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Preliminary Studies Relating to the Harvesting and Canning of Sweet Cherries

By

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HARVESTING AND CANNING SWEET CHERRIES

That time of picking has material bearing upon the dessert and canning quality of sweet cherries is clearly indicated by these preliminary studies.

Premature picking appears to be a common fault of sweet cherry harvesting in Oregon.

When picked prematurely sweet cherries are undersized, are low in sugars, are high in acid, and lose weight readily both in storage and in transit.

Prematurely picked sweet cherries give when canned a product that is soft in texture, more or less flat in taste, considerably shriveled, and requiring excessive amounts of sugar.

Preliminary Studies Relating to the Harvesting and Canning of Sweet Cherries

By

HENRY HARTMAN

INTRODUCTION

While attention has been paid to certain phases of the sweet cherry industry, very little work has been done which bears upon handling practices. No detailed study has been made of the physical and chemical activities of sweet cherries during the period of ripening and decay, and it is generally admitted that under present methods of harvesting, shipping, and processing, the best quality is seldom obtained. While the sweet cherry is potentially one of the finest of all fruits, it is only occasionally that the consumer has the opportunity of appreciating its real worth.

The present study, which is a phase of the general fruit handling problem of the Oregon Experiment Station, was undertaken in 1924. This circular, therefore, covers the work of a single season and is merely a preliminary statement of results. Additional work must be done before a final report can be made.

EXPERIMENTAL

Time of picking in relation to fresh fruit quality. Casual observations of the handling of the sweet cherry have emphasized the fact that the degree of maturity which the fruit has attained when picked exerts a pronounced influence upon its ultimate dessert or fresh fruit quality. To gain more information on this factor, the following experiment was undertaken: Representative lots of Napoleon (Royal Ann) and Lambert were gathered at intervals of two to four days. Altogether, ten pickings of Napoleon were made, the first on June 17, and the final on July 12. Nine pickings of Lambert were made between June 24 and July 22. Within these ranges of season the fruit of each variety passed from a stage of comparative immaturity to one beyond the optimum picking condition. To reduce the probability of environmental difference, all the lots of each variety were taken from a single tree, and an attempt was made to select only the specimens that were of average maturity for the particular time of picking. A portion of the fruit from each lot was placed in common storage at a temperature of 66° F. and a relative humidity of 50 to 60 percent. Tests and observations were made with the aim of ascertaining, so far as possible, the relation of time of picking to (1) firmness, (2) sugar content, (3) acid content, (4) size, (5) dessert quality, (6) keeping quality, and (7) color.

The data obtained in this test are given in Tables I and II.

TABLE I. EFFECTS OF TIME OF PICKING ON THE FRESH FRUIT QUALITY OF NAPOLEON CHERRIES

Lot No.	Date of picking	Pressure test	Sugar in juice (Balling)	Acid in juice (calculated as malic)	Ave. weight of specimen	Increase in weight	Condition at picking time
		gr	%	%	gr.	%	
1	6-17	295.0	12.1	.64	4.89	.....	Undercolored for the variety. Undersized. Sour and more or less bitter in taste. Tendency to show bruises.
2	6-19	272.1	13.2	.59	4.92	.6	Undercolored for the variety. Undersized. Sour and more or less bitter in taste. Tendency to show bruises.
3	6-21	274.2	14.2	.57	5.12	4.7	Considerably richer in color. More or less undersized. Still more or less sour and bitter, but much better in quality. Tendency to show bruises less evident.
4	6-24	260.8	15.3	.55	5.98	22.3	Fairly good color for the variety. Much larger in size. Fair in quality, but still lacking in sweetness.
5	6-26	251.0	15.5	.54	6.04	23.5	Good color for the variety. Still slightly undersized. Fair in quality but still lacking somewhat in sweetness.
6	6-30	266.4	18.9	.51	6.27	26.9	Good color for the variety. Apparently full-sized. Sweet and of good quality.
7	7-3	249.4	19.6	.50	6.28	26.9	High in color. Apparently full sized. Full quality for the variety.
8	7-6	261.2	20.9	.50	6.36	30.0	High in color. Apparently full-sized. Full quality for the variety. Slight indication of shriveling.
9	7-9	255.0	22.4	.44	6.37	30.2	High in color. Apparently full-sized. Very sweet, but slightly insipid. Some indication of shriveling. Scald present on some specimens. Evidently past prime condition.
10	7-12	243.8	22.3	.35	6.37	30.2	High in color. Apparently full-sized. Very sweet but insipid. Some indication of shriveling. Scald present on some specimens. Evidently past prime condition.

TABLE II. EFFECTS OF TIME OF PICKING ON THE FRESH FRUIT QUALITY OF LAMBERT CHERRIES

Lot No.	Date of picking	Pressure test	Sugar in juice (Balling)	Acid in juice (calculated as malic)	Ave. weight of specimens	Increase in weight	Condition at picking time
	gr.		%	%	gr.	%	
1	6-24	294.8	11.3	.41	5.95	.....	Reddish-purple in color. Undersized for the variety. Sour and more or less bitter in taste.
2	6-27	272.0	11.8	.38	6.01	.9	Slightly darker in color. Undersized for the variety. Sour and more or less bitter in taste.
3	6-30	270.4	13.8	.37	6.23	4.5	Darker in color. Undersized for the variety. Better in quality, but still somewhat bitter and lacking in sweetness.
4	7-3	243.8	15.0	.33	6.31	5.9	Darker in color. Still undersized for the variety. Better in quality, but still somewhat bitter and lacking in sweetness.
5	7-6	249.4	16.2	.33	7.34	23.1	Purple in color. Still lacking in size and quality.
6	7-9	244.8	17.8	.33	7.56	26.8	Purple in color. Fairly large in size. Fairly good in quality.
7	7-14	232.4	18.9	.28	7.75	30.0	Dark purple in color. Apparently full-sized. Sweet and of good quality.
8	7-19	217.6	21.1	.26	8.10	35.9	Dark purple in color. Apparently full-sized. Very sweet, with strong cherry flavor.
9	7-22	213.6	22.2	.24	8.12	36.2	Dark purple in color. Apparently full-sized. Very sweet with strong cherry flavor. Slight indication of shriveling. Evidently past prime condition.

