.60	13.30	15.70	
Plus 1 week at 70°	Firm ripe to ripe	Good flavor	11.4	31.7	4.11	.214	15.90	75.38	1.064	26.4	26.5	52.9	18.12	9.32	3.72	13.04	15.15	
3 months' storage	Firm ripe	Flavor fair	11.8	36.1	4.07	.207	15.80	76.73	1.062	33.5	40.6	74.1	18.01	9.41	3.42	12.83	15.00	
Plus 1 week at 70°	Ripe	Flavor poor	10.1	30.0	4.18	.175	15.60	90.03	1.060	35.3	28.2	63.5	17.82	9.88	3.28	13.16	15.25	
4 months' storage	Firm ripe to ripe	Flavor fair	11.4	37.7	4.26	.154	15.60	101.23	1.060	37.1	38.8	75.9	17.34	9.63	3.17	12.80	14.90	

Sept. 20, 1943																
At harvest	Hard	Somewhat sweet, starchy.	16.0	56.0	3.65	.414	14.57	35.20	1,054	36.0	41.0	77.0	16.62	8.55	2.01	10.56		
Plus 1 week at 70°	Firm ripe	Almost eating ripe, full flavor.	12.8	42.0	3.72	.354	14.43	40.70	1,054	30.0	51.0	90.0	16.83	8.62	2.14	10.70		
1 month storage	do	Mostly eating ripe	12.7	48.0	3.62	.379	15.06	39.72	1,060	41.0	45.0	86.0	17.04	8.74	2.34	11.08		
Plus 1 week at 70°	do	Somewhat overripe	11.6	30.0	3.85	.323	15.27	47.29	1,060	30.0	51.0	81.0	17.25	8.51	2.93	11.44		
2 months' storage	Ripe	Mostly overripe	11.2	46.0	3.80	.330	14.67	44.47	1,056	34.0	47.0	81.0	17.27	8.53	2.43	10.96		
3 months' storage	do	Overripe, mealy, flavor lacking.	11.3	45.0	3.98	.291	14.83	50.90	1,058	36.0	46.0	82.0	16.48	8.59	2.21	10.80		
4 months' storage	do	do	11.1	43.0	3.90	.242	14.93	61.60	1,058	33.0	48.0	81.0	17.38	8.81	2.43	11.24		

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates the resistance of the tissue to applied pressure.

TABLE 15.—*Grimes Golden apples: Condition and composition at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis									Tissue analysis					
	Maturity	Quality		Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Sept. 19, 1941			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Firm, unripe	Starchy	16.3	42.2	3.43	0.484	13.07	27.00	1.048	56.4	49.4	105.8	16.42	7.37	3.95	11.32	11.45	------
Plus 1 week at 70°	Firm ripe	Flavor undeveloped	14.2	33.9	3.53	.411	14.14	34.42	1.052	51.2	56.4	107.6	16.95	8.21	5.09	13.30	13.10	------
1 month storage	Firm to firm ripe	Not eating ripe, flavorless.	15.7	47.2	3.52	.390	13.87	35.60	1.052	63.5	38.8	102.3	16.46	7.58	5.08	12.66	12.60	------
Plus 1 week at 70°	Ripe, eating ripe	Characteristic flavor lacking.	10.7	27.1	3.78	.323	14.54	45.02	1.054	35.3	52.9	88.2	16.65	7.97	6.22	14.19	13.45	------
2 months' storage	Firm ripe to ripe	Eating ripe but flavorless	13.3	32.8	3.69	.382	14.40	37.64	1.054	40.6	68.8	109.4	16.36	7.88	5.58	13.46	13.85	------
Plus 1 week at 70°	Ripe	Flavor fair, pulpy	10.6	------	------	------	------	------	------	------	------	------	17.10	8.02	6.26	14.28	14.15	------
3 months' storage	Firm ripe to ripe	Texture fair, flavor poor.	13.3	20.0	3.62	.414	15.73	37.98	1.052	49.4	40.6	90.0	17.32	7.88	4.26	12.14	14.30	------
4 months' storage	Ripe	Flavor poor	11.2	------	------	------	------	------	------	------	------	------	16.21	7.83	3.61	11.44	13.65	------
Sept. 15, 1942																		
At harvest	Firm	Sour, flavor undeveloped	16.5	56.2	3.47	.597	11.97	20.06	1.041	49.4	45.9	95.3	15.36	4.93	4.03	8.96	12.90	------
Plus 1 week at 70°	Ripe	Mostly prime for eating, some with flavor undeveloped.	12.0	31.7	3.62	.502	13.57	27.04	1.045	45.9	42.3	88.2	16.49	5.22	5.24	10.46	12.20	------
1 month storage	Firm ripe	Almost eating ripe	13.9	41.4	3.56	.502	12.72	25.34	1.046	45.9	47.6	93.5	15.31	5.20	4.44	9.64	11.50	------
Plus 1 week at 70°	Ripe	Mostly prime for eating, some overripe.	11.5	------	------	------	------	------	------	------	------	------	15.52	5.43	5.15	10.58	12.60	------
2 months' storage	do	Flavor good, somewhat overripe.	11.8	------	------	------	------	------	------	------	------	------	15.72	5.21	4.55	9.76	12.15	------
3 months' storage	do	Overripe, mealy, flavor poor.	10.7	------	------	------	------	------	------	------	------	------	15.68	5.63	4.49	10.12	12.50	------
Sept. 17, 1943																		
At harvest	Hard	Sour, starchy, inedible	18.2	58.0	3.62	.537	14.00	26.10	1.054	57.0	43.0	100.0	18.12	6.71	2.75	9.46	------	------
Plus 1 week at 70°	Firm ripe to ripe	Almost eating ripe	13.2	25.0	3.72	.435	14.04	32.30	1.057	53.0	43.0	96.0	18.58	6.82	4.80	11.62	------	------
1 month storage	Firm	Almost eating ripe flavor undeveloped.	16.7	45.0	3.64	.456	14.73	32.30	1.056	47.0	45.0	92.0	18.17	6.89	4.07	10.96	------	------
Plus 1 week at 70°	Ripe	Almost overripe, flavor fair.	11.8	------	3.81	.372	------	------	------	------	------	------	18.04	7.24	4.70	11.94	------	------
2 months' storage	Firm ripe	Somewhat overripe, slightly mealy.	14.1	22.0	3.78	.414	15.53	37.50	1.054	49.0	47.0	96.0	18.70	7.41	4.15	11.56	------	------
Plus 1 week at 70°	Ripe	Mealy, overripe	11.4	26.0	4.03	.330	16.40	49.70	1.058	45.0	53.0	98.0	18.26	7.54	4.60	12.14	------	------
3 months' storage	Firm ripe to ripe	Mealy, flavor gone	12.6	------	3.66	.404	------	------	------	16.0	51.0	67.0	17.88	7.31	4.41	11.72	------	------

[1] Terms used in rating samples are defined on p. 6.

[2] Indicates the resistance of the tissue to applied pressure.

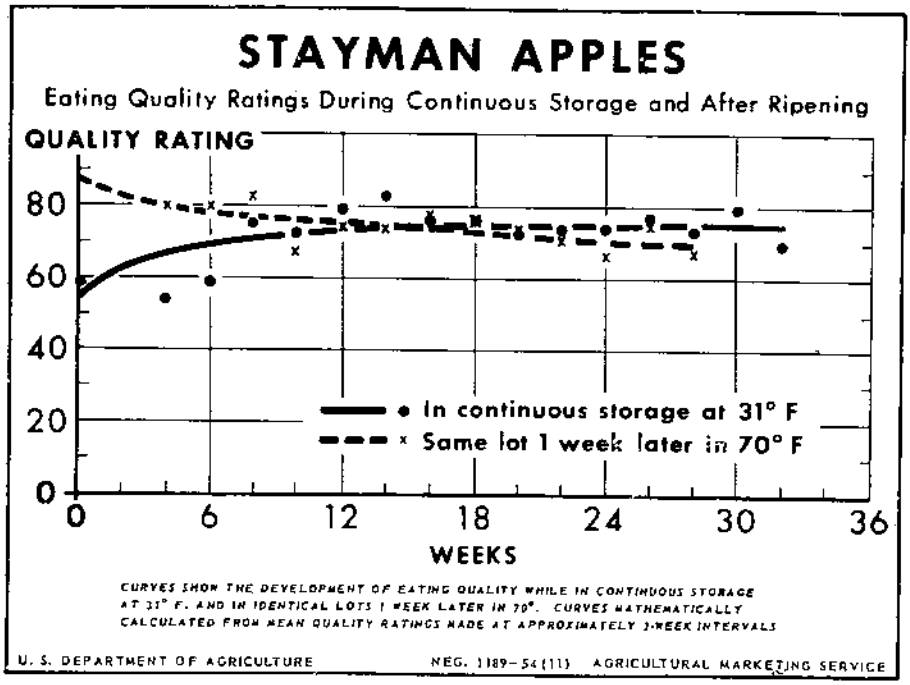
STAYMAN APPLES
Eating Quality Ratings During Continuous Storage and After Ripening
QUALITY RATING
80
60
40
20
0
0
6
12
18
24
30
36
WEEKS
• In continuous storage at 31° F
x Same lot 1 week later in 70° F
CURVES SHOW THE DEVELOPMENT OF EATING QUALITY WHILE IN CONTINUOUS STORAGE AT 31° F. AND IN IDENTICAL LOTS 1 WEEK LATER IN 70°. CURVES MATHEMATICALLY CALCULATED FROM MEAN QUALITY RATINGS MADE AT APPROXIMATELY 2-WEEK INTERVALS
U. S. DEPARTMENT OF AGRICULTURE
NEG. 1189-54(11) AGRICULTURAL MARKETING SERVICE

FIGURE 6.

