FOUR YEARS OF CITRUS PRODUCTS RESEARCH IN FLORIDA*

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In January, 1932, the Citrus Products Station of the U. S. Department of Agriculture at Winter Haven started its projects on the utilization of citrus fruits unsuitable for fresh fruit market because of size or color, and to devise means for recovering by-products from cannery waste. Four years have passed, and several of the products and methods evolved in the laboratory are now in commercial production.

Before passing on to describe the present state of the citrus by-products industry in Florida, it would be of interest to briefly mention the current condition of this industry in California. There, the California Fruit Growers Exchange has two large by-products plants, one at Ontario for orange products, and one at Corona for lemon products. During the 1933-34 season the gross "dollar sales" for all commodities of the orange by-products plant at Ontario were $922,126.00. At the close of the year's business it had $280,-799.00 cash on hand with no notes or other term obligations outstanding. In 1930, at the peak of prosperity, sales aggregated $1,129,366.00.

Past achievements form the most dependable test of the possibilities inherent in co-operation between scientific research and the citrus industry. The following paper will tell briefly some of the results, already obtained, in finding uses for citrus by-products through this alliance of science and industry.

PRESERVATION OF ORANGE JUICE

The packing of orange juice in Florida has been increasing since 1932 (Fig. 1); but is increasing to an even greater extent in California. At the present time it may be said there is no known commercial method for either canning or bottling orange juice to yield a product which will have an aroma and taste exactly like the fresh juice. Similarly, there is no known commercial method at the present time for canning pineapple juice, grapefruit juice, pears, apricots, peaches, asparagus, beans, spinach, milk, etc., which will give a product tasting exactly like the fresh commodity. But it is entirely possible to can all these foods so they will be acceptable to a majority of the people.

In the case of orange juice, researches have shown that a different technique is necessary than is now used for the preservation of prapefruit juice. It is generally believed, and there is much scientific evidence to substantiate this opinion, that the presence of air is detrimental to good keeping qualities of canned orange juice. Prolonged heating, especially in the presence of air, not only has an adverse action upon the taste of the juice, but may seriously reduce the vitamin C content.

Favorable results have been obtained in the laboratory by extracting the juice by slow reaming, then immediately exosing the reamed juice in a thin film to a high vacuum to remove the dissolved air as completely as possible. The de-aerated juice is next pumped through a pasteurizer which consists of a stainless steel (18-8) flattened pipe mounted in a suitable steam jacket. Here the juice is exposed to a temperature of about 200° F. for about 5 seconds, filled into the containers at 175° to 180° F., sealed and rapidly cooled.

From results obtained in the Federal laboratory, and similar results have been found by workers in other laboratories, it has been shown that de-aerated and flash pasteurized orange juice has a more satisfactory taste if packed in bottles or so-called "citrus enamel" cans rather than in plain tin cans. The juice does not possess the full flavor and aroma of fresh orange juice as we know it in Florida, but it is palatable and will retain its original taste for periods as long as nine months to a year if stored at about 60° F. Storage at higher temperatures shortens the keeping period, and if subjected to storage temperatures of 85°