Firmness. The firmness of the fruit at the time of picking was determined by means of a specially constructed pressure tester, consisting chiefly of a round-pointed glass plunger two millimeters in diameter and a Chatilon metric spring scale. With this apparatus (Fig. 1) it was possible to measure the resistance to pressure offered by the epidermal and cortical region of the cherry. The figures given (Tables I and II) represent the average of at least one hundred determinations in each case.

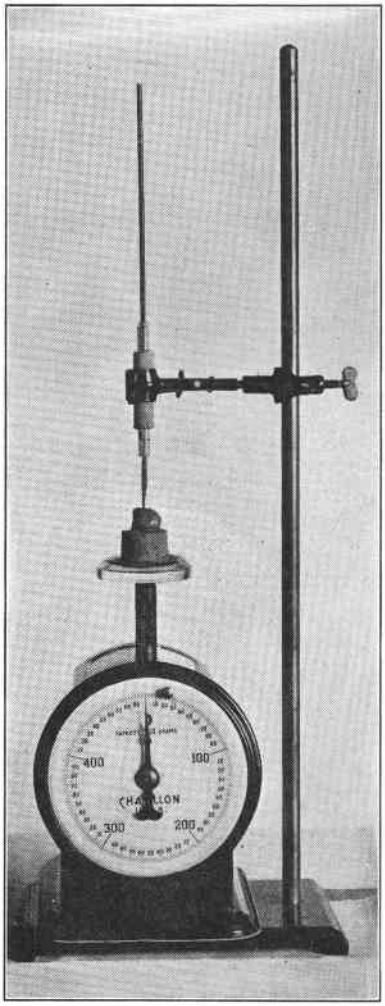

Fig. 1. Special pressure tester devised for determining the firmness of cherries.

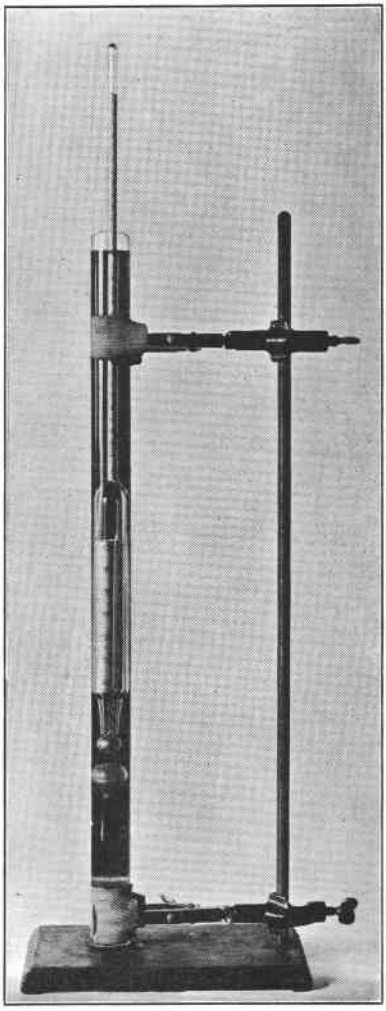

Fig. 2. Balling scale hydrometer and cylinder used in ascertaining the sugars and other soluble solids in the raw juice and sirup.

It is apparent from these figures that there was a gradual decrease of resistance throughout the season. This decrease, however, was less striking than that commonly manifested by other fruits. In Napoleon, for example, the decrease in resistance for the entire period was but 17.3 percent, this in spite of the fact that during this time the fruit passed from a stage of immaturity to one considerably past prime condition. During the period when the variety could really be considered marketable, the decrease in resistance was but 4.1 percent. Allowing the fruit to hang a few days longer, therefore, does not materially affect firmness. Poorly colored specimens such as those growing in the shade, were found to be softer in texture than those that attain full color for the variety.

Sugar content. The sugar content of the juice was determined by means of a Balling scale hydrometer (Fig. 2). The figures given (Tables I and II), therefore, cannot be taken as indicating the exact amounts of sugar present. Rather, they express the percentage of soluble solids. For a comparative study of sugar changes, however, they are fairly adequate. Determinations were made upon fresh juice a few minutes after the fruit was removed from the trees. The juice was extracted by means of a tincture press (Fig. 3). In each case the figures given represent the average of several determinations and are corrected for a temperature of 60° F.

Obviously, there was a consistent and rather pronounced increase in sugars during the period of maturity. The juice of the Napoleon from the time of the first picking to that of the last, showed an increase in soluble solids from 12.1 to 22.4 percent, while that of the Lambert showed an increase from 11.3 to 22.2 percent. Not only was the increase in sugars rapid at the beginning of the period, but it continued even to the time when the fruit was past its prime. The well colored fruit showed a higher sugar content throughout the season than did the fruit that was undercolored.

