AN ABSTRACT OF THE THESIS OF

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Title--Utilization of Surplus Italian Prunes

----------------------------------------(Redacted for privacy)----------------------------------------

Abstract Approved:

(Major Professor)

Prune growers of Oregon are faced with the prospect of large crops and surpluses for the next few years. These surpluses will probably be felt in both fresh and dried prunes. This thesis presents the results of an investigation to find new markets and new products which will be of value in utilizing these surpluses. The following products have been investigated and are included in this report.

Canned prepared dried prunes. A prolonged study was made of the effect of prepared Italian prunes on various types of cans. It was found that plain charcoal cans were entirely satisfactory over a period of 11 months' storage. Single enameled cans should not be used as they swell in less than eight months' storage. Methods of preparation of prunes for canning were studied. A long pre-soaking was found most satisfactory, for high quality. Short hot blanch before canning can be used if proper conditions of syrup and fill are observed. Yields and costs were given for the two methods of preparation.

Prune beverages. Three types of prune beverages were discussed. Pulpy juice was most promising. A cloudy and a clear beverage were also satisfactory. Yields and costs were given and compared.

Pitted prune pulp. Small or low-grade dried prunes were made into pulp by means of a suitable machine. This product was suitable for use in the bakery trade.

Halved Pitted prunes. Fresh prunes were split and pitted before drying. The machine to do this was developed during this investigation. Large savings were effected in drying time, because of quicker evaporation of moisture from these halved prunes. Because of shorter drying time and lower temperature the quality was more nearly that of fresh prunes.

Fresh Prune Juice. Small or low-grade fresh prunes were used to make a pulpy fresh prune juice. This product was excellent in flavor and color. Cloudy fresh prune juice was not satisfactory either in flavor, in body, or in yield.
Fresh Prune Pulp. This was prepared from fresh prunes. It proved to be a very good means of fresh prune utilization.

The combined effect of the products studied in this report, if they are developed and marketed, should prove beneficial to marketing conditions of the northwest Italian prunes.
UTILITY OF SURPLUS ITALIAN PRUNES

by

KEITH PECK PENNER

A THESIS

submitted to the

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1938
APPROVED:

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Chairman of School Graduate Committee
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Chairman of State College Graduate Council
ACKNOWLEDGEMENT

The author gratefully acknowledges the help and guidance offered during this investigation by Professor E. H. Wiegand, Professor T. Onsdorff, and other members of the Food Products Industries Department.
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UTILIZATION OF SURPLUS ITALIAN PRUNES

CHAPTER I

INTRODUCTION

The principal variety of prune grown and dried in the northwest is the Italian or Fellenberg prune and in this study we are concerned with this variety alone. Other varieties are grown to a lesser extent in the northwest, but according to a special Pacific Northwest fruit and berry survey (6), Italian prunes account for about 93 per cent of all prunes and plums grown in these districts. The chief variety grown in California is the French (Petite Prune d'Agen) prune. Italian prunes differ from French prunes in that they have a greater acid content which gives a more tart taste to the Italian prune even though it contains almost the same percentage of sugar as does the French prune. With this flavor difference we find some markets much prefer the northwest prune, while others express a preference for the French prune.

For many years the trend of northwest prune production has been upward while at the same time California and world production have increased correspondingly. Figure I shows northwest production and Figure II, California, United States, and total world production
Figure I
PRODUCTION
OF
NORTHWEST DRIED PRUNES
1900 - 1937
FIGURE II
PRODUCTION OF DRIED PRUNES
UPPER - TOTAL WORLD
MIDDLE - TOTAL UNITED STATES
LOWER - CALIFORNIA
1920-1937

THOUSANDS OF TONS

YEAR

1920  1924  1928  1932  1936
for past years. The effect of this general increase in production has been lower prices for prunes and rather large carry-overs from year to year. As a direct result of these factors, the farmer or orchardist who grows the prunes has not received a fair return on his investment of land, labor, and supplies. As shown in Table I (7), the price to the grower has dropped lower and lower since 1921.

Table I

Prices Paid To Oregon Growers for Prunes to Dry 1921-1937

<table>
<thead>
<tr>
<th>Year</th>
<th>Farm Price per Pound cents</th>
<th>Year</th>
<th>Farm Price per Pound cents</th>
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<tr>
<td>1919</td>
<td>5.8</td>
<td>1929</td>
<td>1.8</td>
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<td>1920</td>
<td>3.8</td>
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<td>1.3</td>
</tr>
<tr>
<td>1921</td>
<td>3.3</td>
<td>1931</td>
<td>0.8</td>
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<tr>
<td>1922</td>
<td>2.6</td>
<td>1932</td>
<td>1.0</td>
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<td>1923</td>
<td>2.1</td>
<td>1933</td>
<td>1.5</td>
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<tr>
<td>1924</td>
<td>2.5</td>
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<td>1928</td>
<td>2.5</td>
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</table>

The five-year average price for 1919-1923 was 3.5 cents per pound while the same average for the years 1933-1937 was 1.2 cents per pound. While these statistics present data for Oregon prunes they are also indicative of the trend in Washington.
It has been proposed that if the lower quality prunes were removed from competition with the better ones, the price structure could be realigned to much advantage. If, for instance, it were possible to utilize all Italian prunes 60/70\* to the pound or smaller in other commodity fields, the strain on prices of larger prunes would be relieved to a great extent.