TABLE 16.—*Condition and composition of Jonathan apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Juice analysis										Tissue analysis					
	Maturity	Quality	Firmness [2]	Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
			Pounds	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Sept. 18, 1940																		
At harvest	Hard to firm	Sour, starchy	16.1	41.1	3.40	0.979	14.20	14.60	1.056	44.1	67.0	111.1	17.99	7.56	2.92	10.48	13.85	0.88
Plus 1 week at 70°	Firm ripe to ripe	Underripe	13.6	40.6	3.38	.846	15.06	17.80	1.058	52.9	70.6	123.5	18.21	8.78	3.06	11.84	15.00	.32
1 month storage	Hard	do	16.9	35.6	3.26	.979	16.00	16.34	1.062	65.2	90.0	155.2	18.79	8.02	3.18	11.80	15.25	.45
Plus 1 week at 70°	Firm ripe to ripe	Eating ripe, spicy	11.2	28.9	3.56	.779	15.13	19.42	1.058	47.6	82.9	130.5	17.59	8.66	3.02	11.68	14.90	.04
2 months' storage	Firm	Underripe	15.0	38.0	3.36	.927	15.77	17.01	1.062	60.0	79.4	139.4	18.58	8.84	3.24	12.08	15.60	.02
Plus 1 week at 70°	Firm ripe to ripe	Fair	10.9	25.6	3.61	.737	15.74	21.35	1.062	58.2	75.9	134.1	18.44	9.16	3.20	12.36	16.20	.01
3 months' storage	Firm to firm ripe	Eating ripe, crisp	13.6	38.7	3.42	.860	16.07	18.69	1.062	63.5	65.3	128.8	18.35	9.08	3.12	12.20	15.65	.02
Plus 1 week at 70°	Ripe	Past prime for eating	10.5	33.1	3.60	.677	15.71	23.19	1.062	58.2	61.8	120.0	17.82	9.38	2.62	12.00	15.35	.01
4 months' storage	Firm ripe	Prime for eating	13.5	41.2	3.52	.769	15.57	20.25	1.061	52.9	70.6	123.5	17.91	9.82	2.66	12.48	15.30	------
Plus 1 week at 70°	Ripe	Flavor lacking	10.5	34.4	3.60	.635	15.87	24.98	1.062	49.4	65.3	114.7	17.71	9.40	2.44	11.84	14.95	------
5 months' storage	Firm ripe	Flavor good to fair	12.5	33.3	3.50	.758	15.87	20.93	1.065	61.7	63.5	125.2	18.30	9.34	2.02	11.96	15.55	------
Plus 1 week at 70°	Firm ripe to ripe	Flavor poor	10.9										17.93	9.64	2.28	11.92	15.20	------
6 months' storage	Firm ripe	Flavor fair	12.8	38.9	3.58	.642	16.37	25.49	1.064	61.7	61.8	123.5	17.40	9.32	2.44	11.76	14.90	------
Sept. 16, 1941																		
At harvest	Hard to firm	Very hard or tough, starchy	16.2	38.3	3.22	.870	14.40	17.01	1.056	47.6	68.8	116.4	16.67	8.60	2.69	11.38	14.05	------
Plus 1 week at 70°	Firm to firm ripe	Unripe, starchy	13.6	43.3	3.42	.695	14.30	20.96	1.055	56.4	44.1	100.5	16.65	8.66	3.22	11.88	13.85	------
1 month storage	Firm	Flavor lacking, starchy	15.8	45.5	3.40	.782	14.90	19.39	1.057	52.9	44.1	97.0	16.68	9.18	2.70	11.88	14.30	------
Plus 1 week at 70°	Firm ripe to ripe	High flavor	10.6	35.3	3.35	.644	14.50	23.03	1.056	35.3	44.1	79.4	16.82	8.93	2.03	11.56	13.75	------
2 months' storage	Firm	Not eating ripe	14.1	50.0	3.46	.702	14.90	21.56	1.057	47.6	54.7	102.3	16.31	8.87	2.51	11.38	13.95	------
Plus 1 week at 70°	Firm ripe to ripe	Slightly overripe	10.9	41.7	3.60	.597	14.70	24.92	1.056	40.6	70.6	111.2	16.56	8.89	2.57	11.46	13.95	------
3 months' storage	do	Prime for eating	11.8	50.5	3.49	.688	14.70	21.55	1.056	60.0	45.8	105.8	16.72	8.95	2.73	11.68	13.75	------
Plus 1 week at 70°	do	Somewhat overripe	11.5	38.3	3.57	.646	13.90	21.90	1.052	47.6	45.9	93.5	16.17	8.52	2.80	11.32	13.10	------
4 months' storage	Firm ripe	Somewhat soft, flavor good.	12.4	48.5	3.55	.656	14.60	22.33	1.055	60.0	37.0	97.0	16.13	8.05	2.05	11.30	13.35	------
5 months' storage	Firm ripe to ripe	Flavor fair	11.5	45.5	3.58	.593	14.00	23.82	1.052	63.5	28.2	91.7	16.56	8.57	2.55	11.12	13.20	------
6 months' storage	do	do	11.2	40.5	3.57	.582	14.10	24.15	1.052	58.2	52.9	111.1	16.21	8.62	2.50	11.12	13.30	------
Sept. 17, 1942																		
At harvest	Firm	Sour, starchy	14.4	50.3	3.46	.516	13.13	25.44	1.048	37.0	49.4	86.4	15.01	7.04	2.78	9.82	12.90	------
Plus 1 week at 70°	Firm ripe	Tart, spicy, almost eating ripe	12.1	54.1	3.51	.474	13.40	28.28	1.050	52.9	40.6	93.5	15.55	7.11	3.17	10.28	13.20	------
1 month storage	Firm	Sour, flavor undeveloped.	14.6	59.2	3.46	.548	13.80	25.20	1.051	45.9	33.5	79.4	15.59	7.18	3.00	10.18	13.20	------

Plus 1 week at 70°	Firm ripe to ripe	Prime for eating	10.9	43.3	3.44	.460	13.20	28.71	1.049	31.7	40.6	72.3	15.01	7.26	2.70	9.96	13.15	
2 months' storage	Firm ripe	Mostly eating ripe	12.9	56.0	3.49	.474	13.47	28.43	1.050	45.8	45.9	91.7	15.42	7.21	2.83	10.04	13.25	
Plus 1 week at 70°	Ripe	Prime for eating	10.1	43.5	3.61	.421	13.64	32.38	1.052	40.6	49.4	90.0	15.14	7.43	2.47	9.90	13.15	
3 months' storage	Firm ripe to ripe	do	11.6	53.0	3.54	.456	13.20	28.93	1.052	44.1	45.9	90.0	15.04	7.78	2.44	10.22	12.60	
Plus 1 week at 70°	Ripe	Slightly overripe	10.4	54.5	3.72	.400	13.20	32.90	1.052	39.7	37.0	76.7	15.22	7.76	2.54	10.30	13.20	
4 months' storage	Firm ripe	Prime for eating	12.1	57.2	3.55	.439	13.83	31.52	1.054	42.3	44.1	86.4	15.54	8.02	2.14	10.16	12.90	
5 months' storage	Firm ripe to ripe	Flavor fair	11.5	52.8	3.90	.337	13.13	38.96	1.050	44.1	56.4	100.5	15.44	8.12	2.20	10.32		
Sept. 15, 1943																		
At harvest	Hard to firm	Sour, starchy	16.3	57.0	3.44	.870	16.17	18.60	1.062	55.0	55.0	110.0	18.64	8.95	1.65	10.60		
Plus 1 week at 70°	Firm to firm ripe	Almost eating ripe, sour but spicy.	13.9	55.0	3.46	.765	16.53	21.90	1.064	57.0	49.0	106.0	18.74	9.91	2.13	12.04		
1 month storage	Firm	Mostly eating ripe, sour, spicy.	15.0	50.0	3.49	.818	16.60	20.30	1.064	69.0	65.0	134.0	18.50	9.91	1.53	11.44		
Plus 1 week at 70°	Firm ripe to ripe	Eating ripe, full flavor	10.9	36.0	3.56	.705	16.57	23.50	1.064	57.0	53.0	110.0	18.72	10.03	1.65	11.68		
2 months' storage	Firm ripe	Mostly eating ripe, spicy	13.1	40.0	3.52	.737	16.66	22.60	1.066	57.0	45.0	102.0	18.78	10.11	1.73	11.84		
Plus 1 week at 70°	Firm ripe to ripe	Soft, good flavor	10.8	38.0	3.62	.646	16.20	25.10	1.062	33.0	57.0	90.0	19.00	9.93	2.07	12.00		
3 months' storage	Firm ripe	Eating ripe, spicy, somewhat soft.	12.8	45.0	3.48	.705	16.30	21.40	1.064	39.0	55.0	94.0	18.43	9.37	2.31	11.68		
4 months' storage	Firm ripe to ripe	Eating ripe, full flavor	11.6	48.0	3.48	.684	16.23	23.70	1.062	58.0	57.0	115.0	18.23	9.30	2.50	11.80		
5 months' storage	do	Somewhat past prime for eating.	11.0	43.0	3.52	.649	15.93	24.50	1.061	48.0	45.5	93.0	17.56	9.30	2.18	11.48		

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates the resistance of the tissue to applied pressure.

TABLE 17.—*Condition and composition of Rome Beauty apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis									Tissue analysis					
	Maturity	Quality		Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Oct. 25, 1939			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Firm	Undeveloped flavor, green background.	16.6										15.66	7.32	3.08	10.40	12.81	0.14
Plus 1 week at 70°	Ripe	Eating ripe, yellow background.	10.5										15.74	7.18	3.34	10.52	13.08	.11
3 months' storage	Firm ripe to ripe	Eating ripe, somewhat soft, yellow background.	12.6										15.65	6.78	2.16	9.04	12.89	.11
Plus 1 week at 70°	Ripe	Full flavor, mealy	10.8										15.38	7.02	2.74	9.76	12.68	.10
4 months' storage	do	Somewhat overripe, fair flavor.	11.6										15.46	6.88	2.52	9.40	12.77	.08
Plus 1 week at 70°	do	Soft, overripe	11.2										14.75	6.80	2.08	8.88	12.24	-------
5.5 months' storage	do	Overripe	11.7										14.88	6.76	1.92	8.68	12.39	.08
Plus 1 week at 70°	do	Overripe, flavor poor	10.8										15.37	6.74	2.30	9.04	12.69	-------
Oct. 8, 1940																		
At harvest	Hard	Starchy, underripe	19.1	37.2	3.42	0.541	14.60	27.01	1.052	42.3	91.8	134.1	17.27	7.04	3.12	10.16	13.15	1.04
Plus 1 week at 70°	Firm ripe	Eating ripe	14.4	20.3	3.70	.407	14.60	35.80	1.055	28.2	90.0	118.2	17.53	7.62	4.74	12.36	14.30	.31
1 month's storage	Hard to firm	Flavor undeveloped	18.3	32.2	3.50	.491	14.72	29.98	1.058	40.6	82.9	123.5	17.50	7.48	4.52	12.00	14.20	.34
Plus 1 week at 70°	Ripe	Fair flavor, rather mealy.	11.8	16.0	3.90	.298	13.92	46.71	1.054	12.3	90.0	102.3	17.23	7.56	5.00	12.56	14.60	.11
2 months' storage	Firm to firm ripe	Eating ripe	15.1	29.1	3.73	.376	14.16	37.70	1.052	37.0	74.1	111.1	16.87	7.54	4.74	12.28	14.35	.15
Plus 1 week at 70°	Ripe	Soft, mealy	12.2	21.1	3.67	.358	15.17	42.37	1.050	45.9	52.9	98.8	16.85	7.06	4.78	11.84	13.90	.08
3 months' storage	Firm ripe	Pulpy, poor flavor	13.9	24.4	3.75	.347	14.53	41.81	1.055	24.7	72.3	97.0	16.61	7.18	4.54	11.72	14.05	-------
Plus 1 week at 70°	Ripe	Pulpy	12.3										16.99	7.50	4.46	11.96	14.20	-------
4 months' storage	Firm ripe to ripe	Overripe	12.6										16.93	7.74	4.10	11.84	14.20	-------
Plus 1 week at 70°	Ripe	do	12.2										16.79	8.62	5.30	11.92	14.20	-------
5 months' storage	Firm ripe to ripe	do	12.9										16.66	8.76	3.20	11.96	14.40	-------
Oct. 8, 1941																		
At harvest	Hard, unripe	Tasteless, starchy	19.2	30.0	3.70	.372	13.66	36.71	1.050	37.0	56.5	93.5	16.43	8.31	3.07	11.38	12.80	-------
Plus 1 week at 70°	Firm	Flavor undeveloped	16.5	26.0	3.79	.302	13.14	43.52	1.049	19.4	44.1	63.5	16.25	8.39	3.11	11.50	12.80	-------
1 month's storage	do	do	17.2	38.6	3.71	.319	13.80	43.21	1.052	26.5	56.4	82.9	15.83	8.35	3.21	11.56	13.15	-------
Plus 1 week at 70°	Firm ripe	Fully ripe, flavor fair	13.7	24.9	3.93	.268	13.60	50.65	1.050	14.1	68.8	82.9	15.58	8.16	3.10	11.26	12.55	-------