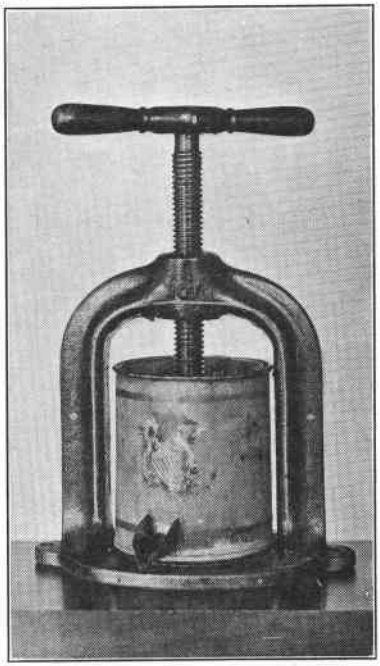

Fig. 3. The tincture press. A satisfactory devise for extracting juice from fresh cherries.

Acid content. A gradual reduction of the acid took place during the ripening period, Napoleon showing a reduction from .64 to .35 percent and Lambert from .41 to .24 percent. The reduction (Tables I and II) seems to have been consistent throughout the season.

The acid content was determined by titrating the fresh juice with N/10 sodium hydroxide, the acid present being calculated as malic. Fifty cubic centimeters of juice was used for each determination, and the figures given are the average of three determinations.

Increase in weight. A matter of particular interest to growers of sweet cherries is that of increase in weight and size of the fruit during the ripening period. What sacrifice in tonnage does the grower make when he picks his cherries prematurely and, conversely, what increase may be expected if the fruit is allowed to hang until fully ripe?

Information on this point was obtained by weighing about 1,000 specimens at the time of each picking and computing the average weight of the specimens.

The data obtained in this manner (Tables I and II) show that there is a rather marked increase in weight from the time cherries begin maturing to the time when they are fully ripened. The Napoleon, during this time, showed an increase of 30.2 percent, while Lambert showed an increase of 36.2 percent. This gives an average daily increase of over 1.2 percent in the case of Napoleon and nearly 1.3 percent in the case of Lambert. Though the greater increase took place just before the fruit reached prime condition (Fig. 4), the specimens continued to gain weight even after full maturity was attained.

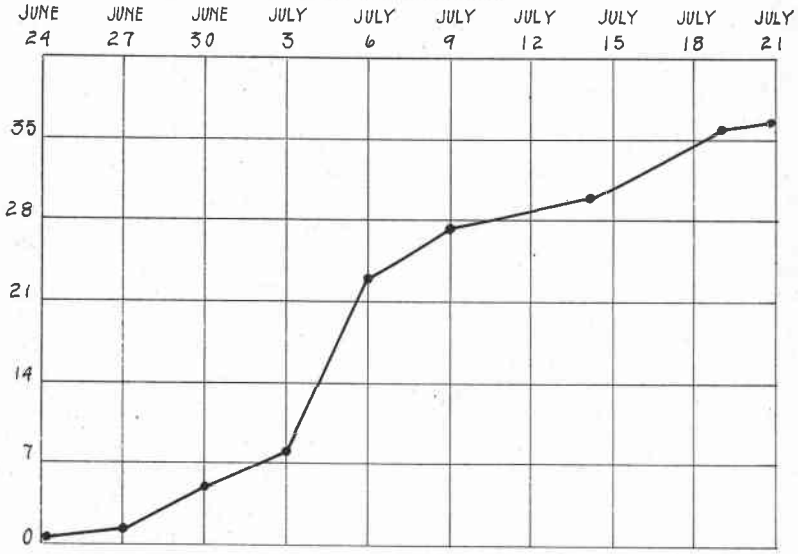

Fig. 4. Curve showing the increase in weight of Lambert cherries during the ripening period. (Increase expressed in percent.)

Dessert quality. Time of picking had a marked effect on dessert quality. All the fruit from the early pickings was sour and more or less bitter in taste. That picked late in the season was very sweet in taste, but was slightly insipid in some cases. By far the best quality for Napoleon was attained by the fruit picked between June 30 and July 6, while the best Lambert quality developed with the fruit picked between July 14 and 19. The juice of both Napoleon and Lambert became richer and more sirupy in nature as the season progressed. The small and undersized specimens from the lower portions of the tree all developed good size and quality when allowed to hang a few days longer.

Observations of the fruit placed in storage gave no indication that sweet cherries ever improve in quality after picking. The reverse of this, in fact, appeared to be true. In the case of the early picked fruit, acidity and bitterness seemed to become more pronounced and in no case was there an apparent increase in sweetness.

Of recent years, there has been a manifest tendency in certain districts of the Pacific Northwest to harvest cherries while still comparatively immature. In 1924 most of the commercial crop in Western Oregon, whether for the cannery or for the fresh fruit trade, was gathered long before the fruit had attained full quality. Already this practice is affecting the market, and unless the matter receives attention soon, the sweet cherry from this region will lose much of the reputation it attained in past years.

Shipping quality. Time of picking does not seem to affect materially the shipping quality of sweet cherries. Cherries picked when fully matured apparently held up as well as did those picked while comparatively green. They did not shrivel so badly and they displayed less discoloration due to oxidase activity. Bruises and decay organisms appear to have much more influence upon the shipping qualities of sweet cherries than time of picking.

Color. Time of picking had a definite effect upon the color of the fruit. Within the time covered by the picking dates of these experiments, Lambert changed in color from a light purplish red to a deep purple. The juice of this variety likewise changed from a light red to a dark purple color. Without doubt, there is a correlation between color intensity and the flavor and sugar content of this variety. Napoleon differs from Lambert in that two distinct color elements are associated with it. The "ground" or "undercolor" changes from a green to a pale yellow and finally to a light gold color during the ripening process. Ground color appears to be directly associated with the maturity changes. The "red" or "overcolor," on the other hand, seems to be brought on by factors not closely related to the ripening process. Generally the overcolor in Napoleon gains in intensity until about mid-season. The juice of this variety does not undergo material color changes during the period of maturity.