Very recently, in the 1937 season, the tonnage of Italian prunes was almost negligible. This was caused by a short crop coupled with brisk demand and good prices paid by canners for fresh fruit. It is not anticipated that this decline in dried prunes will extend to more than the 1937 season.

The fresh prune production is expected to remain at about the 1931-1936 average with only a small decrease in bearing acreage or fresh tonnage, as indicated by Figure III. The dried prune production may be eased somewhat by the increasing demand by canners for fresh prunes. In Oregon during the 1937 season, it was estimated that only 15 to 20 per cent of the Italian prune crop was dried. The same general trend was observed in Washington.

\* Size grading in commercial use based on number of prunes required to make one pound.
Figure III
PACIFIC NORTHWEST
PRUNE ACREAGE
1909 - 1938
From the data which have been presented, it appears that at the present time dried prunes are a liability rather than an asset. One of the purposes of this study is to develop and point out proven and tested processes by means of which an appreciable amount of diversion may be accomplished and a corresponding improvement may be felt in general tone throughout the northwest prune industry.

Aside from diversion, there are other means by which we may increase the per capita consumption of dried Italian prunes. The trend of modern cooking is toward products which require only a short time to prepare and cook. The traditional dried prune requires overnight soaking and cooking, or long simmering before being ready for consumption. Perhaps we may develop prune drying or treating methods which will enable us to refresh and prepare prunes in much shorter periods of time.
CHAPTER II

PREVIOUS STUDIES

Until the present study there has been very little investigation of surplus dried prune utilization in the northwest. Quite extensive investigations have been made in California at the Fruit Products Laboratory of the University of California. These investigations were made on French prunes and do not apply strictly to results which may be expected when using Italian prunes.

A bulletin was published in 1928 by S. W. Shear (5) on "Prune Supply and Price Situation." In this bulletin he said (5:30):

As a result of increasing production the California prune industry is faced with the probability that, on the average, prune prices will be unprofitably low for an unusually large percentage of growers for several years, unless growers, selling agencies, and others financially interested in the industry greatly improve the methods and reduce the costs of marketing and succeed in eliminating the more inferior part of potential production from competition with the better grades of table prunes, and unless growers themselves drastically reduce costs of production.

In so far as the California production of dried prunes is the dictator of world market prune prices (California averages 65 to 75 per cent of the total...
world production), this also indicated low prices for Oregon dried prunes. This prediction, made in 1928, was entirely borne out in the ten years following. The crop in 1935 reached the record total of 297,000 tons of dried prunes for the northwest and California. Fortunately for the condition of the industry, this dropped to 177,200 tons in 1936. The 1937 total for the Pacific Coast was 246,500 tons.

Mrak and Cruess (3) studied means of decreasing the surplus of dried prunes in California. The investigation covered preparation and marketing of various products made from surplus French prunes. Included in their list of products were dried prune pulp, dried prune juice, and prune syrup (a concentrate of prune juice), canned ready-to-serve prunes, canned dry-pack prunes, canned fresh prunes, and alcohol and vinegar possibilities. Although some similar products have been prepared during the present investigation they have been made from Italian prunes.

Mrak and Richert (4), in a bulletin on "The Swelling of Canned Prunes," discussed the nature of causes of hydrogen swelling which was then such a problem in canning prepared dried prunes and developed procedures for canning dried prunes. They determined
that rate of swelling decreased as head space, concentration of syrup, and can size increased, and increased as time of blanch increased. Enameled cans and coke plate cans swelled more readily than plain or charcoal plate cans.

Wiegand, Bullis, and Hatch (9), in a study of the effect of sulfur spray residues on the corrosion of prune cans (using fresh prunes), determined that corrosion and swelling were not accelerated by any sprays as commonly applied. Similarly we may say that sulfur spray residue is not a factor in swelling of canned dried prunes.
CHAPTER III

EXPERIMENTAL

It has long been felt throughout the prune industry that a standardized, high-quality, quickly prepared product will be of great benefit in stimulating sales. One method of obtaining this is through the marketing of prepared dried Italian prunes. Housewives have no standardized procedure for preparation, in fact many consumers do not recognize that there is a marked difference in flavor between Italian and French prunes. Thus, home-prepared prunes seldom attain the quality which is possible through controlled, standardized methods of preparation. On the other hand, because commercial dried prune canning may be used to fill in slack season gaps in production, canners have been willing to make considerable effort to establish markets for canned dried prunes.

Commercial prune preparation and canning was first attempted about 1923. Many concerns saw this as the solution to all their troubles, both for prune growers who had large surpluses and canners who needed slack-season work. However, as prunes were prepared and canned there developed one insurmountable difficulty
which has plagued the canned prepared dried prune for 15 years. Chiefly because of this, the production of prepared dried prunes has been disappointingly small.

This difficulty was due to action of the prune acids on the steel base of the container, which caused the formation of hydrogen gas and soon swelled the container. This was in no way connected with bacterial spoilage (in fact, the prunes were perfectly wholesome and edible), but the cans could not be merchandised in a swelled condition. It was soon apparent that research was needed to overcome the swelling of canned prepared dried prunes.

The problem of hydrogen swelling is the same in either French or Italian type prunes. Mrak and Richert (4) in their bulletin dealt very extensively with the problem in 1930. They determined the factors contributing to the rate of swelling as follows:

1. The small cans swelled faster than large ones. The difference was attributed to the fact that there is more area per unit volume in small cans and more hydrogen gas is evolved per unit volume.