2 months' storage	....do	Flavor fully developed	14.3	30.6	3.67	.340	13.76	40.41	1.052	31.8	47.6	79.4	15.72	8.48	2.88	11.36	12.85	.....
Plus 1 week at 70°	Firm ripe to ripe	Somewhat overripe, mealy.	13.1	30.0	3.83	.330	14.00	42.44	1.054	38.8	47.6	86.4	15.59	8.43	2.93	11.36	12.70	.....
3 months' storage	....do	Good flavor, some mealiness.	12.9	33.9	3.77	.316	13.76	43.56	1.052	31.8	45.8	77.5	15.71	8.75	2.77	11.52	12.95	.....
4 months' storage	....do	....do	12.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.59	8.97	2.99	11.96	13.50	.....
5 months' storage	Ripe	Fair flavor, somewhat mealy.	12.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.53	8.57	2.33	10.90	12.60	.....

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates the resistance of the tissue to applied pressure.

TABLE 18.—*Condition and composition of Stayman apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis									Tissue analysis					
	Maturity	Quality		Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Oct. 14, 1939			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Hard to firm	Flavor undeveloped, starchy.	16.0	----	----	----	----	----	----	----	----	----	18.71	7.88	2.72	10.60	14.83	0.91
Plus 1 week at 70°	Ripe	Full flavor	9.7	...	...	...	...	...	...	...	...	...	19.34	8.62	3.56	12.08	16.55	.23
2 months' storage	Firm ripe	Flavor undeveloped	12.5	...	...	...	...	...	...	...	...	...	19.10	8.02	3.34	11.36	15.82	.39
Plus 1 week at 70°	Ripe	Full flavor, prime for eating.	10.0	...	...	...	...	...	...	...	...	...	18.62	8.10	4.02	12.12	15.70	.27
3 months' storage	Firm ripe to ripe	Flavor undeveloped	11.8	...	...	...	...	...	...	...	...	...	18.93	7.86	4.14	12.00	15.83	.31
Plus 1 week at 70°	Ripe	Full flavor, somewhat soft.	10.0	...	...	...	...	...	...	...	...	...	18.54	7.88	3.84	11.72	15.70	.23
4 months' storage	Firm ripe to ripe	Full flavor, prime for eating.	11.1	...	...	...	...	...	...	...	...	...	18.61	8.04	3.92	11.96	15.76	.23
Plus 1 week at 70°	Ripe	Somewhat overripe, some flavor lost.	10.7	...	...	...	...	...	...	...	...	...	18.41	7.92	3.44	11.36	15.65	.24
6 months' storage	do	Flavor fair, slightly overripe.	10.8	...	...	...	...	...	...	...	...	...	19.24	8.72	3.96	12.68	16.33	.13
Plus 1 week at 70°	do	Overripe, mealy, flavorless.	10.0	...	...	...	...	...	...	...	...	...	18.43	8.48	3.60	12.08	15.89	.14
Oct. 16, 1939																		
At harvest	Hard	Flavor undeveloped, starchy.	19.2	52.2	3.46	0.590	13.72	23.26	1.053	58.2	97.0	125.2	17.73	6.88	4.08	10.96	13.70	1.32
Plus 1 week at 70°	Firm to firm ripe	Flavor undeveloped	14.0	41.2	3.45	.530	14.86	28.04	1.058	60.0	56.4	116.4	16.96	7.20	4.52	11.72	14.15	.32
1 month storage	Hard	Flavor undeveloped, starchy.	17.6	51.7	3.48	.590	15.25	25.85	1.060	60.0	63.5	123.5	17.55	7.20	4.02	11.28	13.95	.63
Plus 1 week at 70°	Ripe	Full flavor, crisp, juicy	10.4	21.4	3.61	.488	15.11	30.97	1.060	47.6	65.3	112.9	17.76	7.70	4.50	12.20	14.95	.20
2 months' storage	Firm	Almost eating ripe	15.4	48.8	3.51	.525	15.01	28.61	1.057	60.0	61.7	121.7	17.63	7.86	4.22	12.08	14.70	.30
Plus 1 week at 70°	Firm ripe to ripe	Flavor fair	11.0	37.2	3.62	.432	14.93	34.58	1.058	61.7	53.0	114.7	17.48	8.30	4.06	12.36	14.80	.12
3 months' storage	Firm to firm ripe	Eating ripe	13.7	50.0	3.50	.488	15.25	31.26	1.061	49.4	68.8	118.2	17.44	8.30	4.02	12.32	14.90	.22
Plus 1 week at 70°	Firm ripe to ripe	Almost mealy	11.1	37.8	3.70	.393	15.48	39.38	1.058	42.3	63.5	105.8	17.84	8.70	3.86	12.56	15.10	.....

4 months' storage	Firm ripe	Eating ripe	12.8	42.2	3.57	.432	15.02	36.18	1.062	60.0	51.1	111.1	17.35	7.32	3.56	10.88	14.95	.42
Plus 1 week at 70°	Firm to firm ripe	Mealy, overripe	11.5										17.48	8.58	3.66	12.24	14.95	.06
5 months' storage	Firm ripe	Flavor fair to good	12.6	44.5	3.52	.484	15.67	32.35	1.060	52.9	63.5	116.4	17.15	8.44	3.76	12.20	14.75	-------
6 months' storage	Firm ripe to ripe	Flavor fair to poor	12.0	43.3	3.55	.411	15.63	38.06	1.060	65.3	58.2	123.5	17.39	8.84	3.40	12.24	15.10	-------
Oct. 23, 1941																		
At harvest	Hard	Flavor undeveloped	17.1	57.2	3.55	.444	14.00	36.06	1.054	47.6	24.7	72.3	18.46	8.48	3.46	11.94	13.85	-------
Plus 1 week at 70°	Firm	Full flavor	14.3	43.3	3.66	.379	16.00	44.50	1.064	38.8	42.3	81.1	19.55	9.54	4.50	14.04	15.00	-------
1 month storage	Hard to firm	Flavor partially developed.	16.1	57.7	3.60	.393	15.70	39.93	1.060	51.2	44.1	95.3	18.78	9.21	4.05	13.26	15.60	-------
Plus 1 week at 70°	Ripe	Somewhat mealy, soft, good flavor.	10.6	38.0	3.74	.358	17.20	48.04	1.054	33.5	61.8	95.3	19.00	9.80	4.26	14.06	15.95	-------
2 months' storage	Firm to firm ripe	Eating ripe, full flavor	13.6	42.8	3.62	.418	16.50	39.57	1.064	60.0	37.0	97.0	18.76	9.32	3.88	13.20	15.15	-------
Plus 1 week at 70°	Ripe	Flavor good, somewhat mealy.	10.1	37.2	3.70	.376	16.20	43.13	1.062	42.3	42.4	84.7	19.01	9.51	4.01	13.52	15.10	-------
3 months' storage	Firm ripe	Full flavor, still crisp	12.7	40.6	3.67	.400	17.30	43.24	1.066	52.9	44.1	97.0	19.97	9.89	4.51	14.40	16.10	-------
4 months' storage	do	Fair flavor, not crisp	12.0	43.9	3.65	.351	16.60	46.91	1.064	45.9	35.5	79.4	19.86	9.97	4.25	14.22	16.25	-------
5 months' storage	Firm ripe to ripe	Fair flavor, soft	11.1	44.5	3.69	.333	16.00	48.10	1.062	47.6	33.5	81.1	19.19	9.75	4.71	14.46	16.25	-------

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates resistance of the tissue to applied pressure.

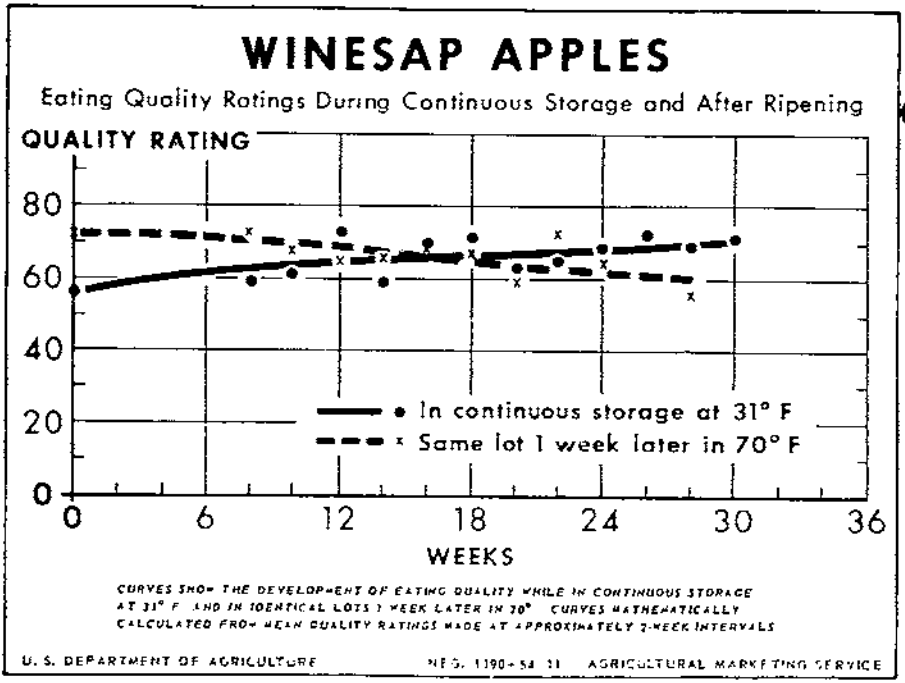
WINESAP APPLES
Eating Quality Ratings During Continuous Storage and After Ripening
QUALITY RATING
80
60
40
20
0
0
6
12
18
24
30
36
WEEKS
• In continuous storage at 31° F
x Same lot 1 week later in 70° F
CURVES SHOW THE DEVELOPMENT OF EATING QUALITY WHILE IN CONTINUOUS STORAGE AT 31° F. AND IN IDENTICAL LOTS 1 WEEK LATER IN 70°. CURVES MATHEMATICALLY CALCULATED FROM MEAN QUALITY RATINGS MADE AT APPROXIMATELY 2-WEEK INTERVALS
U. S. DEPARTMENT OF AGRICULTURE
NEG. 1190-54 (1) AGRICULTURAL MARKETING SERVICE

FIGURE 7.