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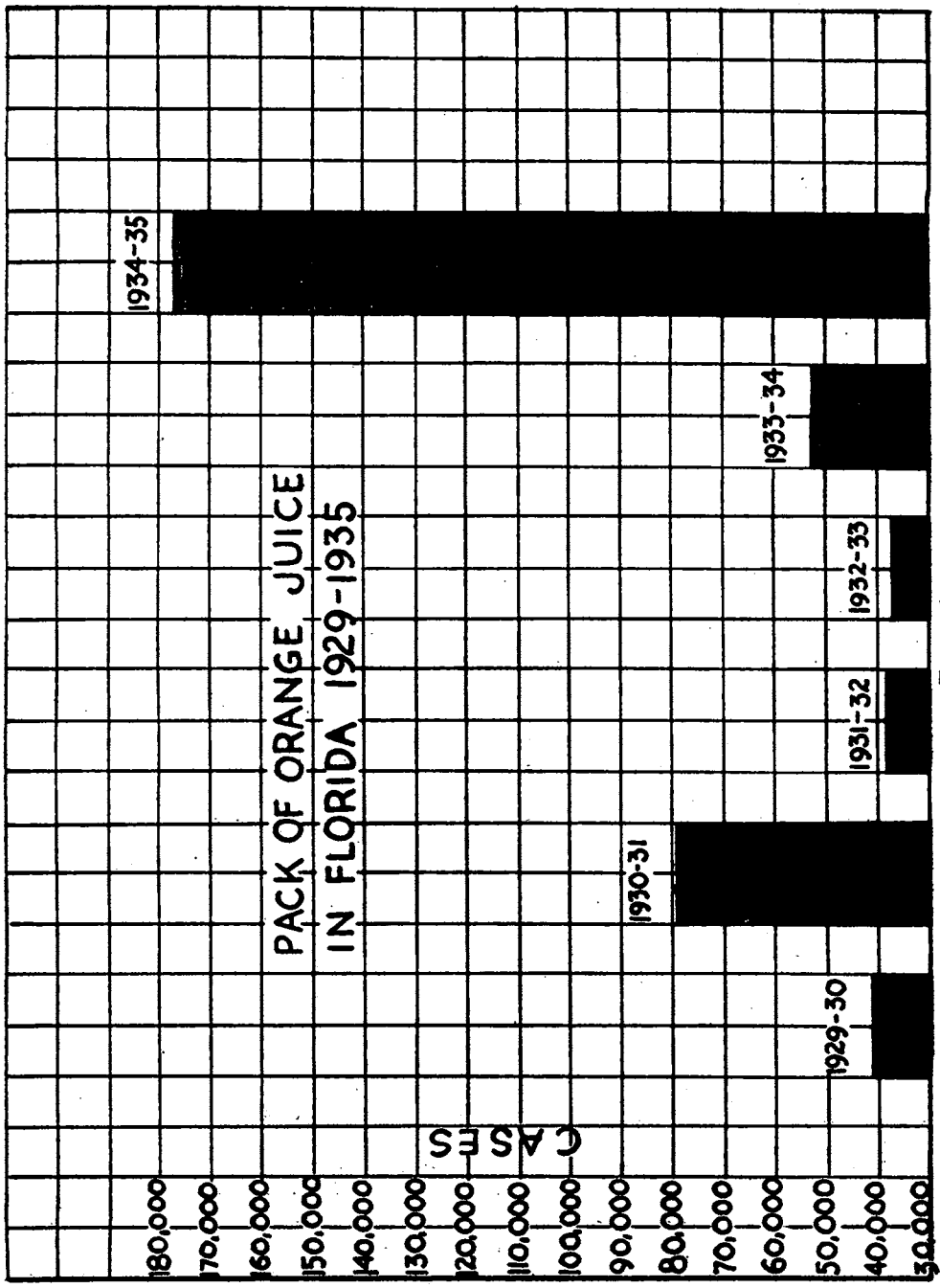
PACK OF ORANGE JUICE
IN FLORIDA 1929-1935
CASES
180,000
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
1929-30
1930-31
1931-32
1932-33
1933-34
1934-35

FIGURE 1

to 90° F. the juice will develop "off-flavors" in from 3 to 5 months. Full technical details of this work have been published elsewhere (1, 2), and therefore will not be discussed here.

Basing methods on results found in the Federal laboratory, an orange juice plant has been established on the West Coast of Florida. This plant is now packing orange juice in bottles, the present capacity of the plant being about 1,600 12-ounce bottles per hour. Figures 2, 3 and 4 show views in this plant. The latest equipment for the processing of orange juice is provided; the sanitary aspects of the procedure are rigidly observed; the floors and all equipment are flushed at least three times every 24 hours with hypochlorite, water and steam. We have been making weekly bacteriological examinations of the air in different parts of the plant, as well as of the juice before and after pasteurization. In this manner we hope to obtain data relative to the biological side of the commercial production of orange juice, when processed according to the newer knowledge of food technology.

A philosopher once said: "Be not the first to grasp what is new, nor the last to discard what is old." With this maxim apparently in mind, the more progressive canners of citrus juices in Florida are now installing de-aerators and constructing flash pasteurizers. The method has been used in California for several years and more recently in Arizona and Texas. In the latter State modern canning of grapefruit juice has increased tremendously this season (1935-36).

Another development in the preservation of orange juice is the so-called "dairy orange concentrate." This product is made by either concentrating orange juice under a high vacuum and adding sugar, orange oil and citric acid or lemon juice, subsequently canning and processing, or by merely adding sugar to orange juice until the proper consistency is obtained, along with citric acid or lemon juice, then canning and processing. A detailed discussion of this product has been published elsewhere (3).