2. Higher syrup concentrations produced less swelling, but syrup cannot be made higher than 30 per
cent Balling* without markedly shrinking the prunes.

3. More head space gave more room for collection of hydrogen gas and thus retarded swelling, although gas formation proceeded at the usual rate.

4. An increase in exhaust time increased the rate of swelling.

5. Cans with heaviest tin-plate swelled least. Plain cans kept longer than single or double enameled cans. The corrosive action is localized in enameled cans and is much more intense at spots where enamel and tin-plate are imperfect. With plain cans this action is distributed evenly over the whole inside of the container.

6. Retort (or pressure) cooking increased rate of swelling.

7. A storage temperature of 30-40 degrees Fahrenheit was recommended to retard spoilage. High temperatures increased rate of swelling.

EFFECT OF DRIED ITALIAN PRUNES ON VARIOUS TYPES OF CANS

Since 1930, when Mrak and Richert (4) made their study, cans have been markedly improved in quality of

* The terms Balling and Brix are used synonymously and refer to the percentage of sugar by weight which is contained in the solution.
the steel base and in the tin-plating. It was felt that studies should be made using these new cans and prepared dried Italian prunes to determine if available cans were satisfactory. The Continental Can Company and American Can Company kindly furnished cans of several types for use in this study. The following types of cans were included.

1. Plain Charcoal Plate, Type L.
2. Plain Coke Plate, Type L.
3. Single Enameled Charcoal Plate, Type L.
4. Single Enameled Coke Plate, Type L.
5. Double Enamel Charcoal Plate, Type L.

The following preparation technique was followed to give a uniform high quality product. Prunes were soaked in water until almost completely refreshed, then canned in 30 per cent syrup. This syrup was made in either of two ways. Number one was a plain 30 per cent syrup. Number two consisted of the filtered liquor in which the prunes had been soaked plus enough sugar to make 30 per cent. To attain a high, uniform, initial vacuum, the cans were sealed in a mechanical vacuum sealer. Cooking time was 45 minutes at 212 degrees Fahrenheit. Storage at 70-72 degrees for 11 months followed.
Method of Vacuum Testing

The loss of internal vacuum is directly proportional to hydrogen formation. Wiegand, Bullis, and Hatch (9) used the equipment designed by Wilbur and Bohart to measure internal vacuum in unopened cans. This instrument was used in the present study with minor modification to allow the use of different size cans. The instrument was connected to a vacuum pump in order to draw a vacuum on the top of the can with the aid of a suction tube and rubber gasket. The amount of external vacuum necessary to "flip" the end of the can was approximately equal to the internal vacuum plus the resistance of the end. Prior to filling the cans a "breaking in" period of 50 to 70 "flips," decreased the resistance of the end to a fairly constant value (Figure IV). However, the design of the can end determined the minimum resistance. Some cans which had three concentric circular ridges in the end had a comparatively high resistance. Others with only one ridge were noticeably lower. Because of this, the data were kept in per cent of original vacuum remaining in each can, rather than any absolute value. All cans had an initial vacuum of 17 inches to which was assigned a 100 per cent value. At the end of the test period vacuum
Figure IV

RESISTANCE OF CAN END TO "FLIPPING"

AVERAGE OF 50 CANS
in inches was obtained by puncturing with a vacuum gage.

**Results From Various Types of Cans**

After 11 months' storage the following results were apparent.

**Plain Charcoal Cans.** The average vacuum was 15 inches with no swells in a lot of over 50 cans. This is 88 per cent of the initial vacuum.

**Plain Coke Cans.** Average vacuum was 13 inches with no swells in over 50 cans. This is 76 per cent of initial vacuum.

**Single Enamel Coke Cans.** This lot began to swell after six months' storage and at 11 months 100 per cent of the cans were either swelled or perforated. Single enameled coke is definitely not the can for prepared dried prunes.

**Single Enamel Charcoal Cans.** This lot was only slightly better than single enamel coke cans and is also unsuitable.

**Double Enamel Charcoal Cans.** The average vacuum was $13\frac{1}{2}$ inches with no swells in 50 cans. This is 80 per cent of initial vacuum. While this can is perfectly satisfactory, the plain cans are as good at a lower cost.
Comparative performances for these types of cans are shown in Figure V.

Cans put up with plain syrup showed no consistent variation from those put up in syrup made from liquor in which prunes were soaked. This is evidently a factor which need not be considered from the spoilage standpoint.

EXPERIMENTAL PREPARATION TECHNIQUES

From the above data it was apparent that when proper type cans were used corrosion and swelling were negligible, at least during one year's storage. Several methods of canning are available for commercial adaptation and trials were made to compare these.

Long Pre-soaking.

In brief, this method consisted of soaking the prunes in water to partly or completely refresh them before canning. Cost of canning was somewhat high and handling difficult if prunes were completely refreshed. Flavor was excellent and prunes were better filled-out by this method.

Time required to refresh Italian prunes was dependent on temperature and depth of prunes in soaking.
Figure V
RETENTION OF VACUUM
PREPARED DRIED PRUNES

TYPE OF CAN
- Plain Charcoal Type L
- Plain Coke Type L
- Single Enamel Charcoal Type L
- Double Enamel Charcoal Type L

TIME OF STORAGE IN MONTHS
PER CENT OF ORIGINAL VACUUM
0 20 40 60 80 100
0 2 4 6 8 10 12
tank. As shown by Figure VI, the time varied from five hours at 170 degrees Fahrenheit to 36 to 40 hours at 50 degrees Fahrenheit. These figures are for prunes which were one foot deep in the soaking tank, to which had been added twice their weight of water.