TESTS OF MATURITY

When left to their discretion, growers have generally determined the time of picking of sweet cherries by the aid of such factors as sweetness, size, and color. Obviously, these are capable of various interpretations, with the result that controversies arise, and that the sweet cherry crop is harvested at widely varying stages of maturity. Doubtless there is need for a test of maturity that will indicate rather definitely the degree of ripeness, that will exclude the human element so far as possible, and that can be easily and quickly applied.

The pressure test. It is true, as already indicated, that sweet cherries manifest a gradual decrease in resistance to pressure during the ripening season, but this apparently is not sufficiently indicative to be a

reliable guide to time of picking. Consequently, the pressure test does not appear feasible as a result of these experiments.

The specific gravity test. As already shown, there is a marked and rather consistent increase in sugars and other soluble solids during the ripening of sweet cherries, and a test of maturity based upon the specific gravity of the juice appears as a possibility at this time. The work of several seasons, however, will be necessary before the practical value of this test can be fully ascertained and before definite recommendations can be made.

A test of this nature would not be difficult to apply under field conditions. The specific gravity of the juice can easily be determined by applying a Balling scale hydrometer of proper size and graduation to a small quantity of the raw juice.

LOSS OF WEIGHT AFTER HARVEST

It is a matter of common knowledge that fruit loses weight following removal from the tree or vine.[1] Sweet cherries, in particular, lose weight under certain conditions. Two factors account for loss of weight in fruit: (1) natural decomposition and (2) excessive transpiration. Loss of weight through natural decomposition is usually insignificant in terms of handling practices, and practically all loss of weight in fruit is occasioned by loss of moisture. This factor, in general, is governed by (1) relative humidity, (2) aeration, (3) temperature, (4) time of picking, (5) condition of the epidermis, and (6) kind and variety of fruit.

The relation of humidity and aeration to loss of weight in sweet cherries. On June 26 twelve pounds of Napoleon cherries were gathered and divided into three lots of four pounds each. Lot 1 was placed in a storage room in which air circulation was abundant, and in which a relative humidity varying between 50 and 60 percent was maintained. Lot 2 was stored at the same relative humidity, but without air circulation. Lot 3 was stored at a relative humidity of 80 to 85 percent, and also without air circulation. All three rooms were kept at a temperature of 66° F. At the end of 28 days, the three lots were removed from storage, and the loss of weight was computed. Table III gives the data obtained.

TABLE III. THE RELATION OF HUMIDITY AND AERATION TO LOSS OF WEIGHT IN NAPOLEON CHERRIES

Lot No.	Date of picking and storing.	Number of days in storage.	Temperature of storage room.	Relative humidity of storage room.	Loss of weight.	Condition of fruit at end of storage period.
			°F.	%	%	
1	6-26	28	66°	50-60 with circulation	76.4	Practically dried. More or less moldy.
2	6-26	28	66°	50-60 without circulation	48.2	Much shriveled. More or less moldy.
3	6-26	28	66°	80-85 without circulation	11.1	Plump and turgid. Very little mold.

The figures given in Table III show that both aeration and humidity have influence upon loss of weight in sweet cherries. The fruit of lot 1