It is the usual practice for the dairy to add about 5½ gallons of water and 5 pounds of sugar to each gallon of concentrate to obtain the finished beverage as dispensed to the consumer. These dairy orange beverages should not and cannot replace orange juice in the dietary. The vitamin C content of such beverages is extremely low when compared to fresh orange juice. Thus, an 8-ounce glass of fresh orange juice contains 2,500 vitamin C units, while an 8-ounce glass of dairy orange beverage contains but 200 units.

In passing, it should be pointed out that some dairies are now dispensing fresh orange juice in milk bottles, handling the juice in the same manner as fresh milk (4). Such dairies rarely dispense orange juice that has been reamed from the fruit more than 24 hours previously, and in most cases the juice is less than 24 hours old when received by the consumer. Such juice would, of course be equal to freshly prepared juice in food value.

Beverage bases are prepared in a manner similar to "dairy orange concentrate." A certain amount of the concentrate is added to each bottle, followed by carbonated water. The finished beverage never contains more than 15 per cent. actual fruit juice, rarely over 10 per cent. Since these beverages are consumed mainly to gratify thirst, or as an ingredient of highballs, their food value is of little import. A carbonated grapefruit beverage has been developed at the laboratory, and this product has now been put on the market by a large bottling concern in this State.

CITRUS OILS

The production of essential oil in Florida from the peel of oranges and grapefruit has increased during the past three years. A few canners are now extracting orange oil from the residual peel, but such extraction is not carried out on as large a scale in Florida as in California. The yield of orange oil averages from 5 to 8 ounces per 100 pounds of peel, depending upon the method of extraction, that of grapefruit oil somewhat less. Nelson and Mottern (5) of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture have made an investigation of the chemical and physical properties of Florida orange and grapefruit oils. Nelson has also studied the composition of Florida tangerine oil (6). In this connection he has isolated a pentamethyl flavonol not hitherto found in a natural product, nor has it