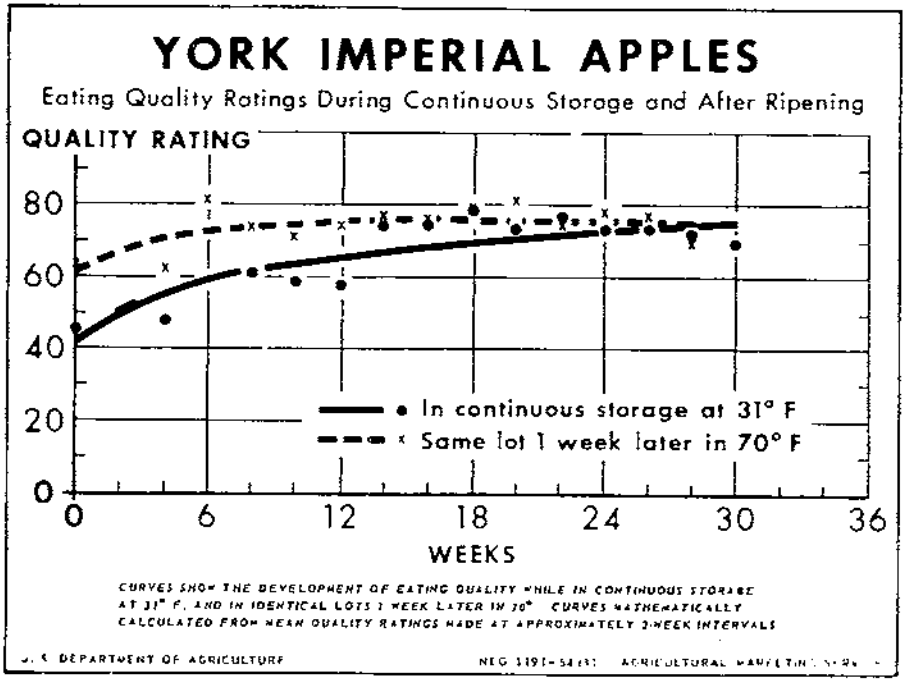
YORK IMPERIAL APPLES
Eating Quality Ratings During Continuous Storage and After Ripening
QUALITY RATING
80
60
40
20
0
0
6
12
18
24
30
36
WEEKS
• In continuous storage at 31° F
× Same lot 1 week later in 70° F
CURVES SHOW THE DEVELOPMENT OF EATING QUALITY WHILE IN CONTINUOUS STORAGE AT 31° F. AND IN IDENTICAL LOTS 1 WEEK LATER IN 70°. CURVES MATHEMATICALLY CALCULATED FROM MEAN QUALITY RATINGS MADE AT APPROXIMATELY 3-WEEK INTERVALS
U. S. DEPARTMENT OF AGRICULTURE

FIGURE 8.

TABLE 19.—*Condition and composition of Wincsap apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis										Tissue analysis					
				Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
	Maturity	Quality			pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Oct. 22, 1942			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Firm	Starchy, sour, tasteless	16.8	61.7	3.52	0.432	12.27	28.42	1.045	49.3	31.8	81.1	14.54	7.23	1.91	9.14	11.40	-------
Plus 1 week at 70°	Firm ripe	do	14.7	48.8	3.70	.365	12.40	33.97	1.046	44.1	44.1	88.2	14.84	7.64	1.88	9.52	11.85	-------
1 month storage	Firm to firm ripe	Starchy, sour, tasteless	15.3	57.8	3.57	.393	12.33	31.37	1.046	45.9	42.3	88.2	14.20	7.36	1.92	9.28	11.95	-------
Plus 1 week at 70°	Firm ripe to ripe	Flavor poor and undeveloped.	12.5	43.9	3.66	.358	12.53	35.00	1.048	44.1	42.3	86.4	14.39	7.53	2.07	9.60	11.80	-------
2 months' storage	Firm ripe	Starchy, flavorless	14.5	59.5	3.52	.411	12.70	30.92	1.048	40.5	45.9	86.4	14.52	7.52	2.22	9.74	12.15	-------
Plus 1 week at 70°	Ripe	Eating ripe	12.0	44.6	3.82	.310	12.70	30.76	1.048	51.2	42.3	93.5	14.72	8.01	1.89	9.90	12.30	-------
3 months' storage	Firm ripe to ripe	Starchy, flavorless	12.8	54.4	3.75	.369	12.26	33.26	1.046	61.7	42.3	104.1	14.53	7.78	1.68	9.46	11.75	-------
Plus 1 week at 70°	do	Eating ripe	12.9	47.3	3.65	.360	12.73	34.54	1.047	52.9	44.1	97.0	14.46	7.95	1.67	9.62	11.95	-------
4 months' storage	do	Eating ripe, flavor lacking.	12.8	56.3	3.59	.376	12.50	33.28	1.046	68.2	52.9	111.1	14.43	7.99	1.33	9.32	12.10	-------
Plus 1 week at 70°	Ripe	Flavor fair	11.7	40.3	3.67	.326	12.43	38.08	1.046	47.6	52.9	100.5	14.47	7.87	1.39	9.26	11.90	-------
5 months' storage	Firm ripe to ripe	Flavor lacking	12.9	52.7	3.63	.351	12.20	34.41	1.046	61.8	56.4	118.2	14.47	8.03	1.45	9.48	12.20	-------
Plus 1 week at 70°	Ripe	do	11.9	40.2	3.79	.309	12.75	41.27	1.046	38.8	47.6	86.4	14.31	8.01	1.27	9.28	12.10	-------
6 months' storage	do	Flavor fair to good	12.4	55.5	3.60	.368	12.43	33.73	1.046	51.1	40.6	91.7	14.52	7.73	1.41	9.14	12.30	-------
7 months' storage	do	Flavor good	11.8	53.3	3.85	.365	12.51	34.36	1.046	40.1	49.8	89.9	14.77	8.08	1.30	9.38	12.00	-------
8 months' storage	do	Somewhat overripe	11.5	38.9	3.60	.347	12.50	35.97	1.049	57.7	64.4	122.1	15.20	8.61	1.13	9.74	12.70	-------
Oct. 15, 1943																		
At harvest	Hard	Tough, starchy	21.1	60.0	3.60	.519	15.50	30.36	1.062	75.0	55.0	130.0	18.24	9.24	2.88	12.12	14.85	-------
Plus 1 week at 70°	Hard to firm	Sour, starchy	18.1	42.0	3.60	.495	16.20	33.28	1.064	65.0	57.0	122.0	18.34	9.74	2.82	12.56	15.40	-------
1 month storage	Hard	Sour, starchy, flavor undeveloped.	19.8	53.0	3.74	.512	15.80	30.67	1.064	61.0	45.0	106.0	18.40	9.70	2.70	12.40	15.70	-------
Plus 1 week at 70°	Firm to firm ripe	Flavor undeveloped	15.3	32.0	3.92	.432	15.50	36.37	1.062	39.0	57.0	96.0	19.11	10.10	2.30	12.40	15.30	-------
2 months' storage	Hard	Sour, starchy, flavor undeveloped.	19.7	45.0	3.67	.537	16.00	30.00	1.062	74.0	48.0	122.0	18.15	10.10	2.02	12.12	15.40	-------
Plus 1 week at 70°	Firm to firm ripe	Flavor undeveloped	15.3	28.0	3.66	.460	15.70	34.40	1.060	53.0	60.0	113.0	18.07	10.52	1.76	12.28	15.50	-------
3 months' storage	Firm	Almost eating ripe	18.1	51.0	3.51	.540	15.80	29.70	1.062	65.0	62.0	127.0	18.45	9.96	1.96	11.92	15.65	-------
Plus 1 week at 70°	Firm ripe	Full ripe, full flavor	14.6	24.0	3.77	.407	15.50	39.00	------	51.0	67.0	118.0	18.40	10.34	2.30	12.64	15.60	-------

4 months' storage	Firm	Almost prime for eating	17.0	43.0	3.51	.409	15.60	30.80	1.001	53.0	45.0	98.0	17.79	10.22	1.08	12.20	15.15	
Plus 1 week at 70°	Firm ripe	Full ripe	14.4	28.0	3.66	.415	15.50	37.90	1.060	50.0	56.0	100.0	18.27	10.28	2.08	12.36	15.45	
5 months' storage	Firm to firm ripe	Eating ripe	15.9	45.0	3.52	.472	15.50	33.54	1.060	81.0	68.0	140.0	18.88	10.48	1.88	12.36	15.60	
Plus 1 week at 70°	Firm ripe to ripe	Full ripe, somewhat soft	13.0	17.0	3.77	.375							18.37	10.52	1.88	12.40	15.55	
6 months' storage	Firm ripe	Full ripe	14.5	41.0	3.79	.439	15.90	36.70	1.062				18.97	10.48	1.72	12.20	15.20	
7 months' storage	Firm to firm ripe	Flavor lacking	15.2	39.0	3.61	.474	15.30	33.01	1.060				18.42	10.28	1.72	12.00	15.05	
8 months' storage	Firm ripe	do	14.4	43.0	3.69	.425	15.00	35.62	1.058				18.37	10.60	1.30	11.90	14.80	
9 months' storage	do	Flesh firm, dry, flavor lacking	14.9	37.0	3.73	.418	15.00	36.87	1.060				18.45	10.00	0.88	10.88	14.25	

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates resistance of the tissue to applied pressure.