Usually it was not best to completely refresh prunes before canning due to increased softness which made handling difficult. If prunes were one-half refreshed they completely filled out during one month's storage.

A typical procedure which was used and found satisfactory follows.

Soaking. One hundred pounds of prunes were washed to remove dirt and foreign matter and then put in a tank or pan with sufficient bottom area so the prunes were not more than one foot deep. Twice their weight, or 200 pounds of boiling water, was poured over them and let stand until cool. This required six to ten hours and at the end of this period the prunes were sufficiently refreshed for canning. After such soaking they weighed about 150 pounds, an increase in weight of 50 per cent. There were 150 pounds of water left from the soaking and it contained about nine per cent
Figure VI

RELATIVE SPEED of PRUNE REFRESHING AT VARIOUS TEMPERATURES
Soluble solids* and prune flavor.

Syrup. Some persons who sampled canned prepared Italian prunes felt that a slight reduction in the strength of prune flavor would be an advantage and result in more pleasing taste. This reduction was accomplished by discarding the soaking water and using a plain sugar syrup in canning. Care had to be exercised to avoid soaking out too much flavor. More than ten per cent soluble solids (as read on a refractometer or saccharimeter) should not be removed. When full prune flavor was desired, the soaking water was filtered and used to make syrup by the addition of the proper amount of sugar.

Proper syrup strength depended on the amount of refreshing and this was proportional to the strength of the soaking liquor. It was found, for instance, that completely refreshed prunes lost about 18 per cent soluble solids in the soaking liquor, while prunes half refreshed lost eight to nine per cent. By experiments it was determined that to obtain a 30 per cent cut-out, the syrup put on the prunes should have 17 per cent more sugar than the soaking liquor of the prunes at the

* Soluble solids. The total amount of dissolved matter in solution. Principally sugars with small amounts of fruit acids.
time of canning. If plain syrup was used the same rule held except that the syrup contained all sugar. A very simple device for calculations of syrup and fill, etc., when amount of refreshing was known, is shown in Figure VII. A ruler or straightedge is held horizontally across the page at the proper level as designated by the left bar. To illustrate: If 100 pounds of prunes are refreshed to 150 pounds, the chart indicates 75 per cent fill, 24 per cent syrup, and three quarts of syrup per dozen for No. 1 tall cans.

**Fill.** Fill was very important and it was somewhat difficult to obtain it properly without slack fill or over-crowding after complete refreshing of the prunes. In general, it was found that prunes doubled their original volume in proceeding from dried prunes to completely refreshed ones. If they were completely refreshed the can was completely filled, but if only one-half refreshed, the can was filled 75 per cent full. Figure VII, as explained above, illustrates this point.

**Exhaust.** In our experiments a mechanical vacuum machine was used to seal all cans. This was adjusted to give a vacuum of 17 inches.

**Processing.** Both retort and open bath processing were practiced. It was found that 15 minutes at 240
<table>
<thead>
<tr>
<th>Weight of 100 lbs. Prunes</th>
<th>Fill, Per Cent</th>
<th>Degrees Brix</th>
<th>Quantity of Sirup per Dozen 16 oz. Cans</th>
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<tr>
<td>200 lbs</td>
<td>100%</td>
<td>30°</td>
<td>2 qts.</td>
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<tr>
<td>190</td>
<td>95</td>
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degrees Fahrenheit or 30 minutes at 212 degrees Fahrenheit was sufficient. The retort cooking was unsatisfactory due to unfavorable flavor changes, and darkening and cloudiness of syrup as compared with results obtained from cooking at 212 degrees.

**Storage.** When proper type of can was used, storage at a temperature of 70 degrees Fahrenheit for one year did not cause excessive loss in vacuum.

**Short Blanch**

This method of pre-treatment was found to be most rapid and economical, but in some cases the prunes did not fill out as completely as was desirable. This was due to the shrinking tendency of the syrup which was used.

Prunes were blanched in steam or hot water (212 degrees Fahrenheit) for a short period, usually between one and three minutes. This time varied with the size of the prunes and moisture which was already in them. Hot water was favored due to its better cleansing properties. From the blancher prunes were run over a sorting belt where trained sorters removed all defective prunes and filled the remainder into cans. The weight increase of 100 pounds of prunes was ten pounds due to
the blanching, which according to Figure VII requires a 55 per cent fill and 20 per cent syrup.

From this point the method was the same as that described under the long-pre-soaking process.

Yield. Inasmuch as prunes doubled their weight when completely refreshed, the highest possible yield was twice that obtainable from the original weight of prunes. There were several factors which lowered the yield, among them brown rot and physical defects. These decreased the yield from five to ten per cent, according to quality and size of the prunes. It was found that splits, slabs, and hard prunes were much more prevalent in the smaller sizes. Brown rot accounted for two to ten per cent in the samples tested.

Actual yield varied from 250 to 275 No. 1 tall cans, depending on the cullage necessary due to the causes mentioned above. The yield of long-soaked prunes was slightly higher due to more complete refreshing of the prunes.