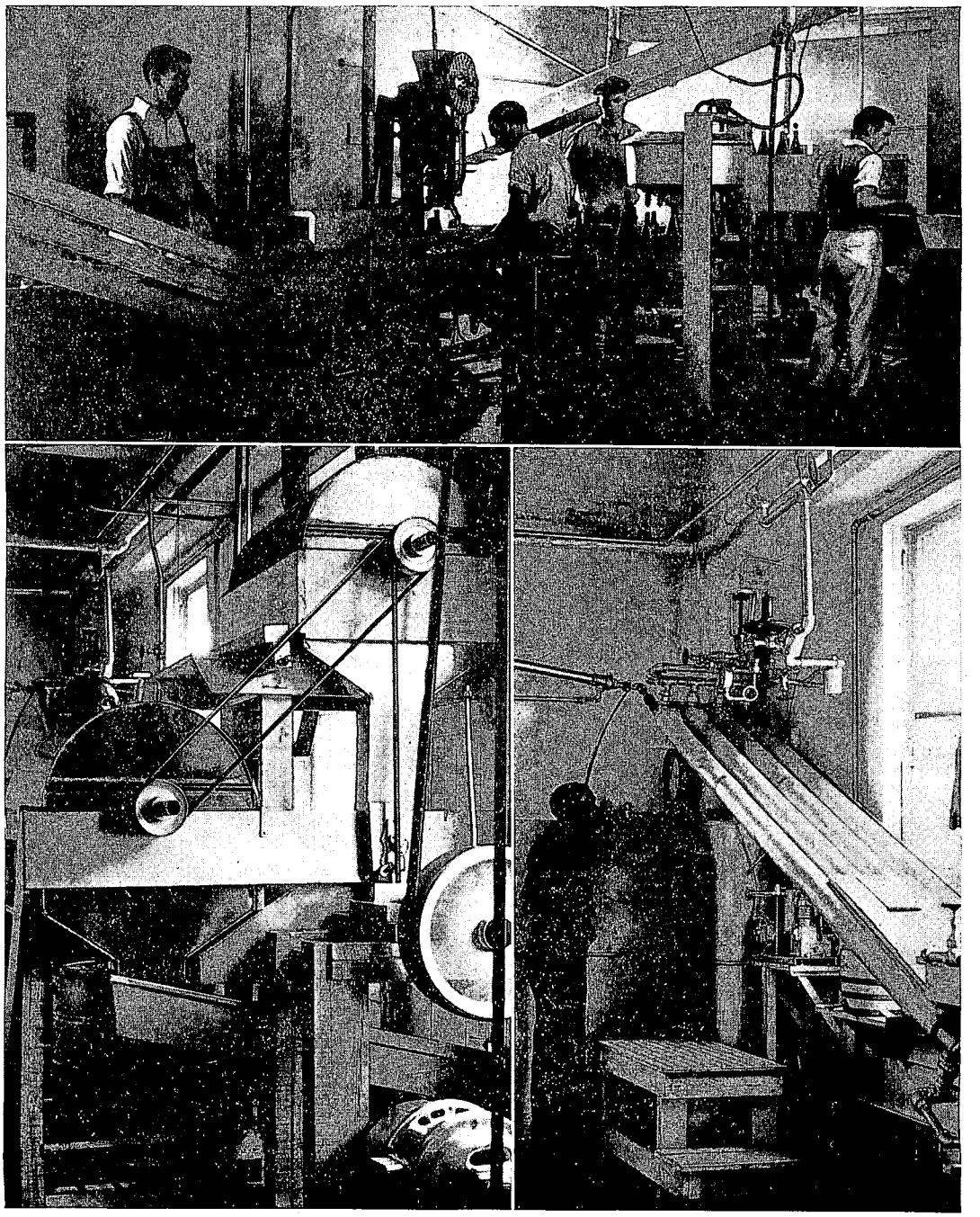

FIGURE 2. Rotating screens for screening orange juice. The pulp is separated from the juice by a continuous operation. (See lower left.)

FIGURE 3. Commercial installation of a pasteurizer for flash pasteurizing orange juice. (See lower right.)

FIGURE 4. Bottling de-aerated and flash pasteurized orange juice. Automatic filler is shown at the center; capping machine at the left. Bottle sterilizer may be seen in the background. (See top picture.)

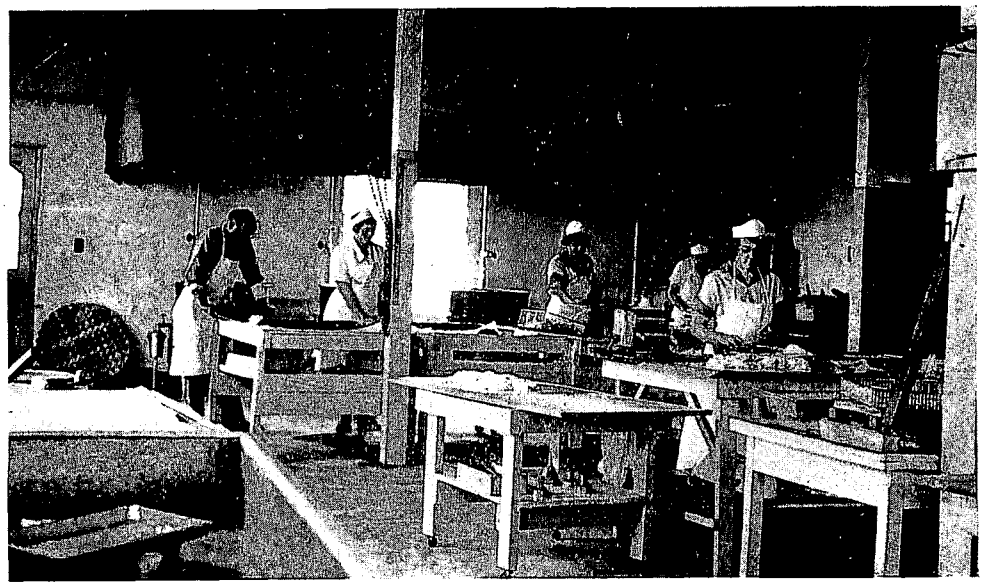

FIGURE 5. View in a citrus candy plant.

FIGURE 6. A Florida Citrus Winery.

ever been elsewhere described. He has therefore named it "tangeretin" (7).

The peel oils are used chiefly in extracts and other flavoring preparations.

The seeds of both oranges and grapefruit contain appreciable quantities of a fatty oil. Because of the comparative ease which grapefruit seeds can be collected from the canneries, preliminary studies of grapefruit seed oil have been made at the Federal station at Winter Haven. The oil can be refined giving a palatable product free from any objectionable bitter taste. It is now believed this oil may have a place in industry, and northern interests have erected a small plant for the extraction of grapefruit seed oil.