TABLE 20.—*Condition and composition of mature Yellow Newtown apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis									Tissue analysis					
				Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
	Maturity	Quality			pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
			Pounds	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oct. 8, 1941																		
At harvest	Firm, unripe	Starchy, sour	17.7	40.3	3.60	0.484	12.56	25.92	1.046	49.4	49.4	98.8	15.15	7.91	2.31	10.22	12.05	.....
Plus 1 week at 70°	Hard, unripe	do	19.9	43.4	3.48	.465	12.84	27.61	1.046	38.8	40.6	79.4	14.91	7.91	2.65	10.56	12.25	.....
1 month storage	Firm, unripe	do	17.5	57.7	3.51	.481	13.06	27.16	1.048	47.6	42.4	90.0	15.16	7.92	2.66	10.58	12.70	.....
Plus 1 week at 70°	Firm	Flavor fair, sweet, slightly starchy.	16.1	47.7	3.58	.397	13.24	33.38	1.048	35.3	47.6	82.9	14.91	8.22	2.50	10.72	12.60	.....
2 months' storage	Firm to firm ripe	Rather tasteless, starchy	15.2	38.6	3.60	.411	13.13	31.97	1.050	45.9	40.5	86.4	14.90	8.04	2.60	10.64	12.60	.....
Plus 1 week at 70°	do	Flavor fair	15.9	44.5	3.65	.451	13.60	30.16	1.052	40.4	38.8	88.2	14.97	8.15	2.41	10.56	12.25	.....
3 months' storage	Firm ripe	Flavor still undeveloped	14.9	43.2	3.66	.425	13.16	30.99	1.050	47.6	35.3	82.9	15.27	7.91	2.43	10.34	12.20	.....
Plus 1 week at 70°	do	Flavor fully developed	13.9	40.0	3.62	.421	13.17	31.27	1.050	40.6	35.3	75.9	14.93	8.39	2.51	10.90	12.55	.....
4 months' storage	do	do	13.1	51.0	3.61	.359	12.70	35.34	1.048	47.6	26.5	74.1	15.02	8.27	2.73	11.00	12.40	.....
Plus 1 week at 70°	Firm ripe to ripe	Almost mealy, flavor good.	12.8	35.5	3.71	.361	12.49	34.55	1.046	37.0	28.3	65.3	14.74	8.17	2.53	10.70	12.05	.....
5 months' storage	do	do	12.8	43.0	3.71	.333	12.70	38.09	1.048	42.3	31.8	74.1	14.79	8.43	2.43	10.86	12.25	.....
6 months' storage	do	Almost mealy, flavor fair.	12.8	39.0	3.68	.386	12.84	33.56	1.049	35.3	35.3	70.6	14.64	8.34	1.82	10.16	12.20	.....
7 months' storage	do	Mealy, flavor fair to poor	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.13	8.58	1.60	10.18	12.20	.....
Oct. 16, 1942																		
At harvest	Firm	Sour, undeveloped	16.1	51.1	3.34	.503	13.94	23.50	1.051	26.5	37.0	63.5	17.10	6.10	4.16	10.26	.....	.....
Plus 1 week at 70°	do	do	16.5	52.2	3.42	.583	14.57	25.00	1.056	35.3	52.9	88.2	16.93	6.50	4.60	11.10	.....	.....
1 month storage	do	Almost eating ripe, good flavor.	16.2	52.7	3.52	.537	14.24	26.52	1.054	26.5	51.2	77.6	16.65	6.22	4.54	10.76	13.60	.....
Plus 1 week at 70°	do	do	14.5	42.5	3.43	.502	14.44	28.77	1.055	35.3	42.3	86.4	16.63	6.47	4.65	11.12	14.60	.....
2 months' storage	Firm to firm ripe	Spicy, nearly eating ripe.	15.4	47.8	3.44	.523	14.99	28.66	1.057	30.0	51.2	81.1	17.00	6.43	4.89	11.32	14.70	.....
Plus 1 week at 70°	Firm ripe	Prime for eating	14.2	37.8	3.62	.483	14.36	29.76	1.056	33.5	45.9	79.4	16.87	6.28	4.68	10.96	14.40	.....
3 months' storage	Firm to firm ripe	do	15.3	53.4	3.54	.519	14.20	27.33	1.054	40.6	47.6	88.2	17.02	6.54	4.36	10.90	13.90	.....
Plus 1 week at 70°	Firm ripe	do	13.5	42.7	3.80	.376	14.13	37.61	1.054	30.0	44.1	74.1	16.79	6.89	4.09	10.98	14.10	.....
4 months' storage	do	do	14.5	47.2	3.53	.505	14.46	28.61	1.055	40.6	61.7	102.3	17.25	6.82	4.44	11.26	14.70	.....
5 months' storage	do	do	14.4	54.1	3.53	.488	14.68	30.09	1.055	28.2	60.0	88.2	17.00	7.07	4.01	11.08	14.20	.....
6 months' storage	Firm ripe to ripe	do	12.8	36.7	3.65	.393	14.27	36.30	1.052	38.8	44.1	82.9	17.22	7.11	3.75	10.86	14.10	.....
7 months' storage	Firm ripe	do	13.8	42.8	3.69	.386	14.13	36.59	1.055	32.2	35.6	67.8	16.92	7.00	3.58	10.58	13.90	.....

Oct. 26, 1943

At harvest	Hard	Starchy, tough	10.4	56.0	3.36	.769	16.40	21.37	1.064	45.0	55.0	100.0	19.36	7.70	3.46	11.16	15.05	
Plus 1 week at 70°	do	do	19.1	50.0	3.47	.698	17.10	24.42	1.066	35.0	57.0	92.0	19.22	7.82	4.06	11.88	15.70	
1 month storage	Hard to firm	Starchy, otherwise fair	18.4	55.0	3.40	.709	15.70	22.10	1.065	39.0	57.0	96.0	19.13	7.60	4.52	12.12	15.75	
Plus 1 week at 70°	Firm	Almost prime for eating	16.7	41.0	3.42	.625	17.30	27.75	1.066	31.0	74.0	105.0	20.01	8.52	3.92	12.44	15.65	
2 months' storage	do	Flavor undeveloped	17.8	47.0	3.31	.727	17.20	23.67	1.068	38.0	62.0	100.0	19.04	8.10	4.22	12.32	16.45	
Plus 1 week at 70°	Firm to firm ripe	Prime for eating	15.9	32.0	3.58	.558	17.20	30.82	1.066	38.0	55.0	93.0	18.99	8.24	4.44	12.68	16.15	
3 months' storage	Firm	Flavor undeveloped	17.5	43.0	3.52	.593	17.10	28.76	1.064	34.0	67.0	101.0	18.88	7.82	4.54	12.36	16.25	
Plus 1 week at 70°	Firm to firm ripe	Full eating ripe, good flavor.	15.9	34.0	3.52	.548	16.80	30.75	1.064	34.0	57.0	91.0	19.35	8.08	4.48	12.56	16.45	
4 months' storage	Firm	Prime for eating	17.4	49.0	3.38	.625	16.80	26.84	1.065	33.0	63.0	96.0	19.23	8.12	4.40	12.52	16.45	
Plus 1 week at 70°	Firm to firm ripe	Full eating ripe, mellow	15.8	33.0	3.56	.498	16.40	32.84	1.062	22.0	67.0	89.0	19.30	8.04	4.24	12.58	16.15	
5 months' storage	Firm	Eating ripe to prime for eating.	17.6	48.0	3.25	.583	16.40	28.09	1.065	31.0	60.0	91.0	19.16	8.44	3.84	12.28	15.70	
Plus 1 week at 70°	Firm to firm ripe	Full eating ripe, mellow	15.4	38.0	3.52	.439	16.40	37.31	1.063	36.0	53.0	89.0	18.87	8.84	3.52	12.36	15.45	
6 months' storage	Firm	Still prime for eating, good flavor.	16.8	48.0	3.43	.562	16.90	30.15	1.066	------	------	------	18.97	8.66	3.70	12.36	15.55	
Plus 1 week at 70°	Firm ripe	Mellow, but good flavor	14.4	36.0	3.58	.463	16.10	34.88	1.062	------	------	------	18.66	8.52	3.32	11.84	15.65	
7 months' storage	Firm	Same as for 6 months	16.2	37.0	3.63	.488	16.30	33.34	1.063	------	------	------	18.96	8.58	3.66	12.24	15.25	
8 months' storage	do	Flavor somewhat lacking	16.9	47.0	3.70	.440	15.90	36.03	1.062	------	------	------	18.77	8.34	3.30	11.64	15.55	
9 months' storage	Firm ripe	Flavor lacking, somewhat stale.	14.2	41.0	3.80	.418	15.30	36.70	1.058	------	------	------	19.23	7.58	3.38	10.96	14.65	

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates resistance of the tissue to applied pressure.

TABLE 21.—*Condition and composition of immature Yellow Newtown apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition when inspected		Firmness[2]	Juice analysis									Tissue analysis					
	Maturity	Quality		Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Sept. 8, 1941			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Hard	Tasteless, inedible	20.7	40.5	3.30	0.667	10.67	16.00	1.038	51.2	91.7	142.9	15.31	6.55	1.91	8.46	10.05	-------
Plus 1 week at 70°	do	do	21.3	37.5	3.31	.646	12.01	18.59	1.046	70.6	40.6	111.2	14.88	7.23	2.25	9.48	11.05	-------
1 month storage	do	do	21.5	38.9	3.39	.618	12.00	19.42	1.044	49.4	47.6	97.0	15.00	7.02	2.12	9.14	10.55	-------
Plus 1 week at 70°	do	do	19.5	45.7	3.44	.611	13.04	21.35	1.048	38.8	58.2	97.0	14.96	7.65	2.89	10.54	11.95	-------
2 months' storage	do	do	19.3	47.5	3.49	.576	13.27	23.05	1.048	54.7	58.2	112.9	14.97	7.39	2.65	10.04	11.80	-------
Plus 1 week at 70°	do	do	19.4	43.3	3.42	.579	12.70	21.93	1.046	44.1	52.9	97.0	14.85	7.48	3.02	10.50	11.90	-------
3 months' storage	do	do	19.3	46.3	3.41	.579	13.67	23.61	1.051	54.7	52.9	107.6	14.84	7.49	3.01	10.50	12.00	-------
Plus 1 week at 70°	Firm	do	17.8	41.7	3.53	.558	12.93	23.17	1.048	51.2	52.9	104.1	15.04	7.60	2.22	9.32	12.55	-------
4 months' storage	Hard to firm	Still inedible	18.5	39.5	3.52	.533	12.86	24.10	1.050	47.6	44.1	91.7	14.70	7.47	2.03	9.50	12.00	-------
Plus 1 week at 70°	Firm	do	17.7	38.9	3.52	.519	12.93	24.64	1.048	44.1	38.8	82.9	14.85	7.63	2.13	9.76	11.95	-------
5 months' storage	do	do	16.1	38.3	3.53	.453	12.94	28.58	1.048	47.6	38.8	86.4	14.87	7.64	1.92	9.56	11.80	-------
Plus 1 week at 70°	Firm ripe to ripe	Flavor lacking, but edible.	16.0	41.0	3.58	.418	12.23	29.28	1.048	47.6	35.3	82.9	15.09	7.83	1.59	9.42	11.70	-------
6 months' storage	Firm	Flavor lacking, eating ripe.	16.5	47.5	3.54	.439	12.67	28.88	1.048	33.5	44.1	77.6	15.10	7.52	1.76	9.28	11.85	-------
7 months' storage	Firm ripe	Yellowish, fair flavor, some green and poor.	14.7	35.6	3.62	.386	12.33	31.93	1.044	38.8	44.1	82.9	14.77	8.13	1.51	9.64	11.75	-------
Sept. 16, 1942																		
At harvest	Hard	Sour, starchy, inedible	20.7	52.3	3.38	.474	10.35	20.26	------	61.8	42.3	104.1	13.96	5.35	2.09	7.44	9.65	-------
Plus 1 week at 70°	do	do	19.0	49.5	3.46	.481	11.50	23.91	1.042	45.9	47.6	93.5	14.11	5.50	2.84	8.34	10.90	-------
1 month storage	do	do	21.1	48.4	3.40	.470	11.01	23.41	1.038	37.1	37.0	74.1	14.22	5.42	2.66	8.08	10.75	-------
Plus 1 week at 70°	Hard to firm	do	18.4	47.8	3.58	.481	11.97	24.89	1.044	40.6	49.4	90.0	14.09	6.16	2.82	8.98	11.45	-------
2 months' storage	do	do	18.0	40.5	3.64	.463	12.01	25.92	1.043	31.8	47.6	79.4	14.49	6.16	2.78	8.94	11.50	-------
Plus 1 week at 70°	Firm	do	16.1	44.0	3.46	.463	12.35	26.66	1.046	28.2	52.9	81.1	14.13	6.19	2.97	9.16	11.70	-------
3 months' storage	do	Flavor still undeveloped.	16.4	43.0	3.52	.463	12.18	26.29	1.044	45.8	51.2	97.0	14.01	6.50	2.74	9.24	11.55	-------
Plus 1 week at 70°	Firm to firm ripe	Flavor fair	15.0	41.8	3.61	.400	12.93	32.32	1.050	40.6	52.9	93.5	14.16	6.69	2.87	9.56	11.50	-------
4 months' storage	Firm ripe	Almost eating ripe, flavor fair.	14.2	45.5	3.50	.456	12.53	27.46	1.046	44.1	47.6	91.7	14.73	6.72	2.66	9.38	11.55	-------