Costs. The following table of costs may be considered typical of either of the experimental methods of canning dried prunes. These figures are for one dozen cans, No. 1 tall.
Table II

Cost of Canned Prepared Prunes

<table>
<thead>
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<th>Item</th>
<th>Cost</th>
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<td>Dried prunes</td>
<td>$ .13</td>
</tr>
<tr>
<td>Labor</td>
<td>.04</td>
</tr>
<tr>
<td>Sugar</td>
<td>.13</td>
</tr>
<tr>
<td>Cans</td>
<td>.23</td>
</tr>
<tr>
<td>Labels</td>
<td>.02</td>
</tr>
<tr>
<td>Cases</td>
<td>.03</td>
</tr>
<tr>
<td>Fuel, light and water</td>
<td>.05</td>
</tr>
<tr>
<td>Overhead</td>
<td>.06</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ .69</strong></td>
</tr>
</tbody>
</table>

DRIED PRUNE JUICES

A prominent western journal (8:136) devoted to the food preservation business had the following to say about the recent trend in the production of fruit juices in general.

The growth of canned and bottled fruit juices in ten years from nothing to an output almost equal to that of any of the Big Three in canned vegetables - corn, peas, tomatoes - and as great as that of any of the Big Three in canned fruits - peaches, pineapple, pears - is the outstanding development of the food-preserving industries in this decade.

The rise to fame of this giant newcomer is remarkable in many ways. His youth, first of all, is noteworthy, for he has attained his present commanding position of more than 20,000,000 cases annually in ten brief summers, an achievement never before recorded. He has taught the American public an entirely new conception of food, the first time such a thing has ever been done in the beverage field. His rise has called into being an
entirely new processing technique, has required hundreds of tons of the finest of corrosion-resistant materials, has caused the erection of close to a hundred fine new food factories of the most modern design. He has gulped down surplus crops with wondrous unconcern, and has developed shortages in regions where growers had been hard-put to find means of disposing of their harvests at any price. And, seemingly, he has accomplished all this without greatly affecting any already established business; his coming has been all assets and no liabilities.

The following table shows the phenomenal growth shown by some of the typical leading juices.

Table III

Canned Fruit Juice Packs in the United States

<table>
<thead>
<tr>
<th>Year</th>
<th>Grapefruit Juice Cases</th>
<th>Pineapple Juice Cases</th>
<th>Tomato Juice Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1929</td>
<td>205,000</td>
<td>185,000</td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td>173,934</td>
<td>1,338,964</td>
<td></td>
</tr>
<tr>
<td>1931</td>
<td>416,683</td>
<td>2,476,000</td>
<td></td>
</tr>
<tr>
<td>1932</td>
<td>288,324</td>
<td>4,447,000</td>
<td></td>
</tr>
<tr>
<td>1933</td>
<td>739,000</td>
<td>700,000</td>
<td>3,873,000</td>
</tr>
<tr>
<td>1934</td>
<td>740,000</td>
<td>2,000,000</td>
<td>5,579,000</td>
</tr>
<tr>
<td>1935</td>
<td>2,556,000</td>
<td>2,500,000</td>
<td>8,171,000</td>
</tr>
<tr>
<td>1936</td>
<td>2,113,000</td>
<td>5,000,000</td>
<td>13,105,000</td>
</tr>
</tbody>
</table>

These juices are marketed either as clear, cloudy, or pulpy juices. Prune juice is adaptable to any of these types. Many prunes which are unsuitable for canning because of small size or defects may be utilized in juice making or various other ways. Development of
markets for juice from dried prunes would result in considerable diversion and remove small prunes from competition with the large sizes.

Experiments on Juice Making

**Pulpy Juice.** Pulpy juice, that is, juice which contains pulp particles large enough to settle on standing, was prepared as follows:

Small prunes 70/80 and 80/90 to the pound were soaked in an equal weight of water until almost all the water was taken up. They were then run, with all the soaking water, through the fine (.02 inch) screen on a Kern finisher. This amount of soaking water is approximately equal to that which was evaporated when the prunes were dried. Thus there was obtained a pulpy juice which approached in flavor strength and sugar content a juice obtained in a similar manner from fresh prunes. The soluble solids of the juice depended on the prunes used, but varied from 20 to 23 per cent when prepared in this manner.

By experiment it was found that the flavor was sufficiently pronounced to allow addition of 50 per cent water if sugar was then added to bring the soluble solids back up to 18 per cent. Thus, from 100 pounds
of small or low-grade prunes, plus 100 pounds of water there was obtained 150 pounds of pulpy liquid (the loss of pits, skins, and some tough fibre amounted to about 50 pounds). To this was added 75 pounds of water plus the required sugar to bring up to 18 per cent soluble solids. Care was necessary in filling cans with this juice to have constant agitation of the storage tank to insure a uniform canned product. This product was best packed in plain or double enameled charcoal plate cans. Cooking time was one-half hour at 190 degrees Fahrenheit for 16 ounce cans.

This pulpy juice was economically and easily prepared when a finisher with a fine screen was available. It was, however, almost impossible to filter juice prepared in this manner due to its tendency to clog the filter pads.

Cloudy Juice. A cloudy juice, that is, one which contained fine non-settling sediment, was prepared in a slightly different manner. Prunes were soaked in warm or hot water until completely refreshed, or to express it in a different manner, 100 pounds of prunes were soaked in 200 pounds of water until only 100 pounds of liquor remained. The 100 pounds of juice contained approximately 18 per cent soluble solids, which was found
suitable for beverage purposes. It was only necessary to strain the juice through flannel to remove particles of skin, pulp, or any pits.