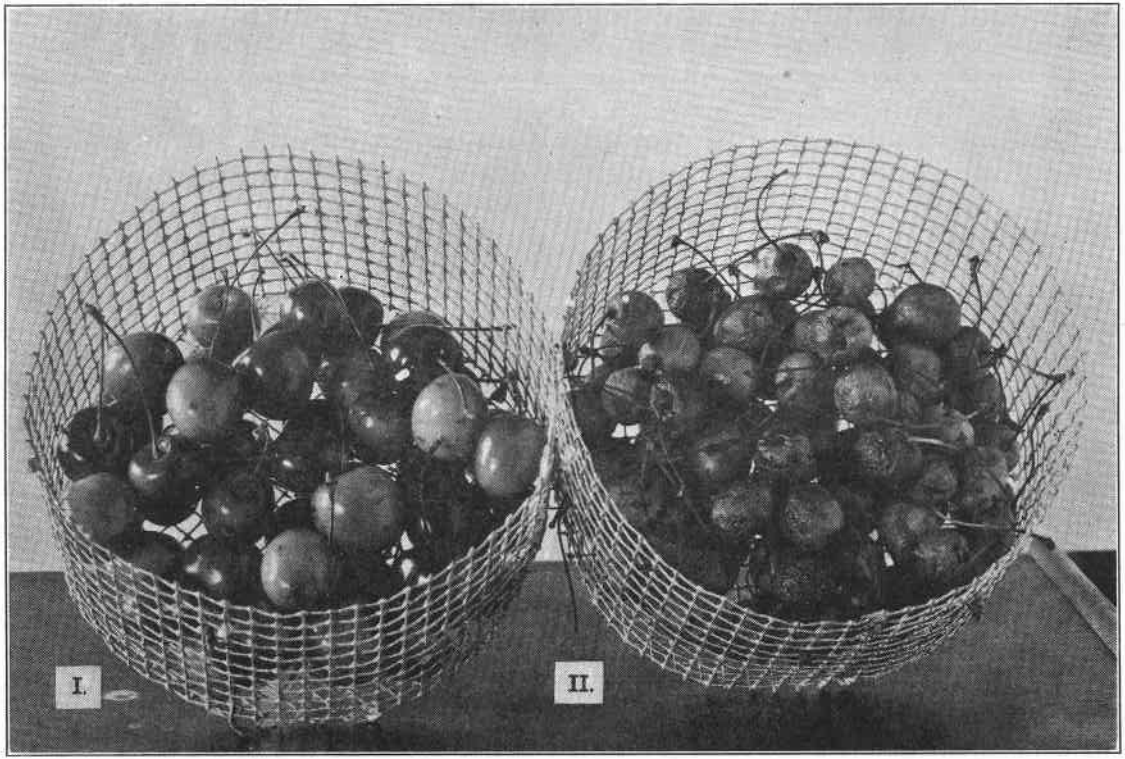

Fig. 5. The effects of humidity on loss of weight in sweet cherries after harvest. (I) Stored for 28 days at a temperature of 66° F. and a relative humidity of 80 to 85 percent. (II) Stored for 28 days at a temperature of 66° F. and a relative humidity of 50 to 60 percent.

showed a loss of 76.4 percent and was practically dried at the end of the 28 days. That of lot 2 showed a loss of 48.2 percent and was badly shriveled, while that of lot 3 showed a loss of only 11.1 percent and was fairly plump and turgid at the end of the period. Fig. 5 shows some of the fruit from lots 2 and 3 at the conclusion of the test.

CAUSES OF DECAY IN SWEET CHERRIES

Fungous diseases are the common cause of decay in sweet cherries. In general, the organisms which cause decay in cherries may be divided into two groups: (1) those which have the ability to penetrate the sound fruit, and (2) those which must rely for entrance upon mechanical injuries and skin abrasions.[2] An example of the former is brown-rot (Sclerotinia cinerea), which during some seasons is very serious in stone fruits of all kinds.[3] This disease must be controlled by spraying and by orchard sanitation. The latter class of organisms is represented by common gray mold (Botrytis) and blue mold (Penicillium). These fungi are responsible for most of the losses in sweet cherries, aside from those occasioned by brown-rot.

The relation of humidity to the development of fungi. The humidity of the air does not seem to be a limiting factor in the development of mold in sweet cherries. In all cases, where skin injuries were present, mold developed, whether the relative humidity was high or low. The juice and moisture exuding from the fruit itself was sufficient for the germination of the spores and for the growth of the mycelium. Cherries which showed the effects of excessive transpiration appeared to be more susceptible to mold than the ones that were plump and turgid. The importance of careful handling as a means of preventing mold was again emphasized in these tests.

TIME OF PICKING IN RELATION TO CANNING QUALITY

In past years the canning trade centered its attention primarily upon processing methods and gave only slight consideration to the handling of the raw product. It is now generally admitted, however, that many of the vicissitudes of fruit canning are due, not so much to variation in canning procedure, as to the differences occasioned by the treatment the product receives in the orchard, on the way to the cannery, and in storage.

To gain information concerning the relation of time of picking to canning quality, Napoleon and Lambert cherries were gathered and canned at short intervals during the season. Altogether, eight pickings of Napoleon were made between June 17 and July 8. Three pickings of Lambert were made on July 4, 11, and 20, respectively. The fruit in each case was processed in accordance with accepted commercial canning practices, the work being done in cooperation with the departments of Horticultural Products and Bacteriology of the Oregon Agricultural College. In the case of Napoleon, six cans of each picking were processed in 40 percent sirup, while a like number were processed in water. The fruit from the Lambert pickings was processed in 40 percent sirup only. Each lot was cooked for 11½ minutes in the Anderson-Barngrover rotary cooker, and was given an exhaust of 8½ min-

TABLE IV. EFFECTS OF TIME OF PICKING ON THE CANNING QUALITY OF NAPOLEON CHERRIES

(Canned in 40 percent sirup)

Lot No.	Date of picking and canning	Sirup cut-out (Balling)	Dilution of sirup	Firmness of fruit after canning	Condition of fruit after canning.
		%	%	gr.	
1	6-17	22.5	43.7	63.1	Small in size. More or less shriveled. Soft in texture. Flat in taste and but slightly aromatic. Pale in color. Juice, light in color. Considerable discoloration at stem ends.
2	6-19	24.7	38.2	61.9	Small in size. More or less shriveled. Soft in texture. Flat in taste and only slightly aromatic. Pale in color. Juice light in color. Considerable discoloration at stem ends.
3	6-21	25.1	37.2	73.0	Larger in size. Less shriveled. Somewhat firmer in texture. Better in taste with stronger aroma. Richer in color. Juice light in color. Slight discoloration at stem ends.
4	6-24	24.7	38.2	82.2	Fairly large in size. Less shriveled. Fairly firm in texture. Better in taste with stronger aroma. Good golden color. Juice light in color. Practically no discoloration at stem ends.
5	6-26	26.2	34.5	83.1	Large in size. Practically no shriveling. Firmer in texture. Fairly good flavor with stronger aroma. Good golden color. Juice light in color. No discoloration at stem ends.
6	6-30	27.6	32.2	90.5	Large in size. Practically no shriveling. Firm in texture. Good cherry flavor, with strong aroma. Good golden color. Juice light in color. No discoloration at stem ends.
7	7-3	28.4	29.0	91.4	Full sized. Practically no shriveling. Very firm in texture. Strong cherry flavor and aroma. Some discoloration evident. Juice slightly darker in color. No discoloration at stem ends.
8	7-8	31.5	21.2	94.4	Full sized. Practically no shriveling. Very firm in texture. Strong cherry flavor and aroma. Considerable discoloration. Juice darker in color. No discoloration at stem ends.