Plus 1 week at 70°	do	do	13.8	44.4	3.61	.351	11.67	33.25	1.044	35.3	44.1	79.4	14.12	6.66	2.68	9.34	11.50	
5 months' storage	do	Eating ripe, flavor fair	14.6	46.2	3.88	.354	12.39	34.95	1.046	33.5	54.7	88.2	14.52	6.84	2.58	9.42	11.40	
Plus 1 week at 70°	do	Eating ripe, flavor poor to fair.	13.9	38.0	3.68	.316	12.07	38.21	1.044	35.3	52.9	88.2	14.18	7.08	2.20	9.28	11.20	
6 months' storage	do	do	13.9	38.9	3.64	.340	11.87	34.86	1.044	58.3	58.2	102.3	14.44	6.18	2.42	8.60	11.40	
Plus 1 week at 70°	do	do	13.6	38.4	3.68	.312	12.19	39.02	1.046	40.6	54.7	95.3	14.14	6.86	2.52	9.38		
7 months' storage	do	Flavor fair	14.0	44.0	3.60	.319	11.97	37.48	1.044	33.5	49.4	82.9	14.25	6.77	2.35	9.12	12.20	
8 months' storage	do	do	13.8	41.0	3.63	.309	12.00	38.85	1.044	42.4	47.5	89.9	14.50	6.78	2.22	9.00	11.50	
9 months' storage	Overripe	Flavor lacking	12.8	36.0	3.74	.284	12.11	42.50	1.043	27.1	61.1	88.2	14.55	6.93	1.99	8.92	12.20	

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates resistance of the tissue to applied pressure.

TABLE 22.—*Condition and composition of York Imperial apples at harvest, after specified periods of storage at 31° F., and after a subsequent 1-week period of ripening at 70°*

Date stored and period of storage and ripening	Condition [1] when inspected		Firmness [2]	Juice analysis									Tissue analysis					
	Maturity	Quality		Volume per 100 gm. of tissue	Acidity		Soluble solids: Brix reading	Solids—acid ratio	Specific gravity	Astringents per 100 ml.			Total solids	Sugars (as dextrose)			Alcohol-soluble solids	Starch
					pH	As malic acid				Tannin	Non-tannin	Total		Reducing	Sucrose	Total		
Oct. 14, 1939			*Pounds*	*Ml.*	*Reading*	*Percent*	*Degrees*	*Ratio*	*Sp. gr.*	*Mg.*	*Mg.*	*Mg.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
At harvest	Hard to firm	Starchy, unripe	18.8										16.60	7.02	1.38	8.40	12.15	1.21
Plus 1 week at 70°	Firm ripe to ripe	Full flavor	14.5										17.77	8.02	2.78	10.40	14.55	.30
2 months' storage	Firm	Flavor undeveloped, green background.	17.8										17.00	7.92	2.40	10.32	13.74	.35
Plus 1 week at 70°	Firm ripe to ripe	Full flavor	14.8										16.70	8.04	2.44	10.48	14.20	.27
3 months' storage	Firm to firm ripe	Flavor undeveloped	16.8										17.15	7.80	2.46	10.32	14.44	.29
Plus 1 week at 70°	Firm ripe to ripe	Full flavor	14.6										17.72	8.20	2.24	10.44	14.85	.13
4.5 months' storage	Firm	Almost eating ripe, yellow-green background.	17.6										19.10	8.14	2.98	11.12	16.09	.31
Plus 1 week at 70°	Firm to ripe	Mostly ripe, full flavor	14.0										18.24	8.28	2.68	10.96	15.26	.23
6 months' storage	Firm ripe	Flavor somewhat lacking.	15.9										17.88	8.44	2.00	10.44	14.91	.20
Plus 1 week at 70°	Ripe	Soft, poor flavor	13.1										17.38	8.46	2.06	10.52	14.68	.17
Oct. 11, 1940																		
At harvest	Hard	Flavor undeveloped, starchy.	21.0	36.7	3.38	0.709	12.99	18.30	1.050	26.5	77.6	104.1	18.00	7.56	1.88	9.44	12.15	2.70
Plus 1 week at 70°	do	do	21.0	36.7	3.40	.612	14.01	22.87	1.053	21.2	72.3	93.5	18.72	8.06	2.78	10.84	13.30	2.15
1 month storage	do	do	21.0	41.2	3.53	.576	13.72	23.83	1.052	31.8	74.1	105.8	18.46	8.06	2.82	10.88	13.35	1.83
Plus 1 week at 70°	Hard to firm	Flavor undeveloped, not starchy.	18.3	32.8	3.52	.502	15.23	27.12	1.060	52.9	70.6	123.5	18.75	8.24	3.60	11.84	14.45	1.15
2 months' storage	Firm	do	20.8	46.7	3.52	.583	14.93	25.62	1.056	31.8	52.9	84.7	18.75	8.00	3.60	11.60	14.25	1.06
Plus 1 week at 70°	Hard to firm	Crisp, juicy, nearly full flavor.	18.7	32.2	3.61	.467	15.57	33.35	1.061	42.3	61.8	104.1	18.21	8.60	3.76	12.36	14.75	.37
3 months' storage	Hard	Practically eating ripe	19.8	40.0	3.52	.540	15.58	28.82	1.061	31.8	65.3	97.0	18.85	7.72	4.40	12.12	14.95	.59
Plus 1 week at 70°	Hard to firm	Eating ripe	18.0	35.6	3.67	.481	15.48	32.19	1.060	21.2	70.5	91.7	18.25	8.16	4.28	12.44	14.95	.21
4 months' storage	do	do	18.8	41.6	3.62	.435	15.37	35.32	1.060	24.7	63.5	88.2	17.82	8.24	3.88	12.12	14.55	.12
Plus 1 week at 70°	Firm	Crisp, fair flavor, some internal browning.	17.6	34.4	3.77	.372	15.47	41.57	1.060	30.0	60.0	90.0	18.73	8.84	3.80	12.64	15.15	.09
5 months' storage	Hard to firm	Flavor fair	18.5	42.0	3.64	.463	15.57	33.61	1.060	28.2	79.4	107.6	18.65	8.78	3.66	12.44	15.10	-------
Plus 1 week at 70°	Firm to firm ripe	Some discoloration, overripe.	16.9	33.9	3.84	.344	15.93	46.31	1.060	7.1	70.5	77.6	18.24	9.02	3.34	12.36	14.80	-------

6 months' storage	Hard to firm	Granular, poor flavor	18.8	43.4	3.63	.432	15.63	36.20	1.060	8.8	74.1	82.9	18.18	8.60	3.76	12.36	15.20	
7 months' storage	Firm	Granular or mealy, poor flavor.	17.5	39.8	3.65	.411	15.79	38.45	1.060	19.4	65.3	84.7	18.17	8.92	3.36	12.28	14.80	
Oct. 4, 1941																		
At harvest	Hard to firm	Flavor undeveloped, starchy.	18.3	42.3	3.46	.439	12.30	27.94	1.044	31.7	44.1	75.8	16.50	7.19	2.13	9.32	11.65	
Plus 1 week at 70°	Firm to firm ripe	Flavor undeveloped	16.5	42.7	3.51	.428	13.40	31.29	1.051	30.0	35.5	65.3	16.64	7.99	2.75	10.74	13.25	
1 month storage	Firm, immature	do	17.3	53.9	3.50	.442	13.60	30.75	1.051	24.7	44.1	68.8	16.52	7.72	2.78	10.50	12.95	
Plus 1 week at 70°	Firm ripe to ripe	Flavor fully developed	14.2	38.4	3.67	.404	14.30	35.50	1.054	37.0	60.0	97.0	16.22	7.88	3.02	10.90	13.35	
2 months' storage	Firm to firm ripe	Unripe	16.8	44.4	3.65	.430	14.10	32.86	1.054	37.0	23.0	60.0	16.56	8.20	2.86	11.06	13.85	
Plus 1 week at 70°	Firm ripe	Full flavor	15.4	41.7	3.71	.351	14.20	40.37	1.054	26.5	58.2	84.7	16.37	8.13	2.75	10.88	13.40	
3 months' storage	do	Almost eating ripe	15.1	50.6	3.62	.449	14.30	31.89	1.055	30.0	40.6	70.6	16.25	8.42	2.60	11.02	13.55	
Plus 1 week at 70°	Firm ripe to ripe	Full flavor	14.7	36.1	3.67	.372	14.30	38.51	1.054	40.6	40.5	81.1	16.69	8.80	2.44	11.24	13.85	
4 months' storage	Firm ripe	do	15.3	47.7	3.71	.347	14.30	41.06	1.054	28.2	33.5	61.7	16.29	8.48	2.66	11.14	13.90	
Plus 1 week at 70°	Firm ripe to ripe	do	14.7	42.2	3.74	.365	13.90	38.00	1.052	28.2	37.1	65.3	16.25	8.56	2.40	10.96	13.60	
5 months' storage	Firm to firm ripe	Mostly ripe, full flavor	16.0	48.6	3.63	.368	13.90	37.72	1.052	31.8	44.1	75.9	16.79	8.48	2.54	11.02	13.35	
6 months' storage	Firm ripe	Flavor fair	15.2	45.0	3.71	.365	14.06	38.52	1.052	33.5	45.9	79.4	16.38	------	------	------	13.80	
7 months' storage	do	Flavor fair to poor	15.2	45.2	3.76	.274	13.94	50.91	1.050	38.8	38.8	77.6	16.27	------	------	------	13.65	

[1] Terms used in rating samples are defined on p. 6.
[2] Indicates resistance of the tissue to applied pressure.