The flavor and the viscosity were varied by changing the temperature of soaking. When soaked at 60 to 70 degrees Fahrenheit the juice was thin; flavorful but not viscous. An increase in temperature of soaking to 125 degrees Fahrenheit brought out a different type of juice with more body. This was due to an increased dissolving of colloidal and pectinous material at the higher temperature.

**Clear Juice.** Clear, brilliant dried prune juice was prepared from the above juice in the following manner. After soaking and straining, the juice was treated with a prepared enzyme preparation to precipitate the gums and colloidal matter which were suspended. It was impossible to filter juice without this pre-treatment due to the suspended material which soon clogs any filter pad.

The following enzymes have been used as clarification agents with varying degrees of success:

- Pectinol A*
- Pectinol M
- Pectinol W

* Röhm and Haas Company, New York City*
Of the three, Pectinol W worked most satisfactorily. The minimum amount of this which performed effectively was three pounds per 100 gallons. This is about three times the weight recommended by the manufacturer for other types of juices. The juice to be treated was heated to 110 degrees Fahrenheit and Pectinol W thoroughly mixed in it. After four to eight hours, depending on the storage temperature, the colloidal, gummy suspended matter settled to the bottom. Figure VIII shows the collection of the sediment at the bottom of a bottle of treated juice. The clear liquid above was siphoned off and put through a pad filter for a final polish.

These juices may be put into either cans or bottles. Usually the pulpy or cloudy juices were filled into cans, while the clear juice was put into bottles where it showed to best advantage. Figure IX shows a comparison of the clarity of the three types of juice as prepared in these experiments.

Cooking time of one-half hour at 190 degrees Fahrenheit was found sufficient for sterilization of a 16 ounce can or a 12 ounce bottle. The temperature of 190 degrees Fahrenheit caused less flavor change in the product than a temperature of 212 degrees Fahrenheit,
Figure VIII. Dried Prune Beverages.

Left - Juice treated with Pectinol W
Right - Untreated juice
Figure IX. Dried Prune Beverages
Left - clear  Center - cloudy  Right - pulpy
and for that reason it was used.

Examination of Dried Prune Juice for Mold

It was thought that during the soaking period of from six to ten hours mold might grow and be present in excessive quantities in the juice, especially in those juices which were not filtered clear. Examination was made of many samples by the Official Method of the Association of Official Agricultural Chemists (1:190), using the Howard mold counting cell. In the samples there were none where over one per cent of the fields were positive. The conclusion drawn was that the hot water poured over the prunes at the beginning of the soaking period inhibited any mold growth during the six to ten hours before juice was made up and bottled.

Yield. From 100 pounds of dried prunes the approximate yield was 100 pounds of the cloudy or clear infusion. There was left about 200 pounds of refreshed prunes which may well be utilized in the manufacture of pulp, as will be considered later.

Costs. At a price of three cents a pound, the prunes in the pulpy juice described above would cost 11 cents per gallon.

At the same price of three cents, the cloudy infusion would cost 25 cents per gallon. The clear is
about ten per cent higher due to added cost of clarifying and filtering. The cost of the two latter juices may seem high, but it must be remembered that we have assigned all the cost of the prunes to this product when in reality they will also be used in pulp or other manner.

**PITTED DRIED PRUNES**

Dried prunes for many years have been sold entirely in the unpitted state. This practice was maintained because the French prune cannot be pitted readily due to its adhering to the flesh. On the other hand, the Italian prune pit is comparatively free and can be removed without great damage to the flesh of the prune.

One of the great advantages of pitted prunes is in packing and shipping. There is an average of 15 per cent of the weight removed from the prunes when they are pitted, as shown by Table IV (2:4).

<table>
<thead>
<tr>
<th>Size</th>
<th>Pits %</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/30</td>
<td>12.62</td>
</tr>
<tr>
<td>30/40</td>
<td>14.14</td>
</tr>
<tr>
<td>40/50</td>
<td>15.90</td>
</tr>
<tr>
<td>50/60</td>
<td>17.48</td>
</tr>
<tr>
<td>60/70</td>
<td>20.03</td>
</tr>
</tbody>
</table>
Recently there has been developed a prune pitter* which has been used very satisfactorily in this study. The pits were removed completely and left the flesh of the prune whole and in good condition as in Figure X, which shows a typical sample. It was necessary to process the prunes in boiling water for one to two minutes to soften them to the center before removing the pit. As they were hot they were packed directly into boxes without further processing.

DRIED PRUNE PULP

A good grade of dried prune pulp finds many uses, especially in the bakery trade where it is used in bread, cake, and pastry. It was best prepared by running pitted prunes through a suitable grinder. It was necessary in some cases to soften the prunes by steaming just previous to pulping. This gave a very stiff pulp which may be diluted by the consumer if necessary.

A thinner pulp was prepared by using prunes from which the soaking liquor had been drawn off to make the infusion mentioned earlier. The texture of this was varied by changing the size of the openings in the

* Elliott Machine Company, Los Angeles, California
Figure 10. Dried Prunes Machine Pitted After Drying.
screen through which the pulp was forced; large openings gave coarse pulp and small openings fine pulp. This pulp-making operation fitted in with the making of the infusion mentioned earlier by using prunes from which some flavor had been removed.

From 100 pounds of completely refreshed prunes, at least 80 pounds of pulp was obtained in all trials. The yield of the very stiff pulp made by grinding pitted prunes was almost 100 per cent of the ingoing weight.