TABLE V. EFFECTS OF TIME OF PICKING ON THE CANNING QUALITY OF LAMBERT CHERRIES
(Canned in 40 percent sirup)

Lot	Date of picking and canning	Sirup cut-out (Balling)	Dilution of sirup	Firmness of fruit after canning	Condition of fruit after canning
		%	%	gr.	
1	7-4	26.8	32.8	71.2	Small for the variety. More or less shriveled. Rather soft in texture. More or less flat in taste. Slightly aromatic. Light purple in color. Juice, reddish in color.
2	7-11	28.0	29.9	79.3	Still undersized. Slightly shriveled. Rather soft in texture. Better in quality but still lacking in flavor. Slightly more aromatic. Darker in color. Juice darker in color.
3	7-20	30.9	22.6	95.8	Full sized. Practically no shriveling. Firm in texture. Strong cherry flavor. Decidedly aromatic. Dark purple in color. Juice, dark purple in color.

TABLE VI. EFFECTS OF TIME OF PICKING ON THE CANNING QUALITY OF NAPOLEON CHERRIES
(Canned in water)

Lot No.	Date of picking and canning	Sirup cut-out (Balling)	Firmness of fruit after canning	Condition of fruit after canning
		%	gr.	
1	6-17	7.1	35.0	Small in size. Not shriveled. Very soft in texture. Decidedly bitter in taste. Slightly aromatic. Lifeless in color. Juice light in color. Considerable discoloration at stem ends.
2	6-19	7.4	36.7	Small in size. Not shriveled. Very soft in texture. Bitter in taste. Slightly aromatic. Lifeless in color. Juice light in color. Considerable discoloration at stem ends.
3	6-21	8.2	56.1	Somewhat larger in size. Not shriveled. Somewhat firmer in texture, but still too soft. Less bitter in taste, but not of good quality. Slighly aromatic. Brighter and livelier in color. Juice light colored, slight discoloration at stem ends.
4	6-24	10.1	58.1	Fairly large in size. Not shriveled. Somewhat firmer in texture. Fairly good in quality. Aroma more pronounced. Brighter and livelier in color. Juice light in color. Practically no discoloration at stem ends.
5	6-26	10.3	60.1	Large in size. Not shriveled. Fairly good in quality. Aroma fairly pronounced. Good golden color. Juice light colored. Practically no discoloration at stem ends.
6	6-30	12.3	72.4	Large in size. Not shriveled. Fairly firm in texture. Good in quality. Strong in aroma. Good golden color, with occasional trace of discoloration. Juice light in color. Practically no discoloration at stem ends.
7	7-3	13.4	75.0	Full sized. Not shriveled. Fairly firm in texture. Good in quality. Strong in aroma. More or less discolored. Juice darker in color. Practically no discoloration at stem ends.
8	7-8	13.8	71.7	Full sized. Not shriveled. Fairly firm in texture. Very good in quality. Strong in aroma. Considerably discolored. Juice darker in color. Practically no discoloration at stem ends.

utes in water at a temperature of 190° F. Common No. 2 tin cans were used. Observations of the canned product were made five months later.

Cut-out or sirup concentration after canning. As shown in Tables IV, V, and VI, there are wide differences in the sirup cut-outs of cherries picked and canned at various times. For example, Napoleon picked and canned in 40 percent sirup on June 17, gave a cut-out of 22.5 percent, while fruit of the same variety picked and canned on July 8, gave a cut-out of 31.5 percent. Napoleon picked and canned in water on the above dates gave cut-outs of 7.1 percent and 13.8 percent, respectively. In other words, cherries of the later pickings invariably gave a higher sirup concentration after canning than did the cherries picked early in the season. This was to be expected since the fruit of the late pickings consistently showed a higher content of sugar and other soluble solids. Figs. 6 and 7 and Tables VII and VIII show that a rather definite correlation exists between the soluble solids of the raw juice and the cut-out or sirup concentration after canning. A method for determining the amount of sugar to use in canning operations is suggested by this relationship. After sufficient data have accrued, one should be able to compute fairly accurately the amount of sugar necessary to obtain any given cut-out by merely ascertaining the percentage of soluble solids in the raw juice with the Balling scale hydrometer.

TABLE VII. THE RELATION OF THE SUGAR CONTENT OF THE RAW JUICE TO CUT-OUT IN CANNED NAPOLEON CHERRIES
(Canned in 40 percent sirup)

Lot No.	Date of picking and canning	Sugar in raw juice (Balling)	Degree of sirup used in processing (Balling)	Sirup cut-out (Balling)
		%	%	%
1	6-17	12.1	40	22.5
2	6-19	13.2	40	24.7
3	6-21	14.2	40	25.1
4	6-24	15.3	40	24.7
5	6-26	15.5	40	26.2
6	6-30	18.9	40	27.6
7	7-3	19.6	40	28.4
8	7-8	20.9	40	31.5

TABLE VIII. THE RELATION OF THE SUGAR CONTENT OF THE RAW JUICE TO CUT-OUT IN CANNED NAPOLEON CHERRIES
(Canned in water)

Lot No.	Date of picking and canning	Sugar in raw juice (Balling)	Degree of sirup used in processing (Balling)	Sirup cut-out (Balling)
		%		%
1	6-17	12.1	0	7.1
2	6-19	13.2	0	7.4
3	6-21	14.2	0	8.2
4	6-24	15.3	0	10.1
5	6-26	15.5	0	10.3
6	6-30	18.9	0	12.3
7	7-3	19.6	0	13.4
8	7-8	20.9	0	13.8

Firmness of the product. Firmness is one of the requisites of well canned fruit. Commercial canners, in fact, frequently reduce the length of the cook and take a chance on keeping quality in order to secure firmness. During these experiments, some interesting facts came to light (Tables IV, V, and VI) concerning the relation of time of picking to

the firmness of the canned product. The pressure tester (Fig. 1), already described, was used in determining the firmness. A large number of determinations were made in each case, and while rather wide variations were recorded between individual readings, the average figures obtained are fairly uniform.