TABLE 23.—*Delicious apples: Ripening at 70° F. as scored after harvest and after storage for specific periods at 31° F. for increasing periods of time, 1944–45 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	26	19	3	48	12	0	33	27	18	78
	4	33	27	29	89		3	33	23	16	72
	7	27	21	24	72		8	24	15	12	51
	10	25	20	23	68		11	21	20	17	58
	14	13	13	20	46		0	33	26	18	77
4	0	31	21	12	64	14	5	33	19	16	68
	4	31	26	16	73		8	32	22	15	69
	7	30	24	21	75		11	27	22	21	70
	11	21	23	17	61		14	20	15	14	49
	13	24	20	20	64		0	30	19	12	61
8	0	30	24	16	70	16	5	33	22	16	71
	4	32	26	16	74		9	32	23	16	70
	7	34	27	15	76		0	32	21	12	65
	10	20	14	22	56	18	3	32	15	14	61
10	0	33	23	15	71		7	31	19	15	65
	4	32	26	14	72						
	7	31	27	23	81						
	10	23	17	19	59						
	13	16	15	12	43						

[1] Direct from orchard.

TABLE 24.—*Delicious apples: Ripening at 70° F. as scored after harvest, and after storage for specified periods at 31° F. for increasing periods of time, 1945–46 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	28	5	15	48	14	0	29	25	18	72
	3	27	17	19	63		4	29	26	15	70
	6	25	26	32	83		7	25	26	31	82
	9	25	26	30	81		10	25	25	32	82
	13	14	26	21	61		13	21	25	19	65
4	0	24	21	21	66	16	0	27	25	19	71
	3	29	28	26	83		4	29	26	19	74
	7	23	26	30	79		7	25	27	21	73
	10	19	27	30	76		12	26	25	19	70
	12	15	26	22	63		0	29	27	16	72
6	0	27	22	25	74	18	5	29	26	23	78
	3	29	27	34	90		7	24	26	21	71
	7	30	26	31	87		11	23	26	25	74
	11	19	26	28	73		14	19	26	18	63
	14	17	26	29	72		0	28	27	23	78
8	0	26	19	21	66	20	4	25	27	26	78
	4	29	25	29	83		7	24	26	18	68
	7	29	27	31	87		10	21	27	21	70
	10	24	26	34	84	22	0	28	26	18	72
	14	20	26	24	70		4	26	26	17	69
10	0	28	26	30	84	24	0	26	26	25	77
	4	28	23	27	78		3	23	26	23	72
	10	26	24	25	75		6	21	26	18	65
	14	19	26	28	73	26	0	27	26	19	72
	17	17	25	23	65		3	24	25	15	64
12	0	27	25	29	81	28	0	23	26	25	74
	4	29	27	23	79		4	20	25	24	69
	7	27	26	31	84	30	0	26	26	23	75
	12	21	26	24	71		3	25	26	15	66
	15	19	25	22	66	32	0	27	26	23	76
						34	0	24	26	14	64

[1] Direct from orchard.

TABLE 25.—*Delicious apples: Ripening at 70° F. as scored after harvest, and after storage for specified periods at 31° F. for increasing periods of time, 1946–47 season*

Treatment						Treatment					
Weeks in storage	Days in ripening room	Texture	Taste	Flavor	Total of texture, taste, flavor	Weeks in storage	Days in ripening room	Texture	Taste	Flavor	Total of texture, taste, flavor
0 [1]	0	19	10	15	44	18	0	27	26	24	77
	4	22	13	20	55		4	27	26	24	77
	7	27	21	30	78		8	27	26	17	70
	10	28	25	34	87		11	27	26	20	73
	14	26	27	36	89	22	0	28	24	27	79
	17	20	26	22	68		3	27	26	25	78
	0	27	24	27	78		7	24	25	23	72
	8	26	26	31	83		10	24	24	20	68
10	11	22	26	26	74		14	22	24	20	66
	15	18	25	20	63		0	27	23	24	74
	18	15	25	19	62	26	3	26	25	20	71
	0	28	25	25	78		6	27	25	21	73
	4	27	22	20	74		10	24	23	13	60
12	7	25	26	25	76		0	27	25	16	68
	10	25	25	30	80	30	4	26	25	19	70
	13	24	26	30	80		8	27	25	19	71
	17	20	26	17	63		11	25	25	10	60
	0	28	25	22	75						
16	3	28	25	26	79						
	10	26	25	17	68						

[1] Direct from orchard.

TABLE 26.—*Golden Delicious apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time. 1944–45 season*

Treatment						Treatment					
Weeks in storage	Days in ripening room	Texture	Taste	Flavor and aroma	Total of texture, taste, flavor	Weeks in storage	Days in ripening room	Texture	Taste	Flavor and aroma	Total of texture, taste, flavor
0 [1]	0	19	17	0	36	8	0	34	34	16	84
	4	26	24	9	59		4	31	30	20	81
	9	31	33	20	84		7	29	30	18	77
	12	25	26	23	73		10	29	27	19	75
	16	27	24	21	72		13	27	22	18	67
	19	26	26	21	73	10	0	35	25	15	78
	23	25	23	17	65		4	32	23	11	66
2	0	28	21	16	65		7	31	25	14	73
	4	30	27	16	73		10	29	17	13	59
	7	33	31	20	84	12	0	31	29	18	78
	10	30	20	24	83		3	30	25	20	75
	13	27	24	20	71		5	31	25	20	76
	16	28	28	16	72		8	28	23	17	68
	19	26	24	14	64	14	0	29	32	18	79
4	0	29	19	10	58		4	26	20	16	62
	4	34	32	11	77		7	29	23	16	68
	7	31	30	23	84	16	0	29	24	15	68
	10	31	24	14	69		3	28	23	17	68
	13	27	24	16	67		7	27	24	16	67
6	0	34	25	13	72	18	0	30	24	14	68
	4	34	31	14	79		5	27	21	13	61
	7	29	26	16	71	20	0	29	21	14	64
	10	28	22	18	68		4	26	21	14	61
	13	28	25	20	73						

[1] Direct from orchard.

TABLE 27.—*Golden Delicious apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1945–46 season.*

Treatment		Texture	Taste	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	25	5	15	45	12	0	24	26	23	73
	3	26	6	16	48		4	24	24	29	77
	6	30	16	19	65		7	23	24	32	79
	9	28	21	21	70		12	22	27	17	66
	13	27	20	21	68		0	25	23	18	66
	16	28	29	33	90	14	4	25	25	23	73
	0	26	10	15	51		7	24	26	19	69
	3	28	15	16	59		0	24	26	20	70
4	7	27	24	26	77	16	4	22	26	18	66
	10	24	27	19	70		7	22	27	20	69
	12	20	24	24	68		0	23	27	17	67
	0	27	17	16	60	18	3	21	27	23	71
	3	27	24	22	73		7	21	27	15	63
6	7	26	28	29	83		0	23	27	14	64
	11	24	29	33	86	20	4	20	25	21	66
	14	24	27	30	81		7	22	27	18	67
	0	27	21	20	68	22	0	21	27	17	65
	4	24	28	24	76		4	21	27	17	65
8	10	25	27	24	76		0	20	26	11	57
	14	24	26	24	76	24	3	21	27	26	74
	17	22	28	24	74		6	20	26	19	65
	0	27	22	19	68						
	4	24	27	23	74						
10	10	22	26	19	67						
	14	22	26	23	71						
	17	22	22	15	59						

[1] Direct from orchard.

TABLE 28.—*Grimes Golden apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1944–45 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	17	15	0	32	6	0	26	18	7	51
	4	24	17	1	42		4	31	29	18	78
	7	33	34	14	81		7	29	28	16	73
	10	29	25	21	75		10	20	17	14	51
	14	25	20	22	67	8	0	27	21	5	53
	0	18	16	0	36		5	27	28	14	69
	4	29	23	12	64		8	32	20	9	61
2	7	29	22	16	67						
	10	25	24	17	66						
	14	25	22	16	63						
	0	22	18	7	47						
	2	30	24	12	66						
4	5	28	20	12	60						
	9	25	20	15	60						
	12	26	20	16	62						

[1] Direct from orchard.

TABLE 29.—*Grimes Golden apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1946–47 season*

Treatment		Texture	Taste	Flavor	Total of texture, taste, flavor	Treatment		Texture	Taste	Flavor	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	18	10	17	45	8	0	20	27	27	74
	4	19	15	15	49		5	23	28	22	73
	7	27	28	33	88	10	0	20	29	30	79
	10	20	28	33	81		3	22	28	25	75
	14	20	28	31	79	12	0	22	29	22	73
4	0	24	15	21	60		4	19	26	20	65
	3	28	27	32	87	14	0	20	28	24	72
	7	21	26	32	79		3	19	27	21	67
	9	19	25	29	73	16	0	19	26	24	69
6	0	27	29	34	90						
	4	22	28	31	81						
	7	22	27	28	77						
	11	19	27	23	69						

[1] Direct from orchard.

TABLE 30.—*Grimes Golden apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1949–50 season*

Treatment		Texture	Taste	Flavor	Total of texture, taste, flavor	Treatment		Texture	Taste	Flavor	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	24	25	31	80	8	0	24	20	34	78
	4	29	27	30	86		3	25	27	31	83
	7	19	23	30	72		6	26	24	32	82
	10	21	26	32	79		13	Remaining apples badly decayed			
	18	17	18	20	55						
4	0	24	17	27	68	10	0	25	27	29	81
	3	25	22	34	81		3	26	25	31	82
	7	26	22	31	79		5	24	28	37	89
	10	Remaining apples badly decayed					8	22	26	27	75
6	0	26	20	29	75	12	0	26	28	35	89
	3	24	28	36	88		3	22	25	26	73
	6	23	26	32	81		5	26	27	22	69
	9	17	24	29	70		8	14	18	13	45
						14	0	26	26	22	74
							3	17	19	19	55

[1] Direct from orchard.

TABLE 31.—*Jonathan apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1944–45 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0[1]	0	26	24	3	53	12	0	31	32	16	79
	4	31	29	15	75		6	27	26	18	73
	7	33	32	20	85		9	25	27	14	66
	10	30	34	24	88		12	25	22	16	63
	14	25	30	22	77	14	0	29	30	15	74
4	0	29	21	10	60		4	26	27	18	71
	4	24	35	22	81		7	26	24	16	66
	7	23	26	21	70		10	26	26	16	68
	11	22	26	16	64		0	26	27	14	67
	14	25	25	16	66	16	3	28	31	19	78
6	0	33	29	13	75		6	29	30	16	75
	4	28	28	22	78		9	28	26	12	64
	7	28	29	19	76		0	27	30	14	71
	11	26	27	16	69	18	4	28	26	14	68
	14	26	29	17	72		7	27	24	14	65
8	0	33	30	14	77		9	27	30	15	72
	4	31	35	17	83	20	4	28	27	16	71
	7	29	34	19	82		7	26	27	13	66
	10	27	28	19	74		0	27	28	14	69
	14	27	27	17	71	22	4	26	26	15	67
10	0	34	32	19	85		7	25	23	12	60
	3	31	29	20	80	24	0	29	29	16	74
	6	29	29	18	76		4	26	24	10	60
	9	28	32	18	78						
	12	27	24	14	65						

[1] Direct from orchard.