To preserve the thinner pulps (any with less than 50 per cent soluble solids), it was necessary to seal them in tin or glass containers and sterilize. The thick pulp kept very satisfactorily if poured hot into an unparaffined barrel. The pulp should completely fill the container to prevent the possibility of mold growth. In addition, either the thin or thick pulps may be frozen as a means of preservation.

HALVED DRIED PRUNES

This product, which shows considerable promise, is prepared by splitting and pitting the prunes before drying. This method of treatment has several advantages which are enumerated below.
1. Shipping costs are reduced. There is no necessity of paying freight on the pits, which amount to ten to 20 per cent of the total weight of the prunes, as shown in Table IV on page 36.

2. Drying time is reduced.

3. Capacity of a dryer is increased.

4. Preparation, or refreshing time, is reduced.

5. The flavor is more natural and better.

6. The product is much more attractive in appearance.

Before trials of this product could be made on a semi-commercial scale, it was necessary to design and build an experimental machine to split the prunes in a suitable manner. After consideration of several types of machines the following was decided on as most satisfactory and an experimental model was built.

The prunes were carried in single file on a split "V" belt, which took them between two rotating, circular, stainless steel knives. These knives were placed, as shown in Figure 11. Both rotated in the same direction so that their circumferences, as the prune met them, were travelling in opposite directions. The rotation was such that a prune was first given a forward thrust by the top knife and at the same time
Figure 11A. View of Prune Halving Machine looking down on belts and knives.

Figure 11B. View of knives of prune halving machine showing their relative position.
it was partly encircled. The bottom knife, travelling at a slower speed, retarded the thrust of the prune and completed the encircling of the pit. Generally then, the two halves fell apart and continued along the belts into a storage pan. Here the pits were removed by hand and the prunes loaded directly on trays for drying. It was found that fully matured prunes were most suitable for they are much more free of the pit than are green or unripen prunes.

This first model was hand-fed, that is, the prunes were placed on the belt by hand. In future models a hopper feed is anticipated which will greatly increase the efficiency of the machine. Even with the present model, 100 pounds of fresh prunes were run in about 20 minutes with two women feeding and two more to remove the pits and tray the prunes. An additional duty of the women is to remove all prunes which exhibit any indication of brown rot or other imperfection. Thus the prunes when dried should be of the highest possible quality. The labor cost for this amounted to about 40 cents per hundred pounds of fresh prunes.

In making a comparison of drying time as compared with whole prunes, care was taken to have similar conditions prevailing. Standard practice is to spread
about 30 pounds of fresh prunes on a tray. Taken as equivalent to that was 25 pounds of pitted halves. The usual drying temperature is 170 degrees Fahrenheit, but in drying split halves the temperature was maintained ten degrees lower at 160 degrees Fahrenheit. Despite the lowered drying temperature, the split halves dried in eight hours. This compared very favorably with 24 to 26 hours which is required to dry whole prunes. The gain is principally in the drying time and not in the total amount of heat to dry the prunes, as the same amount of water must be evaporated from the halved prunes and the whole ones, requiring about the same total quantity of heat. If the halved prunes dry in one-third the usual time, three times the normal quantity of heat must be produced during that period. The shortening of the drying time is due to the greater permeability of the freshly cut surface of the halved prune as compared with that of the prune skin, even after the skin has been lye dipped and checked.

To summarize, the capacity of a dryer may be tripled when halved pitted prunes are dried if the moisture removing capacity of the dryer is sufficient. Because the time is shortened and temperature is lower, the prune retains almost all of its fresh character-
istics, even the color of flesh and skin. No lye or hot water dipping is necessary and thus the skin retains a high gloss. Figure 12 shows some split dried prunes, illustrating the high gloss surface and the light color of the flesh.

Even as the drying time was reduced with halved prunes, so was the refreshing time. Instead of the long soaking and simmering required of whole prunes, the author has often prepared halved prunes in ten to 15 minutes. The flavor is excellent, appearance is much like fresh prunes, and the halves are more conveniently handled and eaten.

This product seems to offer a promising means of stimulating prune consumption. The cost of removing the pits does not exceed savings in drying and shipping costs. The product is more attractive and easier to prepare as evidenced by reception accorded samples which were distributed throughout the community.

**Canned Prepared Split Prunes**

These prunes were also prepared as follows and marketed in ready-to-serve form. A pint glass jar was found to be convenient and attractive and contained:
Figure XII. Dried Prunes Which Were Halved and Pitted Before Drying.
6 ounces halved dried prunes
13 ounces water
2.5 ounces sugar

If more convenient a 16 per cent sugar solution may be added to fill the jar. The jar was then exhausted, sealed, and cooked one-half hour at 212 degrees Fahrenheit. The split prunes refreshed very readily and no soaking or hot blanch was needed, except a very short one to cleanse the prunes of foreign matter.

FRESH PRUNES

Although this investigation has been concerned largely with dried prunes, there is also a need for new products which will utilize small or low-grade fresh prunes. Such a program would increase the returns to the grower by paying him for fresh fruit, which is at present a total loss. Some products have been developed during this investigation which offer considerable promise.

FRESH PRUNE JUICES

Small fresh prunes which are not suitable for canning or drying may be used advantageously to make fresh prune juice. A very satisfactory product is a
pulpy fresh prune juice of the type which is called a "nectar" by the industry.