CANDIED CITRUS PEEL

Although citrus peel has been candied for some time, there are still problems in this field which must be solved through adequate technical knowledge. This is especially true where factory production amounts to 10,000 or more pounds of peel a year. Here the manufacturer is confronted with situations not met with were he processing small batches only during the fruit season. For example, there is the problem of darkening of the candied peel, premature hardening while in the hands of the retailer, unfavorable changes brought about by the microorganisms during storage in warm weather, and, what is most important, economic production. We have concerned ourselves with all these problems, co-operating with manufacturers when they have requested our aid (Fig. 5).

ALCOHOLIC BEVERAGES

More recent studies at the Station have dealt with the possibilities of manufacturing citrus wines, cordials and brandy (8, 9). When the work was first started Federal regulations rendered economical commercial production of these products impossible. These regulations have now been changed so that the citrus wine maker and distiller is governed by the same laws as the grape wine maker and grape brandy distiller (10). At the present time there are approximately six active citrus wineries in the State; none of these is as yet making brandy or fortified wines (Fig. 6).

It is much more difficult to make a satisfactory wine and brandy from citrus fruits than from grapes. The technique for citrus wines is different: the greatest caution must be exercised to prevent contamination by foreign microorganisms, the temperature of fermentation must be rigidly controlled, and the use of pure cultures of wine yeast is indispensable. Two main errors seem to be inherent in commercial citrus wine making in Florida: the insistence of adding excessive amounts of sugar, and the reluctance to use pure yeast cultures. Excessive amounts of residual sugar, failure to adequately control the temperature of fermentation and failure to use pure cultures almost invariably result in a wine lacking proper bouquet and exhibiting poor keeping qualities.

Citrus wines do not possess an aroma and taste that could identify them with the fruit of origin. Whether such a wine can be prepared remains to be seen. If properly made they have a pleasing bouquet. If improperly fermented they are nauseatingly sweet with a medicinal odor. Excessive quantities of aldehydes and esters as well as acetal may be present, the latter substance resulting from the imperfect oxidation of alcohol or from the reaction between alcohol and acetaldehyde. We have found indications of acetal in orange wine which had been fermented at high temperatures and without the use of a pure yeast culture. Since acetal is a hypnotic its presence in carelessly prepared wines may account, in part, for the vertigo and headache complained of by some even though they have partaken moderately of citrus wines.

Perhaps fortified citrus wines offer greater possibilities than the light wines containing 13 per cent. alcohol. Fortified citrus wines are prepared by the addition of citrus brandy to the wines to increase the alcoholic content to 18 or 20 per cent. According to law orange brandy must be used to fortify orange wine, and grapefruit brandy to fortify grapefruit wine. After fortification, the wine is baked at about 125° F. for 60 to 90 days. This gives a product with a sherry-like flavor.

Brandy is prepared by distilling properly fermented orange or grapefruit juice. Distillation must be carried out with care or the product will have a "fiery" taste which aging will never ameliorate. This "hot" taste is due in part to aldehydes

and in part to a fatty substance as yet unidentified. The latter body may be partially removed by chilling the brandy, which throws the oil out of solution, and then filtering. However, if properly distilled the amount of this fatty substance would probably be too low to be of any consequence.

The economic production of alcoholic citrus beverages depends mainly upon the price of raw materials. In years of short crops their production would not be as profitable as in years of heavy crops. Furthermore, brandy can be prepared from a much poorer grade of fruit than can be used for wine. Satisfactory brandy can be made even from certain parts of cannery waste. A field box of fruit, assuming 4.5 gallons of juice per field box, will yield about one gallon of 90 proof brandy, or about 5 gallons of wine containing 13 per cent. alcohol by volume.

We should remember it was 31 years after the discovery of cocaine that it was first used as a local anesthetic in surgery of the eye. It was 68 years after nitrous oxide (laughing gas) was discovered by Priestley that it was introduced as an aid in surgery, and 18 years elapsed after Guthrie discovered chloroform that it was used as a general anesthetic. Twelve years passed after the discovery of vitamin C before it was finally isolated in its pure form from lemon juice. In carrying out the successful synthesis of indigo the Badische Company spent nearly five million dollars during 17 years of research before a pound of synthetic indigo had been sold.

Thus, it is essential that we remember all research is slowly developed and that the application of such results to practical problems is even more slow. Our citrus research progresses, and we believe that the industrial application of our work progresses even faster.

During the World War the Y. M. C. A. issued many valuable booklets. In the foreword of one of these the following little thought, which we might all carry with us, appeared: "To accomplish anything worth while a vision and a program are necessary; he who has only a vision is visionary; he who has only a program is a drudge. He who has both vision and program is a conqueror."

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