TABLE 32.—*Jonathan apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1946–47 season*

Treatment		Texture	Taste	Flavor	Total of texture, taste, flavor	Treatment		Texture	Taste	Flavor	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0[1]	0	21	12	18	51	20	0	24	28	26	78
	5	24	28	28	69		7	23	28	26	77
	7	30	33	35	98		11	21	25	17	63
	9	30	28	37	95		14	20	26	22	68
	12	26	29	36	91	24	0	23	26	25	76
	15	24	30	32	86		4	22	29	24	75
	19	24	27	32	84		8	21	25	19	65
6	0	27	29	35	91	26	0	21	27	24	72
	5	25	27	32	84		3	24	29	23	76
	9	27	26	35	90		7	24	29	18	71
10	12	24	25	31	80		11	22	28	23	73
	16	21	29	29	79	28	0	23	28	26	77
	19	21	29	27	77		4	24	25	22	73
	23	21	28	21	70		7	21	27	18	66
	26	20	27	17	64		0	23	28	20	71
12	0	26	28	30	84	30	3	23	29	22	74
	3	21	25	24	71		7	23	26	20	71
	6	22	28	29	79		11	22	25	13	62
16	13	21	29	27	76	32	0	22	29	11	62
	16	24	28	29	81						
	20	23	30	27	80						
	24	19	27	19	65						

[1] Direct from orchard.

TABLE 33.—*Stayman apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1944–45 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	21	18	10	49	12	0	33	30	12	75
	4	33	30	12	75		3	29	28	16	73
	7	35	33	18	86		6	21	22	16	59
	11	25	31	22	78		9	24	25	17	66
	14	25	26	19	70		12	16	21	15	52
4	0	30	20	9	59	14	0	31	27	16	74
	4	34	31	16	81		3	27	26	14	67
	7	26	29	21	76		6	25	29	16	70
	10	24	24	19	67		9	24	24	14	62
	14	18	21	20	59		0	31	26	12	69
6	0	31	25	9	65	16	4	25	27	14	66
	3	34	30	16	80		7	25	26	14	65
	6	29	30	22	81		11	19	23	12	54
	9	25	23	17	65	18	0	31	31	14	76
	12	24	23	15	70		3	26	27	17	70
	15	23	22	16	62		6	22	27	15	64
10	0	32	30	16	78	20	0	27	28	16	71
	4	28	22	16	66		3	28	30	17	76
	7	20	21	13	54		9	26	25	16	67
	10	30	30	16	86		12	23	24	13	60
	14	21	23	15	59	22	0	30	28	12	70
							4	23	24	12	59
						24	0	28	21	15	64

[1] Direct from orchard.

TABLE 34.—*Stayman apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1945–46 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0	0	24	10	15	49	16	0	29	26	25	79
	4	28	17	22	67		4	27	24	31	82
4	8	32	27	35	94		8	26	22	35	83
	11	21	28	35	84		11	22	20	25	67
	14	21	26	40	87						
	18	21	21	28	70		0	27	23	29	79
	0	26	11	16	53		3	25	26	36	87
	3	29	24	25	78	18	6	32	29	37	98
6	6	27	29	36	92		9	29	26	38	93
	10	24	23	40	87		13	21	24	34	79
	13	24	27	46	97						
	20	16	27	31	74		0	25	22	24	71
	0	28	19	28	75	20	4	27	28	30	93
	4	28	26	31	85		7	24	22	33	79
8	8	27	21	23	71		10	21	27	23	71
	11	21	15	31	67						
	15	26	24	36	86		0	23	21	32	76
	20	16	24	32	72		4	19	26	26	71
	0	26	17	31	74	22	8	28	27	26	81
	3	29	17	25	71		11	22	29	20	71
	8	25	25	34	84		15	19	28	25	72
10	11	21	18	36	75						
	15	21	27	34	82	24	0	23	25	27	75
	18	28	28	30	86		3	22	28	27	77
	0	29	17	28	74		6	([2])	([2])	([2])	([2])
	3	28	29	29	86						
12	6	27	25	40	92	26	0	23	24	35	82
	9	29	27	34	90		4	21	27	31	79
	12	29	29	36	94		8	21	25	31	77
	0	29	27	33	89	28	0	23	23	24	75
	4	27	23	42	92		4	21	25	28	74
14	9	21	23	34	78	30	0	26	29	27	79
	11	24	24	29	77		3	23	29	32	84
	14	17	26	23	66	32	0	23	25	21	69

[2] Not usable.

TABLE 35.—*Stayman apples: Ripening at 70° F. as scored after harvest, and after storage for specified periods at 31° F. for increasing periods of time, 1946–47 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	25	18	25	68	18	0	25	24	24	73
	3	27	26	27	80		3	24	28	26	78
	7	26	30	35	91		7	26	27	23	76
	10	22	30	32	84		10	21	29	25	75
	14	20	28	30	78		14	20	28	25	73
	17	16	26	27	69	20	0	23	27	23	73
	21	17	26	26	69		4	22	29	24	75
	25	16	25	17	58		8	22	29	24	75
8	0	29	24	25	78	22	0	23	26	22	71
	3	25	28	28	81		3	25	29	25	79
	6	24	29	32	85		7	20	27	20	67
	10	20	27	28	75	24	0	26	26	25	77
	13	20	30	27	77		4	22	28	22	72
	16	20	28	29	77		7	20	29	17	66
	19	17	27	24	68		0	22	27	20	69
12	0	27	27	33	87	26	4	22	28	22	72
	3	25	29	34	88		11	21	28	19	68
	7	18	28	25	71	28	0	23	30	15	68
	10	21	29	24	74		3	23	29	16	68
	13	21	27	23	71		7	20	26	13	59
	17	20	27	27	74						
	20	22	27	20	69						
16	0	24	29	26	79						
	3	21	28	25	74						
	10	25	28	27	80						

[1] Direct from orchard.

TABLE 36.—*Winesap apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1944–45 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	29	21	6	56	18	0	33	26	12	71
	4	28	21	9	58		3	34	25	13	72
	7	32	28	12	72		6	33	27	13	73
	10	32	28	15	75		9	30	23	14	67
	13	34	29	15	78	20	0	34	21	8	63
	16	34	25	17	76		3	33	26	12	71
	20	17	14	11	42		6	29	19	11	59
8	0	28	24	7	59	22	0	32	23	10	65
	3	32	22	12	66		4	33	29	14	76
	6	32	28	13	73		7	32	26	14	72
	9	32	28	12	72		0	33	24	11	68
	13	24	20	11	55	24	3	33	24	12	69
10	0	32	22	7	61		6	30	23	11	64
	4	35	23	12	70	26	0	32	27	13	72
	8	32	24	12	68		3	32	29	13	74
	11	31	24	11	66	28	0	32	24	13	69
12	0	33	26	14	73		3	34	27	13	74
	3	32	30	12	74		8	28	17	11	56
	6	31	22	12	65	30	0	34	26	11	71
14	0	31	20	8	59		3	32	22	9	63
	3	33	29	14	76						
	6	31	24	11	66						
16	0	33	25	11	69						
	3	33	23	12	68						
	7	31	24	13	68						

[1] Direct from orchard.

TABLE 37.—*York Imperial apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1944–45 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
0 [1]	0	18	15	16	49	16	0	32	32	12	76
	4	24	23	14	61		3	32	32	21	85
	7	29	29	17	75		6	32	31	15	78
	10	34	34	23	91		9	31	31	18	80
	13	34	33	29	96		12	33	30	17	80
	16	34	30	24	88		16	28	25	17	70
	19	29	32	22	83		19	32	27	17	76
	23	28	23	20	71		23	31	24	14	69
8	0	27	25	15	67	18	0	32	30	14	76
	4	34	31	20	85		3	32	32	15	79
	7	33	31	17	81		6	33	33	17	83
	10	34	29	24	87		9	34	30	14	78
	13	31	30	21	82		12	31	28	18	77
	17	26	19	15	60		16	29	22	16	67
12	0	31	29	12	72	20	0	31	32	16	79
	4	31	29	20	80		3	32	32	14	78
	7	32	30	18	80		6	33	29	16	78
	10	31	27	19	77		10	31	28	17	76
	13	32	28	21	81		13	29	28	17	74
	17	31	26	14	71		16	30	23	13	66
14	0	32	31	16	79	22	0	33	26	16	75
	4	32	32	17	81		6	34	29	14	77
	7	33	30	18	81		9	33	25	15	73
	10	32	31	19	82		12	33	24	14	71
	13	31	29	17	77		16	32	23	13	68
	16	30	31	19	80	24	0	33	20	12	65
	19	30	29	21	80		3	34	26	13	73
	23	32	28	17	77		6	34	29	17	80
	27	31	28	16	75		13	32	28	13	73
	30	29	18	12	59		16	29	28	16	73
							0	27	28	13	68
						26	4	32	27	14	73
							(2)	(2)	(2)	(2)	(2)

[1] Direct from orchard.
[2] Supply exhausted.

TABLE 38.—*York Imperial apples: Ripening at 70° F. as scored after harvest and after storage for specified periods at 31° F. for increasing periods of time, 1945–46 season*

Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor	Treatment		Texture	Taste (sweet-sour)	Flavor and aroma	Total of texture, taste, flavor
Weeks in storage	Days in ripening room					Weeks in storage	Days in ripening room				
	0	17	8	15	40		0	27	23	18	68
	3	21	10	16	47		4	28	25	20	73
	7	22	12	18	52	14	9	27	25	18	70
0 [1]	10	24	16	18	58		11	29	30	21	80
	17	27	28	22	77		14	27	30	16	73
	21	23	29	32	84		0	27	25	20	72
	25	21	27	20	68		4	27	26	19	72
	0	21	11	16	48	16	7	25	30	17	75
	6	24	17	21	62		11	27	29	23	79
4	9	27	24	24	75		14	29	29	23	81
	12	25	23	35	85		0	29	27	24	80
	16	27	27	29	83		3	27	30	22	79
	19	27	26	22	75	18	6	25	30	18	76
	0	25	19	17	61		9	29	29	24	82
	4	28	22	21	71		13	27	28	17	72
8	8	28	25	21	74		0	26	23	18	67
	11	26	25	31	82	20	3	27	29	24	80
	15	29	30	13	72		7	28	28	28	84
	20	26	26	14	66		10	29	28	17	74
	0	28	16	15	59		0	27	27	23	77
	5	27	22	26	75		4	27	25	16	68
10	8	28	24	19	71	22	8	27	28	18	73
	12	28	24	26	78		11	27	29	16	72
	15	27	27	21	75		15	25	28	20	73
	18	22	27	24	73		0	29	28	24	81
	0	26	13	15	54	24	3	27	29	22	78
	3	28	25	19	72		6	28	28	20	76
	6	27	25	17	69		0	28	28	22	78
12	9	27	24	20	71	26	4	26	27	26	79
	12	28	29	32	88		8	28	28	26	82
	16	26	29	23	78	28	0	29	29	14	72
							4	29	28	13	70
						30	0	28	29	12	69
							3	27	29	14	70

[1] Direct from orchard.

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