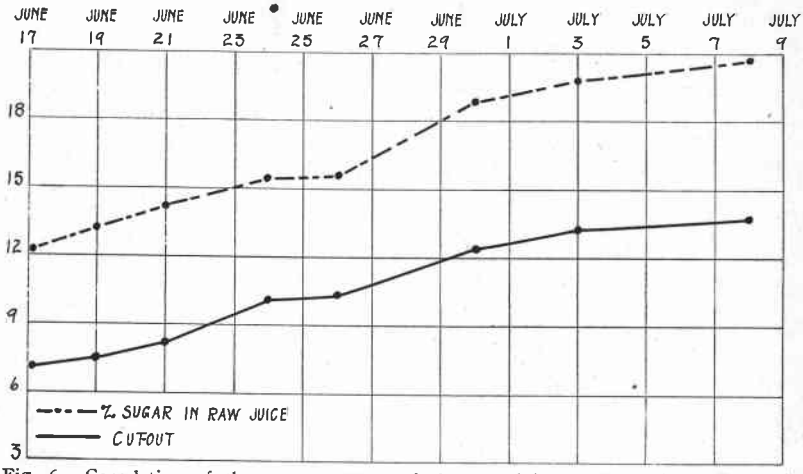

Fig. 6. Correlation of the sugar content of the raw juice and the sirup cut-out in Napoleon cherries. (Canned in water.)

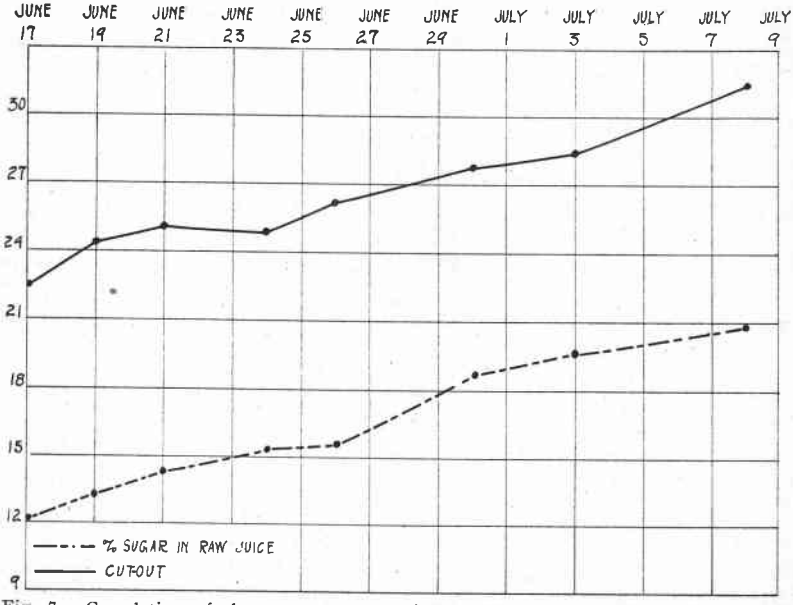

Fig. 7. Correlation of the sugar content of the raw juice and the sirup cut-out in Napoleon cherries. (Canned in 40 percent sirup.)

It will be noted (Tables IV, V, and VI) that the riper cherries consistently gave a product that was firmer in texture than did the fruit that was more or less immature. In the case of Napoleon, canned in 40 percent sirup, for example, the firmness of the fruit of the first picking was 63.1 grams, while that of the fruit of the last picking was 94.4 grams. Similar results were obtained with the cherries canned in water. The difference in firmness between the lots picked and canned at various times was sufficient to be apparent by casual observation in most cases.

Shrinkage. The difference in the amount of shrinkage between fruit canned at various stages of maturity was determined by measuring the volume of Lambert cherries before and after processing. This was accomplished by immersing the cherries in water and computing the amount of displacement.

TABLE IX. EFFECT OF TIME OF PICKING ON SHRINKAGE IN CANNED LAMBERT CHERRIES

(Canned in 40 percent sirup)

Lot No.	Date of picking and canning	Volume of fruit before canning	Volume of fruit after canning	Shrinkage
		c.c.	c.c.	%
1	7-4	1042	865	17.1
2	7-11	1085	931	14.0
3	7-20	1060	955	9.8

Table IX gives the data obtained in this test. Evidently time of picking had a considerable influence upon the amount of shrinkage that took place. Cherries picked and canned on July 4 showed a shrinkage of 17.1 percent. Those picked and canned on July 11, showed a shrinkage of 14.0 percent, while those picked and canned on July 20 showed a shrinkage of 9.8 percent. The riper fruit, in other words, showed much less loss of volume than did the fruit canned while comparatively immature.

Quality and appearance. A considerable difference in the quality and appearance of the canned product was evident between the lots picked and canned at various times. The early picked cherries, in general, yielded a product small in size, more or less flat in taste, soft in texture, and displaying more or less shriveling. Those canned when fully matured had a livelier appearance, were larger in size, firmer in texture, more aromatic, and had a more pronounced cherry flavor. Those canned when past their prime were of exceptionally good quality and texture, but in the case of Napoleon, showed a certain amount of discoloration or "leathering," that might be objectionable to the trade.