**Pulpy Fresh Prune Juice**

Prunes were heated (with a small amount of water to prevent sticking) just enough to draw the color from the skins. This temperature was from 140 to 145 degrees Fahrenheit. While heating they were agitated or stirred to break them somewhat. Too much heating was objectionable as it destroyed all the fresh flavor and substituted a cooked flavor. While still hot the prunes were run through the fine screen (0.02 inch or smaller) of a finisher, blended with water and sugar and immediately bottled. Speed was important to a good quality product as prolonged exposure to air darkens the product excessively. From 100 pounds of fresh prunes, 75 pounds of pulp was obtained to which was added 37 pounds of water plus sugar to raise the soluble solids to 18 per cent. This was a very palatable drink and had rich red color. It was necessary to shake or stir it before serving.

Processing time was one-half hour at 190 degrees Fahrenheit for 12 ounce bottles.
Cloudy Fresh Prune Juice

A smooth fresh prune juice which is cloudy but without sediment is a product which is not very satisfactory either from the flavor or production standpoint.

Prunes were heated to draw color from the skin and in this heating much of the gummy, pectinous matter was also withdrawn from the prune. It was very difficult to press fresh prunes because this gummy material clogged the pores of the filter cloth. The yield of this juice was always less than 50 per cent. Quality was low as regards flavor and body, although color was quite favorable. More work is necessary to find a means of eliminating the viscous body and poor flavor of this juice.

Fresh Prune Pulp

This product was prepared as described above under pulpy prune juice except that a coarser screen was usually used to give a pulp with somewhat more character. As with the other pulp, it must be handled rapidly to prevent oxidation and darkening of the product with accompanying loss of flavor. Various mixtures were made of pulp and sugar in ratios of 4:1, 3:1, and 2:1. The most satisfactory ratio was 4:1.
This mixture is suitable for use as ice cream, milk shake, sherbet, or similar product flavoring.

Fresh prune pulp should be packed in sealed full containers and frozen. Processing adds a cooked flavor and destroys the "freshness" of the pulp. The yield from 100 pounds of fresh prunes was about 75 pounds of prune pulp with soluble solids content of from 18 to 21 per cent.

FROZEN PITTED PRUNES

Fresh prunes were run through the halving machine mentioned earlier, pitted, mixed with sugar in ratio of 4:1 and frozen in 30 pound cans. It was found necessary to add sugar to prevent excessive oxidation during freezing. This pack consisted of symmetrical halves and was especially suitable for bakery, hotel, or home use when symmetrical halves were desired.

When neat halves were not especially desired another machine was found very suitable. This machine, described in an earlier section, was loaned to the Food Products Industries Department by the manufacturer. This device was very fast and efficient in removing pits and although the prune was somewhat torn, this was not detrimental for many uses.
CHAPTER IV

SUMMARY

1. The Italian prune industry of Oregon and Washington is faced with the continued prospect of surpluses, both in fresh and dried prunes. By-products and new markets offer means of utilizing the excess of these crops.

2. Canned prepared dried Italian prunes present a high quality product which requires no long preparation in the home. This is supposed to overcome the objections to the long preparation usually found necessary with traditional methods of handling dried prunes. These should be canned as described in this report.

3. A means of utilizing small or off-grade prunes in dried prune beverages shows much promise of commercial development. Especially favorable is a pulpy beverage made by adding sugar and water to fine, smooth, dried prune pulp. Other beverages were made by leaching flavor and sugar from dried prunes.

4. Pitted dried prunes offer a new means of marketing prunes with a saving in freight costs. A machine has been developed recently which will pit Italian prunes in a very satisfactory manner.
5. Dried prune pulp offers promise as an ingredient in fountain, ice cream, and bakery products. It may be prepared from small or low-grade prunes. The texture or smoothness of the pulp may be varied to best fit the purpose for which it is to be used. The thickness (concentration) of the pulp is governed by the amount of refreshing of the prunes.

The term low-grade or off-grade as used here means food that is wholesome, but for some defect of size or shape is not suitable for standard grades. In no case should prunes affected with mold or brown rot be used in any by-product.

6. Halved dried prunes which are split and pitted before drying offer savings in freight costs and drying time which more than offset the cost of halving and pitting. A machine to do this has been developed during this investigation. These prunes, due to lower temperature and shorter time of drying, retain some desirable characteristic of fresh prunes. Also, they may be prepared for consumption in a very short time. Consumer trials indicate a very favorable response to these halved dried prunes.

7. Small or off-grade fresh prunes also lend themselves well to some by-product uses. Fresh prune
pulp, although more difficult to prepare than dried prune pulp, offers a promise for use in ice cream, fountain, and bakery products.

8. Pulpy beverages made from fresh prune pulp plus water and sugar are very appetizing and worthy of commercial trials.

9. Fresh prune juice is very difficult to obtain by pressing, due to the thick syrupy nature of the juice which is obtained. Yields are often very low. More work is needed to develop this product.

10. Fresh prunes were pitted and frozen with added sugar to make a very satisfactory product.
CHAPTER V

CONCLUSION

It is the firm belief of the author that the solution of the problem of surpluses lies in the development of new fields of distribution and new products. This investigation, while not complete, does offer suggestions which should be of benefit to the prune industry of the northwest.

The Italian prune, because of its nature, is much better suited to use in the products mentioned than is the French prune. For that reason these new products should be in a class by themselves and have little or no competition from the other variety.
BIBLIOGRAPHY


8. Western Canner and Packer, Yearbook and Statistical Number, 1937, May 1937.