Color of the sirup. There seems to be a definite correlation between the degree of maturity in Lambert cherries and the color of the sirup in the canned product. The color of the sirup in this variety varied from a light red with the relatively immature fruit to a deep purple with the fruit that was thoroughly ripe. The sirup of Napoleon, while slightly richer in color with the later picked fruit, showed but little variation in this respect. In no case was the discoloration sufficient to be objectionable.

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SUMMARY

Time of picking, apparently, has material bearing upon both the fresh fruit and canning qualities of sweet cherries.

(1) As indicated by the pressure tester, sweet cherries undergo a gradual decrease in firmness during the ripening period. This decrease, however, is less striking than that commonly manifested by other fruits. In the case of Napoleon, the reduction in firmness was only 4.1 percent between June 19 and July 6.

(2) A consistent and rather pronounced increase in sugars and other soluble solids occurred during the period of maturity. The juice of Napoleon, from the time of the first picking to that of the last, showed an increase in soluble solids from 12.1 to 22.4 percent, while that of Lambert showed an increase from 11.3 to 22.2 percent. Not only was the increase rapid at the beginning of the period, but it continued at a uniform rate even to the time when the fruit was past its prime.

(3) A gradual reduction of the acid content took place during the ripening period, Napoleon showing a reduction from .64 to .35 percent and Lambert from .41 to .24 percent. This reduction seems to have been consistent throughout the season.

(4) A rather marked increase in the size of the fruit occurred during the ripening period. Napoleon during this time showed an increase in the average weight of the specimens of 30.2 percent while Lambert showed an increase of 36.2 percent.

(5) All the fruit of the early pickings was sour and more or less bitter in taste. That picked late in the season was very sweet in taste but was slightly insipid. By far the best quality for Napoleon was attained by the fruit picked between June 30 and July 6, while the best Lambert quality developed with the fruit picked between July 14 and 19. The juice of both Napoleon and Lambert became richer and more sirupy in nature as the season progressed.

(6) Observations of the fruit placed in common storage gave no indication that sweet cherries ever improve in quality after picking. The reverse of this, in fact, appeared to be true. With the early picked fruit especially, acidity and bitterness seemed to become more pronounced with continued storage.

(7) Time of picking does not seem to affect materially the shipping quality of sweet cherries. Those picked when fully mature apparently held up as well as did those picked while comparatively immature. The cherries of the later pickings did not shrivel so badly and displayed less discoloration due to oxidase activity.

(8) A test of maturity based on the specific gravity of the juice seems feasible at this time. The work of several seasons, however, will be necessary before definite recommendations can be made concerning this test.

(9) Humidity and aeration have considerable influence upon loss of weight in sweet cherries after harvest. Low humidity and free air movements within the storage room resulted in excessive loss of weight in all cases.

(10) Fungous diseases such as brown-rot, blue mold, and gray mold are the common cause of decay in sweet cherries. The humidity of the air does not seem to be a limiting factor in the development of mold in this fruit. In cases where skin injuries are present, mold developed whether the relative humidity was high or low. The juice and moisture exuding from the fruit itself was sufficient for the germination of the spores and for the growth of the mycelium.

(11) Wide variations were noted in the sirup concentration or cut-out of cherries picked and canned at various times. Those of the later pickings invariably gave a higher sirup cut-out than did those picked and canned early in the season. Napoleon picked and canned in 40 percent sirup on June 17 gave a cut-out of 22.5 percent, while fruit of the same variety picked and canned on July 8 gave a cut-out of 31.5 percent.

(12) A rather definite correlation was noted between the soluble solids of the raw juice and the sirup cut-out of the canned product. A method for determining the amounts of sugar to use in canning operations is suggested by this relationship.

(13) Cherries that were fully mature consistently gave a product that was firmer in texture than did the fruit that was more or less immature. As indicated by the pressure tester, the firmness of Napoleon of the first picking canned in 40 percent sirup was 63.1 grams, while that of the last picking was 94.4 grams.

(14) Time of picking seems to have had considerable influence upon the amount of shrinkage manifested by the canned product. Lambert picked and canned on July 4 showed a shrinkage of 17.1 percent. Fruit of this variety picked and canned on July 11 showed a shrinkage of 14.0 percent, while that picked and canned on July 20 showed a shrinkage of 9.8 percent.

(15) A considerable difference in the quality and appearance of the canned product was evident between the lots picked and canned at various times. The early picked cherries, in general, yielded a product small in size, more or less flat in taste, soft in texture, and displaying more or less shriveling. Those canned when fully mature had a livelier appearance, were larger in size, firmer in texture, more aromatic, and of more pronounced cherry flavor. Those canned when past their prime were of exceptionally good quality and texture, but, in the case of Napoleon, showed a certain amount of discoloration or "leathering" that might be objectionable to the trade.

(16) There seems to be a definite correlation between the degree of maturity in Lambert cherries and the color of the sirup in the canned product. The color of the sirup in this variety varied from a light red with the relatively immature fruit to a deep purple with the fruit that was thoroughly ripe. The sirup of Napoleon was slightly richer in color in the case of the late picked fruit.

LITERATURE CITED

[1]Hartman, H.

Studies relating to the harvesting and storage of apples and pears. Oregon Station Bulletin 206.

[2]Ramsey, H. J.

Handling and shipping of fresh cherries and prunes from the Willamette Valley.
United States Department of Agriculture Bulletin 331.

[3]Barss, H. P.

Brown-rot and related diseases of stone fruits in Oregon.
Oregon Station Circular 53.